UNIVERSITY OF SUSSEX

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# THE PROCESS OF AGRICULTURAL TECHNOLOGY GENERATION IN BRAZIL: A SOCIAL AUDIT

by

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I hereby declare that this thesis has not been submitted, either in the same or different form to this or any other University for a degree.

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**UNIVERSITY OF SUSSEX**

**Manoel Moacir Costa Macêdo** **Doctor of Philosophy**

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## SUMMARY

The focus of agricultural technology studies in Brazil has been on technology diffusion or adoption. This approach stresses the neutrality of technology and its adoption depends on farmers' psychological and individual values. The agricultural technology generation process and the organisations in which technology is generated have not been considered as active factors. This thesis regards both as highly significant in farmers' adoption or rejection of technology. Approaches to development, modernisation and underdevelopment, along with agricultural globalisation, are the applied theoretical perspectives used to understand what happens in the underdeveloped countries in an integrated world system. This is an *ex-post facto* and *cross-sectional* study. The empirical data, based on a case study, was collected in Brazil, in and around the Brazilian Agricultural Research Organisation (EMBRAPA), a top-down state-owned organisation.

Agricultural technology generation, its adoption, as well as the attitudes of users, clients, policy-makers, politicians and unions to the agricultural technology generation process were investigated. The fieldwork was conducted with eighty-seven agricultural researchers from four national agricultural research centres, one hundred and forty-four farmers, and eighty individuals and organisations' representatives. Qualitative and quantitative analyses indicated that the agricultural technology generation process is related more to scientific issues than to farmers' demands. The technology adopted by farmers was determined primarily by developments within the process of technology generation rather than through any persuasion. The thesis concludes that as a result of the process of technology generation in EMBRAPA, organised and capitalist farmers have been targeted rather than small or subsistence farmers. Therefore, the new *farm as a whole* research model is recommended, which explores the whole production system rather than specific agricultural products.

## CONTENTS

**Chapter 3. Politics, Class and Agricultural Research Organisations**



**Chapter 4. The Formation of EMBRAPA**



**Chapter 5. Agricultural Technology, Researchers and Society**

## List of Appendices

## List of Abbreviations

| | |
|---|---|
| **AAO** | Organic Agricultural Association |
| **AAU** | Agricultural Administration Unit |
| **ABCAR** | Brazilian Rural Credit and Assistance Association |
| **ABEPA** | Private Technical Assistance Association |
| **ABRA** | Brazilian Agrarian Reform Association |
| **ACB** | Christian Association |
| **ACC** | Rural Community Support Association |
| **ACI** | International Co-operation Adviser |
| **ACS** | Social Communication Adviser |
| **AID** | Agency for International Development |
| **AJU** | Law Adviser |
| **ANOVA** | Analysis of Variance |
| **ASBRAER** | Brazilian Rural Extension Association |
| **ASP** | Parliamentary Adviser |
| **ASSOCENE** | North-east Co-operatives Advisers Association |
| **ATA** | Technical and Administrative Adviser |
| **AUD** | Internal Audit Adviser |
| **BR** | Brazil |
| **BS** | Bachelor of Science |
| **CE** | State of Ceará |
| **CEASA** | Central Vegetable Market |
| **CEBRAP** | Brazilian Planning Centre |
| **CEDLA** | Centre for Latin American Research and Documentation |
| **CDR** | Centre for Development Research |
| **CEPLAC** | Cocoa Executive Plan Commission |
| **CERES** | EMBRAPA and EMBRATER Systems Social Insurance Foundation |
| **CGIAR** | Consultative Group on International Agricultural Research |
| **CIMMYT** | International Centre for Maize and Wheat Improvement |
| **CNA** | National Agricultural Confederation |
| **CNEPA** | Agricultural Research and Teaching National Centre |
| **CNPA** | Cotton National Research Centre |
| **CNPAF** | Rice and Beans National Research Centre |
| **CNPC** | Goat National Research Centre |
| **CNPH** | National Vegetable Research Centre |
| **CNPMA** | National Research Centre for Monitoring and Assessment of Environmental Impact |
| **CNPO** | Sheep National Research Centre |
| **CNPq** | National Research Advisory |
| **CNPSo** | National Soya bean Research Centre |
| **CO** | West - Central |
| **CODEVASF** | São Francisco Valley Development Company |
| **CONTAG** | Agricultural Workers' Confederation |
| **COOPERTINGA** | Agricultural Co-operative of the Piratinga Region |
| **CPAC** | *Cerrados* Agricultural Research Centre |
| **CPPSUL** | South Agricultural and Husbandry Research Centre |
| **CTA** | Technical Centre for Agricultural and Rural Co-operation |
| **CTAA** | Agricultural Food Technology Centre |
| **CTI** | Internal Technical Commission |

| | |
|---|---|
| **DAP** | Personnel Department |
| **DATER** | Rural Extension and Technical Assistance Department |
| **DDT** | Technology Diffusion Department |
| **DEP** | Project and Studies Department |
| **DF** | Federal District |
| **DID** | Information and Documentation Department |
| **DIN** | Computer Department |
| **DNOCS** | National Department For Drought |
| **DNPEA** | National Agricultural Research and Experimental Department |
| **DOD** | Organisation and Development Department |
| **DOF** | Finance and Budget Department |
| **DPD** | Diffusion and Research Department |
| **DPE** | Agricultural Research and Experimental Department |
| **DPEA** | Agricultural Research and Experimental Department's Organisational Structure |
| **DPL** | Planning Department |
| **DPU** | Publication Department |
| **DRH** | Human Resources Department |
| **DRM** | Material Resources Department |
| **DTC** | Scientific Technical Department |
| **EBDA** | The Agricultural Development Company of the State of Bahia |
| **ECLA** | The United Nations Economic Commission for Latin America |
| **EMATER** | Rural Extension Agency |
| **EMATER-DF** | Federal District Rural Extension Agency |
| **EMBRAPA** | The Brazilian Agricultural Research Corporation |
| **EMBRATER** | The Brazilian Technical Assistance and Rural Extension Organisation |
| **EMGOPA** | The Goiás Agricultural Research Company |
| **EMPA** | The Mato Grosso Agricultural Research Company |
| **EPAMIG** | The Minas Gerais Agricultural Research Company |
| **EPE** | Experimental and Research Office |
| **ESALQ** | Luiz de Queiroz Agricultural Superior School |
| **EU** | The European Community |
| **FAO** | The Food and Agriculture Organisation of the United Nation |
| **FAPESP** | São Paulo Foundation for the Promotion of Scientific Research |
| **FASER** | National Federation of Association and Unions of Rural Extension Workers |
| **FBTF** | Farm-Back-to-Farmer |
| **FEBRABAN** | Brazilian Bank Federation |
| **FETAG** | Agricultural Workers' Federation |
| **FIBGE** | Brazilian Geography and Statistics Institute |
| **FINEP** | Brazilian Federal Agency for Financing Studies and Projects |
| **FGV** | Getúlio Vargas Foundation |
| **FPR** | Farmer Participation Research |
| **FSR** | Farming Systems Research |
| **FSR/E** | Farming Systems Research/Extension |
| **GATT** | General Agreement on Tariffs and Trade |
| **GDP** | Gross Domestic Product |
| **GO** | State of Goiás |
| **GPR** | Cabinet of Presidency |
| **IAA** | Sugar and Alcohol Institute |

| | |
|---|---|
| **IAN** | Northern Agricultural Institute |
| **IANE** | North-eastern Agricultural Institute |
| **IAO** | Western Agricultural Institute |
| **IAPAR** | Paraná Agricultural Research Institute |
| **IARC** | International Agricultural Research Centre |
| **IAS** | Southern Agricultural Institute |
| **IBA** | Animal Biology Institute |
| **IBAI** | Imperial *Baiano* Agricultural Institute |
| **IBC** | Brazilian Coffee Institute |
| **IBGE** | Brazilian Geography and Statistics Institute |
| **IBRD** | International Bank for Reconstruction and Development |
| **IDB** | Inter-American Development Bank |
| **IDS** | Institute of Development Studies |
| **IE** | Economics Institute |
| **IFAI** | Imperial *Fluminense* Agricultural Institute |
| **IFARD** | International Federation of Agricultural Research Systems for Development |
| **IFPRI** | Food Policy Research Institute |
| **IICA** | Inter-American Agrarian Sciences Institute |
| **IIED** | International Institute for Environment and Development |
| **IITA** | International Institute of Tropical Agriculture |
| **IMF** | International Monetary Fund |
| **INCRA** | National Agrarian Reform and Colonisation Institute |
| **INP** | National Industrial Research Institute |
| **INPES** | Economic and Social Planning Institute |
| **INPI** | National Industrial Property Institute |
| **INRA** | National Agricultural Research Institute |
| **INSS** | National Social Security Institute |
| **IPEA** | Applied Economy Research Institute |
| **IPEAO** | Western Agricultural and Experimental Institute |
| **IPEAOc** | Western Amazon Agricultural and Experimental Institute |
| **IPEACS** | Southern - Central Agricultural and Experimental Institute |
| **IPEAO** | Western Agricultural and Experimental Institute |
| **IPEAL** | Eastern Agricultural and Experimental Institute |
| **IPEAN** | Northern Agricultural and Experimental Institute |
| **IPEANE** | North-eastern Agricultural and Experimental Institute |
| **IPEAME** | Meridian Agricultural and Experimental Institute |
| **IPEAS** | Southern Agricultural and Experimental Institute |
| **IRRI** | International Rice Research Institute |
| **ISNAR** | International Service for National Agricultural Research |
| **ITAIPU** | International Paraguay River Hydroelectric Power |
| **ITR** | Rural Property Tax |
| **IZ** | Zoology Institute |
| **JICA** | Japanese International Co-operation Agency |
| **MA** | Master of Arts |
| **MCT** | Ministry of Science and Technology |
| **MERCOSUR** | Southern Common Market |
| **MS** | State of Mato Grosso do Sul |
| **MSc** | Master of Science |
| **MST** | Landless Workers' Movement |
| **MT** | Mato Grosso |

| | |
|---|---|
| **MVs** | Modern Varieties |
| **N** | North |
| **NAFTA** | North American Free Trade Agreement |
| **NAPP** | Small Production Support Nucleus |
| **NARS** | National Agricultural Research Systems |
| **NE** | North-eastern |
| **NGOs** | Non-governmental Organisations |
| **NI** | Percentage of People Without Income |
| **OCB** | Brazilian Co-operatives Organisation |
| **OCDE** | Organisation For Economic Co-operation and Development |
| **ODA** | Overseas Development Administration |
| **ODI** | Overseas Development Institute |
| **OFCOR** | On-Farm Client-Oriented Research |
| **OVEBASA** | Bahia Plant Oil |
| **PAB** | Brazilian Agricultural Research Journal |
| **PAPP** | Northeastern Small Farmer Support Program |
| **PB** | State of Paraíba |
| **PE** | State of Pernambuco |
| **PFL** | Liberal Front Party |
| **PhD** | Doctor of Philosophy |
| **PI** | State of Piauí |
| **PIN** | National Integration Program |
| **PMDB** | Brazilian Democratic Movement Party |
| **PNAD** | National Domicile Survey Plan |
| **PND** | National Development Plan |
| **PNP** | National Research Program |
| **POLOAMAZÔNIA** | Amazon Agricultural and Mineral Polo Program |
| **POLOCENTRO** | West-Central Development Program |
| **POLONORDESTE** | North-east Integrated Areas Development Program |
| **PRODAECER** | Japanese-Brazilian Co-operative Program for *Cerrados* Development |
| **PROFIR** | Financing Irrigation Equipment Program |
| **PRONAPA** | National Agricultural Research Program |
| **PROPLANTA** | Technical Private Assistance |
| **PROTERRA** | Land Redistribution and North and North-east Agricultural Industry Program |
| **PROVALE** | São Francisco River Valley Special Programme |
| **PR** | State of Paraná |
| **PRA** | Participatory Rural Appraisal |
| **PSDB** | Brazilian Social Democracy Party |
| **PT** | Workers' Party |
| **PTB** | Brazilian Labour Party |
| **RJ** | State of Rio de Janeiro |
| **RN** | State of Rio Grande do Norte |
| **RS** | State of Rio Grande do Sul |
| **S** | South |
| **SAES** | American State Agricultural Experiment Stations |
| **SAF** | Federal Secretariat of Administration |
| **SCPA** | Agricultural Co-operative Research System |
| **SE** | South East |
| **SEA** | Strategic Planning Secretary |
| **SEP** | Research and Studies Department |

| | |
|---|---|
| **SER** | The Rural Extension Secretary |
| **SIBRATER** | Brazilian Rural Extension and Technical Assistance System |
| **SINPAF** | National Agricultural and Forestry Research's Employees Union |
| **SNA** | National Agricultural Society |
| **SP** | State of São Paulo |
| **SPI** | Information and Publication Secretary |
| **SPRU** | Science Policy Research Unit |
| **SPSB** | Basic Seed Production Service |
| **SRB** | Brazilian Rural Society |
| **SSE** | State Systems Secretary |
| **STI** | Industrial Technology Secretariat |
| **SUDENE** | North-eastern Development Superintendency |
| **SUPRA** | Agrarian Reform Superintendency |
| **TC** | Thurstone's Coefficient |
| **TCU** | Union Account Tribunal |
| **TNCs** | Transnational Companies |
| **TOT** | Transfer of Technology |
| **UDR** | Rural Democratic Union |
| **UEPAE** | State Agricultural Research Unit |
| **UNB** | University of Brasília |
| **UNICAMP** | University of Campinas |
| **URU** | Uruguay |
| **US** | United States |
| **USAID** | United States Agency for International Development |
| **USP** | University of São Paulo |
| **WTO** | World Trade Organisation |

## List of Tables

## List of Figures

I dedicate this thesis

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# CHAPTER 1

# INTRODUCTION

## 1.1. General Introduction

Studies of agricultural technology have been dominated by the research of Rogers [1962], Rogers and Shoemaker [1971] and Hayami and Ruttan [1971]. These theorists concentrate on the transfer, diffusion and adoption of technology rather than the social, political and economic contexts of its generation where behaviourism and induced innovation are the prevalent perspectives. Yet there remains an enormous disparity between the agricultural technology generation process and its adoption by farmers. Technology is not neutral and agricultural technology generation is a function of social contradictions. The agricultural technology generated by a state organisation is open to external and internal influences. From this perspective, this thesis proposes an examination of the agricultural technology generation process and its implications for social and economic development, focusing mainly on the relationship between the agricultural technology generation process and its adoption by farmers. Pretty [1995: 27] argues that 'rarely do scientists, policy makers and extensionists question the technologies and the contexts that have generated them. Rather they blame the farmers, wondering why they should resist technologies with such 'obvious' benefits'.

An important point to make is that constraints arise from within society and from the values inherent in the scientific research process itself. Busch and Lacy [1981] argue that virtually all research decisions appear to be the result of complex influences, some of which are internal to science and some of which external. In a similar way, Kim and Sagast [1979], in analyzing the role of science and technology, suggest that the context within which science and technology policies have been formulated has been isolated from economic, social, cultural and political influences at both national and international levels. Moreover, according to Biggs [1990: 1481] the activities of agricultural technology generation cannot be separated from the adoption and diffusion of technologies. Giddens [1995: 68] suggests 'a given form of technology might be associated with varying types of social organisation, and vice-versa'. On the other hand, Eisenstadt [1987] emphasizes that modern technology and modernization have to be seen as one specific type of civilization which originated in Europe and which, since the Second World War, has spread its economic, political and ideological influence over most of the world.

In this thesis, modernisation and underdevelopment theories form the theoretical background to the role of agriculture in the global economy. In the contemporary world, technological innovation constitutes the central characteristic of development where modern society is synonymous with Western society. In contrast to modernisation, underdevelopment theory is one of the critical frameworks used in the Western development model which is diffused to the Third World countries. In the global economy, some countries and groups have clearly gained, and many - perhaps most - societies are better off than they were before. That said, there have been losers, and the gaps between rich and poor have often increased - even though many of the poor are better off than they were before.

The research strategy of the thesis was based on case studies. Empirical data on the agricultural technology generation process were collected within EMBRAPA (the Brazilian Agricultural Research Organisation) in two different regions. In the North-east (the poorest region) two national research centres were surveyed. The first was the Cotton National Research Centre (CNPA) - cotton is an industrial product, and the second, the Goat National Research Centre (CNPC) - goat meat is a domestic food. In the South (a rich region), two national research centres were also sampled: the Soya bean National Research Centre

(CNPSo) - Soya bean is an industrial and export product and the Sheep National Research Centre (CNPO) - sheep meat and skin are for the industrial and the external market. Moreover, information was collected on the influence that the agricultural technology generation process has on farmers and also on the attitude of users, policy-makers, unions and politicians towards the agricultural technology generation process itself.

The case studies outlined above provide the framework for a *social audit* of the agricultural technology generation process. In the thesis, the term *social audit* is not used in its conventional sense, which embodies a wide range of definitions and procedures. Conventionally, social audits were initiated in the 1970s by American companies, and they are linked to 'social accounting', 'social needs' or 'social report'. In one conventional definition, a social audit 'develops measures of social performance for individual corporations and industries'[1]. From this perspective, Blake et al state that a social audit

> is defined as a systematic attempt (an orderly and planned series of studies) to identify (an inventory of an organization's social activities), analyze (analysis of the accumulated social data), measure (if possible), evaluate (the goals and norms), and monitor (a continuing organizational commitment to conduct period reviews '...' shifting norms or goals '...' and administrative rules. [1976: 2-5].

In the same vein, Frankel [1978: xi] describes a social audit as a study of 'environmental and workplace pollution'. According to him a social audit 'is designed to help workers and other members of the public find and understand information about hazards from industry; and, having understood it, be able to appreciate, question, and if necessary protest at

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[1] For example, Bauer and Fenn [1977], *Corporate Social Audit;* Medawar [1978], *The Social Audit Consumer Handbook: A Guide to the Social Responsibility of Business to the Consumer;* Garrett [1986], *Developing State Audit in Britain;* Walker and Walker [1987], *Growing Divide: A Social Audit, 1979-87;* Medawar [1992], *Power and Dependence: Social Audit on the Safety of Medicines;* Saunders [1995], *Capitalism: A Social Audit* and Parik and Thorbecke [1996], *Impact of Rural Industrialization on Village Life and Economy: A Social Accounting Matrix Approach.*

the actions of [those] responsible for controlling hazards on our behalf'. Haughton remarks that

> in essence [social audits] involve an examination of the costs and benefits of a company's activities in the broader social context, including factors such as health, safety and pollution '...' social audits [also] provide a useful tool for analysing the community impacts of decisions to close, cut back, open or expand facilities involving significant numbers of jobs. By incorporating elements of economic, social, environmental and opportunity costs they can extend the costing base of impact analysis '...' [including] the employment repercussions [1987: 255-256].

Percy-Smith [1992: 29] also suggests that a social audit is a particular 'assessment of the impact of policy on social needs and which can act as a vital counter-weight to narrower techniques of policy evaluation'. In Percy-Smith's views, a social audit is a vital component in the policy process and 'has clear application to all areas of policy where needs already play some part in resource allocation, in particular housing, health and social services'. For Aronson and Lofgren [1996] a social audit is also a form of social accounting which leads to 'welfare measurement in an economy where human capital is an important factor'.

However, the *social audit* proposed in the thesis is not used in the conventional meaning. First, it distinguishes between the bureaucratic-centred proposals and the economic cost-benefits analyses which comprise administrative and technical audits respectively. Secondly, it focuses on the implications of the social, organisational and scientific influences on the agricultural technology generation process and the consequences for the technology generated. Thirdly, such a *social audit* includes the connection between technology generation and adoption processes and technology's social role for those representatives interested in agricultural technology in society. In these terms, a *social audit* deals with the agricultural technology generation process as a social practice achieved by agricultural researchers in a state-owned research organisation.

In the context of this research, a *social audit* concentrates on an organisation which is dependent on government funds and open to society's influences. Thus, the technology generated is a result of the influences of the researcher, the organisation and society. First, there are the influences of the researcher's background, including education, training processes and social origins. Secondly, there are organisational influences, such as recruitment, training, research priorities, careers and the hierarchical and bureaucratic structures which make up a top-down organisation. Thirdly, there are external influences acting upon the organisation and the researchers, such as the pressure from political and social movements, interest groups, funding donors and the economic orientation of society.

In addition, the *social audit* also embraces the association between the technology generation and adoption processes. This means that the adoption of technology by farmers is not only a function of the communication between research organisation and farmers. It is also a function of the agricultural generation process. The technology is generated under social, political, economic and organisational constraints which define the preferential targets of the generation process and consequently the technology generated. Also, these constraints lead to the connection between the technology generation process and the incorporation of the technology into the farmers' production systems.

A *social audit* also refers to the attitude of those social actors associated with agricultural technology, especially the ones involved in the decision-making process: the ministers, politicians and governmental organisation managers. There are also those identified as users and clients (small and large farmer's organisations and rural extension agencies) and other critical and informal bodies, such as unions and non-governmental organisations. The important point is to understand the links between the interests of these social groups and the organisation where the agricultural technology is generated.

EMBRAPA has had many economic evaluations of the technology generated, focusing exclusively on losses and gains in monetary terms. These related to research using standard cost-benefit analysis, employing conventional micro-economic models, here referred to as 'technical audits'. In addition, there are 'administrative audits' which deal with administrative procedures and bureaucratic controls. Neither approach concentrates on the social implications of agricultural technology generation and adoption.

Administrative audits include the internal and external audits. They address the fulfilment of legal procedures both at EMBRAPA headquarters and in the research centres. On the one hand, the internal audits are carried out by the advisory unit (AUD) attached to the EMBRAPA executive. AUD inspects the use of the operational rules in the centralised (departments and advising units) and in the decentralised units (research centres). For instance, it focuses on the application of financial resources, the control of materials, human resources norms and other administrative and bureaucratic matters. This internal audit does not follow a regular schedule; the timetable depends on EMBRAPA executive demands. However, normally the units are audited at least once a year. The internal audit outputs are the 'confidential reports' (the audit internal reports) which reveal to the EMBRAPA administration the state of the units from an administrative point of view. This is useful feedback for EMBRAPA executive decisions.

On the other hand, the external audit is carried out for the *Tribunal de Contas da União* (TCU) which, although a state institution, is independent of the government. It is attached to the Parliament and its members, the 'counsellors', have the same status as state

Ministers. The TCU constitutional mission is the fulfilment of federal laws by state organisations. It also examines the constraints faced by these organisations (budget constraints, human resources shortage, etc.) when performing its activities. As with the internal audit, the external one does not follow a rigid calendar, but depends on the government, Parliament and the TCU demands. The results of the external audit are sometimes confidential but occasionally are made public. These reports[2] are delivered to the governmental or parliamentary spheres. TCU can suggest administrative or criminal penalties.

The so-called 'technical audits' are evaluations of EMBRAPA technologies made by agricultural economists and statisticians. They use micro-economic methods (the benefit-cost ratio[3] or the internal rate of return) applied to the assessment of the technology generated, independent of the technology generation process itself. The 'technical audits' methodology deals with the simulation of models taken from mathematics which measure the economic returns of the technological production factors, such as capital intensive technologies in specific agricultural products.

'Technical audits' have been widely adopted by EMBRAPA[4]. They are important tools which demonstrate in scientific and sophisticated language the economic importance of

[2]Tribunal de Contas da União (TCU)[1991], *Relatório de Auditoria Operacional na EMBRAPA.*
[3]Chambers [1988: 6-7], *Normal Professionalism and the Early Project Process: Problems and Solutions,* notes that the cost-benefit analysis 'has difficulty accounting for losers from development projects, and often they are the poorer, and unseen and unheard '...' [the cost-benefit analysis] appears to be what it is rarely, if at all: an objective scientific procedure impartially carried out'.
[4]For example, the works by Cruz et al [1982], *Taxas de Retorno dos Investimentos da EMBRAPA: Capital Físico e Investimentos Totais*; Ávila et al [1983], *Formação do Capital Humano e Retorno dos Investimentos em Treinamento na EMBRAPA;* Cruz and Ávila [1985], *Retorno dos Investimentos da EMBRAPA em Pesquisa na Área de Abrangência do Projecto BIRD I;* Cruz [1987], *Transferência Inter-Regional de Ganhos de Produtividade da Terra e Política Tecnológica para a Agricultura;* Barbosa, Cruz and Ávila [1988], *Benefícios Sociais e Econômicos da Pesquisa da EMBRAPA: Uma Reavaliação;* Kitamura et al [1989], *Avaliação Regional dos Impactos Socio-econômicos das Pesquisas da EMBRAPA;* Lanzer et al [1989], *Avaliação Sócio-econômica das Pesquisas da EMBRAPA na Região Sul;* Santos et al [1989], *Avaliação Sócio-econômica das Pesquisas da EMBRAPA na Região Nordeste;* Teixeira et al [1990], *Avaliação Sócio-econômica das Pesquisas da EMBRAPA na Região Centro-Oeste;* Relatório da Missão de Avaliação Global da [1992], *Workshop de Avaliação*; Souza et al [1993], *The Measurement and Assessment of Quality in*

EMBRAPA technologies. They are often an efficient means of disseminating technology performance through journals and magazines and provide a powerful instrument for supporting the *status quo* of EMBRAPA. The economic findings (for example, economic profitability, gross margin analysis and return of technological and financial investments) are collected from the agricultural technology trials carried out in the experimental stations where the real risks of technology generation and adoption are not considered. In the 'technical audits' approach, technology is a 'neutral' factor of production, useful for all types of farmers and social differentiation is not considered.

By focusing on the social audit, and on the social and other influences on the process of generating agricultural technology and its adoption, this thesis is markedly different in approach from other forms of social, administrative and technical audit. It is a new approach, and one which has been applied specifically to EMBRAPA.

### 1.2. From Modernisation and Underdevelopment to Globalisation

In the era after the Second World War, new economic and political activities emerged; old economic and political powers changed and the world order was re-designed. On the one hand, western capitalism led the extension of capitalism over large areas of the world. On the other, communist regimes were also established. Moreover, other events throughout this century such as the First and Second World Wars, the International Economic Depression of the 1930s, the First and Second Oil Shocks in the 1970s and 1980s and the collapse of Socialism at the end of the 1980s consolidated what became known as the New and Old International Economic Orders, the New and Old International Division of Labour and the New and Old International Division of Power.

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*Agriculture Research Institutions*; EMBRAPA [1994a], *Pesquisa Agropecuária Consequente* and EMBRAPA [1994b], *Produtividade da EMBRAPA*.

As a result, new political and economic trends took over. The period following the Second World War consolidated the 'belief that science was important, not only for winning wars, but in holding the key to future economic development' [Gibbons et al, 1995: 132]. The political conflict between the two world systems, the capitalist and the communist regimes was highlighted. This was known as the *Cold War* era. Colonial countries became nation states under the capitalist or communist wing, and the competition between the two ideologies had great social, political and economic consequences.

In addition to the *Cold War,* there remained divisions between the rich and poor worlds. For Worsley [1995: 83], the term Third World was a product of the *Cold War,* an epoch in which two superpowers dominated the world. Wallerstein [1995: 133] states that after the Second World War, western scholars invented development, invented the Third World and invented modernisation. In truth, although various countries transformed from colonies to nation states, they remained dependent on the communist or the capitalist mandate. According to Giddens [1985], the nation state's origin is linked to 'modernisation, colonisation and decolonisation'. From this perspective, Webster [1990: 45-50] states that the modernisation theory created by western scholars focused on the Third World.

Modernisation theory dominated the international scene in the 1960s and proposed that the developmental trajectory would be driven from the western diffusionist strategies to the poor, previously colonial countries. For Giddens [1991: 63 and 175], 'modernity is inherently globalising', or in other words 'one of the fundamental consequences of modernity is globalisation'. Harrison [1988: xiii] 'writes that modernisation is the result of a process of 'westernization', involving economic, political, social and cultural changes which contrast with the previous 'traditional' stability. In the same vein, Eisenstadt [1987: 1-5] argues that modernisation originated in the West and that in the nineteenth and early twentieth centuries, the major emphasis was on the uniqueness of modern western society.

The central idea of modernisation is that the process of development is a consequence of particular attitudes and values, rather than structural reasoning enacted through capitalist expansion. Traditional societies are characterised by individual, religious and kinship values oriented to the past, whereas in modern society individuals are influenced by rational, universal and utilitarian motivations. Modernisation has its roots in the ideas of Emile Durkheim's social differentiation, Max Weber's rationalisation of society, Pearson's social differentiation as having a specific evolutionary direction and Rostow's analysis of economic growth.

Rostow's [1968] argument is that the diffusion of modern science and technology from the developed western countries to the poor countries, is an influential and determining element for economic 'take-off'. In fact, Rostow's contribution to modernisation theory went beyond the realm of modernisation theory since it was a political and ideological concept. For Wallerstein [1993: 219], Rostow's view represents the liberal ideology of the political leadership of the United States and its western allies.

In this thesis, modernisation is considered to be the evolutionary trajectory of the underdeveloped countries, especially since their traditional organisations and individuals moved from the traditional to the modern or rational. The innovation, transfer and diffusion of technology, from Western countries to poor, backward ones is the main strategy. Eisentadat [1966] mentions the unequal and weak level of internal modernisation in Latin America. The oligarchic elite mirrored European life-styles and focused economically on landownership and other professional values. Also, Goodman and Redclift [1991: 140] illustrate that Latin American modernisation strategies led to 'dichotomous patterns of income, productivity and innovation between sectors producing domestic staples and those specialising in exports, industrial raw materials and luxury food crops'.

In reality, the global economy is unbalanced and unequal with respect to underdeveloped countries and reproduces the interests leading to the accumulation of capital, to intensive competition and to the private control of technology by the advanced western countries. Development (the shift from underdeveloped to developed status), needs deep structural transformations at the level of the production, distribution and consumption of wealth. The adoption of the strategies suggested by modernisation theory have not resulted in the desired development, or in accordance with Rostow's [1968] model, the Third World countries have not reached the economic 'take-off' stage.

Modernisation theory has been criticised, among others by Wallerstein [1993], Frank [1969 and 1971], Webster [1990], and Bauzon [1992], who state that the concepts linked to the paradigm of modernisation do not take into account the historical and structural reality of underdeveloped countries. Ruttan [1996: 60] also remarks that 'many sociologists and historians began to view modernity not as an emancipation from tradition but as the destruction of tradition'. Further, the distinction between traditional and modern is not sufficient to classify societies, so modernisation theory has not explained the developmental model adequately

The purpose of this thesis is to analyse the process by which the values of modernisation, especially in the Western agricultural research model, have been diffused to backward and underdeveloped countries, one example being Brazil. This is particularly important since the Brazilian agricultural technology research process has mirrored the concept of modernisation. The European research institute in the Brazilian imperial era signalled the first manifestation of agricultural research. In the 1970s, during the rule of the military dictatorship rule in which the agricultural modernisation program was consolidated, the model chosen was that of the International Agricultural Research Centre (IARC).

During the 1960s, Latin American scholars presented an alternative view of what was considered the backwardness of the Third World. A theoretical argument was developed to explain the unequal terms of exchange between developed and underdeveloped countries, known as dependency theory. The United Nations Economic Commission for Latin America (ECLA) propagate the idea of *import substitution* as a strategy to achieve industrial development across Latin America (for example in Brazil, Mexico and Argentina). For Prebisch [1963], there was an ancient and unequal price exchange between primary commodities and manufactured products on the international market across Latin America. As a consequence, agricultural exporting countries were condemned to poverty and underdevelopment. Prebisch indicates various internal and external determining factors that cause this inequality, for example, poor agricultural productivity and high land concentration.

Furthermore, other theoretical approaches - the so-called world-system theory, the 'urban bias', and 'putting the last first' proposals were also developed. All sought to understand inequalities in the world economy and the lack of development in the Third World. According to Harrison [1988: 62], all were considered a part of underdevelopment theory. Harrison also states that development and underdevelopment are seen as opposite sides of the same process: development in one region occurs only at the expense of underdevelopment in another [1988: 150].

Underdevelopment theory suggests that a country's backwardness is not a consequence of its internal organisation, or even its incapacity to reproduce the Western experience. There are instead structural constraints such as social class stratification, technology dependency, capital accumulation, international debt and income and land concentration, all of which take their place in an integrated world system where there are winners and losers. The system's parts are linked to a pattern of international trade that is characterised by ***unequal exchange***. Thus, underdevelopment is better explained by reference to the structural position of Third World societies and its organisations in the global economy rather than by modernisation theory.

From this perspective, Cardoso and Faletto's [1977 and 1985: 22] dialectical analysis of structural dependency, shows how the internal and external processes of political domination took place in the Third World and how the inter-relationships between classes and the State at the internal and external levels are addressed. In their view, the dependency approach must be interpreted in light of the historical and structural context of, for example, Latin American countries. They [1985: 22-23] still argue that the capital concentration of transnational companies and the monopolisation of science and technology in the international metropolis are important issues in analysing dependency. The peripheral economy, which is the primary commodity producer, is maintained as a dependent economy. Cardoso [1973] calls this system 'associated-dependent development'.

The most famous underdevelopment theorist, Frank [1992], believes that the idea of a dual society is false and that the policy recommendation to which it leads will, if acted upon, serve only to intensify and perpetuate the very condition of underdevelopment it is designed to remedy. Metropolis-satellite relations are not limited to the imperial or international level but penetrate the very economic and social structure. He argues that the Third World elite was incorporated into international trade through economic activity in the metropolis.

As with Frank, Dos Santos [1970] argues that the expansion of the big imperialist centres around the world is a factor in domination. He says that 'dependency means a situation in which the economy of certain countries is conditioned by the development and expansion of another economy to which the former is subjected'. This means that the insertion of underdeveloped countries into the international division of labour is determined by international pressure from the hegemonic centres. Dos Santos emphasises that technological and industrial dependency was established in the post second world war period, as a new type of dependency based on multinational corporations which look to invest in industries and in the internal markets of undeveloped countries.

Although dependency theory gained a high reputation all over the world, it could not explain Third World backwardness. Aquino [1990: 31] says that underdevelopment theories are criticised, for among other things, their excessive emphasis on exchange and spatial relations rather than on production or class relations. In a similar way, dependency theory is also criticised for its lack of development solutions to the various problems in the Third World and for its irrelevance to the African and Asian continents. The asymmetrical dependency framework analysis of the relationships between rich and poor countries called for change and for new arguments.

Social scientists from the structuralist and dependency schools sought to explain the inequality in the world, particularly the social and economic gap between developed and underdeveloped countries, through the so-called world-system theory. This theory works at the world economic level and is based on the dynamics of the division of labour at the core, periphery and semi-periphery states. According to Wallerstein [1993: 221], the capitalist world-economy works through long cycles of expansion and contraction.

Although the world-system approach adopted many explanations of previous developmental theories, Amin's [1974 and 1976] concept of the global accumulation of capital creating peripheral capitalism was central to it. Further, in his concept of periphery (unevenness in productivity between sectors) and core (integrated industrial structures) definitions were addressed as well. Moreover the world-system used Frank's [1992] concept of core and periphery countries. However, Wallerstein [1993: 220] argues that the concepts of development outlined by social thinkers from Latin America during the 1960s have a critique of the developmental perspective in common and do not use empirical arguments to identify countries in line with that classification. In general, the world-system perspective sees the modern world as a capitalist world-economy which has been emerging historically since the sixteenth century.

According to Wallerstein [1995], the important factor in the world-economy theory is the state's structure. Waters [1994: 315] remarks that 'the state helps to stabilise capitalism by absorbing its costs and managing the social problems which it creates.' By the same token, Giddens [1991: 70] writes that 'the main centres of power in the world economy are capitalist states - states in which capitalist economic enterprise (with the class relations that this implies) is the chief form of production'. Wallerstein [1995] states that the world-system comprises of three type of states:

> First, the core states, which have the control and domination within the system. They are rich and advanced states. Secondly, the peripheral states, which have weak linkages within the system. They are poor and dependent on the core states. Thirdly, the semipheripheral states, which encompass intermediate levels of technology and are dependent on the core states '...' the semiperiphery is needed to make a capitalist world-economy run smoothly '...' this semipheriphery is then assigned, as it were a specific economic role, but the reason is less economic than political.

Like modernisation and dependency theories, the world-system theory could not explain the deep causes of poverty and backwardness in Third World countries. Strong criticisms of the world-economy theory have been made on these grounds. For instance, Worsley [1995: 87-88] disagrees with the existence of only one single world-system, and suggests there are enormous differences (beyond economic issues) between the First World and the communist countries. Robertson and Lechner [1985] criticise the world-system theory for its economic focus. Sklair [1991: 33-34] writes that the world-system theory neglects class struggle analysis and that the idea of a semi-periphery is an artificial invention to describe those cases that are not appropriate to the core-periphery argument.

However, according to Lipton [1977, 1991 and 1993], the roots of the persistent penury of people living in the Third World countries are not distinct from social class conflicts, or even from the confrontation between foreign and national interests. The principal reason for this poverty lies in the concentration of developmental priorities in urban society. In fact, it is the conflict between rural and urban class' interests that emerges as the primary factor. Lipton calls this historical bias the 'urban bias' theory.

In a narrower sense, Chambers [1989; 1993 and 1993a] calls this theoretical framework the 'new professionalism of development', and 'putting the last first', in order to explain poverty and social inequality. The focus is 'deliberately limited to rural poverty and to the Third World'. He distinguishes the following points as important for promoting social change: putting people first; decentralisation; enabling and empowering the poorer and weaker to value and work on what matters to them, and to learn from clients rather than always teach them. In Chambers' words 'when people are put first, and the poorer rural people first of all, it is more they who do the identifying and who set the priorities'. These are embedded in the

Farmer Participation Research (FPR) [Tripp, 1989; Farrington and Martin, 1993, Okali et al 1994 and Chambers, 1994a, 1994b and 1997] and Farming Systems Research (FSR) [Collinson, 1987; Norman et al, 1988; Byerlee and Tripp, 1988; Merril-Sands and McAllister, 1988; Tripp et al. 1990 and Cornwall, et al 1993] approaches.

Overall, underdevelopment theory argues that misery, poverty and deprivation in underdeveloped countries such as Brazil, are not a result of internal organisation, but of the social, political and economic restrictions of the production and the distribution of wealth in an integrated world system. In the global economy, Brazil remains a specialised producer of primary products (precious minerals and agricultural commodities) and an importer of Western technology and industrial products.

### 1.2.1. Technological Change and Diffusion

Modernisation and globalisation look at technological innovation as part of progress and of the transformation from a traditional to a modern society. Development, prosperity and wealth depend on complex factors which work beyond chronological issues; for instance, the role of technology in the global scenario and in economic growth. In this thesis, technology is assumed to be a relation of production embodied in social, cultural and political values. Technology is not neutral, but is intricately involved with ideological values. According to Wallerstein [1996: 84], 'scientific culture became the fraternal code of the world's accumulators of capital '...' it promoted technological innovation'.

Also, according to Nelson and Winter, [1977] and Dosi, [1982] technological development is selective and serves specific ends. Silverman [1983: 110] argues that technology is developed in organisations as socio-technical systems, whose objectives are 'inter-related with the environment' in which the 'organisation is located'. From this perspective, Pavitt [1995] shows that technological innovation has mostly benefited the countries in which the technologies were generated.

Diffusion and technology transfer in the global economy is neither a simple nor a recent phenomenon. Bell and Pavitt [1993: 157] believe that for an understanding of technological accumulation and technical change, it is necessary to emphasise that 'the basic processes of technological accumulation and technical change differ fundamentally between the agricultural and industrial sectors'. In this vein, Rosenberg [1985: 168] claims that 'the transfer of industrial technology is much easier than agricultural technology because industrial technology is at least very much self-contained'. The specific nature of agricultural technology diffusion is indicated by Evenson [1974], Janssen and Sannint [1991] and Thirtle and Ruttan [1985]. For them, agricultural technology transfer is complex and dependent on soil, climate and social circumstances.

In addition, Bell and Pavitt [1993: 158] comment that 'industrial technology is less location-specific than agricultural technology' and that underdeveloped countries could benefit much more from industrial technology diffusion than from the agricultural technologies generated and available in industrial and advanced countries. According to Pavitt [1984], agricultural technology innovation should be classified as a 'supplier dominated' sector. This means that the agricultural technological innovation is due to supplier industries, such as the input industries (fertilisers, seeds, pesticides, machinery and so on). On the other hand, Possas et al [1996: 934] mention that technology innovation is 'seen as a time sequence of progressive shifts of trade-offs between tech-economic variables, specific to a given technology, which indicate technological progress and which stem from innovative efforts of firms and institutions (including public ones)'. This thesis is concerned with the last approach, that is, the generation of the agricultural technology by a public research organisation as a factor of social change.

Thus, according to McMichael and Reynolds [1994], Third World agriculture and its insertion into the global economy depend on the generation of indigenous technology to support local demands and the adoption of 'standardised' technology from developed countries. This thesis is concerned with the first point. The aim is to demonstrate the association between agricultural technology generation and its adoption by farmers in Brazil. In this context, Bernstein [1994: 52] mentions that a central aspect of technical innovation in capitalist agriculture is to standardise its conditions of production and to reduce the variations, obstacles and uncertainties of natural environments and to bring farming closer to the ideal of control exercised in industrial manufacturing. Chambers for example [1986 and 1995], sees technology standardisation as 'a process of technology transfer in one direction, from rich and powerful to poor and weak, from first to last'.

According to Bell and Pavitt [1992: 259] and Parpia [1974], the transfer, accumulation and adoption of technological capability in developing countries depends on adequate facilities for research, development, training and the selection of appropriate technology. Investment in education and continuous growth in demand is also required. Freeman [1995] believes that 'whilst external international connections are certainly of growing importance, the influence of the national education system, industrial relations, technical and scientific institutions and government policies is fundamental'. The Third World lacks almost all of these requirements and as a result, underdeveloped countries fail to maintain a sustainable national system of technological innovation. Thus, the strategy in the short and medium terms is one of continuous technology dependency on the developed countries. Ray [1974: 12-13] suggests that the diffusion of technological innovation between western and underdeveloped countries could promote fast economic growth if western technological innovation and the speed of its diffusion encompasses features such as technical applicability, availability of finance, profitability and management attitudes.

In reality, technological development has been concentrated in the developed countries, mainly in the United States, Japan, and Europe. For Latouche [1996: 17], this means that Western science and technology have been a powerful instrument for the domination of Third World countries. These advanced countries have well-structured national research systems, well-trained scientists, high investment in science and technology and a strong private sector involved in technology innovation in the various fields of commodity production.

The importance of the private sector is that, 'in nearly all sectors, innovative activities increase proportionately with firm size amongst the world's biggest firms' [Patel and Pavitt, 1991: 101]. The largest firms are in the developed countries, mainly the United States. So small firms in undeveloped countries are unlikely to produce their own innovative technology and must rely on diffusion from developed countries. The technology trajectory from the developed to the underdeveloped countries has been traced in several ways. Freeman and Hagedoorn [1994: 778] emphasise that the most common strategies are through innovation, learning by learning, learning by doing, learning by using and catching up in the global market. From this perspective, Gibbons et al [1995: 112] state that 'the ability to transmit information cheaply and almost instantaneously throughout the world does not seem to lead to a more equitable distribution of scientific competence, but rather to its concentration'.

Also, in relation to agriculture in the global economy, Ruttan [1996: 57] emphasises that studies on agricultural technology diffusion in developing countries

> were stimulated by the emphasis on technology development and transfer by the United States Agency for International Development (USAID)[5] and other development agencies and by the return to developing countries of students who received Ph.D. training at American universities.

### 1.2.2. Globalisation and Agriculture

'Globalisation predates modernisation and modernisation in particular can permeate and dissolve boundaries between localities and political entities' [Waters, 1995: 145]. According to Halliday [1993], globalisation involves a broad and highly influential spectrum of factors across the world. Historical, political and strategic factors are moulded by globalisation. In Schuurman's views [1994: 42-45] 'the connotation attached to globalisation '...' is the thesis of cultural imperialism'. Schuurman emphasises that 'the people in the Third World are reduced to passive consumers of an identity imposed upon them by imperialist powers'.

In terms of the global economy, Friedmann and McMichael [1989: 105] believe the transnational restructuring of the agricultural sector was done in two ways. First, by the intensification of agricultural specialisation and the integration of specific crops and livestock into agro-food chains dominated by large industrial capital and secondly, by a shift in agricultural products from final use to industrial inputs for manufactured foods. For Le Heron [1993: 89 and 11], 'globalized agriculture is the product of capitalist forces '...' and represents a very broad field of production and consumption, reflecting the interplay amongst global

[5]The case of Brazil, Marighela [1971: 19-20], *For Liberation of Brazil,* remarks that 'the Education Ministry and USAID agreement has been implemented by the government to establish the US education system in Brazil and turn the universities into private organisations where only the rich can study'.

processes and local action'. Thus, according to Reynolds et al [1993] agriculture is a part of the process of capitalist expansion from the Northern to the Southern hemisphere countries.

It follows that, according to McMichael, [1994] in the so-called new world order, globalized agriculture is achieved through transnational companies (TNCs) and global trade operates from new bases, for example, powerful blocks, such as the EU (European Union) and NAFTA (North American Free Trade Agreement). Drucker [1994] argues that the capitalist domain of the advanced countries is based on the symbolic economy, that is, an economy without a boundary and nationality, without political ideology and without cultural and environmental constraints.

In the capitalist world system, capital flows all over the world in fluid and invisible ways. Its most clear expression can be seen in the powerful TNCs. They carry out technological innovation, exercise control of markets and establish new social values. They create and re-create the means of consumption, mainly in the Third World countries. They influence governments, parliamentarians and impose their priorities on them. At the same time, they are protected from outside interference. Normally, their headquarters are in the stable developed countries. Galbraith [1972: 15-16] says that in the industrial state order

> the corporations always maximise their pecuniary return, they are ultimately subordinate to the pecuniary commands of the market '...' and '...' the consumer and the citizen can be managed by those who, nominally, exist to serve him, then the revised sequence - a tendency toward producer instead of consumer sovereignty - becomes possible.

A positive view of TNCs is provided by Saunders [1995: 37-41], who argues that they are factors of growth and development rather than destabilisers of the economies and governments of the Third World. He believes that transnational companies 'bring new technologies, new management methods, training for local workers, and contracts for local suppliers. They boost foreign earnings by increasing exports, thus opening new domestic markets, they create jobs and they raise local wage levels'.

However, Bernstein [1988: 57-59] shows that technology and technical culture define a particular social status and lifestyle which satisfy specific needs. Thus, technologies are not neutral. Stewart [1978: xi-xii] maintains that Third World countries receive almost all their technology from the advanced western countries. This results in an over-dependency on technology. He explains that 'the technological neutrality view is inconsistent with the facts of economic development in poor countries, and '...' the technology that Third World gets from rich countries is inappropriate' for its requirements.

It is important to perceive the link between Western interests and the national agricultural technology generation system in the global economy. In this thesis, the Brazilian agricultural technology process co-ordinated by EMBRAPA (Brazilian Agricultural Research Organisation), as discussed in later chapters, is shown to be a part of the global system in two ways. First, it absorbs the Western technology embodied in educational training, consultancy, financial support, agricultural inputs and living standards. Secondly, the demands of the economic and organised groups, which are the transnational companies (for instance, the input enterprises) or the national elite (large agricultural farmers and agro-industrial complexes) are associated with international vested interests in a capital-intensive production system of specific export-led staples. Agricultural technology is standardised and transferred[6] as a technological package from the transnational companies' headquarters (normally in developed countries) to the underdeveloped countries in which the transnationals' branches are located.

[6]According to EMBRAPA [1991: 10], *Research for Sustained Development,* 'EMBRAPA has a wide scope of action in the area of international cooperation, first in terms of receiving knowledge from other parts of the world in order to use it in generating appropriate technology and later in transferring it to other countries, especially those of Central and South America and Africa'.

According to Busch [1991: 77], this suggests that transnational companies reduce the responsibility of national countries in relation to agriculture and agricultural research.

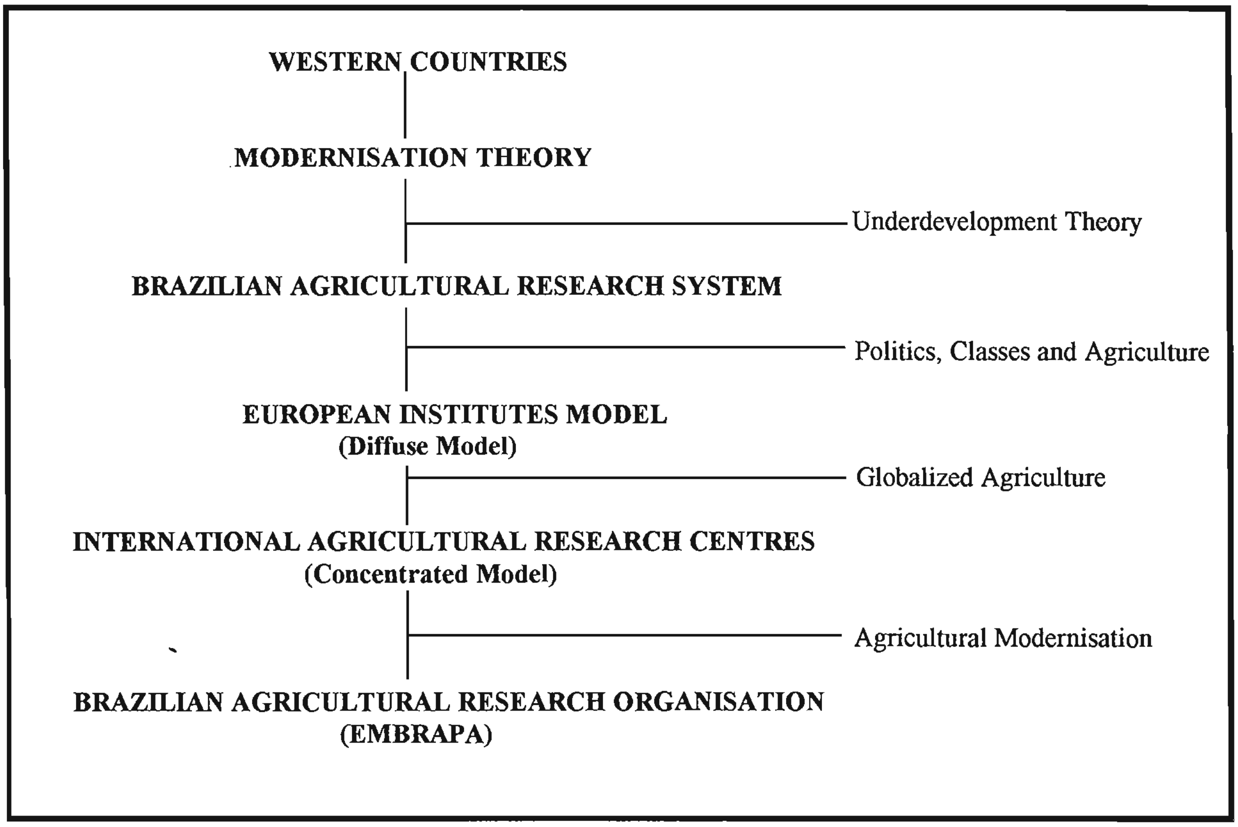
Beyond the transnational companies, two more international finance organisations come within the global economy, the International Monetary Fund (IMF) and the International Bank For Reconstruction and Development (IBRD), the World Bank created at the Bretton Woods conference in 1944. Both aimed to reconstruct the world after the brutality of World War II. They are organisations which are controlled by the advanced countries. Harris [1988: 311] remarks that the IMF and the World Bank are controlled by the United States and Western European countries.

Similarly, in the global economy agricultural aid to underdeveloped countries incorporates various political and commercial strategies in the form of finance, technology, and food itself. Behind apparently charitable aid lie vested interests. For example, Schuh and Norton [1991: 70-71] write that foreign aid has positive effects on poor countries' imports of American farm products. This means that American aid may create the dependency of poor countries on American commodities.

Also, analysing foreign aid after the GATT's Uruguay Round, Saw and Singer [1995] found that food aid programmes have seldom made a large or direct contribution to the alleviation of hunger and poverty. For them, 'the main objective of donors has been political or commercial, the aid has been subject to irregular timing, and there has been little or no programming of the generated funds'.

The overall theoretical framework related to the agricultural technology system in Brazil is summarised in Figure 1.1. Modernisation theory has discussed how Western countries have pursued their values mainly through technology diffusion[7]. Initially, throughout the nineteenth and early twentieth centuries, there was really only one model of development - Western Europe. It provided a model for others to follow.

**Figure 1.1 - The Theoretical Framework of Agricultural Technology Generation in Brazil**




Modernisation theory developed into the popular view and continues to provide the historical backdrop against which agricultural diffusion and development was encouraged over the period of EMBRAPA's existence. First, from the colonial era to the early seventies, the

[7]Hulme [1990: 324], *Agricultural Technology Development, Agricultural Extension and Applied Social Research,* shows that 'modernization theory indicated the main problems in modifying agricultural practices would not lie in the research process, largely controlled by people with 'modern' values, but in the dissemination process. Social and cultural obstacles to the adoption of new [technologies] and products could be anticipated in rural populations with traditional attitudes and conservative values'.

Brazilian agricultural research system had been modelled upon European institutes and secondly, from the seventies onwards, in the context of agricultural modernisation, the model followed was that of the International Agricultural Research Centre (IARC). In contrast to modernisation, underdevelopment theory had policy ramifications and was a critique of past policies, including those on globalised agricultural development, and a prescription for alternative policies which were developed by organisations as a socio-technical system.

**1.3. Purpose and Methodology**

The focus of this study is on the role of EMBRAPA which co-ordinates the Brazilian agricultural research system. EMBRAPA is responsible for the generation and promotion of scientific and technological knowledge in order to make possible the development of agriculture throughout the country. EMBRAPA's role will be discussed in detail later in the thesis. There has been no previous study in Brazil which involves the organisation, users, clients and policy makers of the agricultural technology generation process. In this study they are all seen as active factors, influencing the effectiveness of the agricultural technology generated and transferred to farmers. This study investigates the social, scientific, organisational and economic factors which have influenced EMBRAPA's agricultural technology generation process and its association with technology adoption by farmers.

The research organisation is not a neutral place, but an ideological site subject to several influences. Thus, the agricultural technology generation process is influenced by internal and external forces. In this case it is a state-owned organisation attached to the Ministry of Agriculture of the Federal Government. From this perspective, this research proposes to answer the following questions:

1. Which social, scientific and economic factors have most influenced researchers in their choice of research problems?

2. To what extent has EMBRAPA's organisational structure influenced researchers in the generation of agricultural technologies?

3. What would be the most appropriate agricultural technology research model for the benefit of the majority of Brazilian farmers?

The following hypotheses have been selected to help to answer these research questions:

1. The agricultural technology generation process of EMBRAPA in Brazil has been oriented towards the interests of particular organised groups and concentrated on just a few agricultural products.

2. The organisational structure of EMBRAPA is a factor behind the type of agricultural technology generated. It is also crucial in defining the specific type of agricultural technology generated.

### 1.3.1. Methods Used

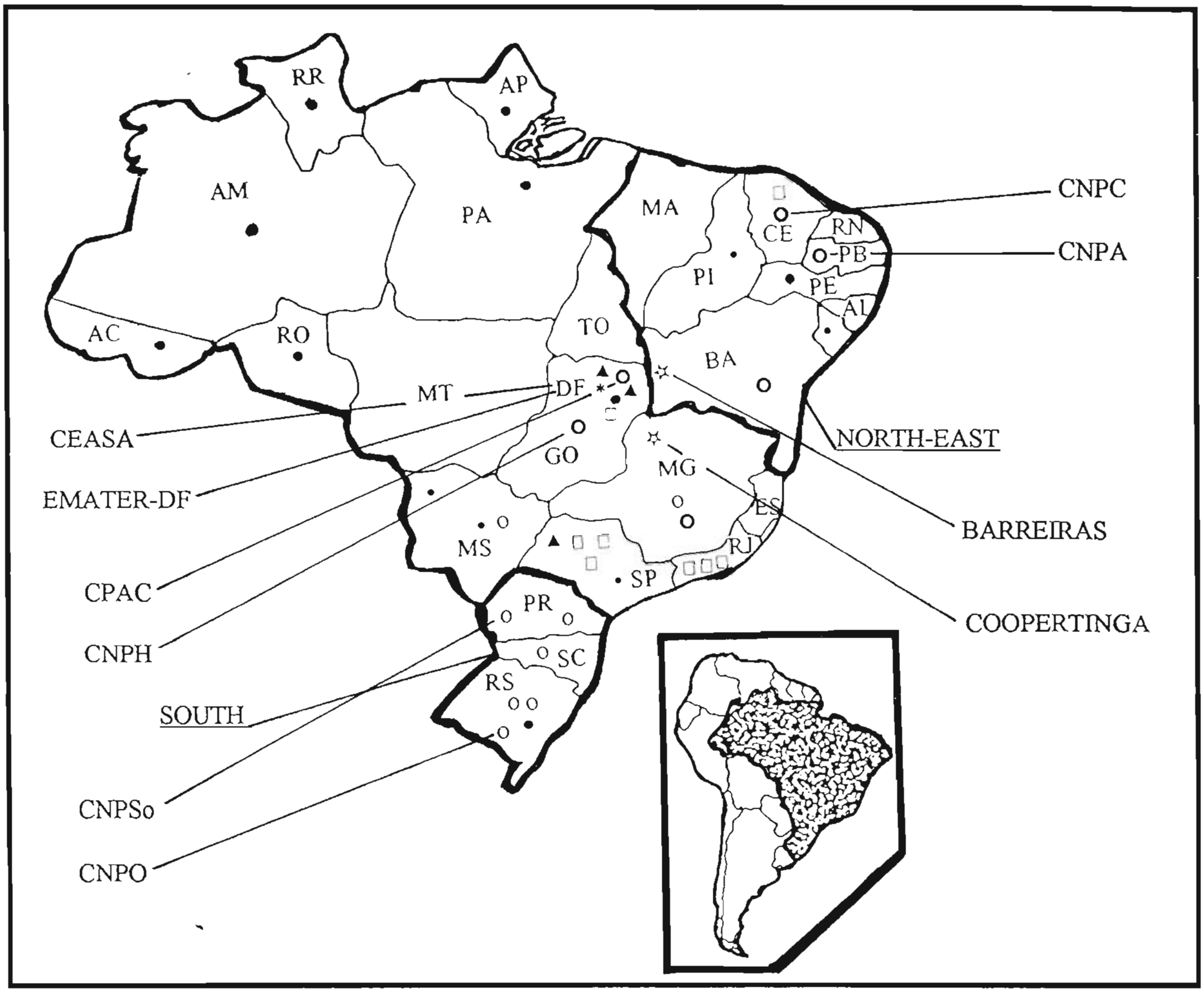
This is *ex-post facto* and *cross sectional* research. It is a case study concerned principally with understanding the behaviour of organisations by getting to know the people involved and their values. Thus, the case study relies on a combination of data collection techniques, including direct observation and systematic interviewing. Here, the strength of the case study is the ability to deal with a broad range of evidence - documents, interviews and observations[8].

The fieldwork took place in Brazil, from August 1994 to February 1995. Evidence was collected through questionnaires, structured and unstructured interviews, observations and secondary data. Almost all data collection was undertaken by the author, who has been involved with the Brazilian agricultural research system for nearly twenty years. This thesis is developed through three stages, and each stage uses its own research methodology.

First, it unpacks the agricultural technology generation process. It analyses how the agricultural researcher generates the agricultural technology, particularly in the four agricultural research products centres. Secondly, it looks at how far and why farmers have adopted two of EMBRAPA's successful agricultural technologies. Thirdly, it considers how individuals and organisations have evaluated the agricultural technology generation process. The individuals and organisations are identified as clients, users, managers, policy makers, politicians, and so on, of the agricultural technology generated by EMBRAPA. Figure 1.2 shows the geographical distribution of EMBRAPA research units and the field-work data collection points.

[8]Yin [1989], *Case Study Research: Design and Methods,* argues that, as a research strategy, the case study is used in many settings including organisational and management studies. The case study is ideal for examining contemporary events when the relevant behaviour cannot be manipulated. Further, according to Eisenhardt [1989: 534-535], *Building Theories from Case Study Research,* case studies typically combine data collection methods such as archival evidence, interviews, questionnaires and observations. The evidence may be qualitative, quantitative, or both.

**Figure 1.2 - The Geographical Distribution of EMBRAPA Decentralised Units and Data Collection Points**




| **Legend:** | **North-east** |
|---|---|
| | CNPA - Cotton National Research Centre ( State of Paraíba, PB) |
| ⁎ Headquarters | CNPC - Goat National Research Centre (State of Ceará, CE) |
| | Barreiras, State of Bahia, BA - The *Doko* Soya bean (Additional Information) |
| o National Commodity Centres | **South** |
| | CNPSo - Soya bean National Research Centre (State of Paraná, PR) |
| • Agroforestry/Agricultural Centres | CNPO - Sheep National Research Centre (State of Rio Grande do Sul, RS) |
| | **West-Central** |
| □ Basic Theme National Centres | CPAC - *Cerrados* Agricultural Research Centre (Federal District, DF) |
| | CNPH - Vegetable National Research Centre (Federal District, DF) |
| ▲ Special Services | CEASA - The *Brasilia* carrot case study (Federal District, DF) |
| | EMATER-DF, Federal District - The *Brasilia* carrot (Additional Information) |
| ☆ Barreiras and COOPERTINGA | **South East** |
| | COOPERTINGA - The *Doko* Soya bean case study (State of Minas Gerais, MG) |

Source: Based on EMBRAPA 1993d: 58.

### 1.3.1.1. Stage 1: The Agricultural Technology Generation Process

The first stage is shown in Chapter 5 and involves four of EMBRAPA's national research centres. The research centres surveyed were the CNPA and the CNPC both located in the North-east, the poorest Brazilian region. The CNPSo and the CNPO both located in the rich region of the South were also surveyed. The research centres chosen involved agricultural and animal research programs. Export crops and food staples were considered as well.

Primary data was collected mainly from the questionnaires[9], using open-ended questions. Busch and Lacy [1981 and 1983], Macêdo [1984], Biggs [1989 and 1990], Buttel et al [1990] and Souza [1993] are the main sources for the formulation of the work categories, including the definitions of the variables and interpretation checks. Secondary data was obtained from a detailed search of EMBRAPA's literature and scientific and technical publications as well as documentary sources - archives, official reports, and circulars. The strategy for the collection of primary data was as follows:

First, questionnaires were prepared and pre-tested with EMBRAPA's researchers. Appointments had been previously made and the objective of the study was explained prior to the distribution of the questionnaires. Secondly, unstructured interviews took place with the management team of each research centre selected. A check list of issues formed the basis of questions put to the research centres' management teams. Normally, the research centre management team comprises a general director and two advisory directors. Sometimes, the interviews were conducted with the whole management team and at other times an individual manager was interviewed. The study was explained and respondents had total freedom to express their view of the agricultural technology generation process at the agricultural

[9]Questionnaires are in appendix 1.

research centre. Answers and observations were noted. The time given to each interview was approximately one hour.

At this stage, the research population comprised the agricultural researchers and the management team of each research centre. The structured interviews with questionnaires were used with the agricultural researchers and the unstructured interviews with the research centre management team. Agricultural researchers developing research activities in various agricultural and animal fields in the four research centres were interviewed. In fact, only the agricultural researchers (from the biology research area) produced significant agricultural technology. In this study, approximately 90% of the agricultural researcher population was covered.

The variables were defined according to EMBRAPA researchers' profiles and internal and external influences on them and on the research organisation. This was within the objectives, research questions and hypotheses of this study[10]. The choice of research problem by the agricultural researcher is the primary and most important step in each research project and defines the path of all further research. The choice of research problem expresses the purpose of the researcher in his agricultural investigation.

Thirdly, the regions and research centres surveyed followed a pattern. It is important to unpack the influences on the agricultural technology generation process involving different agricultural and husbandry products within different research centres located in the various regions. The North-east is the poorest region and labour productivity is four times lower than in the South. This is mainly because of the uncertainties of the climate. Most of the North-eastern farmers lack the appropriate skills in agricultural technology, such as water

[10]The description of variables are in appendix 2.

management and the marketing of agricultural products. The illiteracy rate is around 40% which is the highest in Brazil. The economically active population is about 20 million and 29% of the Brazilian population live in the North-eastern region [IBGE, 1994 and 1996].

In contrast, the Southern region is rich and agricultural activity is based on modern agricultural methods and large-scale production for export. The illiteracy rate is 11%, which is the lowest in the country. The economically active population is 12 million inhabitants and around 15% of Brazilians live in the Southern region. There is no dry season and the private sector is made up of strong co-operatives and companies. Most of the farmers are descendants of Europeans. Many of the agricultural research system's laboratories and well-trained agricultural researchers are concentrated in the South East and Southern regions

The data will be analysed in various ways. First, through a descriptive and narrative analysis of each research centre; secondly, by describing the researchers and the research process and its relation to the choice of research problem by the agricultural researcher within his research centre. Thirdly, a comparative analysis of the research centres will be made in order to identify and describe the differences and similarities between the various agricultural technology generation processes. Finally, some analysis of variance will be made through the mean of some researchers' attitude answers. This allows the importance of researchers' views to be identified whilst they are in their respective research centres. Furthermore, the hierarchy of means between research centres will be shown. This is only possible with questions where answers are based on a continuous scale of numbers , that is, questions with varied responses. In these cases, according to Walsh [1990: 124-125] the means will be compared by Analysis of Variance (ANOVA).

In addition, data analysis using the probability-based model of categorical judgements of Thurstone [1927], Thurstone and Chave [1966] and Souza [1988] will be carried out. This model is based upon an analysis of frequency of researchers' answers, thus constructing a continuous scale that allows the importance of each individual researcher's answer to be identified. It is only possible for questions on such a scale, for example, showing the most important influence on the choice of research problem by the agricultural researcher. Souza [1993] applied Thurstone's coefficient to the analysis of the agricultural technology generation research process under specific conditions in Brazil.

**1.3.1.2. Stage 2: Agricultural Technology Generation and Adoption Successes**

The second stage of the research is concerned with the successes of two EMBRAPA technologies adopted by farmers. In this case, the most important questions to be answered were 'Why did farmers adopt these technologies?' and 'How the agricultural technology generation process influence their choice?'.

EMBRAPA has generated a lot of agricultural technologies[11], that is, the scientific knowledge embodied in peoples minds or in products: - approximately 8,000 technologies [EMBRAPA, 1991] - but not all of them have been adopted by farmers. Most of the research results have been published in scientific journals or presented at meetings, or even now lie on researcher's shelves. This is a continuing criticism of the agricultural technology generation process in Brazil. There is an enormous gap between the agricultural technology generated and that which is incorporated into productive farming systems. There has been no effective social assessment of the technologies adopted by farmers. However, according to EMBRAPA [1991a, 1992, 1993f and

[11]According to Okali et al [1994: 1], *Farmer Participatory Research: Rhetoric and Reality*, 'agricultural technology encompasses plant varieties and animal breeds, farming practices and agricultural production and processing tools, in addition to specific mental constructs, cultural codes and forms of management and co-operation'.

1994], the *Doko* Soya bean and the *Brasília* carrot varieties are two significant examples of technology successes adopted by farmers. Some rural extension agents, researchers and executives also considered these examples of technology successes. Secondary data shows this too. The estimate is that 80% of all production of Brazilian carrots are from the *Brasília* carrot variety.

It is necessary to explain the links between the EMBRAPA agricultural technology generation process and its adoption by farmers. The objective of this study is not a biological evaluation of the *Brasília* carrot and *Doko* Soya bean varieties. This is a social phenomenon. It is important to understand the association between its generation and adoption by farmers. However, biological and social issues have influenced the agricultural generation and adoption process[12]. The *Brasília* carrot variety was generated by the EMBRAPA National Vegetable Research Center (CNPH)[13].

EMBRAPA's research also exposed the myth that Soya beans could only be planted in temperate climates. Today, Soya beans are planted in the *Cerrados*, in the North-east and in the North of Brazil. The area planted with this crop has grown by 36% in the last twenty years due to the generation of numerous strains adapted to the tropical zone. The *Doko* Soya bean variety was the first variety adapted for cultivation in the *Cerrados* area[14]. The *Cerrados* is responsible for 40% of Brazilian grain production. The *Doko* Soya bean variety was generated by EMBRAPA's *Cerrados* Research Centre (CPAC)[15] in collaboration with the Soya bean National Research Centre (CNPSo).

Evidence was collected through a combination of strategies. Primary data was collected by personal interviews with the EMBRAPA researchers responsible for the *Brasília* carrot and the

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[12]The botanical features of the *Brasília* carrot are in appendix 3.
[13]CNPH's general characteristics are in appendix 4.
[14]The *Doko* Soya bean's botanical characteristics are in appendix 5.
[15]A description of CPAC is in appendix 6.

*Doko* Soya bean within their research centres. Secondary data from EMBRAPA reports, archives, official reports and circulars and rural extension magazines were collected. Rural extension agents of the Rural Extension Agency of the Federal District (EMATER-DF), EMBRAPA, executives and researchers, CNPH and CPAC researchers and a CNPSo geneticist were asked about EMBRAPA technology successes and especially about the *Brasília* carrot and *Doko* Soya bean varieties.

Thirdly, evidence about the *Brasília* carrot and the *Doko* Soya bean adoption by farmers was collected through two case studies, which are shown later in Chapter 6. All primary data was collected in the geographical region identified as the *Cerrados* region a agricultural frontier highly subsidised by government. Almost all the data collection was undertaken by the same interviewer, the author of the project. In each study the author was directly involved in the research. The responses received about the *Brasília* carrot and *Doko* Soya bean's advantages in relation to other varieties were noted. In addition, the agricultural characteristics of the *Cerrados* region and the government intervention in this frontier area will be described. Questionnaires, personal interviews and direct observations of *Brasília* carrot and *Doko* Soya bean farmers were carried out[16].

According to Frankfort-Nachmias [1992: 224], the personal interview is a face-to-face interpersonal role situation in which an interviewer asks respondents questions designed to elicit answers pertinent to the research hypotheses. The questions, their wording, and their sequence define the structure of the interview. They review the advantages of the personal interview as follows: flexibility, control of the interview situation, high response rate and collection. Leonard-Barton [1989], notes how within case analyses he used tabular displays and graphs of

[16]Questionnaires and the descriptions of variables are in appendices 7 and 8 respectively.

information to describe each case study. Also, for Mitchel [1988: 200], the process of inference from case studies is only logical or causal and cannot be statistical: extrapolation from any one case to similar situations in general is based only on logical inference.

**1.3.1.3. Stage 3: Attitudes Towards Agricultural Technology**

The third stage of the research considers how individuals and organisations evaluate EMBRAPA's agricultural technology. They are shown in Chapter 7. Unstructured interviews combined with personal interviews were conducted with 80 individuals and organisations. All interviews were carried out by the author[17].

All individuals and organisations' representatives surveyed were asked the following introductory questions: First, 'Has EMBRAPA generated agricultural technology to meet the majority of the Brazilian farmers' needs?' Secondly, 'Is EMBRAPA's organisational structure appropriate for meeting the demands of different types of Brazilian farmers?'. Additional questions on the check list were also asked depending on the interview atmosphere, and the research interest.

The surveyed groups[18] were chosen according to their agricultural technology interests, and the methodological approach of this thesis. These groups have some links with the EMBRAPA agricultural technology generation process. It is important to note that in the personal interview, although the meeting between the interviewer and the respondents is structured and the major aspects of the study are explained, respondents were given considerable opportunities to express their opinion of a situation presented to them. In addition, a procedure of qualitative data analysis was followed involving 'a process that goes

[17]The check list of previously prepared questions is in appendix 9.
[18]The surveyed groups are in appendix 10.

from the use of contact sheets, coding, to the development of concepts, with the assistance of memos, to new categories'. Furthermore, with reference to Miles and Humberman [1984] and Lofland and Lofland [1995: 184-5] logical analyses were also made.

**1.4. The Organisation of the Thesis**

In order to deal adequately with the focus of interest, this thesis consists of eight chapters. Chapter 1 concentrates on the theoretical framework, purposes and methodology of the study. The approach to modernisation, underdevelopment, globalisation and 'urban bias' theories provides an appropriate context in which to understand the capitalist development associated with the internationalisation of agriculture in the global economy. Chapter 2 focuses on the evolution of agriculture in Brazil and explores the history of agricultural production systems since the period of slavery, providing a useful background to the new agricultural apparatus. Chapter 3 explores politics, class and agricultural research organisations since the Brazilian colonial era. The main focus is on the linkages between agricultural technology and the process of the accumulation of capital. Chapter 4 describes the formation of EMBRAPA, its organisational structure, and the agricultural technology research process.

The empirical content is contained in Chapters 5, 6 and 7. Chapter 5 supplies important data on the agricultural technology generation process where information on the external and internal influences on the choice of research problem by agricultural researchers is presented. It is important to establish the relationship between the agricultural generation process and the effectiveness of the technology generated. Chapter 6 seeks to understand the reasons for the success of two agricultural technologies adopted by farmers. The focus is on the relationship between the agricultural technology generation process and the adoption by farmers. Chapter

7 provides findings from representatives of users, clients, and various social and political segments involved and interested in agricultural technology. Finally, Chapter 8 offers the conclusions of the thesis and the major findings are presented. Suggestions for a new agricultural generation process are offered as well as proposals for further research.

### 1.5. Summary

The focus of most agricultural technology studies has been on technology diffusion and adoption. In this context, technology is seen as neutral and the agricultural adoption by farmers depends on psychological and individual values. The agricultural technology generation process itself is not considered an active factor. This thesis on the contrary, considers agricultural technology generation as an influential factor in the technology adopted or rejected by farmers. Agricultural technology is generated by agricultural researchers inside a state-owned research organisation which is viewed as a socio-technical organisation. Approaches to development, modernisation and underdevelopment, along with globalisation, are the theoretical perspectives applied in the attempt to understand what goes on in the underdeveloped countries in an integrated world system. Empirical data was collected in Brazil, in and around the Brazilian Agricultural Research Organisation (EMBRAPA). The agricultural technology generation process was analysed. In addition, two technologies adopted by farmers and views on agricultural technology of the users, clients, policy-makers, politicians and unions, were investigated. Case studies combined with surveys, unstructured and personal interviews and secondary data were the empirical data collection strategy. Quantitative and qualitative data analysis were carried out. The fieldwork comprised interviews with the eighty-seven agricultural researchers, one hundred and forty-four farmers, and eighty individuals and organisations' representatives in eight States of Brazil.

# CHAPTER 2

# SLAVE, TRANSITIONAL AND MODERN AGRICULTURE

## 2.1. Introduction

Agriculture has always been an influential factor in Brazilian social, political and economic history. A variety of production systems were developed in Brazil, some of which are typical of different historical periods, even though technological, social, economic, and political factors overlap from one period to another. An understanding of the background of agricultural development in Brazil and its associated social relations is crucial to an understanding of current agricultural technology and the current methods of agricultural production. In this chapter, Brazilian agriculture will be described from the period of slave production to the one of free labour and then on to the agricultural modernisation of recent years.

## 2.2. Slave Agriculture [1500 - 1888]

In the fifteenth and sixteenth centuries, Portugal was a strong commercial force in the world and Lisbon was an important trade entrepôt for Indian products. Like other European countries, such as Spain, England and the Netherlands, Portugal made various maritime expeditions to acquire new possessions. In this context Brazil was discovered by the Portuguese in 1500. During the first thirty years, the Portuguese crown did not show any interest in its new colony. Furtado [1963: 3] states that the initial economic occupation of Brazil was mainly because of political pressure to protect Portugal's new possessions from various European countries, such as England, the Netherlands and France.

As a result, in 1530, Brazil was divided into fifteen hereditary captaincies. The Portuguese crown transferred significant powers to the European nobility for the exploitation of these huge captaincies. The strategy of occupation and exploitation of Brazilian territory was through organised agricultural production and colonial enterprises. Prado Júnior [1967: 12] argues that Portugal created a settlement pattern which could supply the established trading stations and organise production of the primary commodities needed for international trade. Carvalho [1992: 17] also states that the economic exploitation of Brazil by Portugal was through the utilisation of virgin land. One particular aim of the colonial enterprise was to produce sugar for the international market. The Portuguese were familiar with sugar production systems because sugar had been cultivated in Madeira, another Portuguese colony.

At that time, an important consideration was labour support for theses estates. Indians were the original inhabitants of the colony but their exploitation was complicated. On the one hand, the Crown had an interest in bringing Christianity to the indigenous people and protecting them from enslavement by the landowner. On the other, the native Indians, living in total freedom in the tropical jungle, did not adapt to the slave labour routine of agricultural and sugar mill work and fled to the colony's interior. The solution was to turn to African slaves.

The Portuguese were in the vanguard of yet another feature of the new world, the enslavement of African Negroes and Slave labour which characterised the colonial production mode [Prado Júnior, 1967: 20]. In a period when only the mining of precious metals justified the colonisation of American territories, Portugal initiated agricultural exports from the estates on the coastal strip of Brazil. In fact, Brazil was the first region in the western hemisphere where development was based on agriculture [Furtado, 1965: 82-83].

Gorender [1980: 61] and Frank [1969: 249] stress that the Brazilian colony was part of the capitalist system, while Sodré [1980: 143] and Poppino [1968: 50] suggest it also had distinct feudal elements. However, under Portuguese colonisation, the plantation system supplied tropical commodities which were high in demand such as sugar, cotton, tobacco, cocoa, rubber, and coffee for the European market. Land abundance compensated for poor agricultural technology systems and slave labour had minimal costs. Thus, colonial exploitation combined the utilisation of traditional factors of production, land and labour.

In the colonial period, the Brazilian economy depended on three commodities and passed through three economic cycles. 'Where a cycle is defined as successive epochs around a nuclei. The nuclei is formed by a dominant product in relation to all others activities' [Godinho, 1970]. These were the sugar cycle (1500 - 1655), the gold cycle (1700 - 1750) and the cotton cycle (1750 - 1813) [Morgolis, 1973]. During Brazil's colonisation only one product offered any possibility of regular trade. This was brazilwood, a tincture-producing tree that was plentiful throughout the country. Brazilwood was exploited until it was exhausted. Fishing, the production of salt, and natural forest products were also exploited. Simonsen [1977] estimates that an average of 300 tonnes of brazilwood was sent to Portugal annually between 1500 and 1532 and that the total value of brazilwood exports during the colonial period reached £15 million.

Indeed, the *sesmaria* (large estates) institution remained until Brazil's independence in 1822. As Souza [1993: 46-47] notes, the colonial production system and social structure was based on extensive land utilisation and intensive slave labour. It is important to note that in this period, the social structure had two main levels: the landowner as the dominant class and the slave as the dominated one. In 1798, almost half of the Brazilian population were slaves, as indicated in Table 2.1. Thus, the Brazilian colonial economic, social and political structure was based on the *sesmaria* and the *engenhos* (sugar mills) [Guimarães, 1968: 45].

**Table 2.1 - Estimates of the Brazilian Colonial Population - 1798**

| CONDITION | NUMBER |
|---|---|
| Whites | 1,010,000 |
| Free blacks | 406,000 |
| Indians | 250,000 |
| **Total free population** | **1,666,000** |
| Black slaves | 1,361,000 |
| Mulatto slaves | 221,000 |
| **Total slaves** | **1,582,000** |
| **Total general** | **3,248,000** |

Source: Based on MALHEIRO 1944, quoted by CONRAD 1972: 283.

### 2.2.1. Sugar Cane Production System

Sugar cane dominated agricultural production between 1530 and 1655. It was cultivated from the extreme North, in the State of Pará, to the South in the State of Santa Catarina. During the sixteenth century and the first half of the seventeenth century, sugar was the main export commodity. Brazil held an almost global monopoly on the export of sugar. Simonsen [1977] estimates that the value of sugar exports between 1500 and 1820 was £300 million.

Sugar cane exploitation was more than a commercial source of sugar for Europe. Sugar production entailed a social, political, and economic system around the sugar mills which deeply influenced Brazilian society. In others words, sugar cane exploitation involved activities beyond agriculture, such as processing and commerce. Further, sugar exploitation required vast land areas for sugar cane cultivation and involved the so-called plantation system. Usually, sugar cane was grown as a single crop. The rudimentary industrial process was carried out inside the sugar mills. Sometimes, sugar exploitation was divided into various phases: the landowner produced the sugar cane, the sugar mill owner processed the sugar, the mule owner carried the sugar from the sugar mills to the urban area, and finally the merchant bought and sold it on the international market.

In many cases, the sugar cane landowner, the sugar mill owner and the sugar trader were the same person. In these cases, according to Souza [1993: 48], there was an over concentration of economic, political and social power in the hands of one prominent person who consequently wielded much local power. For instance, in the North-eastern region - a pioneer sugar cane region and the poorest Brazilian region today - such people were known as colonels - *coronéis nordestinos*. In Flynn's [1996: 405] words they were 'local boss politics [who traditionally encapsulate] patronage and corruption'. They also had a strong influence on all aspects of social life, an influence which continues today and which is reflected in local social and cultural institutions. From this perspective, the sugar exploitation system was reproduced all over the country. For example, in the seventeenth century there were sugar mills employing three hundred men, and at least one in Pernambuco, in the North-eastern region with three hundred and seventy slaves [Poppino, 1968: 122]. Table 2.2 shows sugar production and the sugar mills installed in selected regions.

**Table 2.2 - Sugar Production in Selected Regions in Brazil - 1710**

| STATE | REGION | SUGAR MILLS | % | PRODUCTION (CRATES) | % |
|---|---|---|---|---|---|
| Bahia | North-eastern | 146 | 28 | 14,500 | 40 |
| Pernambuco | North-eastern | 246 | 47 | 12,300 | 33 |
| Rio de Janeiro | South East | 136 | 25 | 10,220 | 27 |
| **Total** | | **528** | **100** | **37,020** | **100** |

Source: Based on ANTONIL 1963.

On the one hand, sugar exploitation involved the luxury and opulence of the landowners, sugar-mill owners and sugar merchants, and on the other, brutality and cruelty towards the African slaves. Forbidden any social mobility and capital accumulation, slaves were subjected to a severe work routine. Most of them worked twelve hours a day and on Sundays they produced their own agricultural subsistence foods, such as cassava, beans, maize and rice. Normally, the poor soil not used in sugar cane cultivation was directed to other ends. First, it was used to grow maize to feed the mules, since they were valuable animals for sugar transportation and for operating the sugar mills. Secondly, it was used for food crop cultivation to feed the people living around the sugar mills. The objective was to make the sugar mills self-sufficient units independent of the external environment. Surplus food crops were traded in the nascent urban centres. However, in the mid-sixteenth century, the international trade in sugar collapsed and international prices fell, so that sugar competition from the West Indies brought sugar prices down in the European market.

In relation to the sugar decline, it is important to bear in mind that sugar underwent a revival in the world market in the late nineteenth century. New, more efficient processing techniques turned sugar into an article of mass consumption. Brazil participated in the revival through the early 1880s, but then suffered a decrease in exports after 1900. Competition from beet sugar, protected in the industrial countries and from sugar cane in newer producing areas overcame Brazilian production. Cuba, Puerto Rico and the Philippines acquired preferential access to the United States sugar market [Warren, 1989: 227-228].

### 2.2.2. Other Major Agricultural Export Products

Other major agricultural products were grown in the slave era, though none of them influenced Brazilian society as much as sugar cane. All staple production modes were based on land abundance and slave labour. The main purpose of the agricultural slave was to supply the European market, to transfer net incomes from Brazil to European capitalists and to exchange tropical products for manufactured goods and foodstuffs for the maintenance of the nascent urban centres. However, it is important to state that there was a period of gold extraction between 1700 and 1780. This was known in Brazilian history as the *golden era*. According to Ribeiro [1995: 152], Brazilian gold and diamond production between 1701 and 1828 was worth £ 200 million and Brazilian production was greater than that of the rest of America.

Slave agriculture in Brazil, then, was founded on the plantation system and on a single export crop. There was a strong concentration of land, capital and political power in the hands of the landowners. Agriculture technology was rudimentary and gains in agricultural productivity were obtained by growing crops on abundant virgin land and by the use of slave labour. Food crop production was scarce, and most foods were either produced inside the *sesmarias* and sugar mills, or imported from European countries. The growing of crops for local consumption - such as cassava, maize, and beans - was a mere appendage to commercial agriculture and of subsidiary importance. As Prado Júnior [1967: 165] shows, large-scale agricultural production represented the very nerve of colonial agriculture and most of this was for exporting, as indicted in Table 2.3. The population was basically rural and the social structure was formed by a minority of landowners at one extreme, and a majority of slaves at the other. There was an enormous gulf between these extremes.

**Table 2.3 - Major Brazilian Exports by Decade - 1841 to 1880**

| PRODUCT | 1841- 1850 | | 1851 - 1860 | | 1861 - 1870 | | 1871 - 1880 | |
|---|---|---|---|---|---|---|---|---|
| | (£1000) | % | (£1000) | % | (£1000) | % | (£1000) | % |
| Coffee | 22,655 | 46.99 | 49,741 | 53.67 | 68,004 | 50.38 | 112,954 | 59.49 |
| Sugar | 14,576 | 30.23 | 21,638 | 23.35 | 18,308 | 13.56 | 23,540 | 12.40 |
| Cotton | 4,103 | 8.51 | 6,350 | 6.85 | 27,293 | 20.22 | 19,070 | 10.04 |
| Hides | 4,679 | 9.70 | 7,368 | 7.95 | 8,958 | 6.64 | 11,106 | 5.85 |
| Tobacco | 974 | 2.02 | 2,679 | 2.89 | 4,567 | 3.38 | 6,870 | 3.61 |
| Rubber | 214 | 0.44 | 2,282 | 2.46 | 4,649 | 3.44 | 10,957 | 5.77 |
| Cacao | 537 | 1.11 | 1,033 | 1.11 | 1,388 | 1.03 | 2,438 | 1.28 |
| Mate | 477 | 0.99 | 1,583 | 1.71 | 1,817 | 1.35 | 2,945 | 1.55 |
| **Total** | **48,215** | **99.99** | **92,674** | **99.99** | **134,984** | **100.00** | **189,880** | **99.99** |

Source: IBGE 1940.

In contrast to the sugar cane that was planted along the coastal strip, most other export products were cultivated in the interior. Cotton exploitation was much simpler and less expensive than sugar. It was grown to meet the European textile industry's demands, particularly in England. The State of Maranhão was the largest cotton production area. Cotton was planted in the dry, arid areas of *agreste* and *caatinga* in the North-eastern region. Figures on Table 2.3 show that the peak period of cotton production was the 1860s. During this period, Brazil was amongst the world's largest cotton producers.

Another tropical export staple was tobacco. It was grown all over the country, but the best conditions were in Bahia, in the municipality of Cachoeira in the traditional region of the Recôncavo Baiano. Most tobacco production was exported to Africa, to be traded for slaves. Tobacco was thus an essential commodity for the slave trade. It is worth mentioning that cocoa exploitation was different from the previously mentioned agricultural products. Cocoa was a regional staple. It was initially collected from the Amazon forest. Afterwards it was introduced into Maranhão and planted in Ilhéus in the captaincy of Bahia, mainly in the Atlantic jungle strip. In the same way, rubber was a regional staple from the Amazon area. In spite of the importance of the rubber cycle, it covered a brief span of time, from about 1870 to 1910. Brazil in that period produced 88 per cent of the world's latex [Morgolis, 1973]. At the end of the nineteenth century, rubber was in high demand on the international market and Brazil was the largest rubber exporter in the world.

It is important to note, that like sugar cane, coffee crops also influenced Brazilian social, economic, and political life. For almost a century, coffee was the leading export crop. Table 2.3 shows the leading position of coffee as part of Brazil's primary commodity exports. On average, between 1840 and 1880, coffee accounted for over 50 percent of all Brazilian agricultural exports and Brazil was the world's largest coffee exporter. In fact, there was over-exportation of coffee since Brazil almost monopolised the international coffee market. [Poppino, 1968: 147]. Commercial coffee planting began in the Valley of Paraíba in the State of Rio de Janeiro, and at the end of the nineteenth century, the coffee crops were transferred to the State of São Paulo, especially the fertile soils *(terra roxa)* of the municipality of Campinas. Sugar cane and coffee crop production modes had various similarities. They were based on slave labour and on virgin land and were both geared towards the international market.

Silva [1979: 17] declares that the coffee expansion at the end of the nineteenth century was the basis of modern capitalism in Brazil because of the abundance of land and manpower. The available production factors were manpower, slave labour and abundant land. It is important to note that while the coffee land owners expanded in Brazil, in Europe it was industrial capitalism that flourished. If sugar cane created the landowner *(o senhor de engenho),* the coffee crop generated the coffee baron *(o barão do café).*

Although agricultural production between 1500 and 1888 was based on slavery, various restrictions were placed on slave labour from 1850. For instance, international pressure - mainly from England - and several Brazilian Acts prohibited the slave trade and freed slaves' new born children. However, the Land Law was passed in 1850, which created legal procedures to make land acquisition difficult for free men, such as immigrants and former slaves.

In line with the Land Law, land became a public domain and could only be acquired through direct purchase from the government. This law eliminated the traditional method of acquiring land through occupation and through royal grants from the Crown. Lands that were not adequately utilised or occupied had to be returned to the state as public land [Becker and Egler, 1992: 32]. The abolition of slavery became official in 1888, causing a temporary disturbance to the labour force on the plantations and many planters were ruined before landowners and labourers adjusted to the new situation. There had been almost four centuries of African slavery, characterised by exploitation, cruelty and poverty. In truth, the institution of slavery and the plantation system characterised the agricultural production mode in the colonial, imperial, and newly independent era in Brazil. In Prado Junior's words: 'the colony of Brazil was a regime of universal slave labour' [Prado Júnior, 1987: 91].

### 2.3. Transitional Agriculture [1889 - 1960]

At the end of the nineteenth century and during the seventy-one years of the transitional agriculture period, highly significant changes took place both in Brazil and throughout the world. First of all, the abolition of slavery created a new social status in Brazilian society. The free and salaried labour force consolidated the capitalist mode of production. In the first three decades of the twentieth century, export staples, such as sugar, cotton and in particular coffee remained the most important commercial commodities in the international market.

At that time, the transfer of surplus profits from agriculture to industry began to take place. Several national and international events marked this period, such as the Proclamation of the Brazilian Republic in 1889, the Russian revolution in 1917, the World Depression in 1929, the First and Second World Wars in 1914 and 1945 respectively, and the initial implementation of Brazilian industrialisation, namely the import substitution strategy after 1930. All of these influenced the Brazilian economy and in particular the agricultural sector.

In reality, the transitional agriculture period was characterised by the change from the colonial agricultural mode based on slave labour to the capitalist system of production based on salaried and free labour. However, the Brazilian economy continued to be based on the export of primary commodities. The Brazilian economy was an agrarian economy before Independence and remained an agrarian economy after it. The transition to a modern economy began in the twentieth century, when industry began to displace the traditional economy [Haber and Klein, 1992: 237].

It is important to note that the abolition of slavery enlarged the subsistence economy and decreased labour productivity since many former slaves were absorbed into subsistence activities. This caused a huge reduction in the labour force [Bielschoewsky, 1989: 39]. Thus, the influential and prominent rural oligarchy - principally the coffee bourgeoisie - had to find a substitute for slave labour to maintain capital accumulation. European immigration was the initial initiative of the Republic's government. European immigrants, as distinct from Brazilian migrants - mainly from the North-eastern region *(nordestinos)* - brought agricultural skills and did not affect the subsistence economy.

In this context, in the second half of the nineteenth century, coffee plantations were still heavily subsided by the government and coffee remained the main export commodity, more important than sugar and mining. Further, a few agricultural research organisations were created to support the new agricultural demands at the end of the slave agricultural period by the imperial government in the States of Bahia, Pernambuco, São Paulo, and Rio de Janeiro, the most powerful states in Brazil.

From this perspective, several state organisations supporting agricultural development were later created. In 1933, the Sugar and Alcohol Institute (IAA) was created to meet the sugar and spirit industries' demand, as was the Brazilian Coffee Institute (IBC) to serve the coffee farmers interests, mainly in relation to exportation, research and technical assistance. In 1936, the National Department For Drought (DNOCS) was created to protect the North-eastern drought regions and in, 1943, the Sao Francisco Valley Development Company (CODEVASF) was formed to promote the rational use of the Sao Francisco river valley.

Soon afterwards, in 1948, the Brazilian Rural Extension and Technical Assistance Association (ABCAR) was created to promote rural extension and to diffuse the new agricultural technologies to farmers. And in 1956 the Cocoa Executive Plan Commission (CEPLAC) was formed to promote cocoa crop regional development. Finally in 1959, the North-eastern Development Superintendency (SUDENE) was established to co-ordinate state intervention in the North-eastern region, the poorest region in Brazil. SUDENE's main aim was to implement agricultural and industrial projects to improve the living standards of the North-east's population.

It is important to bear in mind, that the capitalist order in the post-slavery abolition period continued to be based on the plantation *latifundium*. Gorender states that the export plantations - such as coffee and sugar cane - promoted capital accumulation and internal market expansion and as a consequence, maintained the dominant capitalist production system [1980: 62 and 1994: 22].

In reality, land is much more than just a factor of production in agricultural exploitation. Land in Brazil represents social, political and economical power. Table 2.4 shows land distribution in Brazil between 1940 and 1960. The figures show the enormous land concentrations in the hands of a few landowners. As a consequence, the small farmers and peasants did not have enough land to survive in the rural areas.

In this way, the rural oligarchy maintained most of their privileges, mainly through colonial land ownership patterns. Agricultural production continued to be based on the concentration of land and on the production of primary commodities for the international market and new agricultural frontiers were opened.

**Table 2.4 - Land Distribution in Brazil - 1940 to 1960**

| AREA (HECTARES) | % OF TOTAL FARMS | | | % OF TOTAL FARMS AREA | | |
|---|---|---|---|---|---|---|
| | 1940 | 1950 | 1960 | 1940 | 1950 | 1960 |
| Less than 10 | 34.37 | 34.43 | 44.79 | 1.46 | 1.30 | 2.38 |
| From 10 to 100 | 51.21 | 50.98 | 44.68 | 16.75 | 15.31 | 19.04 |
| From 100 to 1,000 | 12.80 | 12.99 | 9.43 | 33.47 | 32.53 | 34.43 |
| From 1,000 to 10,000 | 1.39 | 1.50 | 0.93 | 31.37 | 31.48 | 28.58 |
| Over 10,000 | 0.07 | 0.08 | 0.05 | 16.95 | 19.38 | 15.57 |
| No Data Available | 0.16 | 0.02 | 0.12 | - | - | - |

Source: IBGE 1985: 2-3.

Further, Table 2.5 shows the evolution of the cultivated area and productivity of selected export products from 1931 to 1960. Capital accumulation was maintained through land income and profits were raised from the staples sold on the international market.

However, as a consequence of the First and Second World Wars, the World crisis in 1929 and the fall of international coffee prices, the Brazilian economic base also shifted. In 1930, the prominent rural oligarchy began to be replaced by the new industrial power, and a new industrial bourgeoisie and an embryonic urban proletariat took its place. State bureaucracy was installed with the governing elite recruited from the upper class and influential groups.

**Table 2.5 - Cultivated Areas and the Productivity of Selected Export Products 1931 to 1960**

| PERIOD | SUGAR CANE | | COTTON | | COFFEE | |
|---|---|---|---|---|---|---|
| | 1,000 ha | Kg/ha | 1,000 ha | kg/ha | 1,000 ha | kg/ha |
| **1931-1933** | 369 | 42.2 | 738.4 | 303 | 3,861 | 398 |
| **1934-1936** | 457 | 38.6 | 1,778.7 | 364 | 3,532 | 412 |
| **1937-1939** | 473 | 36.4 | 2,286.2 | 394 | 3,485 | 400 |
| **1940-1942** | 561 | 38.8 | 2,278.8 | 460 | 2,357 | 110 |
| **1943-1945** | 636 | 37.9 | 2,645.0 | 387 | 2,349 | 252 |
| **1946-1948** | 783 | 37.4 | 2,419.1 | 283 | 2,430 | 398 |
| **1949-1951** | 833 | 38.9 | 2,557.7 | 283 | 2,646 | 410 |
| **1952-1954** | 979 | 39.1 | 2,703.4 | 293 | 2,916 | 367 |
| **1955-1957** | 1,123 | 39.4 | 2,693.6 | 342 | 3,450 | 363 |
| **1958-1960** | 1,278 | 41.8 | 2,714.2 | 495 | 4,265 | 802 |

Source: MELO 1983, quoted by CARVALHO 1992: 58-59.

According to Furtado, [1965: 85] Brazilian development after the 1930s was based on industrialisation within which the new social structure flourished. In contrast to the slave agriculture era, the social pyramid in the rural areas in the 1940s was formed as follows: the entrepreneurs were at the top of the hierarchy, followed by the smallholders who worked on their own land and did not pay for labour and the sharecroppers who, not themselves owning any land, worked on others and hired out their labour for wages. Finally the labourers (the salaried manpower) at the bottom [Costa Pinto, 1970: 269-271].

By the end of the nineteenth century and the beginning of the twentieth, the transformation of agricultural manpower due to the abolition of slavery had led to the need for agricultural technology. Agricultural machinery began to be used (mainly on the coffee plantations) [Souza, 1993: 50]. Table 2.6 shows that in the first decades of the twentieth century, agricultural mechanisation was not common. Nevertheless, in the following decades, manpower was replaced by agricultural machinery, even though land and immigrant labour were still abundant.

**Table 2.6 - Tractors in Brazilian Agriculture - 1920 to 1980**

| YEAR | CROPS (1,000 HA) | TRACTORS (NUMBER) | HA/TRACTOR |
|---|---|---|---|
| **1920** | 6,642 | 1,706 | 3,893 |
| **1940** | 18,835 | 3,380 | 5,572 |
| **1950** | 19,095 | 8,372 | 2,281 |
| **1960** | 28,712 | 61,345 | 468 |
| **1970** | 33,984 | 165,870 | 205 |
| **1980** | 51,366 | 530,691 | 97 |

Source: IBGE Various Agricultural Census.

Furtado [1989: 9] says that after the Second World War, the government protected coffee prices in the international market by using subsidies through the devaluation of the national currency. According to him, this measure favoured industrial activities, and promoted industrialisation in Brazil. Furtado states that the World crisis in 1929 and the over-production of coffee were the initial reasons for the promotion of Brazilian industrialisation. Mantega [1989: 35] agrees and notes that the coffee boom produced the financial resources and demand for manufactured goods. In his view, this facilitated initial industrialisation in Brazil. Ianni [1970: 22] argues that industrialisation in Brazil after 1930 constituted the beginning of the internationalisation of the Brazilian economy. However, Sodré [1980: 147-154] suggests that state and local oligarchic power still continued to be based on land monopoly as the transition between the colonial and modern period was slow, and that no bourgeois Brazilian revolution took place. Table 2.7 gives the indices of productivity of the Brazilian economy, indicating that the largest industrial growth was in the post Second World War period.

**Table 2.7 - Indices of the Productivity of the Brazilian Economy - 1948 to 1960**
**Base: 1949=100**

| SECTOR | 1948 | 1950 | 1952 | 1954 | 1956 | 1958 | 1960 |
|---|---|---|---|---|---|---|---|
| **Agriculture** | 95.7 | 101.5 | 111.5 | 120.5 | 126.7 | 141.3 | 156.1 |
| **Industry** | 90.6 | 111.4 | 124.4 | 146.7 | 173.5 | 213.2 | 264.8 |
| **Commerce** | 96.2 | 104.1 | 122.5 | 136.7 | 142.7 | 171.1 | 197.8 |
| **Transportation**[1] | 92.3 | 108.0 | 126.4 | 147.7 | 152.4 | 176.7 | 219.1 |
| **Government** | 97.6 | 102.4 | 107.4 | 112.6 | 118.1 | 123.9 | 130.0 |
| **Service** | 97.1 | 103.0 | 109.4 | 116.1 | 123.3 | 130.9 | 139.0 |
| **Rent** | 96.4 | 103.5 | 111.0 | 119.3 | 128.2 | 137.8 | 148.0 |

[1] Transportation and Communication
Source: Getúlio Vargas Foundation (FGV), quoted by REVISTA BRASILEIRA DE ECONOMIA 1963: 14.

Industrialisation began in Brazil without a change in the traditional agrarian order. The large estates remained part of the Brazilian development process and, during this period, Brazil was still an essentially agricultural country. For instance, in 1950 the agricultural sector absorbed 57.76% of the active working population, the largest employment sector [Costa Pinto, 1970: 265]. However, there was high growth in Brazilian industry of the post World War period, mainly in the 1950s and at the end of the 1970s, when durable consumer goods and other industrial goods were produced [Cruz, 1993: 25].

In agriculture, traditional factors of production - such as labour and animal power - were replaced by machinery. The use of chemical fertilisers, high yielding seeds and agricultural chemicals, such as pesticides, increased land productivity. This meant a basic change in agriculture's technical apparatus. Initially, the new inputs were supplied through imports. For the first time, a government plan - the Target and Goals Plan between 1956 and 1960 - was carried out. This plan focused on energy, transport, education, and food supplies. The best results were obtained in the petrochemical, automobile, shipbuilding and heavy machinery industry. Castro [1984: 320-323] states that this Plan was the foundation of the agricultural modernisation policy.

The link between agricultural research, rural credit, and rural extension organisations led to the introduction of capital inputs and machinery into the new capital-intensive agricultural production system. The investment required for this Plan surpassed the resources of the local financial market and led to an increase in international debt [Auty, 1994: 148]. It is necessary to point out that the Target and Goals Plan, in line with the import substitution model, promoted growth in the consuming sectors (mainly in luxury goods for upper class demands), raised inflation rates and expanded external debt. It did not promote agricultural development in relation to food crop expansion, land distribution, or even the maintenance of rural employment. In fact, it led to the transition to a new balance of capital accumulation between agriculture and industry. According to Gorender, [1994: 17] 'in capitalist production, agriculture is not only agriculture, it has also an industrial wing, such as the textile, chemical, and steel industries'. This dependent relationship between agriculture and industry was known in Brazil as agricultural modernisation.

### 2.4. Modern Agriculture [After 1960]

As a consequence of industrialisation in Brazil in the 1950s, various industrial estates were established, mainly in the South-eastern region (in the States of São Paulo, Rio de Janeiro, and Minas Gerais). This region is the richest in Brazil and the State of São Paulo has the largest industrial estate in Latin America. Industries focused on the production of capital goods, such as machinery, automobiles, steel, cement and working equipment. In the 1960s, tractor, fertiliser and pesticide industries linked to agricultural industries were started up. Agriculture was no longer based on the abundance of land and labour and became capital-intensive. Agricultural research and technical assistance organisations were created, public policies were formulated and technologies based on mechanical, biological and chemical inputs were massively employed. This represented the starting of the so-called modernisation of agriculture in Brazil.

In reality, industrial and agricultural modernisation in Brazil was brought about by external influences. They originated in the developed countries and were transferred to the underdeveloped world as part of the strategy of capital accumulation in the international labour economy. Evans [1979] suggests an intimate relationship between the national (national bourgeoisie), and international capital (transnational companies) and the State (state-owned corporations) in the development of the modernisation of Brazil in the 1970s. He called this *pact*, the *Triple Alliance*, which promoted the basis of industrialisation and of dependent development in Brazil. The fruits of this progress were appropriated by a few privileged social segments and excluded the majority of the population.

Souza [1993: 53] notes that the new agricultural technology, the 'Green Revolution' was based on agricultural chemicals, machinery, and high yield seeds. It originated between the 1930s and the 1950s in the rich countries and was diffused to the Third World. Marinho [1991: 75], in analysing agricultural modernisation in Brazil, says that such technology benefited the capitalised farmers and increased the productivity of select crops grown on the best lands. The Green Revolution package provoked widely variable social transformations in different underdeveloped countries [Martine, 1991: 193]. In sum, the modernisation ideology was intended to transform the traditional culture of the Third World [Thiollente, 1984].

So, agricultural modernisation began in 1960, peaked in the 1970s and continued in the 1980s. Muller [1988] argues that in the sixties and seventies, agriculture was incorporated into the industrial, commercial and financial logic which prevailed in the country. The 1980s led to the growth of modernisation beliefs. Thus, for the first time in 1972, the Federal government put forward the First National Development Plan - PND (1972/1974). Industrialisation, modernisation, external trade, development, and national security were the principal aims. This euphoric period was known as the *Brazilian miracle*. The military government's expectation was an increase in GDP of between 8 and 10% per year. The main targets of the Brazilian development model were 'to transform Brazil from a poor to a developed country' and the 'creation of a modern, competitive, and dynamic economy'[Brasil, 1971: 7-15].

As a result, the government proposed several macro strategies through the First PND, as follows: to develop modern agriculture based on the entrepreneurial mode - mainly in the Central and Southern regions; to modernise the commercialisation and distribution of agricultural products; and to transform North-eastern agriculture, and expand the agricultural frontier to the Amazon, *Cerrados* areas and the Sao Francisco river valley. Indeed, the government was able to transform traditional agriculture and promote national integration [Brasil, 1971: 27].

Overall, the modernisation process in Brazil depended on industrial growth directed towards agriculture, and on public policies to provide incentives for modernisation, such as subsidised credit, and several fiscal incentives. According to Delgado [1986: 16], subsidised agricultural modernisation in Brazil integrated financial capital through rural credit and state fiscal and financial incentives. The support of the government concentrated power in the President of the Republic's hands and was of fundamental importance to the consolidation of modernisation [Muller, 1988: 179].

It is important to bear in mind that the government was the crucial element in the new development model. The military rulers pursued the concept of a great society, that is a powerful capitalist, industrialised and internationally recognised Brazil. From this perspective, the effective segments for public agricultural policy formulation were the 'modernisation planners' located in the Finance Ministry who prioritised the urban industrial development of the country. The 'agricultural planners' located in the Agriculture Ministry directed their efforts at the agricultural sector but their work space had been previously defined by the 'modernisation planners'. In case of conflict between them, the 'modernisation planners' initiatives came first. These were more powerful than those of the 'agricultural planners' [Mueller, 1982: 120].

The government's determination to modernise the country was carried on in the Second National Development Plan - PND (1975 - 1979). The main macro strategies remained the 'consolidation of industrial society'. The 'public incentives for the agricultural frontiers, mainly the Amazon and *Cerrados* areas, continued absorbing political concerns' and 'specific agricultural frontiers policies were formulated', and the 'integration of the country in the international economy' constituted the principal elements of the development proposal at the end of the 1970s [Brasil, 1974].

Further, according to Brasil [1974: 41-45], the 'support for the industrialisation and modernisation expressed the government's target'. Moreover, incentives for agricultural research and rural extension programs were spelt out as follows: the 'formation of a new operational agricultural research model focused on agricultural research and experimentation'. It was 'important to promote agricultural technological support through the Brazilian Agricultural Research Organisation - EMBRAPA, and Brazilian Technical Assistance and Rural Extension Organisation - EMBRATER'. This supports Graziano da Silva's argument, 'that technological progress in the capitalist system means the progress of the capitalist techniques focused on increasing the profits of the private production mode owners' [Graziano da Silva, 1990: 17].

To cope with the goals of the First and Second National Development Plans, various public policies were enacted. First, the previously mentioned incentives for the installation of the agricultural input industries, mainly through foreign capital, were implemented. According to Suzigan and Smrecsankyi [1994: 8], foreign capital flowing to the processing industry in Brazil focused on the growth of the Brazilian internal market and on the exploitation of local raw materials. Secondly, state agricultural research organisations, such as EMBRAPA were created to support the new demands from the capital-intensive mode of agricultural production. Thirdly, rural development programs were established as well as agricultural price policies and heavily subsided rural credit was put in place.

It is important to say that rural credit policy was linked to agricultural technology prescriptions. It was a subtle strategy implemented by the input industries and financial banks through technical assistance and research organisations to diffuse agricultural technology packages. For instance, the national rural credit system was launched in 1967. Between 1969 and 1979, the financial resources increased five-fold in real terms [Silva, 1991: 228]. This forced the adoption of capital-intensive inputs by farmers.

Thus, the expansion of agricultural productivity was a result of the replacement of farm inputs produced and controlled inside the farms by modern inputs from the industrial sector. As Busch and Blach note, 'as a result of this substitution of production factors, a part of agricultural valorisation has been appropriated by the agricultural input and processing industries'. They go on to suggest that agricultural research reinforced this appropriation and, as a consequence, promoted capital accumulation [1990: 80-81]. Their argument is supported by the data in Tables 2.8 and 2.9. From the 1960s to the 1980s, there was an enormous growth in the consumption of chemical agricultural inputs. Table 2.8 points out the increasing consumption of chemical fertilisers between 1961 and 1980.

**Table 2.8 - Consumption of Chemical Fertilisers in Brazil - 1961 to 1980 in Kg/Ha**

| YEAR | NITROGEN (N) | PHOSPHORUS ($P_2O_5$) | POTASSIUM ($K_2O$) | TOTAL |
|---|---|---|---|---|
| **1961** | 1.95 | 4.05 | 2.50 | 8.50 |
| **1962** | 1.71 | 3.96 | 2.31 | 7.98 |
| **1963** | 2.16 | 5.19 | 3.05 | 10.40 |
| **1964** | 1.65 | 4.40 | 2.27 | 8.32 |
| **1965** | 2.26 | 3.84 | 3.20 | 9.30 |
| **1966** | 2.24 | 3.67 | 2.94 | 8.85 |
| **1967** | 3.20 | 6.32 | 4.24 | 13.76 |
| **1968** | 3.48 | 8.31 | 6.52 | 18.31 |
| **1969** | 4.92 | 7.95 | 5.99 | 18.86 |
| **1970** | 8.12 | 12.24 | 9.02 | 29.38 |
| **1971** | 7.89 | 15.20 | 9.95 | 33.04 |
| **1972** | 11.25 | 23.91 | 12.57 | 47.73 |
| **1973** | 9.12 | 21.19 | 13.91 | 44.22 |
| **1974** | 9.88 | 23.20 | 13.23 | 46.31 |
| **1975** | 10.99 | 24.71 | 15.02 | 50.72 |
| **1976** | 11.55 | 30.83 | 16.75 | 59.13 |
| **1977** | 15.84 | 35.29 | 21.35 | 72.48 |
| **1978** | 15.65 | 33.81 | 21.85 | 71.31 |
| **1979** | 16.64 | 35.40 | 23.00 | 75.04 |
| **1980** | 17.30 | 38.29 | 24.72 | 80.31 |

Source: ALVES 1984a: 19.

Further, Table 2.9 indicates that the expansion in land productivity was also obtained through the utilisation of other capital-intensive inputs, such as, pesticides, fungicides, and herbicides. Thus, land and labour productivity were increased through the use of machinery, such as tractors and chemical capital-intensive inputs - the called modern agricultural production factors.

**Table 2.9 - Indices of Consumption of the Chemical Agricultural Inputs in Active Principle - 1970 to 1980 - Base: 1970=100**

| YEAR | PESTICIDE | FUNGICIDE | HERBICIDE |
|---|---|---|---|
| **1971** | 96 | 149 | 147 |
| **1972** | 120 | 319 | 143 |
| **1973** | 134 | 477 | 277 |
| **1974** | 160 | 523 | 437 |
| **1975** | 148 | 184 | 656 |
| **1976** | 101 | 215 | 710 |
| **1977** | 120 | 317 | 583 |
| **1978** | 151 | 296 | 669 |
| **1979** | 137 | 328 | 589 |
| **1980** | 114 | 472 | 829 |

Source: Kageyama and Graziano da Silva 1983, quoted by Silveira 1992: 131.

As a result of the substitution of production factors in the agricultural production systems, especially machinery for labour a significant mass of unskilled rural labourers migrated from the rural areas to the big cities. Table 2.10 shows figures on rural migration between 1940 and 1980. It is important note that, from 1970 to 1980, about one-third of the rural population moved from rural areas to bad living conditions in the large urban centres. In addition, modernisation brought serious consequences for the environment, in particular, chemical pollution affecting labourers, rivers, lakes and animals. In Graziano da Silva's words, this was a 'painful modernisation' [Graziano da Silva, 1981].

**Table 2.10 - Rate of Migration of the Rural Population in Brazil - 1940 to 1980**

| PERIOD | RURAL POPULATION[1] | POPULATION MIGRATED | RATE OF MIGRATION |
|---|---|---|---|
| **1940 - 1950** | 28,356, 133 | 2,749,075 | 9.7 |
| **1950 - 1960** | 33,161.506 | 5,535,515 | 16.7 |
| **1960 - 1970** | 32,987,526 | 10,235,249 | 26.3 |
| **1970 - 1980** | 41,054,053 | 14,015,409 | 34.1 |

[1] Rural population at the begin of each decade
Source: ALVES 1984: 28.

In contrast, Schuh and Alves [1970] argue that the essential task of the agricultural modernisation development was to transfer labour from the agricultural sector to the industrial one. This means, in Schuh and Alves's words to 'make efforts to lower the cost of labour to the entrepreneur' and to modernise the production of export products. Agricultural modernisation was intended to help alleviate the distorted income distribution in the country and, in addition, to alleviate somewhat the nutritional problems associated with low income.

Overall, in the 'Brazilian miracle' era, the economy throughout the 1970s grew at a rate of 10% per year. For Roett [1992: 165], total investment in manufacturing in Brazil increased nearly fourfold between 1970 and 1979, growing at an average annual rate of about 15.5% in real terms. The distribution of investment was highly concentrated in a small number of industries, for instance, metallurgy, transport equipment and chemical products. Jaguaribe [1989] argues that from 1960 to 1980 Brazilian growth was due to industrial development and vertical integration. Although, in this period economic growth promoted high levels of capital accumulation, Oliveira [1981: 67], argues that the income distribution deteriorated in Brazil between 1960 and 1970. In 1960, the richest 1% of the population received 11.72% of total income, in stark contrast to the poorest 40% who received just 11.2%. By 1970, the proportion had risen to 17.77% for richest 1% and fallen to 9.05% for the poorest 40%.

**2.4.1. The Post Miracle Period**

By 1974, the Brazilian *economic miracle* was over. Its adverse effects were said to be a growing inequality in income and wealth distribution with wide social segments of the population marginalized and removed from the rewards of the elitist development model [Moreira Alves, 1993: 227]. In the same way, Mueller [1990] shows that government policies for the expansion of the agricultural frontier - mainly in the Central-West region - did not meet the focused goals. The major consequence was the transfer of financial resources to individuals and to influential groups with no effect on regional development.

From the same perspective, the agricultural occupation of the Amazon followed a military prescription for national security rather than a social development approach. For instance, instead of a land reform program in the Amazon area, the government applied a colonisation scheme. As a result, the private colonisation plan and land conflicts benefited the powerful economic groups but not the peasants and landless rural people. On the one hand, the frontier expansion in Brazil served as social control for high population growth and increasing poverty and social tensions in the urban centres. On the other, it has been a factor of increasing agricultural production, maintaining the archaic and cruel land-tenure system [Martine, 1991: 188].

Another aspect of 'painful modernisation' was land concentration, the continued orientation towards export staples to the detriment of food crops and social and environmental issues. The logic of agricultural modernisation had been directed to export staples, land concentration and capital accumulation. The social and environmental consequences were not part of the agenda. The agricultural capital-intensive production mode, in other words, technology innovation, should have been capable of reducing the risks resulting from the natural determinants of agricultural production - such as climate, soil, light, rain, and so on. Thus, the agricultural process of production could be seen as an assembly line, leading to increased profits. However, land still remains a fundamental factor of production which is highly concentrated. Land has been transferred to the next generation and protected by an archaic heritage law for a long time. Table 2.11 shows land distribution between 1967 and 1985. These figures demonstrate once again that land is concentrated in large estates *(latifundium)* and, in contrast, small farmers only have access to a minor part.

**Table 2.11 - Landownership Distribution in Percentage in Brazil - 1967 to 1985**

| OWNERSHIP | 1967 | 1972 | 1978 | 1985 |
|---|---|---|---|---|
| **Small area (minifundium)** | 12.2 | 12.5 | 8.8 | 8.2 |
| **Rural enterprise** | 4.6 | 9.7 | 5.6 | 22.6 |
| **Estate (latifundium)[1]** | 76.4 | 72.9 | 77.7 | 62.0 |
| **Estate (latifundium)[2]** | 6.4 | 4.9 | 7.8 | 6.7 |

[1] Unproductive estates (land use)
[2] Productive or Unproductive estates (land size)
Source: GUANZIROLI 1984 and INCRA 1986, quoted by SILVEIRA 1992: 125.

In a similar way, Hoffman [1991] when analysing land distribution in the agricultural sector, found that inequality increased as a consequence of agricultural modernisation. The income appropriated for the richest 10% of the economically active urban population increased between 1960 and 1970 from 28% to 45%. Hoffman says this indicates that in the 1970s, Brazil had one of the most unequal income distributions in the World.

In addition, there was increasing inequality within the economically active rural population. The income of the poorest 50% decreased from 15.8% in 1970 to 12.2% in 1980. At the same time, the income of the richest 10% increased from 38.4% in 1970 to 51.0% in 1980. The Gini coefficient, which expresses degrees of income inequality rose from 0.532 in 1970 to 0.622 in 1980. For Cardoso, [1982: 28] this means that the capitalisation of agriculture reproduces the traditional and agrarian social layers on the one hand, and, on the other, creates new social layers, such as 'peasants', and the 'rural proletariat', or in a wider sense, creates segments within the rural workforce. Table 2.12 shows increasing inequality in income distribution of the population occupied in the agricultural sector. These figures indicate income concentration in the upper social strata.

**Table 2.12 - Distribution of the Employed Population in the Agricultural Sector - 1979 to 1987**

| REGION | YEAR | NI (%) | GINI'S INDEX | POOREST [50 -] | RICHEST [10 +] | RICHEST [5 +] |
|---|---|---|---|---|---|---|
| NE+SE+S | 1979 | 32.0 | 0.663 | 6.8 | 49.5 | 37.1 |
| | 1981 | 30.4 | 0.661 | 7.0 | 49.6 | 36.1 |
| | 1982 | 30.7 | 0.659 | 7.2 | 49.2 | 36.6 |
| | 1983 | 31.2 | 0.678 | 6.7 | 52.5 | 39.1 |
| | 1984 | 28.8 | 0.673 | 7.4 | 52.5 | 38.6 |
| | 1985 | 29.7 | 0.683 | 6.7 | 53.4 | 39.5 |
| | 1986 | 26.4 | 0.661 | 8.3 | 51.0 | 37.4 |
| | 1987 | 28.1 | 0.681 | 6.8 | 52.7 | 39.0 |
| | | | | | | |
| NE+SE+S+CO | 1981 | 29.7 | 0.659 | 7.3 | 49.6 | 36.1 |
| | 1982 | 29.9 | 0.657 | 7.4 | 49.3 | 36.7 |
| | 1983 | 30.2 | 0.674 | 7.1 | 52.3 | 38.9 |
| | 1984 | 28.0 | 0.671 | 7.7 | 52.4 | 38.6 |
| | 1985 | 28.9 | 0.682 | 6.9 | 53.5 | 39.7 |
| | 1986 | 25.6 | 0.661 | 8.4 | 51.0 | 37.6 |
| | 1987 | 27.4 | 0.682 | 6.9 | 52.9 | 39.4 |

NE = North-east SE = South East S = South CO = West-Central
NI = Percentage of people without income
Poorest [50 -] = Percentage of income appropriated for the 50% poorest
Richest [10 +] = Percentage of income appropriated for the 10% richest
Richest [ 5 + ] = Percentage of income appropriated for the 5% richest
Source: Based on HOFFMAN 1991: 159.

Following the strategy of previous development plans, the Third National Development Plan (1980-1985) focused on industrial expansion. Indeed, agriculture continued to be dependent on industrial development [Brazil, 1980: 74], but, in contrast to other national development plans, this one was less optimistic. It is possible that the euphoric effects of the *economical miracle* had disappeared as the inflation rate increased.

Furthermore, in relation to the agricultural sector, the main proposals were to support food crop production. For instance, the agricultural sector must 'increase food crop production for food to became cheap, and to feed the low income families', and 'to increase the production of export staples' [Brazil, 1980: 60]. This was the prime role of agriculture in this phase of modernisation. It is important to bear in mind that, during this period (at the end seventies), around 60% of Brazilians lived in cities, mainly in the large urban centres. Thus, three main functions were reserved for the agricultural sector. First, to produce cheap food to feed the urban proletariat and the increasing urban population. Secondly, to produce export staples for international trade and, thirdly, to absorb the industrial inputs to sustain the capital-intensive production mode.

In the 1980s, a decade of Brazilian development witnessed recession, stagnation, and high inflation rates. This decade was known as the *lost decade* because of the adverse social and economic consequences. In 1989, the annual inflation rate was 1,287.0. Kageyama [1992: 16], on analysing the agricultural census of 1985 (this was the latest agricultural census at the time of this research), says that at the beginning of the 1980s there was an increase in absolute poverty in Brazil, in relation to the population occupied in the agricultural sector. She found the proportion of poor people increased from 69.9% to 72.5% between 1981 and 1985.

Another severe consequence of modernisation was the orientation towards export crops to the disadvantage of food crops, such as cassava, rice, and beans. Silva [1991: 119-230], for example, shows that the portion of subsidised rural credit spent on export crops, such as coffee crops, sugar cane and Soya bean varied from 36% to 37% between 1975 and 1987. However, in the same period, rural credit spent on food crops for consumption hovered at around 32%.

Furthermore, according to Martine, [1991: 194-195] the area of food crops cultivated grew at a much slower rate than that of export products. The productivity of food crops (cassava, rice, and beans) levelled off or declined. On the other hand, the productivity of export products (wheat, Soya beans, and corn) increased significantly.

Also Baer [1995: 310] mentions in light of Table 2.13 that 'from the 1940s to 1980s there was no change (and even retrogression) in the productivity of such staple products as rice, bean and manioc [cassava]'. He emphasises that coffee, sugar and Soya bean, 'showed notable productivity increases', and 'from the mid-1980s to the early 1990s, substantial productivity increases occurred in cotton, rice, and wheat'.

In truth, the modernisation process has not stopped. It is a dynamic mechanism in society, involving various social spheres. Nowadays, according to modernisation ideology, the urban lifestyle has dominated material, cultural, and social relations. It is not the rural living standard that moulds urban centres. On the contrary, the urban lifestyle dictates rural lifestyle [Muller, 1988].

**Table 2.13 - Agricultural Productivity in Brazil - 1947 to 1991 in Kg/Ha**

| | 1947-49 | 1961-63 | 1964-66 | 1968-70 | 1972-74 | 1974-76 | 1978-80 | 1983-85 | 1988-91 |
|---|---|---|---|---|---|---|---|---|---|
| **Cotton** | 442 | 554 | 482 | 490 | 526 | 446 | 546 | 679 | 1,321 |
| **Peanuts** | 1,004 | 1,347 | 1,286 | 1,286 | 1,196 | 1,302 | 1,473 | 1,582 | 1,671 |
| **Rice** | 1,552 | 1,634 | 1,536 | 1,464 | 1,533 | 1,461 | 1,415 | 1,700 | 2,171 |
| **Cocoa** | 450 | 312 | 341 | 378 | 436 | 528 | 681 | 623 | 544 |
| **Coffee** | 411 | 415 | 771 | 811 | 1,192 | 1,009 | 1,046 | 1,356 | 1,011 |
| **Sugarcane** | 38,333 | 42,773 | 44,841 | 45,551 | 43,806 | 47,785 | 55,252 | 62,034 | 62,158 |
| **Beans** | 685 | 659 | 656 | 634 | 593 | 566 | 472 | 454 | 485 |
| **Manioc** | 13,347 | 13,404 | 14,120 | 14,662 | 13,168 | 12,278 | 11,770 | 11,601 | 12,526 |
| **Corn** | 1,256 | 1,311 | 1,283 | 1,365 | 1,462 | 1,650 | 1,479 | 1,792 | 1,880 |
| **Wheat** | 789 | 658 | 833 | 945 | 1,110 | 892 | 862 | 1,314 | 1,603 |
| **Soybeans** | - | 1,056 | 1,088 | 1,072 | 1,463 | 1,660 | 1,398 | 1,747 | 1,841 |

Source: PAIVA, Rui Muller; SCHATTAN, Salomão and FREITAS, Claus R. T. de, *Setor Agricola do Brasil* (São Paulo: Secreataria da Agricultura, 1973), pp. 64-65; IBGE, Anuário Estatístico, quoted by BAER 1995: 311.

Table 2.14 reveals the sectoral distribution of GDP in Brazil in which the services and the industry are also the leader sectors.

**Table 2.14 - Brazil: Sectoral Distribution of GDP**

| | 1953 | 1960 | 1965 | 1970 | 1975 | 1980 | 1982 | 1983 | 1992 |
|---|---|---|---|---|---|---|---|---|---|
| **Agriculture** | 26 | 23 | 19 | 11.7 | 9.7 | 8.8 | 9.1 | 12.0 | 9.9 |
| **Industry** | 24 | 25 | 33 | 35.4 | 36.8 | 38.2 | 36.7 | 35.0 | 31.6 |
| **(Manufact.)** | | | (26) | (28.0) | (29.0) | (29.0) | (27.0) | (27.0) | (20.4) |
| **Services** | 50 | 52 | 48 | 52.9 | 53.5 | 53.0 | 54.2 | 53.0 | 58.5 |

Source: CONJUNTURA ECONÔMICA, quoted by BAER 1995: 361.

Further, important data are shown in Table 2.15. It shows the distribution of paid workers in the Brazilian economy. The figures indicates significant growth in the worker population in the services and industrial sectors in relation to agriculture, mainly in the richest and most developed South Eastern region.

**Table 2.15 - Number of the Employed Population according to the Main Activities in the Great Regions in Brazil in 1990**

| ACTIVITIES | BRAZIL[1] | NORTH[2] | NORTH - EAST | SOUTH - EAST | SOUTH | WEST - CENTRAL |
|---|---|---|---|---|---|---|
| **Agriculture** | 18,253,856 | 354,338 | 8,000,287 | 4,671,932 | 3,795,627 | 1,303,782 |
| **Industry[3]** | 13,775,594 | 490,426 | 2,724,173 | 7,305,969 | 2,535,344 | 704,640 |
| **Commerce** | 8,474,935 | 473,984 | 2,236,153 | 3,821,481 | 1,327,741 | 611,520 |
| **Services[4]** | 13,768,652 | 590,590 | 3,041,224 | 6,985,337 | 2,103,340 | 1,028,657 |
| **Transportation[5]** | 2,283,978 | 99,575 | 458,055 | 1,218,080 | 346,768 | 159,331 |
| **Social** | 5,579,321 | 282,387 | 1,431,235 | 2,676,813 | 788,025 | 389,835 |
| **Public[6]** | 3,044,332 | 217,333 | 847,175 | 1,249,963 | 422,478 | 304,314 |
| **Others** | 1,389,089 | 46,455 | 230,424 | 771,395 | 241,122 | 99,897 |

[1]Excluding the rural population of the States of Rondônia, Acre, Amazonas, Roraima, Pará and Amapá
[2]Excluding the rural population
[3]Includes the transformation, the construction, and other industry activities
[4]Includes the auxiliary services in general and the auxiliary services of the economic activity
[5]Transportation and Communication
[6]Public Administration
Source: Based on IBGE 1993: 41.

To sum up, the capitalist production system has changed its strategy in order to maintain the levels of capital accumulation in Brazilian agriculture. For instance, Graziano da Silva [1988: 6-7] considers crucial the transformation of the 'rural complex' (as the natural agricultural practice) into the articulation of the 'agro-industrial complex'. This results in the intensification of agricultural specialisation and the integration of agriculture and industry which promotes the so-called 'modern agrarian pattern', in contradiction to Muller's argument that 'agriculture cannot be reduced to an industry' [1991: 39-40]. Besides, the creation of EMBRAPA in 1972 was part and parcel of this modernisation process, in which the state took responsibility for the creation of national organisations. This would further the development of capitalist agriculture by assisting in the diffusion of Western technology throughout Brazil. The next chapter will focus on agricultural research in Brazil.

**2.5. Summary**

Brazil was 'discovered' by the Portuguese crown and remained a colony from 1500 to 1822. The colonisation strategy was based on the exploitation of natural resources, especially brazilwood and mineral products. The *plantations* agricultural production system aimed at exportation was based on African slave labour and abundant virgin land. In fact, the colonial exploitation system influenced the formation of Brazilian society, particularly of the archaic rural elite. The transitional agricultural production system shifted from the slave workforce to European immigrants. At that time, after pressure from the rural elite, the first agricultural research organisations of the Imperial government were provided. In the 1950s Brazilian industrialisation began and by the 1960s it was definitely established. In the 1970s, under the military dictatorship, the so-called agricultural modernisation following Green Revolution principles took place. At that time, EMBRAPA was created to support the modernisation and capitalist agriculture. Brazil was thus inserted into the international economy as an agricultural exporter and importer of technology and industrial products. Agricultural technology standardisation and the agro-industrial complexes were the main roads leading to capital accumulation.

# CHAPTER 3

# POLITICS, CLASS AND AGRICULTURAL RESEARCH ORGANISATIONS

## 3.1. Introduction

The history of agriculture forms a fundamental part of mankind's history and is intimately linked with its social, political and economic aspects. Although no work of history, this chapter will link the most important aspects of the Brazilian agricultural research system from 1500 to the 1970s to the history of the country itself. Over this period, agricultural research organisations changed and metamorphosed, and it is important to see how vested interests directed those changes.

## 3.2. The Colonial Heritage [1500 - 1822]

In the colonial period the exploitation of agricultural and mineral products formed the economic base of the hereditary captaincies. The colonial establishment supplied the western markets with such basic primary products, such as sugar, cotton and exported raw materials in bulk. According to Furtado [1963], 'Brazil is the only country on the American continent created by commercial capitalism as an agricultural enterprise'.

During the colonial period, there was great interest in the New World. European scientists travelled to Brazil to collect plants and exotic materials and important work was developed in the field of Natural History. Brazilian biological diversity became well known within European countries. Azevedo [1950: 230] argues that 'during the whole colonial period, from its discovery to the arrival of Prince John VI in 1808 from Portugal, there were in fact not recorded in the history of our culture anything but sporadic and isolated manifestations of scientific interest'. This is confirmed by Motoyoma [1985], who argues that in the three centuries after Brazil's discovery, there were no significant events in the scientific or technological fields. Besides, Bethell [1989: 18] reports that 'Prince John VI on his arrival in Brazil immediately identified with the interests of the large Brazilian farmers'[1].

During the administration of Prince John VI (1808-1821), the first institutions of a cultural character were established. Among these were the Royal Press, the Public Library, the Royal Garden, the Royal Museum, and the first higher schools of training for surgeons and military engineers. Azevedo [1950] declares that 'there was an imbalance between literary progress and scientific development'. In truth, there were obstacles to the penetration of the critical and scientific spirit and the spread of the study of the sciences of observation.

Historians are unanimous in their judgement of the first agricultural research organisation in Brazil. This was the Botanical Garden of Rio de Janeiro, created in 1808 by Prince John VI. Its aims were to provide leisure activities and research into agriculture and forestry. The Botanical Garden also introduced some agricultural and forestry specimens. 'At the beginning, the questions of science and agricultural matters were studied', and 'the plant collections, and laboratories were dedicated to address agricultural and forestry problems' [Arquivos do Jardim Botânico, 1974: 13]. In reality, the garden was created to help the colony to respond to the new demands of the recently established Royal family, in Brazil. Along with the other botanical gardens, the Botanical Garden of Rio de Janeiro served Science as well as the State and it was linked to the mercantilist and nationalist spirit diffused from European empires [Brockway, 1979].

[1]The invasion of Portugal by Napoleon forced Prince John VI and the Portuguese Royal family to transfer their court from Lisbon to Rio de Janeiro. At that time, he promoted the opening of the Brazilian ports to friendly nations which was an important stage in the development of agricultural research. It permitted the development of scientific contact between Brazil and European countries and, in particular, scientific expeditions.

In 1821, Prince John VI returned to Portugal and in 1822 Brazil declared its independence. However, Brazil ended its colonial era as an unequal society. The social structure formed and maintained for almost three centuries, based upon sugar cane and slave labour, had retarded Brazilian progress. Gaioso [1818] divided Brazilian society into five classes which reflected the social reality of the late colonial period as follows: first, the most powerful class was that of the metropolitan - European born people who, he felt, monopolised the colony's high offices and honours. Second, the native-born Europeans who, despite their wealth, spent a great deal of time on their status and had little interest in government or commerce. Third, the mestizos and mulattos, the most active group in society, who performed all the mechanical arts and other occupations which the 'superior classes' avoided either out of choice or indolence; fourth, black slaves, and fifth, Indians. Some authors claim that what Gaioso had in mind was not 'class' but caste or racial type. Therefore, Azevedo [1950] argues that the distinction between the classes was established on an economic basis as well as an racial differentiation. For example, the distinction between Portuguese, Indians and Mestizos; Lords and Slaves; Whites and Negroes.

**3.3. The Imperial Period [1822 - 1889]**

In 1822, Brazil gained independence from Portugal and the Brazilian Empire came into existence. Emperor Peter I took the crown and opted for centralised rule. Brazilian independence was relatively quick and peaceful. The political system created at the time of Independence reflected the needs of an elite group of land owners, merchants and their clientele. Baer [1965: 8] argues that monarchical status continued until 1889. As well as this, Schwartz [1975: 138] explains that the 'Brazilian rural oligarchy that sought to maintain itself became the exponent of the principles of nationalism and liberalism from Europe, and was the architect of Independence, whilst simultaneously avoiding civil war and territorial disintegration'.

Furthermore, Viotti [1989] states that the traditional structures of production based on slave labour and the export of colonial staples to the international market were maintained. The elite intended to govern the country without taking into account the mass of the population who lived in fear of it. The system was extremely centralised, oligarchic, and unrepresentative. For Deak [1991], Brazilian independence was led by the dominant land owners, business and bureaucratic servants. They promoted the survival of the colonial structures of production, organised the State and controlled the main economic and social domains. The Brazilian economy remained dependent upon a few agricultural export products. The agrarian structure did not alter its basic characteristics and the colonial agricultural productive system remained as before. Therefore, as Moraes [1993] argues, between Independence and the Republic, the slaves and the land owners constituted the bottom and upper social classes in Brazil.

At the time of independence, less than a third of Brazil's population was white. The great majority was black or mulatto. At least 30 percent were slaves. These figures show the importance of the slaves in the agricultural workforce. The best estimate of the total number of slaves is probably 1,147,515 in 1823 according to Revista do Instituto Histórico e Geográfico Brasileiro [1959]. However, in 1850, after strong international pressure, mainly from England, the transportation of slaves from Africa to Brazil was prohibited. Nevertheless, the General Legislative Assembly voted for the final abolition of slavery in 1888. This led to a scarcity of labour in the agricultural production system. This was the case for coffee expansion which depended on two abundant factors of production, land and slave labour. Silva [1979:

17] suggests that the lack of manpower was a serious obstacle to the expansion of coffee crops between 1860 and 1880. Two attempts were made by the Emperor to solve this problem. First, the Imperial government started to encourage European immigration and, secondly, it created several agricultural research institutes. Table 3.1 shows European immigrants entering Brazil, between 1820 and 1855.

**Table 3.1 - European Immigration - 1820 - 1855**

| PERIOD | IMMIGRANTS (Number) |
|---|---|
| 1820 - 1825 | 3,167 |
| 1826 - 1831 | 6,505 |
| 1832 - 1837 | 1,884 |
| 1838 - 1843 | 7,871 |
| 1844 - 1849 | 5,217 |
| 1850 - 1855 | 50,607 |
| **Total** | **75,251** |

Source: Based on George P. Browne, 'Government immigration policy in Imperial Brazil, 1822-1879, unpublished PhD thesis, Catholic University of America, 1972, p. 328, quoted by BETHELL and CARVALHO 1989: 99.

The imperial government promoted European immigration to compensate for slave labour in the early forties. A budget allocation for immigration was introduced for 1841-42, but this was not enough. The fundamental problem was how to keep free, immigrant labour that was enticed to Brazil, on coffee plantations organised for slave labour when, in the first place, vast expanses of public land were freely available (i.e. how to prevent an immigrant from becoming a landowner by the simple process of occupying public land). Secondly, there was competition from the periphery of the coffee regions for scarce labour [Bethell, 1989: 99]. In truth, for the coffee farmer, the immigrant was simply a source of manpower for the coffee plantation. Restrictions by law made it difficult for immigrants to acquire public land. Land owners expected immigrants to bring agricultural experience from their country to improve the coffee production system.

The scarcity of agricultural manpower (particularly for coffee crops), coincided with important transformations in the world of agricultural science. In that period, a German scientist, Liebig, demonstrated the use of chemistry in agricultural production. As a consequence, European countries began an important movement to modernise agriculture on a new technical basis. In this context, experimental stations were created in Europe and in the tropical countries, and the agricultural research institute model was diffused around the world. Thus, in 1859 the Brazilian Emperor, under the new political order, pressured by the landowners and the coffee farms in particular, created the Imperial Agricultural Institutes in the provinces of Rio de Janeiro, Pernambuco, Sergipe, Bahia and Rio Grande do Sul. In 1860 the Ministry of Agriculture was established as the Secretariat of Agricultural Trade. The agricultural research institutes followed the European model where each had a specific mandate. In general, each institute constituted an independent administrative unit. The institutes were organised into departments and experimental stations. Their mandate covered research, but not teaching or extension.

With respect to the creation of the agricultural research institutes, there is no doubt that pressure from the agricultural exporters prevailed. According to Silva [1878: 17-18], the Imperial Agricultural Institutes' aims met the farmers' demands. First, the agricultural institutes substituted labour by agricultural machinery and equipment; secondly, they promoted technology transfer; thirdly, they acquired better seeds to be distributed to farmers and fourth, they promoted animal breeding to improve stock. In fact, the purpose of their creation was to promote rational agricultural cultivation. Slave labour, once an abundant factor of production, would be substituted by new agricultural techniques created by the agricultural institutes.

In this context, just two agricultural institutes proved successful. First, the Imperial *Fluminense* Agricultural Institute - IFAI, located in the State of Rio de Janeiro. Coffee planting began in this state, in the Paraíba Valley, and it was there that the most powerful land owners and the richest coffee farms were concentrated. Once again, the state served the demands of the dominant class. IFAI introduced new varieties of sugar cane and potatoes, and trained farmers to use agricultural machinery. It offered high quality coffee seeds and cocoa, sugar cane, wheat, rice and cotton for farmers. It is also worth mentioning the publication of IFAI's magazine which diffused information on agriculture, husbandry, economy and business. Souza [1993] argues that the IFAI magazine focused on science as a factor in agricultural modernisation and urged agricultural profitability.

Secondly, the Imperial *Baiano* Agricultural Institute - IBAI, was located in the sugar cane area in the state of Bahia, in the *Recôncavo* region. This region was dominated by large land owners, called the *Barons of the Massapê Land.* This Institute developed studies in cattle-raising, pastures, cassava and agricultural mechanisation, and introduced new varieties of sugar cane, tobacco, cassava, wheat, cocoa, and cotton. The Institute distributed several high quality seeds to farmers. IBAI supported sugar cane and infant cassava processing. After several transformations, it became the modern Agronomy School of Bahia Federal University located in Cruz das Almas. Gonçalves [1993] argues that on the advice of the Emperor, some agricultural institutes shifted their projects from agricultural institutes to agricultural schools.

For him, this permitted the training of the personnel required by the agricultural production system.

By the end of the nineteenth century, coffee crops had moved from the State of Rio de Janeiro to the State of São Paulo where it was greatly expanded. Following this move, this State came to the attention of investors who claimed government support. Knowledge of the agricultural characteristics of the region was essential in order to make coffee cultivation possible, so in 1887, the Campinas Agricultural Station was created. In 1892 it was replaced by the Campinas Agricultural Institute which still exists to this day. For Albuquerque [1986: 85] at the end of the nineteenth century, the most important sector in the economy was agriculture. The large land owners controlled State policies and government incentives were directed towards agricultural export products. Until that period, the growth of agricultural production was through the addition of new agricultural lands.

Once again the State, and not the rich farmers, created the Campinas Agricultural Institute to make possible the generation of agricultural technology, increasing the production and productivity of the farmer's agricultural products, particularly coffee crops. This is noted by Gonçalves, [1993] who suggests the Institute was created as a result of pressure from the agricultural bourgeoisie represented by the coffee farmers and other interested parties in the finance and transport sectors. At the time, the Minister of Agriculture was a coffee farmer from São Paulo and his family had the largest coffee farm in Brazil.

Neither the Imperial period, nor the Colonial period, marked great advances in agricultural science since few agricultural research organisations were created. If in the Colonial era, sugar cane was the main commodity, in the Imperial period coffee crops dominated the economy of the country. According to Cardoso and Faletto [1977: 63], the

Empire was an effective guarantee of the regional interests linked to the slave economy and patrimonial domination. Agricultural technology was not an important factor of production and, as we have seen, the production system depended on new agricultural areas and cheap and abundant manpower. A different position is taken by Azevedo [1950: 249] however, who argues that 'the principal cause of the lack of science, far from resulting from a national lack of aptitude, was rather the type of teaching which was almost exclusively literary which had been implanted in Brazil from the colony down to the end of the Empire period'.

The replacement of the slave labour regime by one of free labour, and the entry of immigrants and foreign capital began a period of intense capital investment and of economic initiatives, such as railroads, factories, banks and navigation companies. The bases of the agrarian economy and the old structure of the country were now obsolete, and, according to Flynn [1978: 12] when the 'army leaders decided to declare the Republic, there was virtually no protest, or opposition, ever from the monarchy'. The Republic was proclaimed in 1889 and the new codes forced the abdication of the Emperor.

### 3.4. From the Old Republic to the Second World War II [1889 - 1945]

Historians usually divide the history of the Republic into two periods, that of the Old Republic from 1889 to 1930 and that of the Second Republic, from 1930 to 1937. The subsequent period of 1937 to 1945 is known as the New State. This section will present the most important developments in the agricultural research system during these periods.

**3.4.1. The Old Republic [1889 - 1930]**

In 1889 the Empire came to an end and the Republic began to flourish. The break with the Imperial regime and the foundation of the Old Republic represented a victory for decentralisation and the landed aristocracy [Roett, 1992]. However, levels of popular participation did not increase and the groups that had occupied prominent positions in the Empire also did so during the Old Republic. The State remained strongly influenced by the landowners, that is to say mainly the coffee and sugar plantation owners, who controlled political and economic policies at national level.

As mentioned before, there was the coffee cycle which began in the Paraiba Valley in the 1830s. This was to be the longest and most important cycle in Brazilian political, social and economic history, and it is still in operation today. Jaguaribe [1972: 46-47] characterises the coffee cycle, as a period of diversification and growing complexity in Brazilian society. A large internal market was formed, creating the conditions for the emergence of a new middle class. Economically marginal, this new class began to concentrate in the cities, pressing for government support. According to Cardoso and Faletto [1977: 64-65], for the first time in the 1870s with slave labour replaced by immigrant and free manpower, Brazilian capitalism became apparent. People and families from the civil bureaucracy and the military formed new influential groups. Thus, at the end of the nineteenth century, the landowners and exporters were the social class that controlled the state apparatus. In addition, Flynn [1978: 31] argues that throughout the whole period of the Old Republic, the State Armed Forces were another powerful new factor in the political equation.

The introduction of free labour on the coffee plantations, the Republican Constitution of 1891, and the First World War are all factors that influenced Brazilian society. Social divisions within the labour force were increasing, the strength of the States was becoming clearer and industrialisation was under way, along with a steady migration to the cities. For Furtado [1963] this all led to higher levels of production and consumption. Above all, according to Azevedo [1950: 413], with the decentralisation imposed by the Federalist ideas of the Republican government and through the Constitution of 1891, the States gained wide new powers to levy taxes, including export taxes, to raise foreign loans, and organise their own militia. They were growing in economic and political importance. For Fausto [1990: 120], the emphasis on political decentralisation served well-defined interests. The new constitutional framework created the conditions which gave power to the coffee bourgeoisie of the States of São Paulo and Minas Gerais.

In the same way, Fausto [1989: 266-267] says that the political system of this, the Old Republic, was founded on three nuclei of power. First, there were the local potentates *(coronéis)* who controlled the rural population of a given area. This was mainly in the Northeastern region. Secondly, were the State oligarchies which existed at an intermediary level and consisted - to a greater or lesser extent - of a *'federation of coronéis'*. And thirdly, at the pinnacle of the power structure sat the Federal government, which was the product of an alliance between the oligarchies of the most important States, such the as São Paulo, Minas Gerais, Rio de Janeiro, Rio Grande do Sul, and Pernambuco, and was, therefore, an expression of the *'federation of oligarchies'*. The Old Republic could be characterised, in other words, as the State controlled by coffee interests and by *política do café com leite* (white coffee policy). This also explains the economic interests of the alliances between the most influential States of São Paulo and Minas Gerais.

Although the agrarian oligarchy was not a part of the new alliances or of the social and political forces of the Republican establishment, its political and economic power remained intact. Oligarchies of the powerful States that included São Paulo and Minas divided the control of economic and social affairs. The oligarchies of the State of São Paulo were interested in the control of the State apparatus in order to realise their economic and private interests, while those of the State of Minas Gerais wanted to control the state apparatus itself [Fausto, 1990: 121]. According to Rodrigues [1987 and 1987a], the Republican government replaced the agricultural organisations' executives with people from the Imperial Regime and, in addition, various agricultural organisations were closed down. However, in the first decade of the twentieth century the agrarian oligarchy became powerful again. In truth it never lost its ability to exert power.

Indeed, in 1906 the Ministry of Agriculture was re-established, fourteen years after being closed down in 1892. The government had acceded to pressure from the landowners in a clear demonstration of the agrarian oligarchy's power at the beginning of the twentieth century. This was despite the fact that according to Baltar [1990: 109] the coffee hegemony at the beginning of the Republic did not need the Ministry of Agriculture, since coffee was a national concern. Thus, coffee crop issues were dealt with by the Ministries of Finance, Industry and Trade, by Parliament, and by the Presidency of the Republic. It is worth stating that the pressures from the Agricultural National Society - SNA - were fundamental to the Ministry's re-establishment. The SNA had been created in 1897 by liberal professionals and farmers concerned with agricultural problems. Its aims were to advise the agricultural sector and to promote rural associations. In the Ministry's absence, it had also undertaken various agricultural research activities.

The coffee production system at this time was based on land abundance and immigrant labour, and the coffee yields were almost entirely a function of the initial fertility of forest soils. This situation, according to Arraes [1972: 43-44], led to many difficulties that arose from the backwardness of agriculture, the underdevelopment of technology and constantly low export prices. Therefore, just three years after its creation, and in accordance with Decree 7501 of 12th August 1909, the aims of the Ministry of Agriculture were as follows: to develop agricultural teaching and agricultural research and experimentation through research institutes and experimental stations across the country. Yet, Warren [1989: 229-230] states that the capital resources that were necessary to improve methods of production were scarce, and that this approach ignored the issue of productivity. According to him,

> Brazil's output of fertiliser was reduced and, by the 1920s, 90% of it was exported. At the time, the productive farming systems were based on rituals, prayers, and the burning of land. Food crops for the domestic market in this period have been little studied, but it appears to have been a lagging sector. And, as a consequence of the growth of the coffee economy, the coffee farmer's demands were increasing, as well.

In the period from 1890 to 1900, the coffee plantation in São Paulo increased from 220 million to 520 million coffee trees [Prado Junior, 1969] and in 1901, the Republican government created the Luiz de Queiroz Practical Agricultural School. For Gonçalves [1993], this demonstrated support for the coffee bourgeoisie. There was a clear need to transfer agricultural technology from other countries to Brazil and, therefore, to train people in the new technology. This practical school changed its name to the Luiz de Queiroz Agricultural Superior School and today, it is linked to the University of São Paulo, an important agricultural teaching centre in Brazil and Latin America. It is situated in Piracicaba, in the State of São Paulo, where it is located on land donated by the landowner and former coffee farmer Luiz Vicente de Souza Queiroz.

The Ministry of Agriculture created and co-ordinated various agricultural experimental stations across the country. Alves [1980] says this was the first agricultural research structure to be linked to the Federal Government and co-ordinated by one centralised organisation. The first experimental station created was the *Campos Experimental Station* in 1910 in the city of Campos, in Rio de Janeiro. It made important contributions to national agriculture, mainly through the creation of important varieties of sugar cane.

Other experimental stations were created across the country. These included the *Escada Experimental Station,* in the State of Pernambuco in 1911 (a sugar cane producer since the colonial period), the *Bento Gonçalves Experimental Station* in the State of Rio Grande do Sul in 1913, the *Experimental Station in Barbacena,* in the State of Minas Gerais in 1912 and the *Cotton Experimental Station in Coroata,* in the State of Maranhão in 1913. All these agricultural research stations were created to support industrial and export products, such as sugar cane, cotton and textiles in the powerful States like Minas Gerais, Rio de Janeiro and Pernambuco, which were great coffee and sugar cane producers. Besides this, Rio de Janeiro was the Federal District where the Brazilian government was located. It is clear that the decentralisation and federalism resulting from the Constitution of 1891 had changed the relationship between the States and the Federal Government and the strongest economic and political States had much more influence over the Republican government than the poorer and smaller States. These interactions were known as the *política dos governadores* (governor politics).

In 1918, after the First World War, the Chemistry Institute was created in the State of Rio de Janeiro. Like other institutes, it was linked to the Ministry of Agriculture. In this period the first signs of industrialisation can be seen in Brazil, although, for Morel [1979] the move towards industrial development in Brazil had already begun with the abolition of slavery and the introduction of a free labour work force well before the establishment of the Republic. In 1918, the agricultural sector was in crisis mainly because of falling coffee prices in the international market and the migration of rural people to cities. This period also saw the initial settlement of the urban bourgeoisie in Brazil in the form of military personnel, engineers, doctors, lawyers, traders, bureaucrats and liberal professionals.

In 1920, the Agricultural Protection Biology Institute was created in the State of Rio de Janeiro. For Alves [1980], the Chemistry and Agricultural Protection Biology Institute offers the first evidence of a specific research organisation at Federal level. Rodrigues [1987] says that after the First World War it was industrial interests in Brazil that prompted chemistry development. Once again, pressures from organised interests were satisfied by State organisations. Another salient point, according to Frank [1971], is that 5,940 new industrial firms were established in Brazil during the years 1915-1919 as an immediate result of the war. Cano [1994: 17] qualifies this by saying that firms established in the period between 1880 and 1930 were almost all light industries. In fact, the post-war period was one of economic recuperation. The 1920s started with euphoria. At this time, various specialist agricultural services were created. Their main aim was to increase agricultural production through research programs and to the diffusion results.

From this perspective, four specialised services were created. They were the Cotton Service, the Seed Service and the Grape Service created in 1920 and the Forestry Service in 1921. Clearly, the nascent agricultural research system focused on specific agricultural products, and not on the agricultural production system of farmers. This is shown by the aims of the Services. The Cotton Service's aims were to study the climate, soil and the geographical distribution of cotton species in the various Brazilian regions, to develop plant-breeding with the objective of selecting better native and exotic cotton varieties, to promote studies into agricultural practices and to select and produce seeds to distribute to farmers. To this end, decentralised units of the Cotton Service were founded. The Seed Service's principal role was to improve the production and quality of agricultural seeds. The aim was to offer seeds to farmers across the nation. The headquarters were situated in the city of Rio de Janeiro, while production sites were located all over the country. The Grape Service, with its headquarters in the State of Rio Grande do Sul, had as principal aims, the study and adaptation of grape varieties in the grape production zone, and the development of plant breeding and productivity and the study of disease resistant varieties. Control of pests and disease and the distribution of seedlings to farmers were also aims. And lastly, the Forestry Service's aim was to promote the conservation or experimentation on trees.

These facts show that the new agricultural research organisations' aims went beyond coffee and sugar cane demands. The State's interest remained focused on cash crops, export products and other economic crops, but Brazil was also building a technical base to support other crops, such as cotton, grapes, and even rice and beans. There were also the new industrial developments to be considered, and the increase in trade from the importation and exportation of commodities. All in all, Brazil ended the 1920s with reasonable agricultural research support to start the new decade. However, the Old Republic remained based on coffee production, a commodity that was heavily subsidised by the government. Brazilian coffee production, which had risen from 3.7 million of 60 kg bags in 1880-1881 to 5.5 million in 1890-1891, reached 16.3 million in 1901-1902. The exceptional conditions for coffee in

Brazil gave entrepreneurs the chance of controlling three-quarters of the world's coffee [Furtado, 1963: 193-194].

However, the world crisis of 1929 disrupted the economy. International coffee prices declined by 60%, leading to an external devaluation of Brazilian currency and an economic crisis which in turn led to the political crisis that built up throughout 1929 until the presidential election of 1930. The result was the successful *Revolution of 1930*. Frank [1971: 50] states that this political and economic movement was supported by the bourgeoisie (whose interests had been prejudiced by the preceding events) and was directed against the agrarian, commercial and metropolitan interests which had shaped and benefited from previous government policy. Flynn [1978] argues that the whole system of the Old Republic showed its inability to survive serious conflict. The armed forces decided that civil war could only be avoided by removing the President of the Republic and thus it was the army that started and finished the Old Republic.

### 3.4.2. The Second Republic [1930 - 1937]

In Brazilian history, the 1930s were significant for several political, social and economic events within the scientific area. In 1929 the Brazilian economy had been in crisis. Coffee prices had dropped and farmers were running into debt. The agrarian bourgeoisie had become poor. It was within this context that the *Revolution of 1930* took place. This phase encapsulated the defeat of the agrarian oligarchy and the expansion of the industrial and urban bourgeoisie allied to the new proletariat. Ianni [1965] says this represented a reaction to the traditional orientation which had led to the explosion of the economic and social agrarian bourgeois structure associated with the coffee trade.

According to Alencastro [1987: 20], the *Revolution of 1930* represented a milestone for Brazil. The labour market was settled and for the first time the State became concerned with the new working class. Roett [1992: 23] states that in this period the government moved to revise and modernise the economy. It put down revolts against the centralisation of State power. Similarly, Cano [1994: 15-16] analysing the backward industrialisation of Brazil, affirms that the elite had not previously permitted industrialisation. It had been more important to maintain the economy as it was, based on slavery. For him, it was between 1930 and 1955 that Brazilian industrialisation first began.

The urban proletariat flourished amid the conflicts between the coffee and industrial bourgeoisie. Cardoso [1975] states that Brazilian industrialisation received considerable incentives from the State. There was internal market protectionism to promote the infant industries, income transfer from the agricultural sector to the industrial sector and an increase in productive activities. The rural population began to move to the cities and the internal markets grew. Furthermore, in line with Baltar [1990: 32], in the late 1930s the landowners maintained their relationship with the State in order to control the land and the work force. Baltar believes that this was a fundamental strategy to maintain power through archaic social relations. Avelino Filho [1987: 36] argues that between 1930 and 1937, a capitalist society came into being and capital accumulation was properly developed. All these changes influenced Brazilian society. Ianni [1963: 23] states the period between 1930 and 1938 was later to prove to be merely an intermediate phase during which there was reintegration of the various social classes.

During this period there was no one in the country capable of financing the importation of necessary consumer goods, so, as Jaguaribe argues, 'in a spontaneous process of industrialisation by import-substitution' production began locally [Jaguaribe, 1972: 48]. Thus, the agricultural sector faced two challenges: to increase the productivity of agriculture and husbandry to enable the production of cheap food for the urban proletariat and to deal with the loss of manpower to the industrial sector. As a result of the *Revolution of 1930*, the Ministry of Agriculture underwent a deep reform in order to meet these new demands. In 1933 the General Scientific Directory was created. This was a great innovation. The Directory co-ordinated various organs, such as those of agriculture, animal, husbandry and chemistry. Under the co-ordination of the Directory the following institutes were created: the Agricultural Chemistry Institute, the Agricultural Biology Institute, the Animal Biology Institute, the Agricultural Ecology and Meteorology Institute and the Technology Institute.

In truth, the Brazilian economy was still predominantly an agricultural economy and it was only after the Second World War that Brazil embarked upon a deliberate and substantial industrialisation drive which was to markedly alter the structure of its economy [Baer, 1965: 12]. Indeed, industry and not agriculture was now a government priority. However, Poppino [1968: 239] explains that since the 1930s the growing ranks of owners and directors of industry had comprised an effective pressure group with a major voice in the formulation of national economic policies, leaving agriculture in a secondary and supporting role. At the time of the Second Republic, the agrarian bourgeoisie had apparently become obsolete. For instance, the Ministry of Agriculture in this period expresses agriculture's financial difficulties as follows: 'an increase in the budget of 50% is imperative to guarantee the normal development of the Research Institutes linked to the Scientific General Directory' [Távora, 1933]. Against the wishes of the Ministry of Agricultural interests, another general reform took place in 1934. The General Scientific Directory was closed down and three national departments based upon crop, animal and mineral areas absorbed all the other institutes. The Chemistry and Agricultural Biology Institutes were subordinated to the National Agricultural Production Department. The Animal Biology Institute moved to the National Animal Production Department and the Agricultural Ecology and Meteorology Institutes were closed down. The Technology Institute moved to the Ministry of Labour, Industry and Trade. This organisational structure remained intact until 1938 when, according to Ianni [1963: 23], there was a reorganisation of the social groups that had originated from the Old Republic.

**3.4.3. The New State [1937 - 1945]**

In 1937, Brazilian history registered another important social and political event: the New State. The President of the Republic called upon his extensive powers and executive authority which were greatly expanded in the following eight years. The President ruled by decree and chose not to convene the legislative assembly, thus avoiding any potential check on his unlimited power. The Federal government intervened in all spheres of society. The central power assumed the role of creator of public policy. Public organisations were created in line with the social and economic order. For Sodré [1980: 154], the New State was a natural consequence of the movement of 1930, and the reforms that the new political order required. Ianni [1963: 23-24] writes that during this period of dictatorship, various social and political groups were formed and it was effectively then that the new, modern industrial systems were developed. As a consequence, a clear social class structure (with industrial, agrarian, commercial bourgeois, proletariat and middle class elements) began to emerge. The result was a new urban and industrial society in Brazil. Morel [1979: 75] comments that Brazilian industrialisation was based on import substitution to serve the demands of the upper class, basically producing luxury goods in the same way as industry in developed countries.

The important feature of the administrative structure of the New State was the new network of State corporations and regulatory agencies. Public enterprises included railroads, shipping, steel, oil, electric power, and synthetic rubber which was added after 1945. Coffee, tea, pine, sugar and others were subject to the supervision of Federal agencies [Skidmore, 1973: 32]. The first effect of this government centralisation in the Ministry of Agriculture was the creation of the National Agricultural Research and Teaching Centre (CNEPA). This was formed from the National Agronomy School, the Agricultural Chemistry Institute, the Agricultural Ecology Institute and the Agricultural Experimentation Institute. The Oil Institute and the Fermentation Institute were later linked to the CNEPA.

It is important to note that CNPEA was an attempt to link agricultural teaching and agricultural research in the same organisation. It followed the American agricultural research and teaching model of the land-grant colleges. According to Gonçalves [1993: 15], these organisational changes reflected America's economic and political influence over peripheral countries. Indeed, we see a great expansion of American industrial companies (especially those in agricultural processing) in this period in the Latin American countries. Jaguaribe [1989: 107] also argues that from 1940, Brazil has been deeply influenced by the United States and has been from the very start, dependent upon external support. Biato [1971] reasons that this technological dependency goes beyond the purchase of capital goods and involves technical and specialised knowledge, too.

Brazil was basically an agricultural country until 1930s. For example, the report sent to the President of the United States by the American technical mission that visited Brazil in 1942 was concerned that Brazilian industry was very backward. This was known as *Cooke's Mission*. It expressed its view of Brazilian scientific stature in the following way: 'Brazil is a teenager as an industrial nation. It has a great future ahead. The best solution to these difficulties is to acquire the technical knowledge developed in the United States since the beginning of this century'. *Cooke's Mission* emphasised the South East as the area best suited to rapid growth in the years ahead [Fundação Getúlio Vargas, 1949: 15].

Furthermore, the transformations in the agricultural production system and the intensification of the industrialisation process provoked changes in the agricultural research system. The economic, political and social transformations that occurred in the 1930s addressed the needs of new labour and new technology. It was necessary to train labour for the public bureaucracy, for the industrial sector and for scientific and teaching organisations. Thus, the new Industrial State required a new agricultural technology model.

Thus, in 1943, CNEPA was again restructured to form the Rural University, formed from the National Agronomy School, the National Veterinary School and the Agricultural National Research Service (SNPA). The headquarters were on the Rural University campus in the State of Rio de Janeiro. In line with government priorities, that is, for the expansion of Federal Government influence in the individual States, SNPA was based upon centralised units and a network of experimental agricultural research units.

The experimental agricultural units were formed from the National Agricultural Experimental network, that is to say, the experimental stations and regional institutes. Their main tasks were to co-ordinate agricultural research across the country, to classify the agricultural regions according to their ecological and climatic conditions and to collaborate with the Rural University in activities related to training and courses. Their main objective was the generation of technologies which would increase the production and improvement of crops. Table 3.2 shows SNPA's agricultural research units across the country.

# Table 3.2 - Experimental Agricultural Research Units

| UNITS | LOCATION BY STATE |
|---|---|
| **1. Northern Agricultural Institute - IAN** | **Belém, capital of Pará, North region** |
| Experimental Station of Belém | Pará |
| Experimental Station of Solimões | Amazonas |
| Experimental Station of Rondônia | Rondônia |
| Experimental Station of Rio Branco | Acre |
| Experimental Station of Porto Velho | Rondônia |
| Experimental Station of Turiaçú | Maranhão |
| Experimental Station of Paratins | Amazonas |
| **2. North-eastern Agricultural Institute - IANE** | **Recife, capital of Pernambuco, North-eastern region** |
| Experimental Station of Curado | Pernambuco |
| Experimental Station of União de Palmares | Alagoas |
| Experimental Station of Itapirema | Pernambuco |
| Experimental Station of Surubim | Pernambuco |
| Experimental Station of Alagoinha | Pernambuco |
| Experimental Station of Seridó | Rio Grande do Norte |
| Sub-Experimental Station of Barbalha | Ceará |
| Laboratory of Fibres of João Pessoa | Paraíba |
| **3. Eastern Agricultural Institute - IAL** | **Cruz das Almas, Bahia, North-eastern region** |
| Experimental Station of Quissamã | Sergipe |
| Experimental Station of Aracajú | Sergipe |
| Experimental Station of Sao Gonçalo dos Campos | Bahia |
| **4. Western Agricultural Institute - IAO** | **Sete Lagoas, Minas Gerais, South-eastern region** |
| Experimental Station of Água Limpa | Minas Gerais |
| Experimental Station of Sete Lagoas | Minas Gerais |
| Experimental Station of Lavras | Minas Gerais |
| Experimental Station of Patos | Minas Gerais |
| Experimental Station of Machado | Minas Gerais |
| Experimental Station of Pomba | Minas Gerais |
| Experimental Station of Anápolis | Goiás |
| Experimental Station of Cárceres | Mato Grosso |
| **5. Southern Agricultural Institute - IAS** | **Pelotas, Rio Grande do Sul, Southern region** |
| Experimental Station of Pelotas | Rio Grande do Sul |
| Experimental Station of Passo Fundo | Rio Grande do Sul |
| Experimental Station of Caçador | Santa Catarina |
| Experimental Station of Ponta Grossa | Paraná |
| Experimental Station of Curitiba | Paraná |
| **6. Animal Biology Institute - IBA** | **Rio de Janeiro, capital of Rio de Janeiro,South-eastern region** |
| Animal Viral Diseases Section | Rio de Janeiro, capital of Rio de Janeiro |
| Animal Parasitology Section | Rio de Janeiro, capital of Rio de Janeiro |
| Animal Bacterial Diseases Section | Rio de Janeiro, capital of Rio de Janeiro |
| Ornithology Section | Rio de Janeiro, capital of Rio de Janeiro |
| Chemistry and Pharmacology Section | Rio de Janeiro, capital of Rio de Janeiro |
| Pathological Anatomy Section | Rio de Janeiro, capital of Rio de Janeiro |
| **7. Zoology Institute - IZ** | **Uberaba, Minas Gerais, South-eastern region** |
| Reproduction Physiology and Insemination Section | Uberaba, Minas Gerais |
| Genetics and Breeding Section | Uberaba, Minas Gerais |
| Animal Nutrition Laboratory | Uberaba, Minas Gerais |
| Experimental Breeding Section | Uberaba, Minas Gerais |
| Experimental Pastures Section | Uberaba, Minas Gerais |
| Poultry and Silkworms Section | Uberaba, Minas Gerais |
| Experimental Breeding Farms | Uberaba, Minas Gerais and Desengano, Rio de Janeiro |
| Experimental Station of the Reproduction Physiology | Across the country |

Source: Based on RODRIGUES 1987a: 145-147.

SNPA's centralised units were located in the States of Rio de Janeiro and São Paulo. For example, Agricultural Chemistry, Oil and Fermentation Institutes were located in the State of Rio de Janeiro. Also, some Agricultural Ecology and Experimental Institutes were located in the States of São Paulo and Rio de Janeiro.

In fact, SNPA represented an advance in the Federal agricultural research organisation in Brazil. Although concentrated in the South and South East regions, in the States of São Paulo, Rio de Janeiro, and Minas Gerais, it expanded across the country. This was a reflection of the development model designed by the Federal Government. The industrial sector was also concentrated in the South East region. The logic of the Federal Government was thus to control agricultural research in one centralised organisation. In conclusion, according to Paulinyi [1981: 21], the 1940s were characterised by three factors: the recognition of the importance of science and technology within industrial development, the military demands and the impact of the Second World War.

### 3.5. From the Second World War Until the Early 1970s [1945 - 1972]

After the Second World War, many countries in Europe and the Americas looked to science and technology as valuable tools to increase economic development. In Brazil, the agricultural sector with the help of agricultural research, could be used to produce cheap food to feed the workforce absorbed by the emerging industrial sector in urban areas. It could also supply labour from rural areas and produce for export purposes. Rodrigues [1987] explains that in the post-war period the Brazilian economy changed its developmental focus in a way that was to contrast with the former period which had been dominated by the agricultural export of coffee and sugar cane crops. In the 1950s, the economy became based on industry.

This was the focus of capital accumulation and of the division of labour. At that time, the industrial bourgeoisie was the strongest social segment [Fernandes, 1995]. For Fernandes, the new 'development' was due to American policies of 'outside help'. The Government invested in the 'production sector', without considering wealth democratisation or grave social problems.

In addition, the 1946 Republic was characterised by social mobilisation and an urban electorate led by the great increase in urban labour. As a consequence, the conflict was now between the agrarian and the industrial bourgeoisie. There was a type of social pact between the nascent industrial bourgeoisie and the urban proletariat against the old landowners [Oliveira, 1981: 40]. By the 1950s industrial capitalism had consolidated its position. The State had created the necessary conditions to support the national bourgeoisie and to facilitate the movement of international capital into the Brazilian economy. The resulting industrialisation in Brazil was based upon technology importation and demanded a qualified work force and wider organisational support to test the external technology. Imported agricultural technology, for example, had to be tested with respect to specificity, climate and land influences and its effect on local economic agricultural production. It was also imperative to increase agricultural productivity and husbandry to compensate for the transfer of rural manpower to the cities. Agriculture in general, and coffee crops in particular, were still the basis of the national economy, as Valla and Silva [1981] state, pointing out that coffee crops in 1948 were still responsible for as much as 41% of all Brazilian exports.

In this vein, the Goals and Bases for Government Action 1956 to 1960 [Brasil, 1958] focused on the modernisation of agriculture. There was an imbalance between the agricultural and industrial sectors and, while industrial production increased by 128% from 1947 to 1961, agricultural production increased by only 87% in the same period. This led to support for the transformation of agriculture. There were attempts to change agricultural production based on forestry soils to that based on capital-intensive technology (fertilisers, tractors, pesticides, and high produce varieties). Essential goods such as drugs, pesticides, and fertilisers, could be freely imported, while goods such as fuel, essential foodstuffs, cement, paper, printing equipment and machinery received priority in the licensing system [Baer, 1965: 49]. This became known in Brazil as *agricultural modernisation.*

The next significant political event was the resignation of the President of the Republic (Mr. Jânio Quadros) in 1961. He had been elected in 1960 with the support of the Conservative Political Party. The Vice President (Mr. João Goulart), a Labour Party leader, became chief executive. Weffort [1978] characterised this period as one of populist politics. The government tried to reduce social inequalities through various superficial reforms, but the country demanded more profound changes and called for *basic reforms*. Land reform was the most urgently demanded. A mass movement, united in its demand for basic reforms, rose up across the country, threatening the political and economic order.

Under these circumstances, in 1962, the Ministry of Agriculture underwent a further reform, the act of a populist government. Animal and agricultural research at Federal level was co-ordinated by the already created Agricultural Research and Experimental Department (DPEA). DPEA's headquarters were in the city of Rio de Janeiro. SNPA's organs and those linked to the National Animal Production Department were transferred to the DPEA. Once again, this reform was more a superficial and bureaucratic one than a deep reform of technical and structural priorities. Rodrigues [1987b] states that the DPEA was defined as a central and normative organ. It was responsible for agricultural research analysis, experiments and the agricultural programme. It was structured in three ways. First, the DPEA's general directory was created from the general directory and SNPA's directory. Secondly, the central organs were added. Thirdly, the regional institutes were created. The DPEA's agricultural research programme followed the top-down model. The agricultural research programs, sub-programs, plans and projects were controlled centrally and agricultural research sub-projects were controlled by the researcher at the regional institute level. The DPEA's headquarters were the overseers. The DEPA's organisational structure is shown in Table 3.3.

The DPEA emphasised agricultural research into food crops, cash crops, reducing crop imports and increasing crop exports. On the international front, the DPEA began to systematically develop relationships with international organisations. The technical agreement with USAID is the main example and involved various agricultural research projects. Surely, this is the seed of the strong support for the overseas training of agricultural researchers nowadays. The Brazilian Research Agricultural Journal known as PAB was also created at this time and continues to be published to this day.

**Table 3.3 - Agricultural Research and Experimental Department's Organisational Structure (DPEA)**

| UNITS | LOCATION |
|---|---|
| **1. General Directory** | Rio de Janeiro, RJ - South-eastern region |
| **2. Centralised Organs** | Rio de Janeiro, RJ - South-eastern region |
| Fitotecnic Division | Rio de Janeiro, RJ - South-eastern region |
| Zoology Division | Rio de Janeiro, RJ - South-eastern region |
| Penology and Soil Fertility Division | Rio de Janeiro, RJ - South-eastern region |
| Agricultural and Food Technology Division | Rio de Janeiro, RJ - South-eastern region |
| Oil Institute | Rio de Janeiro, RJ - South-eastern region |
| Fermentation Institute | Rio de Janeiro, RJ - South-eastern region |
| **3. Regional Institutes** | |
| Northern Agricultural and Experimental Research Institute - IPEAN | Belém, PA, Northern region |
| Northeastern Agricultural and Experimental Research Institute - IPEANE | Recife, PE, North-eastern region |
| Eastern Agricultural and Experimental Research Institute - IPEAL | Cruz das Almas, BA, North-eastern region |
| Central-Western Agricultural and Experimental Research Institute - IPEACO | Sete Lagoas, MG, South-eastern region |
| South Central Agricultural and Experimental Research Institute - IPEACS | Itaguaí, RJ, South-eastern region |
| Southern Agricultural and Experimental Research Institute - IPEAS | Pelotas, RS, Southern region |

Source: Based on RODRIGUES 1987b: 209-210.

### 3.5.1. From the Military Dictatorship to EMBRAPA's Creation [1964 - 1972]

By 1964 a mass movement were united in the demand for 'basic reforms'. It was in direct response to this pressure to the political and economic order that the populist government was overthrown by a military dictatorship. The military coup d'etat shifted the former social, economic and political path of the country. Instead of a populist pact, the new strategy was based on national and international capital. State-owned organisations were formed and a technocracy began to develop within the strong new state's superstructure. Valla and Silva [1981: 68] says that under the banner of 'development and security', the military revolution of 1964 aimed to build a developed, modern, progressive and humane society in Brazil. From this point of view, science and technology represented a strategic way to progress and to modernise and, indeed, agricultural modernisation constituted the military government's priority. The military rulers wanted a *powerful Brazilian nation* and political slogans declared *Love Brazil Or Leave, Export Is What Matters and Integrate It or Lose It.*

Consequently, on 25th February 1967, a far-reaching reform in accordance with the administrative Decree-Law Number 2000 was established. Its influence touched all public organisations. However, with regard to the agricultural research organisation linked to the Ministry of Agriculture, its effects were marginal. The DPEA was renamed the Experimental and Research Office (EPE). In 1970, EPE's headquarters moved from Rio de Janeiro to Brasília in the Federal District, which had been constructed in 1961 to house the executive, judicial and legislative organs. EPE remained the central and normative organ of agricultural research and analysis but, as a consequence of this reform, three regional institutes and various central organs were also created. Table 3.4 shows EPE's organisational structure.

**Table 3.4 - Experimental and Research Office's Organisational Structure**

| UNITS | LOCATION |
|---|---|
| **1. General Directory** | Brasília, Federal District |
| Technical Adviser | |
| Agricultural Research Relations Sector | |
| Technical Personnel Training Sector | |
| Experimental Statistics and Economic and Analysis Sector | |
| Expedient Sector | |
| **2. Central Organs** | Brasília, Federal District |
| Rural Engineering Team | |
| Fitotecnic Team | |
| Soil Fertility and Pedology Team | |
| Agricultural Technology Team | |
| Zoology Team | |
| Animal Pathology Team | |
| Fermentation Institute | |
| Oil Institute | |
| Agricultural Food Technology Institute | |
| **3. Regional Organs** | |
| Northern Agricultural and Experimental Institute - IPEAN | Belém, PA, Northern region |
| North-eastern Agricultural and Experimental Institute - IPEANE | Recife, PE, North-eastern region |
| Eastern Agricultural and Experimental Institute - IPEAL | Cruz das Almas, BA, North-eastern region |
| Western-Central Agricultural and Experimental Institute - IPEACO | Sete Lagoas, MG, South East region |
| Western Agricultural and Experimental Institute - IPEAO | Campo Grande, MS, Western-Central |
| Meridian Agricultural and Experimental Institute - IPEAME | Curitiba, PR, Southern region |
| Southern -Central Agricultural and Experimental Institute - IPEACS | Itaguaí, RJ, South East region |
| Southern Agricultural and Experimental Institute - IPEAS | Pelotas, RS, Southern region |
| Western Amazon Agricultural and Experimental Institute - IPEAOc | Manaus, AM, Northern region |

Source: Based on RODRIGUES 1987b: 216-217.

In 1971, through Decree Number 68,593 of 6th May, the EPE was replaced by the DNPEA. The transformation did not make any substantial difference to the work EPE had been carrying out. In a narrow sense, DNPEA continued to develop the same programmes. However, to the central organs of EPE, DNPEA added Pathological Zoology, Zoology and Rural Engineering divisions and created the Agricultural Food Technology Centre - CTAA.

The agricultural production system in the 1970s demanded modern inputs, such as fertilisers, tractors and pesticides. Agricultural research systems needed to satisfy the production system's demands for increased agricultural production and productivity and profits. In Rodrigues' view [1987b: 220], the new agricultural research program was a fundamental tool to support the politics of rural modernisation. The financial support for agricultural research activities came from the American government through its Agency for International Development - USAID - and the Inter-American Agrarian Sciences Institute - IICA. From 1965, according to Graziano da Silva [1988], a 'specific process of agricultural industrialisation' was underway that meant the subordination of agriculture to industrial demands. The State promoted deep transformations in agriculture's technical base. As a result of the ongoing agricultural modernisation, the social structure of agriculture in Brazil became divided into three groups. There were the capitalist corporations who used labour and modern technology in their production systems, the family companies who used high capital investment, plus labour, and finally, there was the traditional sector, where families with small-holdings neither used intensive labour, nor technology nor capital. The ever more backward system of husbandry was a part of the traditional sector [Sorj, 1980: 124].

Thus, it became necessary for the creation, (in the 1970s) of the National Fertilisers Plan whose aim was to triple the fertiliser production of Brazilian industry, and the National Agricultural Defences Plan, involving mainly pesticides and other agricultural chemicals. Many factories were built to support the transformation of Brazilian agriculture, providing another demonstration of capital accumulation from agricultural activities in the industrial sector. Changes like these were fuelling the ever-increasing migration from rural areas to the cities. Rural labour was effectively thrown out by capital-intensive agricultural production. Furthermore, there was an enormous concentration of land in just a few hands. Hoffman [1971] found that in Brazil, (between 1920 and 1967) the Lorenz Land Concentration Index was around 0.84 signifying over-concentration.

To support capital-intensive agriculture, several government incentives were promoted, mainly through the National Development Plans. For example, in the Second

National Development Plan - PND (1975-1979), the government provided support for the modernisation of agriculture. The utilisation of modern inputs was suggested and technical assistance was provided by the organisations linked to the Ministry of Agriculture [Brasil, 1974].

Moreover, other public policies geared to agricultural modernisation took place. First, rural credit was subsidised encouraging farmers to adopt new agricultural technology and thus helped guarantee high productivity. This technology was based on new inputs, such as fertilisers, breeding seeds, machinery and pesticides. Secondly, the Government created various agricultural organisations to support the new agricultural demands, for instance the creation of EMBRAPA in 1972 which is shown in the next chapter up until then Brazil - a country of continental dimensions - had not had a strong or modern agricultural research organisation to serve the demands of agricultural modernisation on a nation-wide basis.

### 3.6. Summary

The Brazilian agricultural technology system has not been an autonomous factor in the process of social change. On the contrary, it has been a consequence of the social, economic and political aspects of the country's history. Agricultural technology organisations were formed to support the rural elite's capital accumulation. The first agricultural organisation established in Brazil (The Botanical Garden in Rio de Janeiro) aimed to provide a place of leisure for the Portuguese crown rather than a scientific or technological organisation. After the abolition of African slavery, the shortage of manpower forced the creation of the initial agricultural technology system. European institutes were the chosen model and agricultural research institutes were established all over the country, mainly in the sugar cane, coffee, rubber and cotton regions. At that time, these were the major agricultural export products.

Domestic food crops did not draw the attention of the Colonial or Imperial governments. The institute model was in place by the beginning of the 1970s, when capitalist agriculture under military rule demanded wide government support to increase agricultural export production and productivity - this was termed the *modernisation of agriculture.* The initial government response was the creation of a modern and flexible state-owned agricultural research organisation, the so-called Brazilian Agricultural Research Organisation - EMBRAPA.

# CHAPTER 4

# THE FORMATION OF EMBRAPA

## 4.1. Introduction

History records that EMBRAPA (Brazilian Agricultural Research Organisation) replaced a diffuse agricultural research system, identified by Brasil [1972] as inefficient, unproductive and overcrowded with bureaucratic personnel, which was inappropriate for Brazilian development. This model, known in Brazil as the Diffuse Model, was co-ordinated by the National Agricultural Experimental and Research Department (DNPEA) from 1971 to 1973.

## 4.2. The DNPEA

The DNPEA was created by Decree 68,593 of 6th May 1971. Linked to the Ministry of Agriculture, it was a state organisation which co-ordinated a network of regional institutes of agricultural research and experimentation across the country. Its research objectives were based on regional demands. It supported agricultural production in Brazil from agricultural export products to food crops. Under this system, Brazil had achieved high productivity levels in export products, such as coffee, sugar cane, oranges and cocoa as well as in food crops such as rice, beans, maize and peanuts.

Following the European agricultural institute model, the agricultural research institutes linked to the DNPEA were organised by departments and experimental stations that covered more restricted regions and research areas. Another feature of the model (the Diffuse Model) is that each research unit tried to diversify its activities, researching many different products and attempting to generate a wide array of technologies.

The DNPEA developed various agricultural products and many technologies of regional interest. It represented an appropriate system for the organisation of research at a regional level. However, Pastore & Alves [1980] analysing the DNPEA, show that in the 1960s, Brazilian agricultural research seems to have been negatively affected by two forces. First, due to the relative abundance of land and labour, there was little pressure for research to develop technology which economised on these factors. Secondly, there was a prevalence of extremely individualistic research patterns imported from developed countries. Changing political forces at the beginning of the 1970s led to an expansion of agricultural production in order to satisfy increased domestic and international demand for food and fibres.

In April 1972, in accordance with Edict Number 143, the Ministry of Agriculture appointed the DNPEA's Director and an executive of the Agricultural Inter-American Institute (IICA), an agricultural organisation linked to the United Nations and a former World Bank's executive. They were responsible for constituting a committee to explore agricultural research limitations and propose improvements. Brasil [1972] remarks that, the aim was to formulate 'a programme of expansion in Brazilian agricultural research activities for a period of five years in accordance with the Brazilian-American loan for agricultural research'.

The official explanation for the failure of the DNPEA was the scarcity of financial resources for research and a limited number of innovative farmers with far-reaching influence in Brazil. Furthermore, the DNPEA generated a large amount of information that had a low probability of crystallising into new technology. The committee responsible for the evaluation of the agricultural research system reported on the Diffuse Model's advantages, addressing such aspects as building, equipment, research laboratories and experimental stations and a few research specialists and research managers in only a few pages. By comparison, the disadvantages listed covered sixteen pages. This seems very one-sided and supports the conjecture that the report existed merely to legitimise decisions previously taken at a political level to change the system.

According to Brasil [1972], the DNPEA's negative points were presented in detail and focused on research policy, organisation, the research programmes, and human and financial resources. Tables and figures were given. Overall, the DNPEA's technical and administrative organisational structure did not permit appropriate decision-making. The negative points were related to technical and administrative issues as discussed next.

First, with regard to the research policies, the obstacles were that basic national needs for agriculture were unknown to most of the DNPEA personnel. There was no interaction between the research team, rural extension agents and farmers. The diffuse model did not integrate the agricultural research plan in relation to the human and financial resources available. It lacked a systematic postgraduate researcher training program and an appropriate method to evaluate the research programs all over the country. The focus of research generation did not satisfy social or economic demands and there was a scarcity of sociologists, economists and statisticians. Also, Pastore and Alves [1984: 120-3] argue that this research model 'provides an atmosphere of freedom in the choice of research projects', instead of concentrating it in few agricultural products.

Secondly, the financial and human policies failures were presented, showing there was no administrative structure for the recruitment, training and promotion of personnel. A complete lack of internal communication between units and researchers was evidenced by the large numbers of parallel projects involving unimportant products. The salary policy linked to government rules did not allow the recruitment of the specialised and well-qualified researchers. Besides, good salaries could be obtained only in administrative positions. Further, it was difficult to provide funds from the private sector or other alternative sources beyond the government since the norms and controls of the federal government were too inflexible.

Finally, it was argued that DNPEA did not exploit the technological advances made in developed countries through the technology transfer process. The agricultural modernisation securely established in Brazil in the 1970s needed strong agricultural research support to promote the transference and generation of capital-intensive technologies to the capitalist agricultural sector. In addition, the diffuse agricultural research model was not considered appropriate to support the demand for enlarged agricultural production based on capital-intensive technology. Also, the diffuse model was unable to meet the new economic forces, namely the increased domestic and international demand for food and fibres, along with the political need to feed the increasing urban population in the 1970s.

The desire to create a new agricultural research organisation came some time ago and was in line with government proposals. The agricultural sector had to be part of the policy of modernisation of the country. It was fundamentally important to have a 'revolution' in agriculture. Therefore, technology development based on the prioritisation of modern inputs was to be the way forward. This is shown by the national programmes of agricultural mechanisation, fertilisers, pesticides, and agricultural experimentation developed in Brazil [Brasil, 1970].

Also, in the First National Development Plan (1972-1974), according to Brasil [1971: 24] the following points were presented: in the 'South-central region modern agriculture based on private principles will be developed, to develop competitive international products, including wheat'. In the Northeastern region 'a new agriculture changing from a traditional to market base will be developed', 'new food crop technologies will be introduced' and 'expanding the agricultural frontier to the humid valleys in the North-east and the new Amazon and *Cerrados* areas'. To complete the agricultural transformation through the use of modern inputs, a strong agricultural research program of national dimensions embracing the main agricultural products was to be implemented. As a result of the committee investigating the DNPEA, disadvantages were found and EMBRAPA was formed.

**4.3. The Creation of EMBRAPA**

In December, 1972, EMBRAPA was officially created[1]. The new organisation was brought into being to help realise government plans for the increased productivity of agricultural land and labour. In order to meet these goals, EMBRAPA was able to recruit its personnel through selection rather than through public competition and its operations were broadly based on the agricultural modernisation concept. The induced innovation theory by Hayami and Ruttan [1971], focused on labour and land saving technology and supported EMBRAPA's agricultural research model. Alves [1984: 86] believes that Hayami and Ruttan influenced Brazilian thought on the causes of the backwardness of agricultural productivity.

In this context, EMBRAPA was set up as a State-owned organisation, that is a public organisation with a judicial personality and private rights with its own patrimony and which was founded by the State and the private sector. State-owned organisations are thus created to develop activities of an entrepreneurial character which the government cannot carry out due to administrative inconvenience. There is also the fact that they are able to recruit members

[1]Although, Pastore and Alves [1984: 126], *Reforming the Brazilian Agricultural Research System.* In: Brazilian Agriculture and Agricultural Research, mention that 'the year 1973 was transitional and EMBRAPA assumed the operation of research activities in 1974'.

and seek financial support abroad in line with its priorities. It was not necessary to follow the 'rules' in the federal administration.

In comparison to the DNPEA research model (the Diffuse Model), EMBRAPA was based on the Concentrated Model[2]. In general terms, the basic concepts of this research model had been developed in a document presented by the committee nominated in Edict 143 of 18th April 1972 of the Ministry of Agriculture. The document covered almost forty pages, drawing together the principal points of the new agricultural research organisation in Brazil. The researchers were only to develop scientific work and the users were there to adopt the technology generated [Brasil, 1972].

From this perspective, EMBRAPA could meet two specific demands. First, the so-called 'present demand', can be identified as government demands. Secondly, the 'potential demand' can be identified as scientific trends, and researchers' intuition about Brazilian economic tendencies and international experience. In fact, according to Brasil [1972] EMBRAPA focused on 'present demand' that is, the 'current needs' of society, whilst 'potential demand' was more appropriated to the Brazilian universities. Overall, this was a kind of division of labour. In truth, the seventies in Brazil were marked by increasing economic development. The agricultural production systems were based - in vast areas - on agricultural export crops and on capital-intensive technologies. This modernisation of agriculture was in accordance with the concepts of the Green Revolution.

To cope with the social and economic reality of the time, EMBRAPA based its aims on the generation and transference of agricultural technology packages. The technological

[2]Pastore [1984: 100], *Brazilian Agricultural Research.* In: Brazilian Agriculture and Agricultural Research, emphasises the important points of the Concentrated Model as: '(1) research tends to be more effective in so far as the crop can be concentrated in a few good areas. (2) research is more responsive to the extent that the crop can be industrialised. (3) effectiveness is facilitated to the extent that technology transfer is feasible'.

package was created following developed countries demands and aimed to increase technical and economic efficiency, but environmental and social issues were not part of the agenda. The package could promote increased productivity of crops and husbandry. Behind this was the subtle technology transfer of new inputs to farmers, in a single technology package.

This strategy advocated the increasing use of modern inputs (fertilisers, seeds, machinery, irrigation equipment, and pesticides) by farmers. The transference of EMBRAPA's agricultural technological package to farmers was linked to state policies, such as subsided credit and rural technical assistance. Normally, agricultural credit agencies lent money only for the purchase of modern inputs. The technological package was thus the principal factor by which farmers acquired credit and technical assistance.

EMBRAPA would follow the success of the International Agricultural Research Centres (IARC) which concentrate a mass of well-trained experts, obtain positive research results and develop strategies to transfer their technological packages. Most are supported by international agencies, such as the Rockefeller and Ford Foundations and the World Bank. The majority of IARCs are located in poor countries. This gives an illusion of progress in agricultural research for local populations. However, most of IARC's agricultural technologies are in accordance with the advanced countries' demands[3].

Overall, EMBRAPA's Concentrated Model aims to serve the objectives of agricultural modernisation, the first of which is the transference of foreign technology to the agricultural sector as a valid means of improvement. Among the types of technological transfer, training

[3]Pardey et al [1996: Abstract], argue that 'the U. S. economy gained at least $3.4 billion and up to $14.6 billion from 1970 to 1993 from the use of improved wheat varieties developed by CIMMYT. In the same 23-year period, the U.S. economy realized at least some $30 million and up to $1.0 billion through the use of improved rice varieties developed by IRRI '...' the benefit-cost (B/C) ratio of U.S. support to these programs has been grater than 26 to 1. Investment projects whose B/C ratio exceeds 1 are profitable'.

abroad and recruitment of overseas personnel are both defined as being most applicable to Brazilian social reality. Private sector demands are to operate as the originators and the controllers of most of the research projects. This means that research inspiration could come from the needs of concrete agricultural production systems. Secondly, the research organisation as a modern bureaucratic structure can attend to demands from the private sector through agreements and advice. A closer relationship was to be developed with the rural extension service and the agricultural input industries in order to speed knowledge dissemination throughout the country. Thirdly, knowledge from international research centres and from other foreign research centres was to be adapted and diffused throughout the country. Finally, a strong and flexible organisational structure to meet these demands was necessary.

## 4.4. EMBRAPA's Organisational Structure

In Brazil, the agricultural research system consists of Universities and Schools of Agriculture or Colleges, most of which belong to the Federal government; State organisations (research institutes and companies); organisations of the Ministry of Agriculture (EMBRAPA and CEPLAC) and private sector institutes.

This thesis is concerned specifically with the National Agricultural Research System linked to the Ministry of Agriculture which is co-ordinated by EMBRAPA. EMBRAPA is a nation-wide organisation with thirty-seven decentralised units - thirty-four research centres and three special services - and has about ten thousand employees, two thousand of whom are researchers. Appendix 11 shows how EMBRAPA is organised in the country. At the time this research was carried out, EMBRAPA was co-ordinating 3,200 agricultural research projects

[EMBRAPA, 1993e: 5], and providing, nearly 43% of Brazilian agricultural research funds in 1991 [Alves, 1992]. Table 4.1 gives a break down of agricultural research funding in Brazil.

**Table 4.1 - The Share of Agricultural Research Funding in Brazil - 1991**

| ORGANISATION | MILLION - U$ | PERCENTAGE SHARE |
|---|---|---|
| EMBRAPA | 197.6 | 42.6 |
| CEPLAC | 25.0 | 5.4 |
| State[1] | 70.8 | 15.2 |
| Universities[2] | 133.6 | 28.8 |
| Private Sector | 37.1 | 8.0 |
| **Total** | **464.1** | **100.0** |

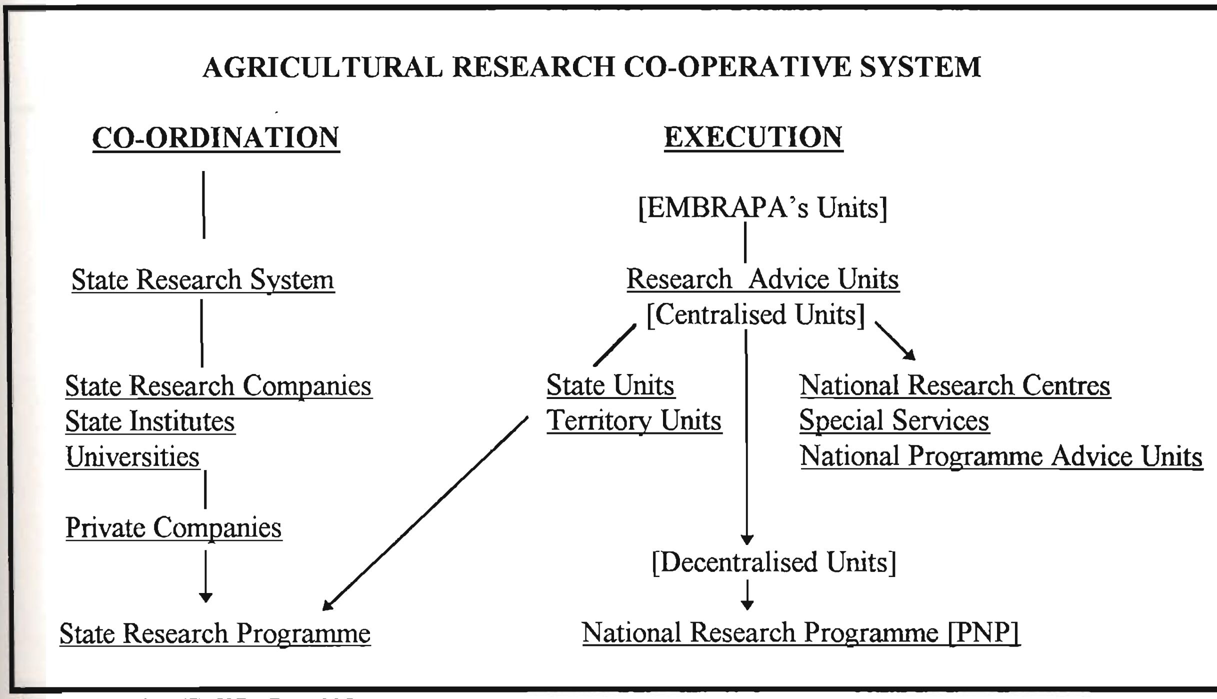
[1] Institutes and Companies
[2] State and Federal
Source: ALVES 1992: 17.

In the context of the 1970s and in line with military rule, the Brazilian economic model was highly successful. The agricultural productivity of the factors of production - mainly land and labour - increased. The main aim was to serve the demands of the global arena through agricultural exports. The strategy of the military rule was one of State intervention in principal economic activities through state-owned organisations and EMBRAPA was created to support this aim. According to Pastore [1982], the 'pragmatic ideology' of EMBRAPA was established rapidly because of the political and administrative support it received - power was highly concentrated in the sphere of the Federal government. Also, Quirino [1989: 3] states that 'no doubt the strong centralised power in the hands of the military government was one of the factors that helped change the agricultural research system'.

To comply with this strategy, EMBRAPA centralised the co-ordination of the agricultural research system. EMBRAPA's institutional research model comprises the State agricultural research institutes and companies, university agricultural departments, private research, existing federal and state-funded research agencies, and its own centralised and decentralised units which complete the system. It was called the Agricultural Co-operative Research System - SCPA. However, the mandate of the State-level organisations was to adapt research to local conditions. According to Rosseto [1975], the EMBRAPA institutional model divided Brazilian agricultural research and its researchers authoritatively between first and second categories i.e., into those who create and those who adapt agricultural technology. EMBRAPA generated the agricultural technology and all the other institutions tested and adapted it. The abundance of funds and EMBRAPA's military rule alliance guaranteed the co-ordination of the agricultural research programs. It controlled and distributed most of the financial resources from the Federal government. Figure 4.1 shows EMBRAPA's initial institutional research model.

Following the SCPA procedure, the research planning was co-ordinated by the centralised units at EMBRAPA's headquarters. Two research planning systems took place in EMBRAPA. The first was the planning system developed at EMBRAPA's creation and which functioned until 1979. In theory, the system involved researchers, managers and users of agricultural technology. The main objective was the permanent evaluation of research results. This research planing system embraced the research centres, state agricultural research companies and other agricultural research organisations.

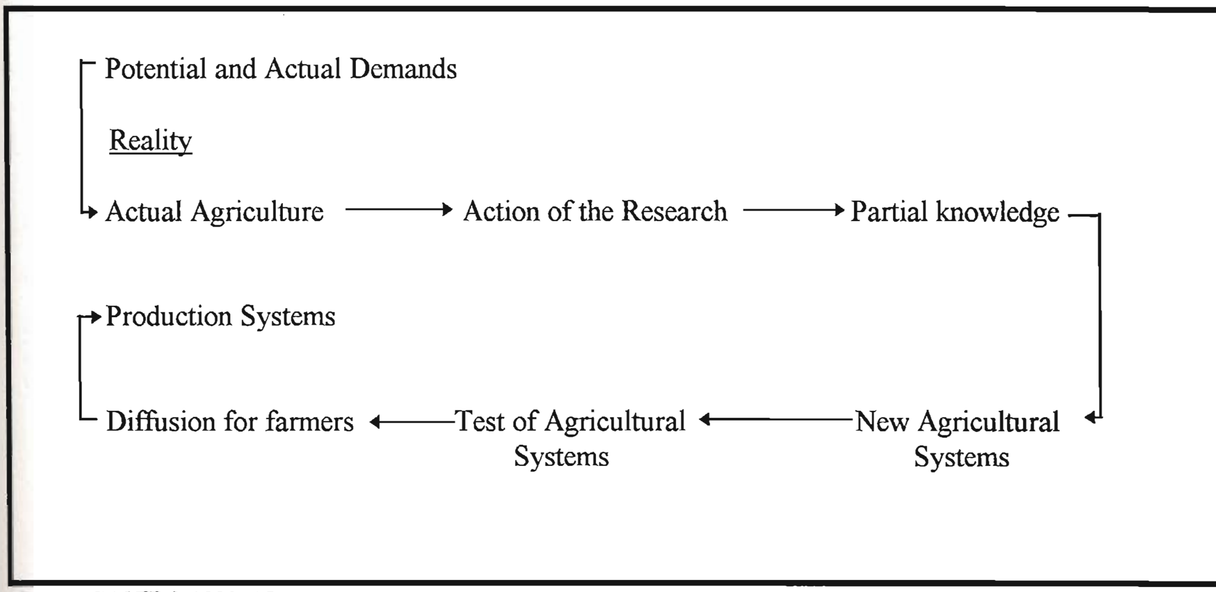
**Figure 4.1 - EMBRAPA Research Institutional Model**




Source: Based on EMBRAPA 1985.

The second one was the circular model research programme. This was used from 1979 to 1993. In this model, the choice of research problem would be inspired by rural reality. In other words, where *agricultural research begins and ends with the farmer*. The circular model research was based on two research planning instruments. First, the National Research Programme - PNP which was co-ordinated by the Agricultural Research Centres. For Rivaldo [1986], each PNP had specific priorities, objectives and goals defined by the scientific community. Second, the research project involved the agricultural researcher who was responsible for the definition of research priorities to address farmers' problems. The research project involved both administrative and scientific proposals. It is important to note that the research project is the basic unit of the SCPA. Figure 4.2 shows the circular model research programme.

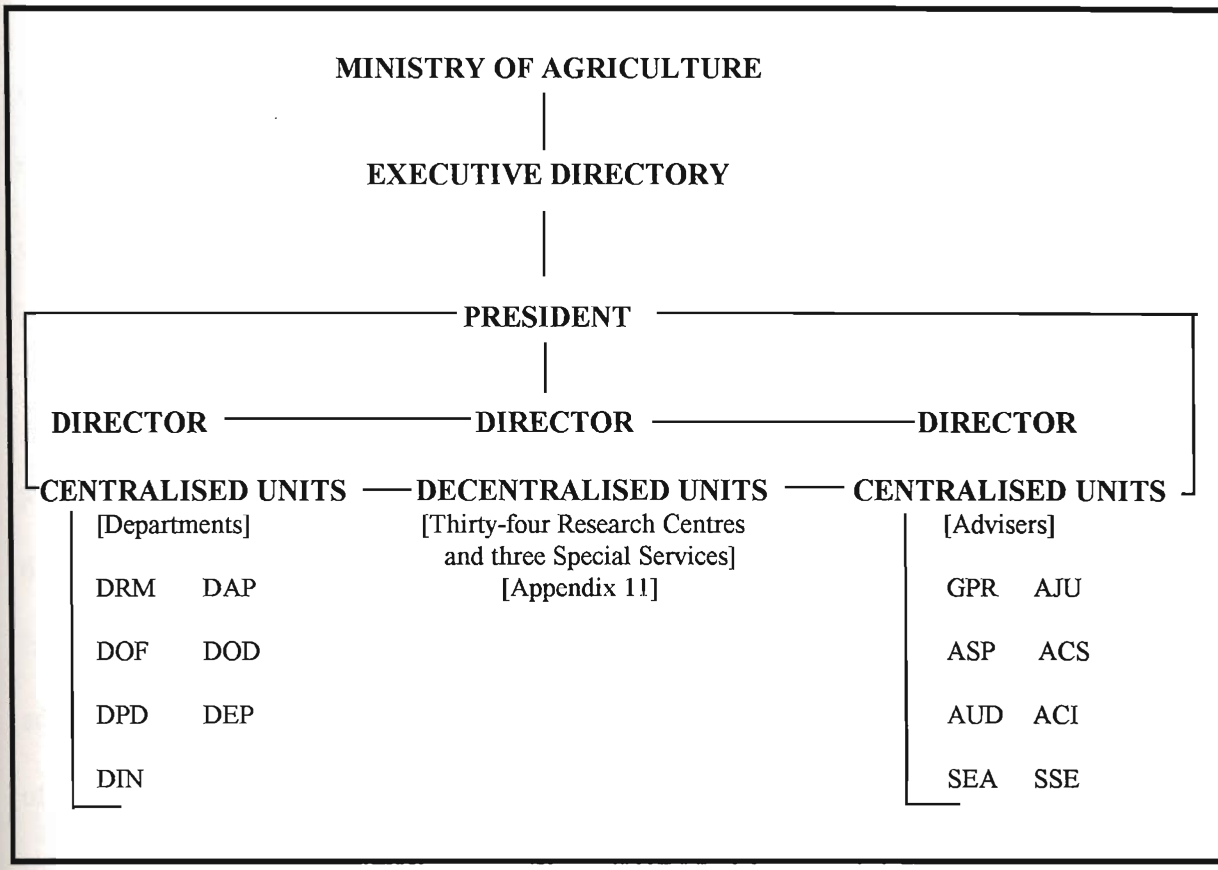
**Figure 4.2 - The Circular Model Research Programme**




Source: CASTRO 1980: 15.

In accordance with the institutional research model, EMBRAPA's organisational structure is divided in two: centralised units (executive, departments, and advisers) and decentralised units (state research units, national research centres and special services). The centralised units are those located at EMBRAPA headquarters. They advise the executives and the decentralised units. EMBRAPA is a presidential organisation and power lies principally in the President's hands. The number of centralised units have varied since EMBRAPA was created. They are not fixed, but rather depend on the Executive Directory. In essence this organisational configuration - centralised and decentralised units - has remained intact since EMBRAPA's creation. Figure 4.3 shows EMBRAPA's organisational structure.

**Figure 4.3 - EMBRAPA's Organisational Structure - 1993**




**LEGEND**:

AUD - Internal Audit Adviser
DOD - Organisation and Development Department
DOF - Finance and Budget Department
ACI - International Co-operation Adviser
ASP - Parliamentary Adviser
ACS - Social Communication Adviser
SEA - Strategic Planning Secretary
SSE - State Systems Secretary
AJU - Low Adviser
GPR - Cabinet of Presidency
DAP - Personnel Department
DPD - Diffusion and Research Department
DRM - Material Resources Department
DEP - Project and Studies Department
DIN - Information Department

Source: Based on EMBRAPA, 1993g.

In fact, while the variation in the number of centralised and decentralised units is not an important issue, the function of headquarters is. Historically, EMBRAPA headquarters held much of the power over the organisational structure, reflecting dependency on the president. A strong structure is necessary to support EMBRAPA's executive as it is a nation-wide organisation. EMBRAPA's headquarters also control strategic functions, for instance financial support, human recruitment and training, research programs and planning, international relationships and some administrative procedures. This shows the power of headquarters. Centralised units are directed by a manager, co-ordinators and supervisors. The power lies in the manager's hands. Below him are the co-ordinators and supervisors. Beyond these are the officials. At the time of the field-work the centralised and decentralised units' executives had all been recruited from EMBRAPA employees.

The decentralised units are responsible for the agricultural technology generation process - these are called the research centres. They are located outside headquarters in different states of the country. As with centralised units, they vary in number according to Executive Directory decisions. Decentralised units have an organisational structure for administrative and scientific affairs. Normally, the administrative structure follows the pattern of headquarters. Both administration and technical structures are created by EMBRAPA's Executive Directory. Decentralised units are directed by one General Head and two or three Advice Heads, depending on the research centre's characteristics. Co-ordinators, supervisors and officials are part of the structure.

At the highest level, EMBRAPA's executive has one President and three Executive Directors chosen by the President of the Republic. They are responsible at the highest level for the organisation, advice, co-ordination, control and evaluation of the organisation's activities. The power lies in the President's hands. EMBRAPA was created as a bureaucratic, formal and top-down organisation. It is a state-owned organisation linked to, but not directly administered by, the Ministry of Agriculture. It is therefore, a public enterprise with indirect administration. It has its own administration and its own rules. As stated, EMBRAPA's executive is chosen by the President of the Republic, and, at the time of the research only the executive could be chosen from outside EMBRAPA.

In EMBRAPA, there is a clear bureaucratic division of labour between research and support staff activities. Research activity is divided into three levels, namely BS, MSc, and PhD. The research category has more status than management. Support staff are divided into supervisors, auxiliary and executive administrators. Salary levels vary depending on the qualification of the official. In Table 4.2 personnel distribution according to location and careers is shown. It indicates that 1,964 employees are researchers, representing 20.85% of all personnel. It is interesting to note that about 570 employees are located at headquarters, which is a considerable number. This however, reflects the centralisation of power at the executive level in EMBRAPA.

**Table 4.2 - EMBRAPA's Personnel - 1994**

| Location | Researcher I | Researcher II | Researcher III | Supporting Staff | % | Total |
|---|---|---|---|---|---|---|
| **Headquarters** | 5 | 34 | 56 | 475 | 6,05 | 570 |
| **Outside EMBRAPA** | 16 | 11 | 49 | 200 | 2,93 | 276 |
| **Research Centres** | 228 | 959 | 606 | 6,781 | 91,02 | 8,574 |
| **Total** | **249** | **1,004** | **711** | **7,456** | **100,00** | **9,420** |
| **Percentage** | **(2,64) [12,68]** | **(10.66) [51,12]** | **(7,55) [36,20]** | **(79,15)** | **100,00** | |

Research I = BS Research II = MSc Research III = PhD
(%) = Percentage of all EMBRAPA's personnel
[%] = Percentage of EMBRAPA's researchers
Source: EMBRAPA 1994d.

Indeed, since its creation, EMBRAPA's organisational structure has not greatly changed. The dominant logic of the bureaucratic structure is the same as when it was created.

The divisions between headquarters, centralised units and decentralised units remains similar to those at its formation. Its power structure has not shifted, since EMBRAPA's executives have only added or reduced departments, advisers or research centres to meet new priorities or political pressures from outside the organisation.

In EMBRAPA's organisational structure, following its general procedures [EMBRAPA, 1985], all administrative and technical activities are divided according to the official's specialisation and skills. The officials undertake specific activities and the recruitment and training processes follow these requirements. The rewards, salaries, promotions and career plans are decided at headquarters. All administrative and technical procedures are standardised across the country, even though in practice, many of these procedures have not followed the organisational principles due to political, unionist or even individual interests. To cope with its aims, EMBRAPA, at the time of the field-work in 1994, had almost ten thousand employees and a budget of 260 million dollars. Appendices 12 and 13 present the distribution of expenditures and personnel between 1973 and 1993 respectively.

It is important to note that in 1990, with the election of the first civil President after 25 years of military and controlled rule, EMBRAPA started a new phase in its institutional history. A new board of directors brought forward a proposal for institutional change which has proven to be compatible with the massive environmental, social, economic, political, scientific, technological and institutional changes taking place on the national and international scenes. From this perspective, a strategic and institutional organisational plan was produced that would enable it to achieve the efficiency of a private enterprise while carrying out its public functions.

According to Flores [1991], Flores and Silva [1992] and Silva and Flores [1993]

The work was a monumental undertaking, including reviews of the mission, objectives, policies, priorities, and the strategies of EMBRAPA's national headquarters, and of each of its research centres individually. For them, EMBRAPA strategic management is understood as a management system which has the following elements: it maintains an open posture to change, it places a high value on the intelligence and creativity of staff, it continuously monitors the external environment and the organisation's mission, it judges EMBRAPA's effectiveness in terms of satisfying social demands, it has a strong commitment to the future, it manages conflicts and resistance through technical and political negotiation. A new organisational design and a new planning system were structured. The new planning system called for the participation of the agricultural technology users, mainly through their demands.

However, the organisational structure based on centralised and decentralised units remained intact[4].

**4.5. EMBRAPA' s Research Process**

In the same way as the organisational structure, the research process follows centralised and autocratic principles. The agricultural technology generation process has been developed by researchers within research centres. It is not an autonomous process at researcher level. It is associated with internal and external vested interests, for instance with Western influences on the Third World, mainly through the institution building approach. EMBRAPA researchers were trained at Western universities and at Brazilian universities organised along Western lines, e.g. Federal Viçosa University, Luiz de Queiroz Agricultural Superior School linked to the University of São Paulo and Federal Ceará University.

Busch and Sachs [1981: 143-144] describe institution building as a 'network of formal organisations capable of providing agricultural research in the underdeveloped countries, whose aim would be to reproduce the American agricultural model. For them, 'the institution building model was unabashedly elitist in its perspective'.

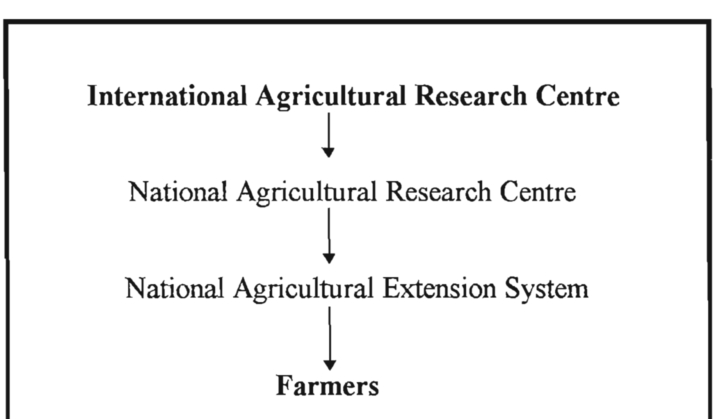
[4]At the time of this research it was not possible to evaluate the new system.

According to this viewpoint, Biggs [1990: 1481] has illustrated the agricultural research perspective of the top-down model according to the behaviour of the scientist in agricultural research policy as follows:

> in the central source model (central model), most major technical and institutional innovations are seen to arise from the systematic work of international research centres. New innovations are passed down to national research systems, extension agencies and finally to farmers. There is clear one-way progression in the research, extension and adoption process '...' the most important reason for dominance of the central model is the training of scientists and the literature available on understanding past processes of agricultural research and technology promotion.

Moreover, Biggs [1995a: 5] writes that this type of science is a 'formal science meaning western science', different from 'informal science meaning indigenous knowledge'. Goodman and Redclift [1991: 152] indicate as an example of formal and western science the agricultural knowledge from 'the International Agricultural Research Centres (IARC) network, which provided the main channel for the transfer of plant breeding techniques and the dissemination of high yield varieties'. Figure 4.4 indicates the central model of agricultural innovation.

**Figure 4.4 - The Hierarchical Structure of the Central Source of Innovation Model**



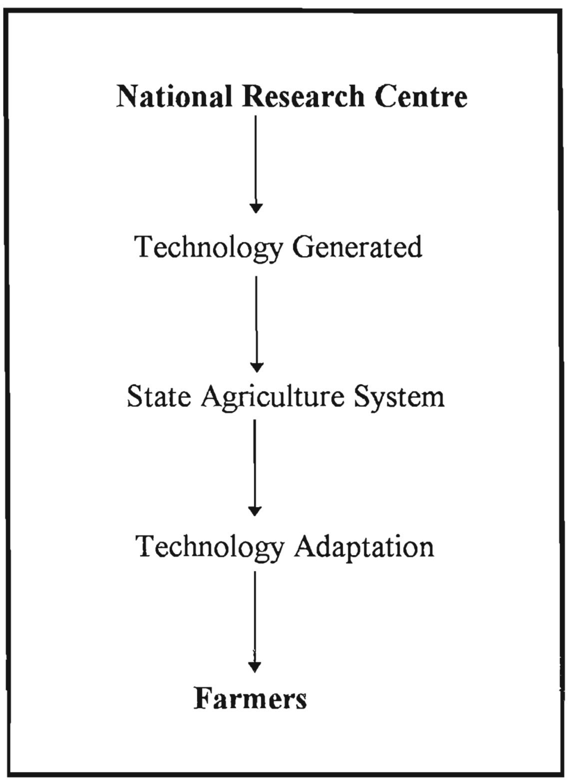

Source: Based on BIGGS 1990: 1142.

EMBRAPA's research process at the national level follows the same principles of hierarchical centralisation. The model rests on two basic concepts: First, scientific interdisciplinarity, that is, the various specialised and well-trained researchers (Masters and PhD researchers) who form an interdisciplinary research team and work together to select and solve specific agricultural and animal research problems. This team work in solving research problems has had limited results. This is the end result of the researchers' specialisations who have individually defined and developed their research projects, rather than responding to farmers' demands. Secondly, the new element is the concept of the agricultural technology diffusion. This means that the agricultural technology generated may meet the farmers' production systems.

In practical terms, agricultural technology generation, diffusion and adoption are independent and separate activities. The implications of these differences has affected the research process. There is a division between the *biology and the social research processes.* The impetus for the biology research process (the agricultural technology generation process) comes from the research team. However, the control of the social process (diffusion, transfer and adoption of the agricultural technology generated) is modified or even manipulated by the organisation. This illustrates the conflicting interests of those involved in agricultural technology from the researchers, farmers and rural extension agents to the consumers themselves.

Figure 4.5 shows the EMBRAPA agricultural generation process carried out by national research centres throughout the country. It has the structure of a centralised hierarchy and a form of supply-oriented research directed at farmers. In line with its institutional model of research, the researchers in the decentralised units create agricultural technology for a few agricultural commodities. Afterwards, the technological results are passed down to the State agricultural research corporations which are a part of what is termed the Agricultural Research Co-operative System (SCPA) which tests and adapts them. Finally, the technology is transferred to rural extension agencies which transfer it to farmers. This is also a typical top-down research process. Farmers, rural extension agents, environmental organisations, and other social actors do not participate in the research process.

**Figure 4.5 - National Research Centres' Agricultural Technology Generation Process**




Source: Based on SOUZA and STAGNO 1990: 38.

The EMBRAPA research process is sustained by two essential institutions: the National research programme (PNP) and the research project. Both are related to specific agricultural products or goal-oriented research problems. The PNP is involved in a formal gathering of individual and organisational interests in a specific agricultural programme. Most come from the scientific community (research organisations and universities). In truth, the research project is the materialisation of the research process. Through the project, researchers express their scientific creativity and their needs in the scientific realm. The research project is thus a researcher's administrative and scientific document.

Research project approval by the scientific community (first, by the research centre's internal technical commission, then by the formal PNP's meeting), must be guaranteed by scientific peers. The final decision rests in the scientific domain, that is in the hands of EMBRAPA's executives. The PNP comprises the research projects across the country for specific agricultural products. Moreover, through bureaucratic rules (forms, norms, tasks, and so on), the organisation controls the research process in order to reach the research organisation's goals, creating a scientific body separate from society. According to Merton [1973], this seems a scientific ethos, that is the institutional imperatives of universalism (the international aspect of science), communism (the public use of the scientific discoveries), disinterestedness (the researcher's scientific recognition) and organised scepticism (the consensus on public knowledge), all encourage and support the scientific process.

In a strict sense, an EMBRAPA research project consists of the main phases of scientific methodology related to a problem-solving activity which is achieved by the researchers as follows:

> The title (summarising of the research proposal); the research problem and literature reviews (the definition of the research object and the theoretical framework, the most important research phase); the objectives (addressing the researcher's goals); the hypotheses (the researchers' suggestions about the causes and solutions of the research problem); the methodology (the research practices used by researcher to accept or reject the hypotheses); the strategies of action (the timetable and organisational relationships); the technology diffusion (researcher's strategies for transferring research results. There is neither farmers' nor rural extension's participation); the bibliography (the literature used by the researcher); the budget (the financial support required by the research project, normally, decided by the bureaucratic official); and finally the research team (all the researchers effectively involved in the research project [EMBRAPA, 1989].

Indeed, the focus of the research process is increasing the production and productivity of commodities and animals. The research process of the researcher starts with a biology research problem. Afterwards, the agricultural researcher processes it according to his scientific beliefs and professional background and ends it with the research results which are reproduced in a scientific publication.

In short, an attempt will be made to describe a typical research project beginning at the moment the agricultural researcher arrives at EMBRAPA and starts work and which will include the life cycle of a research project. It is not a simple process. EMBRAPA is a nation-wide organisation which focuses on several agricultural products and animals[5]. Further, the research projects comprise different specialisations, for example insect chemical controls (entomology) which is distinct from research on the new animal stock (genetics and breeding). Both these examples deal with distinct approaches encompassing different theoretical backgrounds, research time, financial support and interests.

The standard research process could be argued as having two stages. The first comprises the researcher recruitment by the organisation. The second is the insertion of the researcher in the research centre where the agricultural technology generation process takes place. So, the recent postgraduate or graduate student is selected as an agricultural researcher by the Personnel Department at the headquarters based on their academic record. For the majority, this is their first job. Afterwards, the researcher will be allocated to a research centre throughout the country depending on their specialisation and the research centre's available space, interest and research proposals. These decisions are controlled by the

[5]There is also the fact that Brazil is a huge country. It covers an area of 8,512,000 sq. km, occupying nearly half the total land area of the South American continent. The entire eastern border is more than 7,400 km. of the Atlantic coast. The climate ranges from tropical to subtemperate.

organisation which deals with bureaucratic procedures, such as labour contracts, salaries and researchers' allocations.

The second phase is the placement of the researcher at the research centre. This context will significantly shape the researcher's performance. Here, the managers or the senior researchers give him the initial information about the research model, the awards, successes and failures. Normally, these are stressful projects where failures are briefly argued[6]. After that, the researcher is put into a multidisciplinary research team. In theory, this means the specialised researchers focus on one agricultural product or animal. This is the *applied researcher*. Usually, the multidisciplinary nature of the research comes from the researcher qualifications of Masters or PhD degrees. Once again, the new researcher is advised by colleagues and much of the information comes from the scientific realm.

The formulation of the research project is crucial. It is the researcher's main tool. It comes from the researcher's initiative in addressing one research problem[7] on a specific agricultural product or animal. It is undertaken in the research centre and is connected and approved by PNP. The research project comprises the recommendations of the Research Department at headquarters and is given to the research centres. In essence these activities consist of the description of the research problem, the aims, goals, hypothesis, methodology and material and financial support [EMBRAPA, 1982: 9].

In theory, the researcher would seek inspiration for the research problem from the farmer's needs. This includes dealing with farmers and rural extension involvement in the

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[6]According to Bezerra [1988: 277], *Pesquisa Básica versus Pesquisa Aplicada,* who is a former EMBRAPA executive 'the Brazilian agricultural research is a part of the particular scenario which deserves special analysis'.

[7]Pereira [1979], *The Heuristic Method in Research,* calls this 'the heuristic method in research'. It suggests that the researcher uses a structured system of action for each research problem identified.

experimental stages and the diffusion of results. As stated before, this means that *agricultural research begins and ends with the farmer* or in other words, *the researcher is also a diffusionist.* However, in practice the research project supplies technology through the researcher's work. It is subjected to two assessments: the first to the researcher's peers in the research centres and the second to the PNP at national level. Both are dominated by scientific representatives. Afterwards, the research project becomes a reality at the laboratory or experimental field. Here it shifts from the abstract or theoretical proposal to the concrete experiment in the field or green house. The aim is to control the phases of the agricultural production process which is based on the soil-plant-climate complex system and to simulate the conditions of the farmer's fields.

As an example of a research project life cycle, Macêdo [1984: 51-52] found the following stages in the rice research project case: First, the research project elaboration and approbation takes between one and six weeks. It comprises the literature reviews, the formulation of the proposals and the approbation. This can be said to be the work at the library, with the peer contacts and at the researcher's office. Secondly, the establishment and management of the research experiment takes between ten and twenty weeks. It deals with the phases of the crop productive system and the technologies used[8] and the testing of the hypothesis in the experimental field or at the laboratory. Thirdly, the crop harvest concerns the analysis and publication of results taking between four and twenty weeks. This involves a mixture of the researcher's activities: at the experimental field or laboratory and at the library, the peers contacts and the researcher's office. It is necessary to say that the rice cycle crop is

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[8]Based on Aguiar [1986: 14], *Abrindo o Pacote Tecnológico: Estado e Pesquisa Agropecuária no Brasil,* it consists of: (1) Clearing of the land (by agricultural machinery); (2) Soil correction (by mechanical calcium distribution); (3) Soil preparation (by agricultural machinery); (4) Seeding (high yield seeds); (5) Fertilisation (by chemical fertilisers); (6) Control of weeds, insects and diseases (by herbicides, pesticides and fungicides); (7) Harvest (manual or mechanical harvest) and (8) Post-harvest (insect control by pesticides and storage).

around twenty weeks. It is called a short life cycle crop. Borges-Andrade [1991: 21] found that on average, the life cycle of the EMBRAPA research projects is around 3,5 years[9]. This involves elaboration, approbation, installation and collection of experiment results.

To sum up, EMBRAPA's is a top-down organisation linked to the government, in particular to the Ministry of Agriculture. It deals with the supply-led model using well-trained agricultural researchers. The growth of agricultural and husbandry production and productivity of specific agricultural products form the main inspiration for research projects. They are a part of agricultural modernisation principles, the most important of which is to increase the productivity of agricultural exports to support the government's aims. Social, cultural, environmental and objectives regarding the *farm as a whole* were not on EMBRAPA's research agenda.

**4.6. Summary**

In 1972 EMBRAPA was created. It replaced the DNPEA, also called the *Diffuse Model* which was based on regional institutes. The new state-owned organisation was established to support the military government's policies for the increased productivity of agricultural land and labour and is focused on the *Concentrated Model*. EMBRAPA has co-ordinated agricultural research all over the country. It is a bureaucratic organisation of the top-down type. At the time of its creation, EMBRAPA recruited its personnel through selection instead of public competition. Social and environmental matters are not taken into account in the research priorities. The basis of EMBRAPA's agricultural research process is the increasing of agricultural productivity, through well-trained agricultural researchers in national

[9]Busch [1980: 41], *Structure and Negotiation in the Agricultural Sciences,* shows that in American State Agricultural Experiment Stations (SAES), 'an typical agronomic experiment will take at least three years to complete. Foresters and horticulturists working with tree crops must have substantially longer temporal

research centres in specific agricultural commodities. The researcher projects focused on the specific agricultural products and agricultural scientific issues. This is the principal researcher's technical and administrative tool. Holistic approaches, the *farm as a whole* concept, social science, the relationship with the public rural extension agencies, and the small and subsistence farmers' demands are not part of EMBRAPA's agricultural research strategy.

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perspectives, as is also the case for animal scientists. On the other hand, soil agronomists, many entomologists, and agricultural engineers can often complete experiments in under three months'.

# CHAPTER 5

# AGRICULTURAL TECHNOLOGY, RESEARCHERS AND SOCIETY

## 5.1. Introduction

Technology is an important tool for economic development and plays a crucial role in society. It is therefore essential to examine the process by which agricultural technology is developed and its implications for society. Agricultural technologies are generated within complex organisations and to meet specific needs. In Brazil, agricultural technology is usually generated through the research of agronomists, biologists, veterinarians, chemists and agricultural engineers (here referred to as the field of biology), who work within the state agricultural research organisations and are susceptible to both internal and external influences. The research organisation is part of a socio-technical system and owns the means of production necessary for scientific work. The researcher controls his own technical and scientific skills. Thus, it is important to understand 'What social, scientific and economic factors have influenced EMBRAPA's researchers in the choice of research problems?' and 'To what extent has EMBRAPA's organisational structure influenced researchers in the generation of agricultural technologies?'

The aim of this study is to consider the agricultural technology generation process as an influential factor in agricultural technology transfer and adoption by farmers. This is in contrast to the behaviourist approach which views farmers as individual actors responding to *stimuli* in adopting new agricultural technology. Primary data was used as the main source of analysis. A structured questionnaire was given to eighty-seven agricultural researchers, representing approximately 90% of the agricultural researcher population in the four research centres sampled Cotton, Goat, Soya bean and Sheep National Research Centres[1] respectively.

In light of this, Biggs [1995: 161] argues that 'the development and use of research approaches and methods cannot be separated from the political, economic and institutional context in which they were developed and used'. On the contrary, agricultural research and extension activities involve 'complex personal and social processes' [Biggs and Smith, 1995: 1-2]. Thus, Biggs [1982] suggests analysing agricultural technology within the organisations that generate it. These are defined by Silverman [1983: 109] as socio-technical organisations which 'stress the inter-relationships of technology, environment, [and] the sentiments of the participants and organisational form'. Also, according to Silverman [1983a: 92], socio-technical organisations act upon an 'action-oriented perspective to organisation orientation '...' which 'alternative is to view organisation as the product of the action and interaction of motivated people pursuing purposes of their own [interests]'.

### 5.2. A Description of the National Agricultural Research Centres

As mentioned before, the four research centres surveyed are located in two different regions. The regions investigated provide a comparative study of different social, political and economic realities. The North-east is the poorest and backward region. In contrast, the Southern region is rich and agricultural production is based on modern methods.

In the North-east, the National Cotton Research Centre (CNPA) and the National Goat Research Centre (CNPC) were surveyed. Cotton is an industrial cash crop, whereas goat meat is a domestic food product. In the South, the National Soya bean Research Centre

[1]The locations of the centres surveyed are in Figure 2 and the questionnaires are in appendix 1.

(CNPSo) and the National Sheep Research Centre (CNPO) were sampled. Soya bean is an industrial and export staple and the products of sheep (meat and skin) are traded on the internal and external markets. In Brazil, cotton research is mainly public. After the appearance of the *Boll weevil (Anthonomus grandis, Boheman)*, the private sector has imported cotton varieties. Soya bean research is also mainly public. Animal research is mostly public and oriented toward nutrition and health issues.

### 5.2.1. The National Cotton Research Centre - CNPA

CNPA was created in 1975 in the city of Campina Grande, in the State of Paraíba. Its initial mission was to promote research activities to address the cotton problems in Brazil. In 1980 the first National Cotton Research Program (PNP - Cotton) was created.

CNPA's objective is to co-ordinate national cotton research in Brazil, specifically in the North-eastern region. Furthermore, its mission includes agricultural technology generation for the North-eastern textile industry. National cotton research co-ordination is through state research systems and covers sixteen Brazilian states. Overall, the aim is the 'generation, adaptation and transfer of knowledge and technologies to ensure the sustainable development of productive systems of fibre and oil crops in accordance with regional peculiarities' [EMBRAPA, 1993: 25].

To achieve this, CNPA[2] has 220 employees, including a scientific team of 43 researchers in various areas of agricultural science, embodying a management team, researchers on postgraduate courses and a few researchers located in experimental stations, along with an administrative support team of 177 people. The research team covers the

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[2]CNPA's organisational structure is in appendix 14.

following areas thus: the biology area: 36 researchers; 2 economists; 4 technology diffusionists and 1 statistician. According to the argument of this thesis, only the agricultural researchers effectively involved in the biology area generate technology. Thus, during the field-work 26 agricultural researchers were actively developing their research activities. The other ten researchers were in full-time postgraduate education or outside the research centre. Twenty-five researchers were interviewed, representing 96% of all CNPA agricultural researchers.

### 5.2.2. The National Goat Research Centre - CNPC

CNPC was created in 1977 in Sobral, in the State of Ceará. The initial mission was to promote research activities in order to increase goat productivity in the main Brazilian goat producing regions. The goal was to increase the production of goat meat, milk and skins. From 1977 to 1989, 65% of all research activities were aimed at increasing the goat and the tropical production of sheep. Nowadays, the mission has changed to the 'co-ordination, generation, adaptation, diffusion and transfer of goat and sheep technology to support the sustainable development of goats and tropical sheep for the benefit of society' [EMBRAPA, 1993a: 19].

CNPC[3] has 137 employees, of which 24 (including the management team) are researchers i.e. - biologists, economists, researchers on postgraduate courses and technology diffusionists. Administrative support is provided by 113 employees. The research team is as is made up of 23 researchers in the biology area and 1 sociologist. Sixteen agricultural researchers were interviewed. The other seven researchers were in full-time postgraduate education. Thus all the agricultural researchers were interviewed.

[3]CNPC's organisational structure is in appendix 15.

### 5.2.3. The National Soya Bean Research Centre - CNPSo

CNPSo was created in 1975 in the city of Londrina, in the State of Paraná. In 1980 the Soya bean National Program (PNP-Soya bean) was initiated and it dealt with three main Soya bean regions. The first was Soya bean in the States of Rio Grande do Sul, Santa Catarina and Paraná in the South. The second was the Soya bean expansion region - the States of Mato Grosso, Mato Grosso do Sul, Goiás and Minas Gerais in the West-Central region. The third was the Soya bean potential region - Rondônia, Roraíma, Amapá, Maranhão, Piauí and Bahia in the North and North-eastern regions. In the traditional areas, the Soya bean research programme was based on varieties of Soya bean from the United States.

According to EMBRAPA [1993b: 24], CNPSo's mission is the 'generation and promotion of knowledge and technology for the development of the Soya bean and sunflower, including its relationship to other cultivation and its insertion into the agricultural industrial complex, for the benefit of society'.

To achieve its mission, CNPSo[4] has 339 employees. The research staff comprises 56 people in various areas of the agricultural sciences, a management team and researchers on postgraduate courses or working in the socio-economic research area. The support personnel include 230 field and laboratory technicians and field workers and 53 people in the administrative sections. The research team comprises 49 agricultural researchers, 3 technology diffusionists, 3 economists and 1 statistician. During the period of the field-work, 38 agricultural researchers worked in Soya bean research and 24 were interviewed. That is, almost 63% of all agricultural researchers proceeding with research activities were

[4]CNPSo' organisational structure is in appendix 16.

interviewed. It is necessary to point out that during the period of the field-work, various agricultural researchers were absent either for work purposes or on holiday.

### 5.2.4. The National Sheep Research Centre - CNPO

CNPO used to be an experimental station linked to the Ministry of Agriculture and from 1937, was an Experimental Husbandry Farm. It underwent several transformations. After EMBRAPA's creation, it became the State Agricultural Research Unit, the UEPAE at Bagé. In 1987 it became the National Sheep Research Centre. The main objectives were the promotion of scientific investigation to solve problems that have limited the development of sheep farming.

In 1993, after this thesis had been started, the CNPO changed its name to the Southern Husbandry Research Centre (CPPSul). However, the research proposals remain the same and its mission is 'the generation, adaptation and promotion of scientific knowledge for the development and modernisation of agricultural integrated systems, prioritising cattle-raising and sheep and preserving natural resources in the South' [EMBRAPA, 1993c: 23].

CNPO's headquarters are located in Bagé, in the State of Rio Grande do Sul in the South, on the border between Brazil and Uruguay. CNPO[5] has 121 employees and of these, 29 are researchers in various areas of animal science. The research team has 25 agricultural researchers, 3 technology diffusionists, and 1 statistician. During the field-work, 24 agricultural researchers were involved in research activities and 22 were interviewed; that is approximately 92% of all active agricultural researchers.

[5]CNPO's organisational structure is in appendix 17.

## 5.3. The Agricultural Technology Generation Process

The agricultural technology generation process is the most important aspect of research work developed by agricultural researchers in the centres. In this thesis it is investigated through the profile of the researchers, the research project and the choice of research problem.

The presentation of data in this chapter follows a pattern. First, agricultural researchers are characterised by a number of factors including gender, age, levels of schooling, origins (birth place and father's occupation), academic background and scientific specialisation. Secondly, the recruitment process, the corporate ethos, involvement in the community, research focus and the research projects are explored. Finally, the factors influencing agricultural researchers' choice of research problems - including external, internal and organisational influences - are discussed.

A combined data analysis procedure is used. First, qualitative analyses are offered, where descriptive and narrative analyses are provided, and secondly quantitative analyses are undertaken, where frequency, percentages, associations, coefficients and means are indicated. The objective here is to take note of the general trends derived from the empirical results. This strategy permits a better understanding of the agricultural technology generation process of EMBRAPA as a key part of the wider socio-economic environment[6].

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[6]Silverman [1983], *The Theory of Organisations: A Sociological Framework,* argues that an organisation is arranged according to socio-technical principles when it focuses on the actors who make up the system, their class and status groups. There is also a focus on the wider political context, the distribution of power and the role of the scientific and academic community at the national and international levels.

### 5.3.1. The Profile of Agricultural Researchers

#### 5.3.1.1. Gender

In this study, males dominate the research. Table 5.1 shows that around 90% of all agricultural researchers are male, distributed as follows: 92% at CNPA, 87.50% at CNPC, 91.67% at CNPSo and 86.36% at CNPO. This great gap between men and women in the agricultural research activity can be interpreted as a result of EMBRAPA's preference for contract agronomists when it was created. It is normal for Brazil's agronomy to be dominated by men[7].

**Table 5.1 - Agricultural Researchers' Genders**

| Centres | Gender | | | |
|---|---|---|---|---|
| | Male | | Female | |
| | Frequency | % | Frequency | % |
| CNPA N=25 (28.74)[1] | 23 | 92.00 | 2 | 8.00 |
| CNPC N=16 (18.39) | 14 | 87.50 | 2 | 12.50 |
| CNPSo N=24 (27.59) | 22 | 91.67 | 2 | 8.33 |
| CNPO N=22 (25.29) | 19 | 86.36 | 3 | 13.64 |

N= number of the agricultural researchers interviewed in research centre
[1] The figures in parentheses are in percentages (100% = 87 agricultural researchers interviewed)

[7]This is despite the fact that, according to IBGE [1994: 20], in 1991, the Brazilian population was around 147 m inhabitants, 49% being men and 51% women. Also, IBGE [1996] reveals that 60% of the Brazilian economically active population are male and 40% are female.

### 5.3.1.2. Age

Most agricultural researchers at the four research centres are between 44 and 49 years old. Table 5.2 shows that 63.22% of all agricultural researchers are over 44 years of age[8]. There is no one under 26 years of age. In all the research centres surveyed about 60% of researchers were over 44 years old. The CNPSo has the highest number of researchers in the upper age bracket where 66.67% were 44 years old or more.

**Table 5.2 - Agricultural Researchers' Ages**

| Age / Centres | Under 26 | 26-31 | 32-37 | 38-43 | 44-49 | 50-55 | 56-61 | Over 61 |
|---|---|---|---|---|---|---|---|---|
| **CNPA N=25 (28.74)[1]** | - | - | 3 (12.00) | 6 (24.00) | 9 (36.00) | 4 (16.00) | 2 (8.00) | 1 (4.00) |
| **CNPC N=16 (18.39)** | - | 2 (12.50) | 2 (12.50) | 2 (12.50) | 7 (43.75) | 3 (18.75) | - | - |
| **CNPSo N=24 (27.59)** | - | 1 (4.17) | 3 (12.50) | 4 (16.67) | 10 (41.66) | 5 (20.83) | 1 (4.17) | - |
| **CNPO N=22 (25.29)** | - | 2 (9.09) | 2 (9.09) | 5 (22.73) | 6 (27.27) | 2 (9.09) | 4 (18.18) | 1 (4.55) |

N= number of the agricultural researchers interviewed in research centre
[1] The figures in parentheses are in percentages (100% = 87 agricultural researchers interviewed)

According to the National Social Insurance Institute (INSS), the retirement age in Brazil is 65, or after 35 years of continuous work. However, private social insurance companies have their own rules. In this case, the insurance company that deals with EMBRAPA, the so-called CERES (EMBRAPA and EMBRAPA Systems Social Insurance Foundation), stipulates that the retirement age is 58 years old with 35 years of continuous

[8] Busch and Lacy [1983], *Science, Agriculture and the Politics of Research,* found that the average age of the American agricultural researcher was 48 years old.

work. Thus, in this study 60% of researchers are nearing retirement and are specifically about 10 years from retirement, indicating that EMBRAPA does not often recruit younger researchers. After 1985, the recruitment was through public competition and depended on the authorisation of the President of the Republic. EMBRAPA itself does not have the authority to recruit their researchers. Normally the recruitment process is a long, negotiated political process and involves EMBRAPA executives and the Ministers of Agriculture, Planing, Public Administration. The final decision rests with the President of Republic.

The fact that there are relatively elderly agricultural researchers in EMBRAPA has two implications: First, the knowledge acquired over the years by researchers and paid for by Brazilian society is not being transferred to young EMBRAPA researchers. Ideas about agricultural technology have stayed in the same researchers' hands, thus suggesting relatively little change in policy or leadership since the beginning of EMBRAPA. Secondly, the average age of retirement (58) is nearly the same as average life expectancy in Brazil which is 65 (62 years for men and 69 for women). Although, average life expectancy in the North-eastern region is 64 (61 for men and 68 for women) [IBGE, 1993a].

### 5.3.1.3. Origins

Researchers' origins refer to their state and region of birth and their father's main occupation. For instance, 57.50% of the agricultural researchers are from the South, South East and West-Central regions, which are richer than the North-eastern and Northern regions. The origins of the agricultural researchers within each research centre are highly significant. The agricultural researchers in the research centres in the North-east are generally from the same area. For instance, 90% of all CNPA's agricultural researchers were born in the North-east and 81.25% of all CNPC's agricultural researchers were also born in the North-east.

Similarly, in the research centres located in the South, agricultural researchers were also born in the South: 67% of all CNPSo's agricultural researchers were born in the Southern regions, one of CNPSo's agricultural researchers was born in the North-east and 95.45% of all CNPO's agricultural researchers were born in the South. Furthermore, 54.5% of all CNPO's agricultural researchers born in the South were actually born in the same town.

Table 5.3 also shows that 25.29% of the occupations of the researchers' fathers related to agricultural and/or husbandry matters. CNPA had the highest percentage of agricultural and/or husbandry as the fathers' main occupation, while 40% of the CNPA's researchers' fathers were involved in agriculture or husbandry. The lowest percentage was at CNPSo (8.33%). In a similar way, 42.% and 33% of the population over 10 years old in North-east and the South respectively are involved in agricultural activities [IBGE, 1996: 44]. Overall, around 75% of the fathers' main occupation was not connected with *agriculture and husbandry*.

**Table 5.3 - Agricultural Researchers' Fathers Main Occupation**

| Centres<br>Occupation | CNPA<br>N=25<br>(28.74)[1] | CNPC<br>N=16<br>(18.39) | CNPSo<br>N=24<br>(27.59) | CNPO<br>N=22<br>(25.29) |
|---|---|---|---|---|
| **Civil servant** | 1 (4.00) | 5 (31.25) | 5 (20.83) | 6 (27.27) |
| **Liberal professional** | 3 (12.00) | 1 (6.25) | 4 (16.67) | 5 (22.73) |
| **Business** | 5 (20.00) | 2 (12.50) | 3 (12.50) | 1 (4.54) |
| **Agriculture and Husbandry** | 10 (40.00) | 3 (18.75) | 2 (8.33) | 7 (31.82) |
| **Other** | 4[2](16.00) | 4[3](25.00) | 10[4](41.67) | 3[5](13.64) |
| **No Answer** | 2 (8.00) | 1 (6.25) | - | - |

N= number of the agricultural researchers interviewed in research centre
[1] The figures in parentheses are in percentages (100% = 87 agricultural researchers interviewed)
[2] Accountant and Driver
[3] Accountant, Carpenter, Military Officer and Retired
[4] Captain, Mechanic, Barber, Doctor, Driver, Retired and Laboratory Official
[5] Broker, Business Manager and Bank Official

It is important to note that 68.12% (47) of the 69 agricultural researchers who indicated their place of birth were born in urban areas, compared with 31.82% (20) who were born in rural areas. The highest percentages of those born in urban areas are: CNPC (81.82%) followed by CNPSo (77.78%), CNPO (68.85%) and CNPA (50.00%). As shown in Table 5.2, 63.22% of all agricultural researchers are over 44 years of age, indicating that these researchers were born in the 1950s. In the 1950s, Brazil's population was 51,944,397, of which 36.16% and 63.84% lived in urban and rural areas respectively. Brazil was essentially a rural country. By contrast, in 1991, Brazil's population comprised 146,917,459 inhabitants and of these 75% lived in urban areas and 25% lived in rural areas [IBGE, 1993a: 2-8].

### 5.3.1.4. Education

Education is here delineated as the level of formal schooling attained by agricultural researchers. At EMBRAPA, a high level of formal education is vital and researchers have generally obtained PhDs [Ávila et al 1983 and Coqueiro 1981]. According to Gibbons [1995: 135], this is the result of the state's intervention in the 1970s: 'The expectation was that good academic science would lead to technology, high technology would lead to basic competence, technological competence would lead to industrial success, and elite education would lead to mass education'.

In contrast, Watanabe [1985: 246] argues that primary and secondary education levels are more relevant to the development of technology generation than higher education. The Newly Developed Asian Countries have followed this strategy[9]. Bastos [1995: 68] mentions

[9] According to Flynn [1996: 409], *Brazil: The Politics of the 'Plano Real'*, in Brazil 'only 44% of children completing primary school and only 17% of children of secondary school age being educated, compared, in the latter case, to 55% in Mexico, 91% in Taiwan and 96% in Japan'.

that 'a high illiteracy rate and an inefficient system of primary education have constituted general constraints on innovation' in Brazil. Almost 20% of Brazilians can neither read nor write and in the North-east the illiteracy rate is 40% [IBGE, 1994]. Also, McDonald et al point out the Brazilian contradiction: Brazil has the world's fifth largest population and the tenth world economy, but is seventy-fourth in national educational achievement [1995: 158-61].

**5.3.1.4.1. Primary and Secondary Courses**

Seventy percent of researchers attended primary school within the state system. For instance, in CNPA, 88%; CNPC, 62.50%; CNPSo, 79.17% of agricultural researchers studied in state schools. However, in CNPO, only 45.45% of the agricultural researchers studied in state schools. Some differences can also be seen in relation to secondary schooling. In CNPA, 40.00%; CNPC, 44.75%; and CNPO, 40.91% of the researchers studied in private secondary schools, while in CNPSo 87.50% of the agricultural researchers studied in state secondary schools. CNPO and CNPSo are located in the South. Nowadays, the best secondary schools in Brazil are private ones but they are expensive and are only available to the middle and upper social classes.

With respect to university courses, 93% of all the researchers studied in state universities. In Brazil the best universities are the state ones. In fact, the majority of students are admitted to university after national public selection, termed the *vestibular* and come from private secondary schools. The selection for university is very competitive and students from secondary state schools are not usually successful in the university entrance examination.

**5.3.1.4.2. Undergraduate Courses**

With respect to undergraduate courses, 72% of the agricultural researchers undertook an agronomy undergraduate course, as follows: CNPA, 84%; CNPC, 43.75%; CNPSo, 95.48% and CNPO, 50%. This represents an enormous degree of homogeneity, particularly in CNPA and CNPSo. The domination of agronomy is probably related to the academic diversity of the agronomy curriculum which permits agricultural research specialisation in various agricultural and animal knowledge areas. In Brazil, the agronomy curriculum is basically focused on the field of botany. Social, economic and environmental issues have not been a significant part of its disciplinary content.

Even though, in the case of CNPC and CNPO, veterinary undergraduate courses dominate, research is mainly undertaken into husbandry and nearly 50% of CNPC and CNPO agricultural researchers are veterinary surgeons. Similarly, the curricula of agronomy and veterinary university degrees permit various scientific specialisations. There was little diversity in the undergraduate courses taken by researchers in the research centres surveyed. Thus, the agricultural researchers' scientific specialisations were mainly in the field of the agricultural and animal sciences. In the seventies, university agronomy and veterinary courses were often the main ones offered by Brazilian universities in the fields of agriculture and husbandry.

It is important to note that 98.85% of all agricultural researchers completed their undergraduate courses in Brazilian universities, the majority of them in the same regions in which the research centres were located. For example, 95.65% of the 23 CNPA and 66.67% of the 15 CNPC respondents respectively completed their courses in the North-east. In the same way, 95.24% of 21 CNPSo and 88.89% of the CNPO respondents completed their university courses in the South. This does not indicate regionalisation of research in Brazil; on the contrary, the EMBRAPA research model is focused on national research problems. It is important to stress that during EMBRAPA's formation, researchers were recruited from all over the country. The decision as to where each researcher worked was decided by the organisation. Thus, many were allocated to different regions across the country. Afterwards the researchers returned to their home regions where the research centres are located.

Another important point is that normally in Brazil, agronomy schools are situated in small towns outside the main university campuses. Such is the case with the Viçosa and Piracicaba schools, which are the most famous Brazilian agronomy schools. Both are located in the interior of the State of Minas Gerais and São Paulo respectively. Most of EMBRAPA's researchers studied in these schools. Apart from this, there is no intensive interaction between agronomy students and other university students due to the distance involved. Moreover, the agronomy curriculum is based upon specific agricultural problems, particularly in the field of botany and there is little attempt to study the rural and social contexts in which agricultural problems arise. Hanson et al [1995: 245], in analysing the challenges to agronomists in the developing countries, argue that in the future, agronomists will require a holistic curriculum which 'must emphasise resource conservation and environmental protection'. Also, Guzinán and Molina [1996: 158] state that it is necessary for agronomists to understand the relationship between the social, the cultural and the economic factors of the agricultural production systems.

#### 5.3.1.4.3. Postgraduate Courses

Postgraduate courses here refer to Masters and PhD courses. Table 5.4, shows that 96.55% of all agricultural researchers have undertaken masters courses. This massive training program should be reflected in EMBRAPA's priorities. 87.36% of masters degrees were obtained from Brazilian universities, 9.19% from American universities and 3.45% from European ones. It is important to note that the Masters courses offered specialisation in various kinds of agricultural production and husbandry fields, reflecting the concentration in agronomy and veterinary degrees and the formation of a multidisciplinary research team.

**Table 5.4 - Agricultural Researchers' Masters Courses**

| Centres / Masters Courses | CNPA N=25 (28.74)[1] | CNPC N=16 (18.39) | CNPSo N=24 (27.59) | CNPO N=22 (25.19) |
|---|---|---|---|---|
| **Meteorology** | 1 (4.00) | - | - | - |
| **Biochemistry** | - | 1 (6.25) | - | - |
| **Botany** | 1 (4.00) | - | - | 1(4.55) |
| **Soil and Nutrition** | 1 (4.00) | - | - | - |
| **Soil Science** | - | - | 2 (8.33) | - |
| **Biology Science** | - | - | 1 (4.17) | - |
| **Science and Technology** | 1 (4.00) | - | - | - |
| **Animal Diseases** | - | 3 (18.75) | - | 1 (4.55) |
| **Agricultural Engineering** | 3 (12.00) | - | - | - |
| **Irrigation** | 1 (4.00) | - | - | - |
| **Entomology** | 2 (8.00) | - | 1 (4.17) | - |
| **Agricultural Production** | 11 (44.00) | 2 (12.50) | 13 (54.17) | 3 (13.63) |
| **Genetics** | 1 (4.00) | - | 2 (8.33) | 1 (4.55) |
| **Range Science** | - | 2 (12.50) | - | - |
| **Animal Breeding** | - | 2 (12.50) | - | - |
| **Animal Production** | 1 (4.00) | - | - | 5 (22.73) |
| **Animal Science** | - | 1 (6.25) | - | - |
| **Seeds** | - | - | 2 (8.33) | - |
| **Plant Protection** | - | - | 2 (8.33) | - |
| **Plant Breeding** | - | - | 1 (4.17) | - |
| **Zootechnology** | - | 5 (31.25) | - | 6 (27.27) |
| **Veterinary** | - | - | - | 2 (9.09) |
| **No Answer** | 2 (8.00) | - | - | 3 (13.63) |

N= number of the agricultural researchers interviewed in research centre
[1] The figures in parentheses are in percentages (100% = 87 agricultural researchers interviewed)

As stated, 87.36% of all agricultural researchers undertook their masters courses in Brazilian universities. It is important to note that 52.17% of 22 CNPA, 21.42% of 14 CNPC, 50% of 12 CNPSo and 78.95% of 15 CNPO respondents respectively took their masters courses in the region where the research centres were located. CNPC is an exception. Thus, 82% of all the agricultural researchers were born in the regions where their research centres were located. 77% undertook undergraduate courses in universities located in the same regions in which they were born and where their research centres were located, and 46% undertook Masters courses at the same universities which they had attended as undergraduates.

In contrast to the Masters qualification, PhD specialisation is restricted to specific knowledge fields. Table 5.5 illustrates that the PhD qualification was concentrated in only a few scientific areas and only 38% of all agricultural researchers had undertaken PhD courses[10]. The distribution is as follows: CNPA 32%; in CNPC 25%; in CNPSo 66.67% and in CNPO 22.73%. CNPSo has the highest proportion of agricultural researchers with PhDs and 47.06% of all the agricultural researchers with PhD's work in CNPSo. Furthermore, 37.50% of CNPA, 75% of CNPC, 43.75% of CNPSo researchers undertook PhD courses at American universities. 80% of CNPO researchers took their PhD's at European universities.

**Table 5.5 - Agricultural Researchers' PhD Courses**

| Centres<br>PhD Courses | CNPA N=25 [n=8] (32.00)[1] | CNPC N=16 [n=4] (25.00) | CNPSo N=24 [n=16] (66.67) | CNPO N=22 [n=5] (22.73) |
|---|---|---|---|---|
| Agricultural Production | 4 (50.00) | 1 (25.00) | 9 (56.25) | - |
| Range Science | - | 2 (50.00) | - | - |
| Animal Science | - | 1 (25.00) | - | - |
| Animal Production | - | - | - | 1 (20.00) |
| Animal Breeding | - | - | - | 1 (20.00) |
| Animal Diseases | - | - | - | 1 (20.00) |
| Genetics | 1 (12.50) | - | 1 (6.25) | 1 (20.00) |
| Pastures | - | - | - | 1 (20.00) |
| Entomology | 2 (25.00) | - | 1 (6.25) | - |
| Agricultural Engineering | 1 (12.50) | - | - | - |
| Plant Disease | - | - | 1 (6.25) | - |
| Seed Physiology | - | - | 1 (6.25) | - |
| Biology Science | - | - | 1 (6.25) | - |
| Soil and Nutrition | - | - | 2 (12.50) | - |

N= number of the agricultural researchers interviewed in research centre
n= number of PhD qualified agricultural researchers in research centre
[1] The figures in parentheses are in percentages (100% = 87 agricultural researchers interviewed)

[10]Huffman and Evenson [1993: 75], *Science for Agriculture: A long-term perspective,* found that more than 80% of agricultural researchers in American state agricultural experimental stations have PhD degrees.

Further, the majority of agricultural researchers completed their PhD's at American or European universities, not Brazilian ones, as is the case for the Master's qualification: all the CNPSo and 80% of CNPC agricultural researchers gained their PhD degrees in American or European universities. This shows that the EMBRAPA strategy to promote the diffusion and transference of agricultural technology from the advanced countries to Brazil was through highly qualified researchers.

It can be seen that a large percentage of agricultural researchers were born, studied, completed their undergraduate and master courses and worked all in the same region. Also, as can be seen in the previous data, 68.12% of 69 agricultural researcher respondents were born in urban areas and 75% of all their fathers' main occupations were not connected with agriculture or husbandry issues. Moreover, 33.33% of the agricultural researchers had studied in private secondary schools. This has three implications. First, the agricultural researchers are intimately familiar with the social reality of the potential users and clients of EMBRAPA technology. Secondly and alternatively, agricultural researchers may maintain their view according to their social class expectation. Thirdly, agricultural researchers may be affected by external and internal influences. As a consequence of the second and third implications, the generation of agricultural technology may be unrelated to the needs of the majority of Brazilian farmers.

Miliband [1987: 17] writes that 'in all capitalist societies a growing class of professional people - technicians, scientists, administrators, etc. and medium-sized entrepreneurs form the main elements of a middle class'. In Brazil, according to Ribeiro [1995: 211], small farmers, peasants and share croppers are part of the lowest social class whilst civil servants - for instance the EMBRAPA agricultural researchers - are part of the middle class.

Nonetheless, Hebette [1996: 42] argues that the relationship between researchers and farmers is not only a working relationship, but also one that involves different social classes. This suggests that it may be difficult for agricultural researchers coming from the middle class to create an agricultural technology to serve the farmers at the bottom of the social system. D'Incao and Roy [1995], studying Brazilian rural settlements found that the conflicts and contrasts between farmers and researchers originated from their different social classes. According to Hebette [1995: 5], this difference between researcher and farmer can be explained in two ways: first, the researcher may have academic expertise unaffected by social class structure. Secondly, the researcher as a member of the middle class, may be sensitive to the demands of the dominant class.

Further, Coqueiro [1981] argues that after 1979, the main goal of EMBRAPA's postgraduate programme was the acquisition of PhD degrees because researchers with PhD's were allegedly more able to apply foreign technologies to Brazilian agricultural problems. Ávila et al [1983: 41] show that 'EMBRAPA training has been fundamental to construct an appropriate agricultural research system. This was the initial intention and this is the trend of the organisational effects already realised'. Bell and Pavitt [1995: 94] remark that an important method for the acquisition of foreign technology is through 'educational channels'. This is confirmed by Sephar [1994: 169], who writes that the initial Soya bean varieties for the breeding programme were 'obtained from crosses between American and Brazilian varieties'. The EMBRAPA Soya bean breed program was started by the EMBRAPA Soya bean geneticist who undertook his postgraduate work (Masters and PhD) in the United States.

### 5.3.2. The Research Process

As illustrated in this thesis, the process of the generation of agricultural technology comprises several stages, including selective recruitment, the definition of the research project and the choice of research problem. The research work is developed in EMBRAPA's research centres under various constraints and controls. EMBRAPA, as a public organisation, follows government guidelines and is part of the Brazilian state apparatus. Moreover, it is dependent on the Federal government for almost 85% of its financial support.

The research work is crucially dependent on the research project. The research project mainly involves the selection of the research problem, research areas and the funding application. It is the researcher's technical and administrative tool and requires approval through administrative and technical rituals as described below.

The researcher outlines his research project and submits it to the research centre's internal technical commission and then to the external national research programme (PNP). If the project is approved, it is subsequently submitted to EMBRAPA headquarters for examination and lastly to EMBRAPA's executive for the final decision. After that, all research projects are included in the national agricultural research programme and financial resources are allocated to the research centre in which the project will take place. Finally, at the research centre, the research project is effectively transformed into experimental research. This is a bureaucratic process and there is often an enormous gap between the initial plan and the final research results. The process of research is managed by agricultural researchers recruited as described in the next section.

### 5.3.2.1. The Recruitment Process

As a state-owned organisation founded under military rule, EMBRAPA selected its personnel according to its own particular priorities. This did not comprise competitive selection or any other universal criterion. Two questions were asked of the agricultural researchers about the recruitment period. First, 'When did you join EMBRAPA?' and secondly, 'When did you start work in your current research centre?'. Table 5.6 shows EMBRAPA's recruitment (that is, including researchers recruited by other research centres, or even through EMBRAPA headquarters) and in the four research centres surveyed.

**Table 5.6 - Agricultural Researchers' Recruitment Dates**

| Dates / EMBRAPA[1] Centres | 1973-1976 | 1977-1980 | 1981-1984 | 1985[2]- 1988 | 1989-1992 | After 1992 |
|---|---|---|---|---|---|---|
| EMBRAPA | 14 (56.00) | 6 (24.00) | 2 (8.00) | - | 3 (12.00) | - |
| CNPA N=25 (28.74)[3] | 5 (20.00)[4] | 10 (40.00) | 3 (12.00) | 2 (8.00) | 5 (20.00) | - |
| EMBRAPA | 5 (31.25) | 1 (6.25) | 3 (18.75) | 2 (12.50) | 4 (25.00) | 1 (6.25) |
| CNPC N=16 (18.39) | - | 4 (25.00) | 2 (12.50) | 2 (12.50) | 7 (43.75) | 1 (6.25) |
| EMBRAPA | 16 (66.67) | 3 (12.50) | - | 1 (4.16) | 4 (16.67) | - |
| CNPSo N=24 (27.59) | 10 (41.67) | 8 (33.33) | - | 1 (4.16) | 4 (16.67) | 1 (4.17) |
| EMBRAPA | 13 (59.10) | 1 (4.54) | 2 (9.10) | 1 (4.54) | 5 (22.72) | - |
| CNPO N=22 (25.29) | 9 (40.91) | 4 (18.18) | 2 (9.10) | 1 (4.54) | 6 (27.27) | - |

N= number of the agricultural researchers interviewed in research centre
[1]**EMBRAPA** (that is, including researchers recruited by other research centres, or even through EMBRAPA headquarters)
[2]The first EMBRAPA's public selection was in 1985
[3]The figures in parentheses are in percentages (100% = 87 agricultural researchers interviewed)
[4]Researchers recruitment was through the research centre and this was their first post

The figures indicate that 55% of all agricultural researchers were recruited by EMBRAPA and joined the research centres sampled between 1973 and 1976. Thus, researchers were strongly influenced by EMBRAPA messages and their subsequent financial benefits. They did not have any professional experience prior to their employment at EMBRAPA.

Except in the case of CNPC, Table 5.6 shows that the majority of CNPA (56%), CNPSo (66.67%) and CNPO (59.10%) agricultural researchers were recruited during EMBRAPA's start up period between 1973 and 1976. It is important to note that CNPC is situated in a small and isolated town in the North-east. It is difficult for the researchers outside the North-east region or even outside the State of Ceará to live where CNPC is located. As a consequence, there is a high turnover of CNPC researchers, mostly from the developed Southern and South-eastern regions. In EMBRAPA's experience, research centres situated in small towns show a high rate of researcher mobility[11]. As a result, 62.5% of CNPC researchers were recruited through public selection after 1985 (when democracy was established in Brazil).

### 5.3.2.1.1. EMBRAPA's Methods of Recruitment

To cope with government priorities in the 1970s[12], EMBRAPA selected its researchers according to its own methods, which meant recruitment required organisational consensus within the organisation. It did not allow political issues and research proposals to conflict. Also, recruitment did not allow broad participation from Brazilian researchers. When asked of

[11]Arce and Long [1992: 221], *The Dynamics of Knowledge: Interfaces between Bureaucrats and Peasants.* In: Battlefields of Knowledge: The Interlocking of Theory and Practice in Social Research and Development, believe that 'geographical isolation is associated with being a *rough place*, poor in services and resources, and being culturally 'traditional' and therefore outside the mainstream of *modern life*'.
[12]EMBRAPA was officially created in 1972.

researchers, 'How were you recruited by EMBRAPA?', Table 5.7 shows that only 19.5% of researchers were recruited by public competition and that EMBRAPA recruited its researchers based mainly on four factors. First, recruitment was influenced by the researchers' academic ability. Secondly, there was a preference for a few researchers selected from the National Agricultural Experimental and Research Department - DNPEA (the previous EMBRAPA). Thirdly, recruitment was based on EMBRAPA's executive selection and lastly on recommendations from outside EMBRAPA.

**Table 5.7 - EMBRAPA Researchers' Methods of Recruitment**

| Centres<br>Methods of Recruitment | CNPA N=25 (28.74)[1] | CNPC N=16 (18.39) | CNPSo N=24 (27.59) | CNPO N=22 (25.29) |
|---|---|---|---|---|
| **From the DNPEA (previous EMBRAPA)** | 5 (20.00) | - | 9 (37.50) | 6 (27.27) |
| **Academic evaluation** | 8 (32.00) | 8 (50.00) | 6 (25.00) | 7 (31.82) |
| **Selected by EMBRAPA's executive** | 5 (20.00) | 3 (18.75) | 3 (12.50) | 1 (4.54) |
| **Recommended by friend or politician** | 1 (4.00) | - | - | - |
| **Public competition** | 4 (16.00) | 5 (31.25) | 3 (12.50) | 5 (22.73) |
| **Other[2]** | 2 (8.00) | - | 3 (12.50) | 3 (13.64) |

N= number of the agricultural researchers interviewed in research centre
[1] The figures in parentheses are in percentages (100% = 87 agricultural researchers interviewed)
[2] Selected in accordance with an agreement between EMBRAPA and a state research company, researchers with PhDs and ten or more years of professional experience and EMBRAPA's internal assessment

Another important way in which recruitment affected the research process was EMBRAPA's priority of recruiting inexperienced researchers. Table 5.8 reveals that 24.14% of all agricultural researchers completed their first university course in the period 1973-1976, and were thus part of EMBRAPA without any professional experience. The majority had finished their undergraduate courses either before 1973 or in the 1973-1976 period; thus 69% of all agricultural researchers had completed their first university course during these periods. Recruitment favoured young and recent graduates over experienced researchers. EMBRAPA was established in 1973, so this suggests that the agricultural researchers absorbed

EMBRAPA's ideas more easily because they did not have previous professional experience for the purposes of comparison.

**Table 5.8 - Period of the Completion of the Agricultural Researchers' Courses**

| Periods / Centres | Before 1973 | 1973 - 1976 | 1977 -1980 | 1981 - 1984 | 1985[1] -1986 | After 1986 |
|---|---|---|---|---|---|---|
| **CNPA N=25 (28.74)[2]** | | | | | | |
| **BS** | 9 (36.00) | 7 (28.00) | 5 (20.00) | 2 (8.00) | 2 (8.00) | - |
| **MSc[3]** | 1 (4.00) | 3 (12.00) | 10 (40.00) | 4 (16.00) | 1 (4.00) | 5 (20.00) |
| **PhD** | - | - | 1 (12.50) | 1 (12.50) | 1 (12.50) | 5 (62.50) |
| **CNPC N=16 (18.39)** | | | | | | |
| **BS** | 7 (43.75) | 2 (12.50) | 2 (12.50) | 2 (12.50) | 1 (6.25) | 2 (12.50) |
| **MSc** | 2 (12.50) | - | 2 (12.50) | 3 (18.75) | 2 (12.50) | 7 (43.75) |
| **PhD** | 1 (25.00) | - | - | - | - | 3 (75.00) |
| **CNPSo N=24 (27.59)** | | | | | | |
| **BS** | 13 (54.17) | 7 (29.17) | - | 3 (12.50) | 1 (4.16) | - |
| **MSc** | 13 (54.17) | 7 (29.17) | - | 3 (12.50) | 1 (4.16) | - |
| **PhD** | - | - | 1 (6.25) | 4 (25.00) | 3 (18.75) | 8 (50.00) |
| **CNPO N=22 (25.29)** | | | | | | |
| **BS** | 10 (45.45) | 5 (22.73) | 2 (9.09) | 4 (18.18) | 1 (4.55) | - |
| **MSc[4]** | 3 (13.64) | 5 (22.73) | 4 (18.18) | 1 (4.55) | 2 (9.09) | 4 (18.18) |
| **PhD** | - | 1 (20.00) | - | 1 (20.00) | 1 (20.00) | 2 (40.00) |

N= number of the agricultural researchers interviewed in research centre
[1] The first public competition in EMBRAPA's recruitment
[2] The figures in parentheses are in percentages (100% = 87 agricultural researchers interviewed)
[3] One agricultural researcher did not have Masters qualifications
[4] Three agricultural researchers did not have Masters qualifications

It is important to note that CNPSo has the highest percentage of agricultural researchers who concluded their undergraduate courses before 1973 (54.17%). Between 1973 and 1976, the figure was 29.17%. Macêdo [1984] had similar findings in research developed on the agricultural technology generation process in the EMBRAPA Rice and Bean National Research Centre - CNPAF. Bastos [1995: 784] found that in various state science and technology organisations - such as the National Industrial Research Institute (INPI), the

Industrial Technology Secretariat (STI) and the National Research Advisory (CNPq) - recruitment 'mixed meritocratic procedures and political appointments'. Also, the Ministry of Education recruitment procedures were essentially political. In EMBRAPA's case, during the military dictatorship's rule, employee recruitment was first submitted to EMBRAPA's internal military security advisory board. Bastos [1995: 72] argues that 'recruitment patterns and bureaucratic career paths affect internal coherence '...' and contribute to the constitution of corporate culture'.

**5.3.2.1.2. Agricultural Researchers and the Corporate Ethos**

The corporate ethos can be observed in EMBRAPA in various ways. For instance, Table 5.9 shows that around 91% of all agricultural researchers consider *EMBRAPA as the best Brazilian agricultural organisation* and 94% very much *enjoy being an EMBRAPA researcher*. The greatest satisfaction with EMBRAPA came from CNPSo (100%) and CNPO (100%) agricultural researchers, who all said that they very much *enjoy being an EMBRAPA researcher*. Both research centres are located in the rich South region. Furthermore, Soya bean is an important agricultural export commodity and the CNPSo technology has been a factor in increasing national Soya bean productivity. The lowest accordance was CNPC researchers with 75% of agreement. As stated before, CNPC is located in a small town in the Northeastern region, which has limited facilities to attract researchers of other regions, mainly from the South and South East. Goats are small animals kept by poor and subsistence farmers in the semi-arid area of the North-east but CNPC technology has not been adopted by goat farmers.

Further, 76.62% of them agreed that *EMBRAPA is researching the most important problems in Brazil*. On the one hand, CNPSo has the highest degree of consensus with

91.67% and on the other, CNPO presented the highest disagreement with 50%. These figures could be interpreted in two different ways. First, during the field-work, CNPSo's researchers said that Soya bean technology has been adopted by Soya bean farmers and has increased Soya bean productivity. They support the research model which focused on the national research programme concentrated on specific agricultural products. Second, it was also observed that CNPO was formerly an experimental station; its researchers had a close relationship with local and regional farmers. As a result, CNPO's researchers presented a more critical view of the EMBRAPA technology generation process for the national sphere.

**Table 5.9 - EMBRAPA Researchers' Views**

| Centres<br>Views | CNPA<br>N=25<br>(28.74)[1] | CNPC<br>N=16<br>(18.39) | CNPSo<br>N=24<br>(27.59) | CNPO<br>N=22<br>(25.29) |
|---|---|---|---|---|
| **EMBRAPA is the best organisation** | [+] 22 (88.00)<br>[-] 3 (12.00) | [+] 14 (87.50)<br>[-] 2 (12.50) | [+] 22 (91.67)<br>[-] 2 (8.33) | [+] 21 (95.45)<br>[x] 1 (4.55) |
| **EMBRAPA researchers do not have enough freedom** | [+] 9 (36.00)<br>[-] 16 (64.00) | [+] 6 (37.50)<br>[-] 10 (62.50) | [+] 3 (12.50)<br>[-] 21 (87.50) | [+] 5 (22.72)<br>[-] 17 (77.28) |
| **EMBRAPA is researching the most important research problems** | [+] 21 (84.00)<br>[-] 4 (16.00) | [+] 12 (75.00)<br>[-] 4 (25.00) | [+] 22 (91.67)<br>[-] 2 (8.33) | [+] 11 (50.00)<br>[-] 11 (50.00) |
| **It is a pleasure to be an EMBRAPA researcher** | [+] 24 (96.00)<br>[-] 1 (4.00) | [+] 12 (75.00)<br>[-] 4 (25.00) | [+] 24 (100.00) | [+] 22 (100.00) |
| **EMBRAPA is similar to a private organisation** | [+] 5 (20.00)<br>[-] 19 (76.00)<br>[0] 1 (4.00) | [+] 1 (6.25)<br>[-] 13 (81.25)<br>[0] 2 (12.50) | [+] 4 (16.67)<br>[-] 19 (79.16)<br>[0] 1 (4.17) | [+] 2 (9.09)<br>[-] 20 (90.91) |

N= number of the agricultural researchers interviewed in research centre
[1] The figures in parentheses are in percentages (100% = 87 agricultural researchers interviewed)
[+] Agree [-] Disagree [x] No opinion [0] No answer

It is important to note that researchers in the research centres sampled agreed with the view that *EMBRAPA researchers have the freedom to choose their research problem*. The percentages of agreement varied from 62.50% in CNPC; 64.00% in CNPA; 77.38% in CNPO to 87.50% for CNPSo. It is worth noting that in the North-eastern research centres (CNPA and CNPC), there is less agreement than in the Southern ones (CNPO and CNPSo). This may illustrate a strong connection between CNPO and farmers' regional demands and the high CNPSo technology adoption by farmers. The South is rich - the agricultural production systems are based on modern inputs, land is better distributed and farmers are organised in co-operatives. There is no conflict between researchers' and farmers' demands. On the other hand, the North-east is the poorest region in the country and the majority of farmers are poor and disorganised and land is extremely concentrated. Normally, there was no connection between the Northeast research centres and the rural extension agencies and the poor and subsistence farmers.

Figures in Table 5.9 show that the research centres disagreed with the notion that *EMBRAPA is similar to a private organisation.* CNPO (90.91%), CNPC (81.25%), CNPSo (79.16%) and CNPA (76%) showed high rate of disagreement. The researchers in all the research centres sampled indicated a high disapproval of EMBRAPA bureaucratic controls. For them, EMBRAPA was slow in its routine and administrative matters. This does not imply that the researchers were defending the privatisation of Brazilian agricultural research. On the contrary, they would like to have the facilities of the private sector and yet retain the privileges of the state organisations.

The corporate ethos can also be perceived as follows. In 1988, after the new Brazilian constitution was established, the Brazilian Parliament and political parties became more powerful. One result of this was that the Brazilian budget, and EMBRAPA's budget in particular, needed to be approved by Parliament. However, when researchers were asked 'Who gives political support to EMBRAPA?' 84.51% of 71 responses were distributed as follows: 71.43% of CNPA, 85.71% of CNPC, 89.47% of CNPSo and 94.12% of CNPO said that *all political parties give support because of the importance of EMBRAPA*. It seems that researchers overestimate EMBRAPA's importance in relation to Brazilian social and economic issues, including those prioritised by the political parties.

The highest score was for CNPO (94.12%) followed by CNPSo (89.47%) which is located in the South region. This region is known as a politically conservative region, possessing in the State of Rio Grande do Sul a 'separatist movement' whose aim is State independence. On the other hand, the lower percentages were for the North-east research centres, CNPA (71.43%) and CNPC (85.71%) respectively. In the North-east, political movement has involved the educated social segments. Secondly, during the time of the field-work it was reported that the majority of researchers continued to be involved with EMBRAPA even in outside activities. This indicates that researchers activities are *connected with EMBRAPA's work.*

Another important point was illustrated when they were asked 'How could EMBRAPA improve its agricultural technology generation process?'. The aim was not to evaluate the role of the governmental or non-governmental agricultural organisations, such as rural extension agencies, co-operatives, universities and NGOs. The question was asked to understand the extent researchers acknowledged the importance of other agricultural organisations around them. Also, it was important to reveal the researchers' views related to partnership in the generation process and to identify in a different way the researcher's corporate ethos.

Figures in Table 5.10, including *ANOVA* outputs, show that all the researchers rejected links between EMBRAPA and NGOs, EMBRAPA and rural extension agencies and EMBRAPA and co-operatives. The lowest mean, was CNPSo's mean of 1.17 related to EMBRAPA's *link with rural extension agencies* which are organisations connected to the farmers' production units. The CNPSo's mean of 1.65 was related to EMBRAPA's *association with NGOs.* Once again this is an illustration of EMBRAPA's dilemma of association with organisations concerned with local issues and the small farmers' demands.

**Table 5.10 - How Could EMBRAPA Improve its Agricultural Technology Generation?**

| Centres / Improvements | CNPA N=25 (28.74)[1] Mean[2] | CNPC N=16 (28.39) Mean | CNPSo N=24 (27.59) Mean | CNPO N=22 (25.29) Mean | F Ratio | F Probability | Scheffe Test |
|---|---|---|---|---|---|---|---|
| Link with rural extension agencies | 2.04 | 2.13 | 1.17 | 1.95 | 3.195 | 0.028 | ** |
| Associate with NGOs | 2.00 | 2.13 | 1.65 | 2.09 | 0.643 | 0.589 | ** |
| Associate with universities | 3.04 | 2.81 | 2.92 | 3.18 | 0.283 | 0.838 | ** |
| Associate with co-operatives | 3.16 | 2.81 | 3.17 | 3.41 | 0.623 | 0.602 | ** |
| EMBRAPA only needs money | 2.60 | 3.25 | 4.08 | 2.86 | 5.385 | 0.002 | ++ |

N= number of the agricultural researchers interviewed in research centre
[1] The figures in parentheses are in percentages (100% = 87 agricultural researchers interviewed)
[2] The means come from the responses which were allocated to a scale of 1 to 5, where 1 is the lowest and 3 is the average
** No two groups are significantly different at the 0.050 level
++ CNPSo is significantly different to CNPA and CNPO respectively at the 0.050 level

The highest mean in Table 5.10, was CNPSo's of 4.08, followed by CNPC's mean of 3.25 indicating the opinion that *EMBRAPA only needs money* (financial support). In this case, ANOVA outputs point to the statistical differences between CNPSo's mean of 4.08 and CNPA's mean of 2.60 and between CNPSo's mean of 4.08 and CNPO's mean of 2.86

respectively. These indicate a strong corporate ethos within EMBRAPA, mainly in the CNPSo and CNPC. On the one hand, the researchers see EMBRAPA as an independent organisation which could survive provided it is financially supported. On the other hand, there really is a financial crisis in all developing countries, mainly in the science and technology field[13]. Also, the CNPSo highest mean of 4.08 also suggests that CNPSo needs a great deal of money to keep up the Soya bean national research program. The CNPC mean of 3.25 pointed to a persistent and constant shortage of financial resources.

In relation to EMBRAPA's association with universities, ANOVA outputs do not show statistical differences among research centres. However, they have different means. For example, the highest CNPO's mean of 3,18 indicates some involvement between CNPO's researchers and a local, private, agricultural and husbandry university where the CNPO is located. This is another facet of CNPO regional concerns. The CNPA mean of 3.04 could also show the relationship between CNPA's researchers and a well-known Northeast university (the Federal University of Paraíba at Campina Grande) where CNPA is. The CNPC mean of 2.81 and the CNPSo mean of 2.92, which are below the average mean, 3, indicate that these research centres have not connected with universities, although there are state and private universities where the CNPC and CNPSo are located. This implies that these research centres were closed in on themselves with a solid corporate ethos.

Table 5.10 (particularly CNPA's mean of 3.16; CNPC's mean of 2.81; CNPSo's mean of 3.17 and CNPO's mean of 3.41) shows the researchers' tendency to agree that

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[13]According to Vargas [1996: 7], *Brazilian System of Science and Technology*, who is the Brazilian Minister for Science and Technology (S&T), the Government has been applying 0.7% of GDP in Science and Technology and 90% of S&T expenditures was met by the Government while private investment accounted for only 10%.'

*EMBRAPA could associate with co-operatives.* CNPC's mean of 2.81 is the lowest mean followed by CNPA's mean of 3.16. This shows that small farmers were disorganised in the North-east. However, CNPO researchers' answers had the highest mean of 3.41 followed by CNPSo's mean of 3.17. This relates to the high level of modern farmers organised in co-operatives in the Southern region. This also suggests, according to Goodman et al [1985], that a co-operative strategy was used by the Brazilian authoritarian government to promote agricultural modernisation.

It is important to note that in Brazil organisations such as rural extension agencies, co-operatives, NGOs and Universities are relatively open and more sensitive to the demands of society. Their organisational structures, objectives and strategies are more connected with the requirements of the social movements where they are located. For instance, in this thesis the rural extension representatives are concerned with the farmer's social and anthropological values and the farm as a whole. Also they are scattered among the municipalities. NGOs are decentralised organisations and linked to grassroots movements. In the same vein, agricultural co-operatives are linked to the needs of their members and have developed their missions in local and regional spheres.

EMBRAPA, as seen before, has an organisational structure[14] based on national research centres and focused upon specific agricultural commodities. It is a specialised organisation of the top-down type. Its hierarchical and bureaucratic structure makes the participation of small and subsistence farmers, rural extension workers and grassroots movements difficult. This configuration leads EMBRAPA to meet the large and capitalised farmers who grow cash crops, export and industrial commodities.

[14]Figure 4.3 and the appendices 14, 15, 16 and 17 respectively show EMBRAPA's and the research centres' surveyed organisational structures.

### 5.3.2.2. Agricultural Researchers Involvement in the Local Community

When researchers were asked 'Which of the following describe your involvement in the local community?', responses in Table 5.11 indicate that there was weak researcher involvement in the local community (the means are less than 3 which is the average). An exception was *church membership* of which the CNPA mean of 2.20 was significantly distinct from the CNPC mean of 1.13 at the 0.050 level. There are no statistical differences among the other research centres. The highest means of community involvement were related to *speakers at schools* (this indicates the lectures, seminars and speeches given by researchers in the schools and universities in the community) where CNPSo's mean is 3.08, CNPC's mean is 2.75 and CNPO's mean is 2.73 and other means are below 3.0. For example, researchers had poor involvement in *Rotary or Lions clubs, Masonic movements, church membership, co-operative movements,* or *council activities.*

**Table 5.11 - Which of the Following Describe Your Involvement in the Local Community?**

| Centres / Involvement | CNPA N=25 (28.74)[1] Mean[2] | CNPC N=16 (18.39) Mean | CNPSo N=24 (27.59) Mean | CNPO N=22 (25.29) Mean | F Ratio | F Probability | Scheffe Test |
|---|---|---|---|---|---|---|---|
| Rotary or Lions Club Member | 1.04 | 1.19 | 1.25 | 1.36 | 0.973 | 0.409 | ** |
| Masonic Movement | 1.80 | 1.94 | 1.17 | 1.00 | 3.385 | 0.022 | ** |
| Church Member | 2.20 | 1.13 | 1.79 | 1.32 | 4.089 | 0.009 | ++ |
| Adviser to Development Bank | 1.17 | 1.00 | 1.00 | 1.00 | 1.79 | 0.156 | ** |
| Council Activities | 1.17 | 1.31 | 1.13 | 1.27 | 0.343 | 0.795 | ** |
| Speaker at Schools | 2.36 | 2.75 | 3.08 | 2.73 | 1.064 | 0.369 | ** |
| Co-operative Movement | 1.48 | 1.25 | 2.46 | 2.24 | 3.935 | 0.011 | ** |
| Links with Prominent People | 2.08 | 1.94 | 1.67 | 2.41 | 1.245 | 0.299 | ** |

N= number of the agricultural researchers interviewed in research centre
[1]The figures in parentheses are in percentages (100% = 87 agricultural researchers interviewed)
[2]The means come from the responses which were allocated to a scale of 1 to 5, where 1 is the lowest and 3 is the average
**No two groups are significantly different at the 0.50 level
++CNPA is significantly different to CNPC at the 0.050 level

Table 5.11 indicates that CNPSo researchers (with a mean of 3.08) were associated with being *speakers at schools* in the local community (CNPSo researchers had better academic qualifications, mainly PhD's). Further, CNPSo is located in the third most important city in the South. However, CNPC researchers were involved with *Masonic movements*, with the highest mean of 1.94 and CNPO's highest mean of 2.41 represents *links with prominent people* in the local community. This can suggest that 'cosmopolitan' researchers like CNPSo researchers tended to be more creative and concerned with scientific topics. However, 'local' researchers like CNPC researchers were concerned with local power and internal matters.

Another type of researcher involvement in the local community was related to *private consultancy* which CNPA's mean of 1.92; CNPC's mean of 1.87, CNPSo's mean of 1.25 and CNPO's mean of 2.59 indicated. *ANOVA outputs* show that CNPO's *private consultancy* is significantly different from CNPSo's at the 0.050 level. There is no statistical difference between CNPA, CNPC and CNPSo. This indicates that CNPO agricultural technology may be associated with the regional farmers' demands. CNPO still shows the highest mean of 2.41 indicating friendship *links with prominent people*. Once again, this pinpoints the association between CNPO and organised and capitalised regional farmers. As a general pattern, the figures on agricultural researchers' involvement in the local community can suggest that they nurtured their private interests (private consultancy or friendship links with prominent people), rather than social and regional development which could attend to all types of farmers.

This seems, in Merton's [1965] definition, to indicate that CNPSo's researchers were more influenced by 'cosmopolitan' issues, than CNPA, CNPC and CNPO researchers, who were concerned with 'local' issues, such as religious and Masonic movements. Also, Tendler [1993] found examples of the dissemination and adoption of agricultural technology by farmers in the North-eastern region of Brazil, which were influenced by researcher involvement in the local community. One example of this would be the case of the dissemination of new disease resistant orange varieties (the 'pear' orange). The director of the experimental station (Boquim experimental station in the State of Sergipe) and other locals were researchers at that station. They were born or had lived in the Boquim city for many years and played an important role in the cases of the successful 'pear' orange diffusion and adoption by farmers. Tendler [1993: 1574] writes that the agricultural researchers

> were perhaps small commercial farmers themselves, officers in local civic associations, or even mayors '...' they were referred as 'sons of Boquim' - proud of their region, wanting it to progress, taking responsible positions in the local orange-producer association and in town government.

**5.3.2.3. The Research Focus in Agricultural Biology**

EMBRAPA's research projects are driven by specific lines of biological research. In theory, the objective was to form a disciplined research team, well-trained and able to solve specific agricultural and husbandry problems. The research project would link into various research lines tò solve these problems. In practical terms, the research project follows either scientific disciplinary lines or specific agricultural and husbandry problems for a few agricultural products and animals. Normally, the specialisation of the researcher is in tune with the postgraduate qualification and their scientific discipline.

From this perspective, when the researchers were asked 'What is your research line?', responses in Table 5.12 indicates that *genetics and breeding* dominate all the research centres sampled; 32.00% of CNPA; 31.25% of CNPC; 20.83% of CNPSo and 22.72% of CNPO. This means that 26% of all agricultural researchers were working in the area of plant or animal genetics and breeding. In contrast, for instance, soil science and pathology research are represented by 9.2% and 8.0% respectively of all the agricultural researchers.

Table 5.12 shows that CNPA has 32%, the highest percentage of all agricultural researchers working in *genetics and breeding* research. It is difficult to compare the dominant research work in the different research centres. Each research centre has its own priorities and research concerns. In reality, the high *genetics and breeding* percentages mean much more than the figures suggest. The figures indicate that the EMBRAPA research model has followed the Green Revolution principles and selected research topics which promote agricultural modernisation.

**Table 5.12 - Agricultural Researchers' Research Lines**

| Centres / Research Lines | CNPA N=25 (28.74)[1] | CNPC N=16 (18.39) | CNPSo N=24 (27.59) | CNPO N=22 (25.29) |
|---|---|---|---|---|
| **Agricultural Production** | 2 (8.00) | - | 3 (12.50) | 1 (4.55) |
| **Animal Nutrition** | - | 2 (12.50) | - | 3 (13.63) |
| **Biotechnology** | - | 1 (6.25) | - | - |
| **Genetics and Breeding** | 8 (32.00) | 5 (31.25) | 5 (20.83) | 5 (22.72) |
| **Soil Science** | 2 (8.00) | - | 5 (20.83) | 1 (4.55) |
| **Biotechnology** | - | 1 (6.25) | - | - |
| **Chemistry** | 1 (4.00) | - | - | - |
| **Entomology** | 4 (16.00) | - | 3 (12.50) | - |
| **Irrigation** | 4 (16.00) | - | - | - |
| **Mechanisation** | 1 (4.00) | - | - | - |
| **Physiology** | 2 (8.00) | - | 2 (8.33) | 1 (4.55) |
| **Pathology** | - | 3 (18.75) | 2 (8.33) | 2 (9.09) |
| **Pastures** | - | 3 (18.75) | - | 4 (18.18) |
| **Parasitology** | - | - | - | 1 (4.55) |
| **Seeds** | - | - | 3 (12.50) | - |
| **Weeds** | - | - | 1 (4.18) | - |
| **Taxonomy** | - | - | - | 1 (4.55) |
| **No answer** | 1 (4.00) | 1 (6.25) | - | 3 (13.63) |

N= number of the agricultural researchers interviewed in research centre
[1] The figures in parentheses are in percentages (100% = 87 agricultural researchers interviewed)

It is through genetics and breeding research that plants become disease resistant, suitable for mechanisation, and achieve high productivity. *Genetics and breeding* constitute the foundation of agricultural modernisation principles. The final target is to increase profits through the increase of agricultural productivity and to homogenise plants and animals in relation to farm production system requirements. That is to ensure that they have similar internal and external characteristics (height, length, colour, harvest season, etc.). This facilitates farming activities - such as mechanisation and processing activities - in a similar way to the assembly-line in industrial plants.

All this suggests that the main the agricultural researchers' research lines is the area of genetics and breeding, which targets the standardisation of agricultural production. Environmental issues, the social consequences of technology and technology dependency are not explored. It is mainly through genetics and breeding research that the so-called agricultural modern varieties (MVs) of 'new seeds and poor people' are developed [Lipton and Longhurst, 1989]. Sobral [1989] points out that EMBRAPA's research priorities are linked to the production of new and highly productive varieties. In other words, EMBRAPA research is related to the Green Revolution concept. Also, Goodman and Redclift [1991: 150 and 103] state that

> the nexus between agri-genetic innovation and profit, reinforced by calculation of political advantage, was the driving force behind the Green Revolution '...' advances in plant genetics overcame one of the fundamental constraints to industrial control of the production process, and brought plant breeding to the forefront of technological change in agriculture '...' plant-breeding programmes, could be designed to develop fertiliser-responsive varieties and to adapt plant architecture to withstand mechanical harvesting.

Finally, Clever Jr. [1972: 81] writes that the scope of the Green Revolution went beyond agriculture and animal breeding. It was an American strategy of the Cold War period to dominate and achieve social control motivated by profit.

### 5.3.3. The Research Project

The research project represents the researcher's principal administrative and technical reference through which he promotes his scientific aims. The research project comprises all the research phases, from the choice of the research problem through to the financial sponsorship of the research activity; from the researcher's participation in meetings, the visits to his scientific peers and related organisations to subsequent publications.

When asked of researchers 'Which of the following activities do you undertake before choosing a research project?', the figures in Table 5.13 reveal that though there is no statistical difference among the research centres, the highest score was given to *literature reviews*, such as CNPA's mean of 4.08, CNPC's mean of 3.62, CNPSo's mean of 3.67 and CNPO's mean of 3.77.

**Table 5.13 - Which of the Following Activities Do You Undertake Before Choosing a Research Project?**

| Centres / Activities | CNPA N=25 (28.74)[1] Mean[2] | CNPC N=16 (18.39) Mean | CNPSo N=24 (27.59) Mean | CNPO N=22 (25.29) Mean | F Ratio | F Probability | Scheff Test |
|---|---|---|---|---|---|---|---|
| **Literature reviews** | 4.08 | 3.62 | 3.67 | 3.77 | 0.612 | 0.609 | ** |
| **Consult scientific peers** | 2.68 | 2.75 | 3.38 | 3.18 | 1.564 | 0.204 | ** |
| **Farmers' meetings** | 2.76 | 3.25 | 3.17 | 3.45 | 0.963 | 0.414 | ** |
| **Rural extension meetings** | 2.44 | 2.75 | 2.75 | 3.50 | 2.357 | 0.778 | ** |
| **Investigate financial sources** | 2.00 | 2.25 | 1.75 | 1.86 | 0.566 | 0.639 | ** |
| **Follow up government priorities** | 2.25 | 2.13 | 2.21 | 2.14 | 0.448 | 0.987 | ** |
| **No answer** | - | 1(7.69) | - | 2 (10.53) | - | - | - |

N= number of the agricultural researchers interviewed in research centre
[1]The figures in parentheses are in percentages (100% = 87 agricultural researchers interviewed)
[2]The means come from the responses which were allocated to a scale of 1 to 5, where 1 is the lowest and 3 is the average
**No two groups are significantly different at the 0.050 level

This indicates that *literature reviews* are the most important factor in the choice of research project. In contrast, *rural extension meetings* gave the following scores: the CNPA's mean of 2.44; CNPC's mean of 2.75; CNPSo's mean of 2.75 and CNPO's mean of 3.50, which are all below those of the *literature reviews*. This suggests that *rural extension demands* were not the most important source of reference for the agricultural researchers' research projects. Further, the *investigation of financial support* in all the research centres had the lowest mean of between 1.75 and 2.25. *ANOVA* outputs in Table 5.13 show that *no two groups are significantly different at the 0.050 level of statistical significance*.

Another important point is that 70% of all the agricultural researchers, distributed as 68% of CNPA, 75% of CNPC, 75% of CNPSo and 63.64% of CNPO said that the research projects had been approved by National Research Meetings (PNP). This means that the research projects were approved by their scientific peers. In the PNP meetings, the majority of members are associated with scientific organisations and universities. In a few cases there are farmer and rural extension representatives, but they do not have enough power or scientific argument to push for their demands. Furthermore, control in PNP meetings lies in the hands of scientific representatives and in particular, in the hands of EMBRAPA's agricultural researchers.

In the CNPSo case, 75% of the agricultural researchers stated that their research projects were approved by PNP representatives. CNPSo has supported the continuation of this research project approval process. All the research centres had high percentages of positive responses to this issue. In fact, farmers, rural extension agents and other social group representatives had not participated in the research project approval process. However, in 1994, a new research planning system was established but at the time of the research, no results were available.

Moreover, when asked of researchers: 'How would you characterise your research project?' Table 5.14 shows the CNPA mean of 3.40, the CNPC mean of 3.50, the CNPSo mean of 4.42 and the CNPO mean of 2.68, indicating a belief in the research project as *a solution to national problems*. In this case, *CNPSo is significantly different to CNPO at the 0.050 level*. This reflects the research model based on specific commodities all over the country. However, the description of the research project as *a solution to national problems* (where it proposes addressing the Soya bean problems all over the country) neither addresses the needs of small farmers and rural extension services nor the farmers demands as a whole. These groups would prefer agricultural research appropriate to different production units in line with factor endowment and local priorities.

**Table 5.14 - How Would you Characterise Your Research Project?**

| Centres / Characteristics | CNPA N=25 (28.74)[1] Mean[2] | CNPC N=16 (18.39) Mean | CNPSo N=24 (27.59) Mean | CNPO N=22 (25.29) Mean | F Ratio | F Probability | Scheff Test |
|---|---|---|---|---|---|---|---|
| **Solution to local problems** | 3.24 | 2.87 | 3.26 | 4.23 | 2.762 | 0.047 | ** |
| **Solution to national problems** | 3.40 | 3.50 | 4.42 | 2.68 | 7.327 | 0.000 | ++ |
| **Funding requirements** | 1.72 | 1.50 | 1.71 | 1.59 | 1.513 | 0.217 | ** |
| **Advancement of science** | 2.72 | 2.81 | 3.37 | 3.22 | 0.972 | 0.410 | ** |
| **Scientific curiosity** | 1.52 | 1.94 | 1.25 | 1.54 | 1.51 | 0.217 | ** |

N= number of the agricultural researchers interviewed in research centre
[1]The figures in parentheses are in percentages (100% = 87 agricultural researchers interviewed)
[2]The means come from the responses which were allocated to a scale of 1 to 5, where 1 is the lowest and 3 is the average
**No two groups are significantly different at the 0.050 level
++CNPSo is significantly different to CNPO at the 0.050 level

In a different way, with the CNPA mean of 3.24, the CNPC mean of 2.87, the CNPSo's mean of 3.26 and the CNPO's mean of 4.23, the research project is seen as *a solution to local problems*. There is no statistical difference among the research centres. CNPO's answers (the highest mean of 4.23) suggest that it prioritised regional research strategy, and reflected the links between CNPO researchers and their region (95% of CNPO's researchers were born in the same region in which CNPO is located).

It is important to note that all the research centres had low means and that there was no statistical difference in relation to *funding requirements*. In this way, 84% of the agricultural researchers interviewed said that they knew where the financial sources for their research project came from. At the same time, 85% of all the agricultural researchers argued that EMBRAPA was the financial source for their research project. This was particularly so in the case of CNPSo and CNPO, where 100% and 95.5% respectively stated that EMBRAPA was the financial source of research project funding. In a general sense, the agricultural researchers do not have a precise understanding of the sources of research finance. For them, EMBRAPA - the federal government - provides the necessary funds, independent of any social evaluation.

Although, EMBRAPA has been sponsored by national and international sources, in relation to training programmes overseas and the acquisition of laboratory equipment and computers, the main financial support has been the World Bank and Inter-American Development Bank - IDB. The agricultural researchers were unaware of this. For them it is only EMBRAPA that is responsible for financial support. In addition, there are various national and international sources for different agricultural and regional programmes. These are not identified by the agricultural researchers.

The research project absorbs much of the researchers' time. In this respect, the following question was put to the researchers: 'How do you allocate your time in the research project?'. Table 5.15 shows research activities within the research project. The majority of researchers (90%) spent up to 10% of their research time with *farmers and at rural extension* meetings. 92% of CNPSo's and 88% of CNPA's agricultural researchers spent up to 10% of their research time with *farmers and at rural extension meetings* respectively. CNPO was the exception: 50% of researcher time was spent with *farmers and at rural extension meetings.*

**Table 5.15 - How Do You Divide Your Time in Research Activities?**

| Activities / Centres / Time | Literature Reviews | Writing up Research Projects | Participation in scientific meetings | Writing up Scientific Papers | Farmer and at Rural Extension Meetings | Bureaucratic Activities | Seeking Financial Resources |
|---|---|---|---|---|---|---|---|
| **CNPA N= 25 (28.74)[1]** | | | | | | | |
| **Up to 10%** | 11 (44.00) | 14 (56.00) | 23 (92.00) | 11 (44.00) | 22 (88.00) | 11 (44.00) | 17 (68.00) |
| **11% to 20%** | 12 (48.00) | 9 (36.00) | 2 (8.00) | 8 (32.00) | 2 (8.00) | 6 (24.00) | 3 (12.00) |
| **21% to 30%** | 1 (4.00) | - | - | 4 (16.00) | - | 7 (28.00) | - |
| **Over 30%** | 1 (4.00) | 2 (8.00) | - | 2 (8.00) | 1 (4.00) | 1 (4.00) | 5 (20.00) |
| **No Answer** | - | - | - | - | - | - | - |
| **CNPC N=16 (18.39)** | | | | | | | |
| **Up to 10%** | 5 (31.25) | 7 (43.75) | 13 (81.25) | 5 (31.25) | 12 (75.00) | 5 (31.25) | 13 (81.25) |
| **11% to 20%** | 6 (37.50) | 5 (31.25) | 1 (6.25) | 9 (56.25) | 1 (6.25) | 5 (31.25) | - |
| **21% to 30%** | 2 (12.50) | 3 (18.75) | - | 1 (6.25) | - | 2 (12.50) | - |
| **Over 30%** | 2 (12.50) | - | - | - | - | - | - |
| **No Answer** | 1 (6.25) | 1 (6.25) | 2 (12.50) | 1 (6.25) | 3 (18.75) | 4 (25.00) | 3 (18.75) |
| **CNPSo N=24 (27.59)** | | | | | | | |
| **Up to 10%** | 18 (75.00) | 20 ( 83,33) | 22 (91.66) | 15 (62.50) | 22 (91.66) | 7 (29,17) | 16 (66.67) |
| **11% to 20%** | 5 (20.83) | 3 ( 12,50) | 1 (4.17) | 8 (33.33) | 2 (8.34) | 8 (33,33) | 3 (12.50) |
| **21% to 30%** | - | 1 (4,17) | - | - | - | 3 (12,50) | - |
| **Over 30%** | - | - | - | - | - | 6 (25,00) | 5 (20.83) |
| **No Answer** | 1 (4.17) | - | 1 (4.17) | 1 (4.17) | - | - | - |
| **CNPO N=22 (25.29)** | | | | | | | |
| **Up to 10%** | 8 (36,36) | 12 (54.55) | 20 (90.90) | 12 (54.54) | 11 (50.00) | 13 (59,09) | 14 (63.64) |
| **11% to 20%** | 7 (31,82) | 9 (40.90) | 1 (4.55) | 4 (18.18) | 5 (22.73) | 4 (18,18) | 1 (4.55) |
| **21% to 30%** | 6 (27,27) | - | - | 4 (18.18) | 6 (27.27) | 5 (22,73) | - |
| **Over to 30%** | - | - | - | 1 (4.55) | - | - | - |
| **No Answer** | 1 (4,55) | 1 (4,55) | 1 (4.55) | 1 (4,55) | - | - | 7 (31.81) |

N= number of the agricultural researchers interviewed in research centre
[1] The figures in parentheses are in percentages (100% = 87 agricultural researchers interviewed)

This could be a result of two things. First, the CNPO evolved from a regional agricultural research unit (UEPAE of Bagé). Presumably, many links between researchers and regional farmers remain. Secondly, the previous CNPO consisted of regional or local research units. However, almost 50% of all agricultural researchers spent more than 10% of their research time on *literature reviews*, while only 19.5% of all agricultural researchers spent more than 10% of their research time with *farmers and on rural extension affairs*.

It is important to note that 80% of all agricultural researchers spent up to 30% of their research time on *bureaucratic activities*. EMBRAPA was created as a state-owned organisation to facilitate administrative support. However, after 22 years (in 1994), it resembles, in certain ways, a highly bureaucratic organisation. Eighty-two percent of all agricultural researchers said that EMBRAPA is not organised like a private enterprise as there are administrative delays and shortages of funds.

In practical terms, the research project concludes with the publication of the results in a scientific journal or is presented at a scientific meeting. The researcher's career assessment is according to scientific production and is not related to the adoption of agricultural technology by farmers. Thus, 86% of all agricultural researchers publish their research findings individually and jointly in approximately equal proportions. In all the research centres, more than 77% of all agricultural researchers have published their research results in this way.

On the one hand, this shows that the researchers have relationships with their scientific peers within and/or outside their research centres. On the other hand, it is possible that this publication procedure allows many researchers to publish more scientific papers either as first authors or co-authors. This scheme is in line with EMBRAPA's research assessment based on the number of scientific papers published. Further, 40% of all agricultural researchers prefer publishing their findings in EMBRAPA publications (for example, the Brazilian Agricultural Research Journal - PAB). In particular, 54% of all the Soya bean researchers would like to publish through EMBRAPA and 45.45% of CNPO researchers prefer publishing their research results at *scientific meetings*. However, the most crucial point is that no researcher responded with a preference for publishing findings in *rural extensions' publications*.

Biggs and Farrington [1991: 61] write that many scientists see the main target of their work as the publication of results. They also argue that these researchers have no real interest in obtaining information about farmers' needs, particularly farmers' contributions with respect to the types of technologies they require for their systems of production. Indeed, all the agricultural researchers would rather publish their research findings in scientific publications than in rural extension agencies' publications. For Merton, this is an indication of the so-called 'disinterestedness' of the scientific ethos. This means that the researcher's recognition is based on his scientific contribution [1965: 558-559]. Also, Farrington argues that in

> many countries the researchers' reward system is based more on papers published than on levels of adoption. In addition, the accountability focuses more on report-writing than on adoption. Both sets of pressures discourage the search for feedback on technology adoption by farmers. In the same way, financial sources are not a valuable factor in the biology research decision. It may be that the biology researchers do not have a clear idea of the financial and social costs and in particular, of financial support sources [1994: 3].

So far, the agricultural researchers' role has only been to generate agricultural technology. The social, environmental and financial consequences of the technology generated has not been a crucial concern. According to Pinstrup-Andersen [1982: 29] this is a result of the fact that the majority of agricultural research is financed by public funds. The principal reason is 'that a private firm may be unable to acquire a sufficient proportion of the economic gains associated with the research results to make a research undertaking profitable'.

The social and political consequences of the agricultural technology process have not been part of EMBRAPA's agenda. Chambers [1993a] suggests that this type of agricultural technology generation process is 'reductionist, measuring a few variables in controlled conditions'. According to him, this is a 'typical top-down technology transfer, in which priorities and definitions of the research agenda are previously determined'. From this perspective, Gibbons et al distinguish between two types of knowledge production. EMBRAPA's knowledge production is of the Mode 1 type.

> Mode 1 in which problems are set and solved in a context governed by the disciplinary, hierarchical, homogenous, largely academic, interests of a specific community. And Mode 2 in which knowledge is carried out in a context of application, transdisciplinarity, is heterogeneous, heterarchial and transient and more socially accountable and reflexive. Moreover, it is one of the imperatives of Mode 2 that exploitation of knowledge requires participation in its generation. In socially distributed knowledge production the organisation of that participation becomes the crucial factor [1995: 3-15].

### 5.3.4. The Choice of Research Problem

The generation of agricultural technology is a social process, which comprises individual researchers, the research organisation and wider structural levels. Research organisations are public organisations and operate like other formal organisations as socio-technical systems, involved in interaction with the wider social and cultural environment.

In theory, the research process is not an individual's task; agricultural researchers have several types of collaborators, the so-called interdisciplinary research team. Accordingly researchers were asked the following question: 'Who have you collaborated with?'. The responses in Table 5.16 show the researcher's collaborators. The figures in brackets give Thurstone's coefficient in decreasing order (which analyses the frequencies and grades of the importance of researcher response). In a general sense, the principal researcher's collaborators are *scientific peers* and *farmers' organisations*. The *scientific peers in Brazil*, especially in the CNPC's TC= 1.56[1] are the most influential of the agricultural researchers' collaborators. *Agro-industries* and *International Research Centres* represent the lowest degree of collaboration in the CNPC's TC= -1.88[23].

**Table 5.16 - Who Have You Collaborated With?**

| Centres<br>Collaborators | CNPA<br>N=25<br>(28.74)[1]<br>[TC][2] | CNPC<br>N=16<br>(18.39)<br>[TC] | CNPSo<br>N=24<br>(27.59)<br>[TC] | CNPO<br>N=22<br>(25.29)<br>[TC] |
|---|---|---|---|---|
| **Previous supervisor** | -0.85 **[13]** | -0.91 **[14]** | -2.00 **[22]** | -1.15 **[20]** |
| **Scientific peers overseas** | -0.80 **[12]** | -1.71 **[21]** | -0.88 **[13]** | -1.01 **[15]** |
| **Scientific peers in Brazil** | 0.45 **[4]** | 1.56 **[1]** | 1.03 **[2]** | 0.49 **[3]** |
| **Farmers' organisations** | -0.71 **[11]** | -0.49 **[8]** | -0.27 **[5]** | -0.34 **[7]** |
| **Rural extension agencies** | -0.65 **[10]** | -1.05 **[17]** | -0.95 **[15]** | -0.30 **[6]** |
| **Agro-industries** | -1.07 **[18]** | -1.88 **[23]** | -0.57 **[9]** | -1.08 **[19]** |
| **IARC[3]** | -1.02 **[16]** | -1.88 **[23]** | -0.57 **[9]** | -1.08 **[19]** |

N= number of the agricultural researchers interviewed in research centre
[1] The figures in parentheses are in percentages (100% = 87 agricultural researchers interviewed)
[2] The figures in brackets gives Thurstone's coefficient [TC] in decreasing order
[3] International Agricultural Research Centres

It is important to note that the *scientific peers in Brazil* are the most important agricultural researcher collaborators in all research centres, while *the previous supervisor* TC= -2.00[22] is the least important collaborator. Following the decreasing order of Thurstone's coefficient the *farmers' organisations* are placed between CNPSo TC= -0.27[5] and CNPA TC= -0.71[11]. Table 5.16 shows that *agro-industries* have a small influence on the agricultural researchers' collaboration. The coefficient of Thurstone's decreasing order ranges from CNPSo TC= -0.57[9] to CNPC TC= -1.88[23].

However, 84% of agricultural researchers strongly *agree* that *EMBRAPA is very important for the modernisation of Brazilian agriculture* and 36.37% agree that *export and food crops are treated differently in EMBRAPA*. Seen from another perspective, this means that *agro-industry* has influenced the choice of research problem. For instance, there are influences upstream of the agricultural industry include insecticides, fertilisers and irrigation equipment, and downstream influences, such as agricultural processing companies, which all affect the agricultural technology generation process. However, this is not perceived to be the case by agricultural researchers.

Moreover, EMBRAPA was established in the seventies as support for the agricultural modernisation process in Brazil. At that time, the International Agricultural Research Centres' (IARC) research strategies focused on highly productive varieties - the Green Revolution recipe - which influenced many national research systems around the world. As a consequence, agricultural researchers were asked 'Why has EMBRAPA been very important in the modernisation of Brazilian agriculture?'.

The responses in Table 5.17 illustrate EMBRAPA's role in agricultural modernisation in Brazil. The highest coefficient of Thurstone's decreasing order ranging from CNPC TC= 1.56[1] to CNPA TC= 0.45[4] is related to EMBRAPA's agricultural technology influence on the growth of *agricultural exports* in all research centres. Once again, this confirms the relationship between agricultural modernisation, International Agricultural Research Centres' influences, agricultural exportation and the utilisation of modern inputs, such as fertilisers, pesticides and agricultural machinery. All these influences are related to agro-industry's role, either in relation to agricultural processing or as input producers. In fact, these subtle aspects did not emerge in a single agricultural researcher's response.

**Table 5.17 - Why Has EMBRAPA Been Very Important in the Modernisation of Brazilian Agriculture?**

| Centres / Modernisation Importance | CNPA N=25 (28.74)[1] [TC][2] | CNPC N=16 (18.39) [TC] | CNPSo N=24 (27.59) [TC] | CNPO N=22 (25.29) [TC] |
|---|---|---|---|---|
| **It has encouraged using modern equipment** | - 0.85 **[10]** | - 0.91 **[12]** | -2.00 **[16]** | - 1.15 **[14]** |
| **It has trained agricultural researchers** | - 0.80 **[9]** | - 1.71 **[15]** | - 0.88 **[11]** | - 1.01 **[13]** |
| **It has increased agricultural exportation** | 0.45 **[4]** | 1.56 **[1]** | 1.03 **[2]** | 0.49 **[3]** |
| **It helped the introduction of modern inputs** | - 0.71 **[8]** | - 0.49 **[7]** | - 0.27 **[5]** | - 0.34 **[6]** |

N= number of the agricultural researchers interviewed in research centre
[1] The figures in parentheses are in percentages (100% = 87 agricultural researchers interviewed)
[2] The figures in brackets gives Thurstone's coefficient [TC] in decreasing order

In this context, it is possible to infer that the choice of research problem by an individual agricultural researcher is not a simple issue. Many influences can affect the agricultural researchers' research activity. This is a crucial phase of the agricultural technology generation process. Tactful questions were asked of researchers. First, 'Who or what influences your choice of research problem in your research project?'. Secondly, 'How did you develop an interest in the solution to your research problem?'.

Responses in Table 5.18 explore the main influences on the choice of research problem. It is important to note that the highest Thurstone coefficient, that is, CNPSo's TC= 0.99[1] is related to *professional experience*. This means that an agricultural researcher's background is the most influential factor regarding the definition of the research problem. However, 69% of agricultural researchers completed their undergraduate courses either before 1973 or in the 1973-1976 period. This shows that the majority of agricultural researchers were recruited without any professional experience.

**Table 5.18 - Who or What Influences Your Choice of Research Problem in Your Research Project?**

| Centres / Influences | CNPA N=25 (28.74)[1] [TC][2] | CNPC N=16 (18.39) [TC] | CNPSo N=24 (27.59) [TC] | CNPO N=22 (25.29) [TC] |
|---|---|---|---|---|
| **Professional experience** | 0.07 [12] | 0.11 [10] | 0.99 [1] | 0.49 [3] |
| **Farmers demands** | -0.05 [17] | 0.00 [16] | 0.35 [5] | 0.87 [2] |
| **Scientific background** | 0.25 [7] | 0.42 [4] | 0.32 [6] | 0.14 [9] |
| **Scientific literature** | -0.12 [18] | 0.21 [8] | 0.09 [11] | 0.01 [15] |
| **Rural extension demands** | -0.24 [20] | 0.03 [13] | -0.13 [19] | 0.02 [13] |
| **Scientific pairs** | -0.69 [23] | -0.45 [22] | -0.29 [21] | -0.24 [20] |
| **Government programmes** | -0.80 [24] | -1.25 [26] | -1.03 [25] | -1.81 [31] |
| **Financial sources** | -1.38 [28] | -1.42 [29] | -1.91 [32] | -1.60 [30] |
| **Research centre executive** | -2.29 [34] | -1.27 [27] | -3.00 [35] | -2.11 [33] |

N= number of the agricultural researchers interviewed in research centre
[1] The figures in parentheses are in percentages (100% = 87 agricultural researchers interviewed)
[2] The figures in brackets gives Thurstone's coefficient [TC] in decreasing order

Apart from the CNPO and CNPSo, which had the second and fifth highest TC= 0.87[2] and TC= 0.35[5] respectively, related to *farmers' demands* as an influence on the choice of research problem, the following high coefficients of Thurstone, that is the fourth, sixth, seventh and eight are related to *scientific background* and *scientific literature*[15]. Thus, data in Table 5.18 reveals that the choice of research problem by agricultural researchers is more significantly influenced by factors from the scientific domain, such as *professional*

[15]Souza [1993: 142], *A Sociedade, O Cientista e o Problema de Pesquisa,* found that in Brazil the most influential factor on the choice of the research problem for agricultural researchers was 'importance to society'. It is an ambiguous criteria, which leads to several interpretations. Also Velho [1985: 259], *'Science on the Periphery: A Study of the Agricultural Scientific Community in Brazilian Universities'* emphasises that in the case of the Brazilian universities, 'agricultural research is mostly oriented towards practical problems'.

*experience, scientific background and scientific literature* than by the rural realities of *rural extension and farmers demands.*

Also, the survey shows that 55% of all agricultural researchers assessed the agricultural technology they generated as *neutral and of general application* and *appropriate to the development of scientific knowledge*. CNPO and CNPSo have the highest percentage in relation to that assessment, that is, 50% and 45.83% respectively. This implies that the choice of research problem is a simple routine within agricultural technology development. It does not have any links to farmers' or rural extension demands. It is only a scientific activity within a scientific sphere.

Pretty [1995a: 1249] calls this kind of scientific investigation Cartesian, that is, experimental and empirical, positivist or rationalist. 'Science seeks to discover, predict and control natural phenomenon. Investigators proceed in the belief that they are detached from the world. Knowledge about the world is then summarised into discrete parts in the form of universal generalisations or laws'. In these terms, the choice of research problem leads to the standardisation of agricultural technology for specific types of farmers but social differentiation is not considered. From a different viewpoint, Biggs and Farrington [1991: 8] note that 'agricultural research does not take place in an institutional or political vacuum', instead various factors influence the type of technology being generated.

In a similar vein, Busch and Sachs [1981], argues that it is important

> to examine the agricultural sciences as social products that themselves shape the broad process of social and economic development. It is crucial to understand the degree to which the agricultural technology generation process is influenced by the subject matter - the so-called internalist view, or determined by various social and economic pressures on scientists and research organisation - the externalist view'. Further, it is difficult to identify and measure the factors that influence the agricultural technology generation

process. Sometimes, coming from 'within the psyche' of the biology researchers - origin, social strata, schooling, and so on - and at other times they work within and outside the organisation - organisational structure, recruitment process, reward system, funds available, 'interest groups', and so on. In sum, they are part of the social, political and economic apparatus of society.

In reality, the internal and external interests are constant influences, even as restrictions on the scientific practice developed by researchers. Scientific activity is a continuous process of negotiation with the factors which influence research activity. There are two kinds of influences on researcher practice (mainly regarding the choice of research problem). First, there are internal influences - 'the internalist view'. This view considers science to be autonomous and scientific knowledge independent of external manipulation. The choice of research problem is only dependent on the theoretical framework of the researcher. The State is neutral and works as a mediator between distinct social interests and conflicts. Secondly, there are external influences - 'the externalist view', where science is a social product and is related to social, economic and political ideologies. Science is influenced by society and hence the State is not neutral but exists to serve specific social strata. From this perspective, Biggs [1990], states that agricultural research and technology diffusion are always integrated with political, economic, and organisational matters. For him, there is not a 'neutral', apolitical research and development system. Science and technology are connected with economic and political events.

To sum up, the agricultural technology generation process was generally developed by an agricultural researcher who is male and middle class, between 44 and 49 years old, and born in an urban area in the South, South East or West-Central region (the rich regions). Most of them were well-trained (with Masters and PhD qualifications) agronomists or veterinarians and working for EMBRAPA was their first job. EMBRAPA recruitment was based on academic curriculum and there was no competitive selection. As a consequence, there developed corporate ethos which influences researchers' activities within EMBRAPA as well as outside it. Researchers have little involvement in the local community and continue to be involved in activities related to EMBRAPA's issues, even in their outside activities. EMBRAPA is viewed as a socio-technical organisation. The research activity is based on research projects mainly concentrated on genetics and breeding matters. The choice of research problem by the agricultural researcher is usually influenced by literature reviews and scientific peers rather than farmers and extension agents.

### 5.4. Summary

The agricultural technology generation process has been a social process developed by agricultural researchers within a state-owned organisation. This process is a commodity-led model of the top-down type that is viewed as a socio-technical system. Well-trained agronomists and veterinarians (Masters and PhD qualified), have concentrated on the development of agricultural technologies in the areas of genetics and breeding. Most of them were born, studied and are working in the same region where the research centres are located. Empirical data were collected in four national agricultural research centres, focusing on different commodities (cotton, goat, Soya bean and sheep) situated in two distinct regions in Brazil, respectively the North-east (the poorest region) and the South (a rich region). Eighty-seven agricultural researchers were surveyed and qualitative and quantitative analyses were carried out. The data were used to construct a profile of agricultural researchers and to explore the research activity and projects and the choice of research problem. These are considered as the most important and influential phases of the agricultural technology generation process. All take place inside the organisation where the agricultural researcher develops the research activity. The results suggest that both influences from the researcher and inside and outside the research organisation affect the type of agricultural technology generated. The process of agricultural technology generation has a crucial influence in agricultural technology effectiveness. And it is an activity much more within the scientific realm and within organised and capitalised groups than a contribution to the majority of farmers' needs. Literature reviews, scientific peers, and the publication of scientific papers are more influential factors in the choice of research problem than the demands of rural extension programmes and farmers' *farm as a whole* requirements.

# CHAPTER 6

# AGRICULTURAL TECHNOLOGY, RESEARCHERS AND FARMERS

## 6.1. Introduction

This Chapter shows how farmers have adopted two of EMBRAPA's agricultural technologies. The *Doko* Soya bean and the *Brasília* carrot cases are examples of successful EMBRAPA agricultural technology generation and adoption processes. Both varieties have been cultivated in the *Cerrados* region - the Brazilian Savannahs. In the early 1970s, prior to the creation of EMBRAPA, no capitalist agricultural exploitation had been developed in this region. Government help, such as financial support and agricultural research and technical assistance, made this new agricultural frontier possible[1]. The aim of this chapter is to answer the following questions: 'Why have farmers adopted the *Brasília* carrot and the *Doko* Soya bean varieties?' and 'How did their generation processes influence their adoption by farmers?'

This study does not directly address the assessment of the rural extension or technology diffusion programmes or even of EMBRAPA technology successes or failures. This chapter concentrates on the agricultural technology generation process's influence on the adoption by farmers of only two successful agricultural varieties[2]. Further, it focuses on understanding the behaviour of the agricultural researchers, particularly the research leaders within the research organisation in which the varieties were developed. It assumes that generation and adoption are part of same social process and farmers are unequally related to the agricultural technology generation process.

[1]Appendix 18 shows the *Cerrados* region on the map of Brazil.

[2]Farrington and Martin [1993: 62], *Farmer Participation in Agricultural Research: A Review of Concepts and Practices,* argue that 'the focus on genetic material perhaps highlights the area of greatest complementarity between researcher and farmer'. Ploeg [1993: 217], *Potatoes and Knowledge.* In: An Anthropology Critique of Development, also notes that the 'superiority' of the new varieties is seen as one of the main factors that may induce farmers to accept the improved varieties'.

It has been argued that the generation process, particularly the identification of the research problem by the researchers was an important factor in influencing the farmer's decision to adopt or reject technology. This is in accordance with Busch [1991: 71-72], who argues that 'agricultural scientists who develop new varieties of crops and animals change the structure of social life as well'. The new variety developed alters the social relations of production affecting 'the behaviour of the farmer who adopts' and the 'consumer that uses it'. For him 'were this not to occur, we would say that no technical change at all had taken place'. Further, Ruttan [1996: 58], describing the criticisms on the adoption-diffusion research, remarks that 'inadequate attention was given to the identification of [the research] problem'.

By contrast, Rogers' [1960: 401-402 and 1962: 81-86] approach, which has been popular throughout the developing countries, embraces two separate tenets. The first of these is that technology adoption by farmers is independent of the circumstances in which it is generated, and the second is that technology is neutral and its adoption by farmers is related to their individual and psychological values. For him, technology adoption is 'a mental process through which an individual passes from first hearing about a new idea to final adoption'. This process comprises five stages, 'each of these stages is characterised by different activities, attitudes, influences, and sources of information. The stages are as follows: (1) awareness, (2) interest or information, (3) evaluation or application, (4) trial and (5) adoption'. Carr et al [1996: 381-383], state that Rogers' proposals constitute 'a predictable linear pattern' in which the 'ethical questions that accompany innovations and their diffusion in a social system' are neglected. To them, it 'seems to favour the 'top-down' approach towards the diffusion of innovations'. This is in line with Boudon's [1989: 19] argument that social scientists 'often develop their theories within logical frameworks incongruent with the real world'.

### 6.2. The *Cerrados* Region

The *Cerrados* is a Brazilian geographical region of almost 200 million hectares comprising the States of Minas Gerais, Goiás, Mato Grosso do Sul, Mato Grosso, Tocantins, Maranhão, Bahia and Piauí, where a substantial percentage of Brazil's grain is grown. Approximately 137 million hectares are arable and suitable for agricultural production. The soils are acidic, flat, deep, poor in essential nutrients such as nitrogen, phosphorus, potassium and calcium, and has a high level of aluminum which is detrimental to plant cultivation. There are dry periods, known as *veranicos* and, in the past, the soil has been defined as Al-rich low fertile and useless for agriculture[3]. Today only 10% of arable *Cerrados* land is used with a yield of approximately 30% of national grain production and 40% of meat.

Historically, the Central and Southern regions were the grain producers of Brazil - European immigration, combined with suitable soil and an appropriate climate meant greater agricultural yield in the Southern region. However, there was a shortage of land for agricultural production. As a result, the Federal government promoted the opening of new agricultural frontiers. The *Cerrados* was chosen because of its geographical location in relation to urban centres, as distinct from previous agricultural frontiers, has been characterized by the use of modern agricultural technology. The Brazilian capital, Brasília, is situated in the Western-Central region which includes 75% of the *Cerrados* area.

Since the 1970s, the government has given various incentives for agricultural production in the *Cerrados,* such as subsidized credit, technical assistance, agricultural research and investment in rural electricity, roads and storage capacity. The government's aim was to develop an agricultural

[3]FAO [1996: 7], *Role of Research in Global Food Security and Agricultural Development,* states that the acidic Savannahs are a suitable environment in which to increase agricultural productivity through research programmes.

production system based on modern inputs and high technology, independent of existing types of cultivation and environmental or social concerns[4].

The government's strategy was stated in the First National Development Plan (PND) 1972-1974: 'agricultural development will be directed to achieving competitive capacity and to permit an annual growth rate of above 7% a year'. It aimed at 'increasing the agricultural frontier and incorporating the humid Northeastern valleys, namely from the Sao Francisco river and new Amazon and Central areas'. Besides this, 'the Brasília geographical-economic region will be created, to integrate with the Central area and to permit its integration with other Brazilian macro-regions', and 'an intensive agricultural research program will be developed, especially in relation to the main *Cerrados* cultivation, irrigation methods and tropical food technology' [Brasil, 1971: 24-51].

According to Brasil [1974: 41-45], the Second PND (1975-1979), showed how the Federal government stressed agricultural production for the *Cerrados*, in particular, the

> occupation of the new areas as an important process of agricultural and husbandry expansion, in consideration of the fertile and disposable land in the new agricultural frontiers. Moreover, the transport system permits the utilisation of large areas in the Western-Central and Amazon regions.

It urged the 'expansion and utilisation of modern inputs and the creation of a new operational model for agricultural and experimental research programs, rural extension, education and food technology development linked to the public sector'. To cope with these proposals, 'the action of organisations attached to the Ministry of Agriculture, such as

[4]Macêdo [1996: v], *First International Symposium on Tropical Savannahs:* Biodiversity and Sustainable *Production of Food and Fibres*, argues that agricultural production in the *Cerrados* has been based on capital-intensive technologies and heavy machinery. On the one hand, this has increased agricultural production and productivity. On the other hand, it has caused environmental pollution, soil erosion and the dissemination of weeds, insect pests and diseases.

EMBRAPA and EMBRATER (the Brazilian Technical Assistance and Rural Extension Organisation) was argued as very important'.

At the core of the Third PND (1980-1985) was the Federal Government's emphasis of the importance of the West-Central region: 'the West-Central region development will focus on the agricultural and industrial potential, including the *Cerrados* area' [Brasil, 1980: 86-87]. In this context, the government aimed to enlarge development programs such as POLOCENTRO (*Cerrados* Development Program). This was created in 1975 to promote the occupation of the West-Central region, particularly the *Cerrados* area and to encourage the diversification and expansion of transport, energy, communication and storage capacity.

The First PND of the New Republic (1986-1989) also stressed the importance of the West-Central region, [Brasil, 1986: 236-238]. This was the most recent Brazilian PND at the time of field-work, and argued that 'the West-Central region will redirect the instruments of development promotion in accordance with the new development strategies'. The Federal government prioritized the

> POLOCENTRO program to support the development and agricultural modernization of the *Cerrados*. This program was to integrate the action of agricultural research, rural extension and rural credit, and to promote transport, energy, communication and storage facilities [Brasil, 1980: 86-87].

In order to reach the goals of the National Development Plans, the Federal government developed other agricultural and regional development programs. For instance, the PRODAECER (Japanese-Brazilian Cooperation Program for *Cerrados* Development) and the PROFIR (Financing Irrigation Equipment Program). PRODAECER was created in 1976 following a financial agreement between the Japanese and Brazilian governments. Its focus was the occupation of the vast *Cerrados* areas based on the co-operative model and entrepreneurial farms. PROFIR was created in 1982 to facilitate the acquisition of modern irrigation systems to remedy the effects of the dry period.

Under these circumstances, the *Cerrados* development became possible and, in line with government plans, agriculture was targeted at the export market and served the interests of the industrial sector. State-owned organisations such as 'EMBRAPA and EMBRATER were responsible for providing free agricultural technology and technical assistance support for *Cerrados* farmers' [Salim, 1986: 337]. Thus, government strategies for agricultural development of the *Cerrados* area, focused on the acquisition of agricultural machinery and modern inputs. Graziano da Silva [1988: 55] emphasises that *Cerrados* exploitation has been based on selective and capital-intensive technologies which have led to land and wealth concentration, rural exodus and rural unemployment.

Martine [1991: 188] also explains that in Brazil, frontier expansion like *Cerrados,* has served two basic functions. First, it has been used as a means of social control, releasing tensions caused by poverty and high population growth. Secondly, frontier expansion has allowed an increase in agricultural production, maintaining the land-tenure system and traditional forms of social organisation. In Kageyama's view [1993], the government selected the new agricultural frontier following official 'colonisation' as a political strategy to maintain the archaic agrarian structure. In addition, Goodman et al [1985: 40] state that Brazilian agricultural modernisation was deeply selective. The plantation, export and industrial staples, the regions of the South, West-Central (*Cerrados* area) and South East were all privileged through the state policies of the 1970s.

In this context, two case studies involving two EMBRAPA agricultural technologies adopted by farmers - one domestic crop (the *Brasília* carrot) and one industrial and export crop (the *Doko* Soya bean) in the *Cerrados* region will be analysed. Carrot and Soya bean researchers were surveyed, as well as the research leaders in CNPH (National Vegetable Research Centre) and CPAC (*Cerrados* Agricultural Research Centre). Further, the adoption of the *Brasília* carrot and the *Doko* Soya bean by farmers were investigated in the CEASA (Central Vegetable Market) and the COOPERTINGA (Agricultural Co-operative of the Piratinga Region) cases.

### 6.3. Case Study 1 - The *Brasília* Carrot

The *Brasília* carrot variety was developed by CNPH and released in 1981. Carrot is a highly appreciated food crop in the Brazilian domestic market and consequently has several features which both consumers and farmers demand. The important characteristic of the *Brasília* carrot is its summer growing period[5]. In addition, the development of the *Brasília* carrot has also incorporated qualitative factors relevant to marketing, such as cylindrical root form, good taste and light orange colour.

Following the dissemination of the *Brasília* carrot, the summer production of carrots in the Federal District area increased from 8,129 tonnes in 1981 to 15,913 tonnes in 1988 [EMATER-DF, 1994]. This amounts to 83% of all carrot output in the West-Central region. Imported carrot varieties are not really adapted to growing in the summer and do not have the colour and shape favoured by the Brazilian consumer. The *Brasília* carrot currently has 80% of the market and has increased farmer's profits by 30%. Carrot cultivation was dispersed throughout the country. For example, it was planted from May to October in the North, West-Central and North-east and from December to April in the South East and South of Brazil.

[5]The botanical features of the *Brasília* carrot and the CNPH's description are shown in appendices 3 and 4 respectively.

[EMBRAPA, 1991a and EMBRAPA-CNPH, 1986 and 1994]. Table 6.1 shows the national level of high yielding carrot seed production.

**Table 6.1 - Brazil: Carrot Seed Production - 1986 to 1989 in Kilogram**

| CULTIVAR | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|
| **Brasília** | 14,724 | 36,442 | 40,795 | 56,644 |
| **Kuroda** | 1,572 | 1,206 | 2,475 | 2,263 |
| **Kuronan** | 1,195 | 5,466 | 5,151 | 7,929 |
| **Tropical** | 7,437 | 8,810 | 10,852 | 15,541 |
| **Total** | **24,928** | **51,924** | **59,273** | **82,377** |

Source: EMBRAPA-CNPH 1994: 25.

### 6.3.1. The *Brasília* Carrot Generation Process

The *Brasília* carrot generation process was carried out within CNPH by a geneticist (who was the research project leader), a plant pathologist and technology diffusionists. It is important to note that a researcher of Japanese origin was part of the research team. He facilitated the relationship between the research organisation and the Japanese carrot farmers[6]. This process also engaged rural extension agents, carrot farmers[7] and consumers at various phases of the research program. To understand the *Brasília* carrot generation process it is necessary to ask: 'What is the background of the research leader[8]?' and 'How was the *Brasília* carrot generation process carried out[9]?'

[6]In Brazil many vegetable farmers are of Japanese origin. They are called *nissei*.

[7]Okali et al [1994: 30], ibid., emphasise that 'a better understanding of local farming systems came to be considered essential for the successful development of new technology'.

[8]Chambers [1997: 57], *Whose Reality Counts? Putting the First Last,* argues that 'our personal mental frames are made up from our past learning and experience, and our constructs, beliefs, values and preferences'. Further, Biggs [1990: 1491], *A Multiple Source of Innovation Model of Agricultural Research and Technology Promotion,* states that in the hierarchical agricultural research system of the top-down type, which he calls 'the central source model', there is 'a dominant elitism of education and research'. The researchers are well-trained

The *Brasília* carrot geneticist was from a rural area, was born in a small town, and his father was a retired farmer. He reached primary and secondary education levels in state schools and took his undergraduate, Masters and PhD degrees in a Brazilian agricultural university. He had some work experience before coming to EMBRAPA. For him, the desirable consequences of agricultural technology were *increasing yields, greater farmer income, price reduction for the customers and the reduction of pesticide application*. He presented a critical view of the current EMBRAPA top-down research model and instead proposed an alternative where the farmer's demand was the first source of the researcher's inspiration. For instance, he said that the *farmers' needs have not been clearly identified by researchers.* He argued that EMBRAPA should give an explanation of its procedures to society.

The *Brasília* carrot generation process had taken about six years (1976-1981) and comprised of (1) identification of the research problem, (2) elaboration and execution of the research project and (3) the dissemination of the research results. In EMBRAPA's schema, the research project form is standardised for several research proposals, agricultural products and regions throughout the country. The research leader is responsible for all phases of the research project. He plans research requirements, financial support, participation in scientific events, technology diffusion activities, and so on. Formal approval comes from the National Programme Research (EMBRAPA's PNP) and financial support can be provided by EMBRAPA or through other national or international sources. In this case, the financial support came from EMBRAPA.

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with Masters and PhD qualifications while the farmers are thought to be 'ignorant, even backward and traditional'.

[9]Busch and Lacy [1981: 124] *Sources of Influence on Problem Choice in the Agricultural Sciences: The New Atlantis Revisited,* 'note that organisational structure, interpersonal relationships, and methodological difficulties, as well as the scientist's disciplinary concerns, shaped the [research] problem choice'.

According to the research leader, the identification of the research problem was drawn from the carrot farmers, rural extension agents and consumer's demands. Further, information on carrot market prices was collected, including carrot seasonal prices. A great variation of prices between the winter and summer periods was noted. At that time, there was no disease resistant carrot variety suitable for summer cultivation and carrot farmers depended on imported carrot seed. From this perspective, the elaboration of the research project took into account the farmers, the rural extension agents, the consumers demands, as well as the carrot market prices and information from specialised literature.

The execution of the research project (including experimental work), was not an isolated activity in the research centre and was instead shared between researchers, rural extension agents and farmers. Genetics experiments in the CNPH experimental area used the native carrot species. The carrot cross-breeding selection which led to the ideal *Brasília* carrot variety involved researchers, farmers and rural extension agents who chose the best carrot seedlings.

The validation of the *Brasília* carrot in farmer's fields involved researchers, farmers and rural extension agents. Further, other diffusion technology activities, such as farmer's field tests, field days and demonstration units were also made across the country. However, according to the research leader, the *Brasília* carrot tests in 'real' farmer's fields was evidence of the farmers decision to adopt it.

Likewise, the diffusion of experimental results did not depend on a scientific paper published in a journal or given at a conference. The research team, including the research leader grew the *Brasília* carrot on a large-scale to be distributed to farmers. This was called the *production of the basic carrot seed.* Afterwards, the technological production of the

*Brasília* carrot seed was transferred to private companies and farmers. In accordance with Biggs' [1987] typology of degree of interaction between researchers and farmers, the *Brasília* carrot generation could be called the 'collaborative' research process. Okali et [1994: 20] argue that in 'collaborative' research, 'researchers and farmers are partners in the research process and continuously collaborate in activities'.

### 6.3.2. The *Brasília* Carrot Adoption Process: The CEASA Case

This case study involved vegetable farmers who grew the *Brasília* carrot in the Federal District, particularly those who sold vegetables directly to consumers. Normally, every Tuesday and Thursday vegetable farmers sell their vegetables either to shops or directly to consumers in the CEASA[10]. In order to answer the following questions: 'Why do carrot farmers grow the *Brasília* carrot variety?' and 'How did the *Brasília* carrot generation process influence its adoption by carrot farmers?', this case study is concerned with farmers who sell carrots directly to consumers.

CEASA is a mixed economy enterprise and was created in 1972. It is linked to the Federal District Government and attached to the Agricultural Secretariat. Its main objectives are first, to increase productivity in the distribution sector of vegetable products and secondly, to reduce costs at consumer levels. It also aims to improve market conditions, especially the elimination of vegetable intermediaries and to use new technologies in the commercialisation and communication processes between farmers and consumers [CEASA, 1994].

Primary data were collected from CEASA informants and farmer registrations which identified *Brasília* carrot farmers. Questionnaires were filled, personal interviews carried out

[10]The CEASA location is shown in Appendix 18.

and observations made over a period of one month, each Tuesday and Thursday between seven o'clock and ten o'clock in the morning. Although an exact record of carrot farmer registration does not exist, thirty-five carrot farmers are registered with CEASA [1993] and twenty-nine farmers were interviewed, constituting 83% of carrot farmers[11] who were selling carrots directly to consumers.

Additional evidence[12] (beyond CEASA's sample) was collected from the rural extension agency, that is, forty-three additional *Brasília* carrot farmers were interviewed and farms visited. There was no formal strategy for data collection. It was collected following EMATER-DF (Federal District Rural Extension Agency)[13] selection. EMATER-DF is a state rural extension agency linked to the Federal District government and importantly, to the Agricultural Secretariat. In 1994, EMATER-DF assisted 255 small and medium scale carrot farmers. Sixty per cent of all vegetable production in the Federal District has been produced by small scale farmers and most of them have been assisted by EMATER-DF [EMATER-DF, 1994]. These figures show a part of the rural extension agreement in the carrot diffusion process and technical assistance carried out with the carrot farmers.

In the CEASA case, all the carrot farmers were male, most of them from rural areas and had reached primary and secondary education levels. None had a university degree. Their main source of income came from the *Brasília* carrot, although they said that they also grew other minor crops. All farms were located within 50 km of Brasília, the Federal District and

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[11]Questionnaires are in appendix 7.

[12]According to Fielding and Fielding [1986: 12], *Linking data,* in the process of research, if diverse kinds of data support the same conclusion, it increases confidence in the results. Additionally, Ragin [1992], *Introduction: Cases of 'what is a case?': Exploring the Foundations of Social Inquiry*, argues that the use of evidence which is repetitious and extensive in form, as when it is based on observations of many cases or of a variety of cases, has proved to be a reliable way for social scientists to substantiate their arguments. Sanders and Liptrot [1994: 48], *An Incomplete Guide to Qualitative Research Methods For Counsellors*, also argue that 'the use of multiple data collection will enhance the reliability and validity of findings'.

[13]The EMATER-DF location is shown in Appendix 18.

60% of *Brasília* carrot farmers were born in the West-Central and South Eastern regions, although 10.3 % had Japanese origins. In Brazil, Japanese people are said to be synonymous with progress. They arrived in Brazil during the last century as a result of the Brazilian government's immigration policy. Japanese immigrants to Brazil, as distinct from other immigrants, have achieved rapid success and socio-economic improvement. It is necessary to note that free agricultural technical support, farmer specialisation and small land area characterise the *Brasília* carrot production system. Eighty-six per cent of the CEASA farmers only grow the *Brasília* carrot, 93.0% had technical assistance from the EMATER-DF and 55.2% of all farms hold less than 20 hectares. All farmers own up to 50 hectares[14].

When carrot farmers were asked: 'Why do you grow the *Brasília* carrot variety?', 72% argued that they cultivated the *Brasília* carrot because of its resistance to disease, 18% considered its regional adaptability and 10% for other reasons, such as carrot quality and productivity. These points were similar to those brought forward by the research leader as the main inspiration for identification of the research problem. Another important point is that 45% learnt about the *Brasília* carrot from the EMATER-DF, 21% from EMBRAPA and 34% from their neighbours. This means that 66% of the carrot farmers followed the research organisation and rural extension agency recommendations[15].

Once again, the figures show the importance of the 'collaborative' generation process, particularly the contribution of the rural extension agency. First, in the process of the *Brasília* carrot diffusion, and second, in the technical assistance to *Brasília* carrot farmer's production systems. At the time of field-work, the technology diffusionists involved in the *Brasília* carrot

[14]In accordance with Ribeiro [1995], *O Povo Brasileiro: A Formação e o Sentido do Brasil*, social class stratification in Brazil, this profile of the *Brasília* carrot farmers points to a subaltern class.
[15]Chambers, R. [1988], *Normal Professionalism, New Paradigms and Development,* argues that 'when people are put first, and the poorer rural people first of all, they do the identifying of priorities '...' the question is not just identification for whom, but identification by whom'.

generation process said that they promoted various diffusion technology activities, such as field days, technology observation and demonstration units, and training and visiting, which involved researchers, farmers and rural extension agents. It is important to observe that when carrot farmers were asked: 'Will you cultivate the *Brasília* carrot in the future?', 93% responded that they would be happy to grow it. However, 7% said that they would not be happy with the *Brasília* carrot because of its precocious flowering. All the farmers said that there was no carrot variety better than the *Brasília* carrot.

In a general sense, the additional information from the EMATER-DF case is similar to that of the CEASA. For instance, all EMATER-DF carrot farmers are men. 74.42% are under 49 years old and 60.46% were born in rural areas. The farms are located up to 50 km from Brasília, DF and all have up to 40 hectares. Technical assistance comes from the state agency and 93.02% of the farmers will grow the *Brasília* carrot in the future.

Evidence shows that, in practice, the *Brasília* carrot generation process was no longer a top-down and technology-transfer approach. The agricultural researchers, especially the research leader, did not embrace the generation process of what was considered to be an exclusive research organisation. The researchers did not themselves decide 'what and why' to research, and to 'whom' the research results would be transferred. Instead the generation, diffusion and adoption processes were 'collaborative', involving researchers, rural extension agents and farmers in all the phases of *Brasília* carrot generation, validation and adoption.

As a result, the *Brasília* carrot adoption by farmers was a profitable deal and reached the rate of 80% of farmer's adoption across the country. This meant a proactive and visible chain among the agricultural research organisation (EMBRAPA-CNPH), the state rural extension agency (EMATER-DF) and the carrot farmers.

### 6.4. Case Study 2 - The *Doko* Soya bean

The *Doko* Soya bean variety was developed by the *Cerrados* Agricultural Research Centre (CPAC) as part of the National Soya bean Research Program (Soya bean PNP) co-ordinated by the CNPSo and released in 1980. The *Doko* Soya bean has high productivity, aluminium tolerance, is suitable for the primary *Cerrados* cultivation and permits mechanical harvesting. Disease resistance was not deemed an important botanical characteristic in initial breeding cross studies[16]. It is important to note that the *Doko* Soya bean variety was the first Soya bean variety adapted and cultivated on large-scale in the *Cerrados* region[17].

In contrast to carrots, a domestic food crop, the Soya bean is an important industrial export crop for the Brazilian economy. The United States, Brazil, China and Argentina produce 80% and trade 90% of all Soya beans in the World. Brazil produced 18 per cent of the world's Soya beans in 1993. Table 6.2 shows Soya bean production and productivity in Brazil.

The Soya bean requires high technology to be competitive on the international market, either as Soya bean grains or processed as oil and animal feed complexes. Table 6.2 indicates that Soya bean crops increased in production and productivity even while farming area decreased, as was the case between 1990 and 1993. Bonte-Friedheim et al [1994], quoting Ayres [1985] mention that the rates of return (using cost-benefit analysis) to Soya bean research in Brazil was between 46 and 49%.

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[16]The *Doko* Soya bean's botanical features and the CPAC description are in appendix 5 and 6 respectively.
[17]In 1985, around five million hectares in *Cerrados* region had cultivated the Soya bean. According to Souza et al [1991: 18], *Expansão Agrícola nos Cerrados do Brasil: Manejo da Cultura da Soja.* In: Seminário Sobre os Problemas da Pesquisa Agronômica na Região dos Cerrados; this means that the Soya bean is the most important agricultural product in the *Cerrados* area, constituting about 40% of national Soya bean production.

**Table 6.2 - Brazil: Area, Production and Productivity of the Soya bean - 1970 to 1993**

| PERIOD | AREA (HA) | PRODUCTION (TONNE) | PRODUCTIVITY (KG/HA) |
|---|---|---|---|
| **1970-1971** | 1,716,420 | 2,014,291 | 1,174 |
| **1971-1972** | 2,191,454 | 3,223,965 | 1,471 |
| **1972-1973** | 3,615,247 | 5,011,614 | 1,386 |
| **1973-1974** | 5,143,367 | 7,876,527 | 1,531 |
| **1974-1975** | 5,824,492 | 9,893,008 | 1,699 |
| **1975-1976** | 6,417,000 | 11,227,123 | 1,749 |
| **1976-1977** | 7,070,263 | 12,513,406 | 1,770 |
| **1977-1978** | 7,782,187 | 9,540,577 | 1,226 |
| **1978-1979** | 8,256,096 | 10,240,306 | 1,240 |
| **1979-1980** | 8,774,023 | 15,155,804 | 1,727 |
| **1980-1981** | 8,501,169 | 15,007,367 | 1,765 |
| **1981-1982** | 8,203,277 | 12,836,047 | 1,565 |
| **1982-1983** | 8,137,112 | 14,582,347 | 1,792 |
| **1983-1984** | 9,421,202 | 15,540,792 | 1,650 |
| **1984-1985** | 10,152,751 | 18,278,422 | 1,800 |
| **1985-1986** | 9,537,000 | 13,400,000 | 1,405 |
| **1986-1987** | 9,134,000 | 16,968,000 | 1,857 |
| **1987-1988** | 10,602,000 | 18,053,000 | 1,702 |
| **1988-1989** | 12,218,000 | 24,087,000 | 1,971 |
| **1989-1990** | 11,465,000 | 19,850,000 | 1,731 |
| **1990-1991** | 9,583,000 | 15,522,000 | 1,620 |
| **1991-1992** | 9,528,000 | 19,175,000 | 2,012 |
| **1992-1993** | 9,474,396 | 19,184,919 | 2,033 |

Source: IBGE 1992, quoted by ROESSING and GUEDES 1993: 19 and IBGE 1993a: 3-38.

From this perspective, Wilkinson and Sorj [1992: 23] argue that the Soya bean complex has become the 'symbol of Brazilian agricultural modernisation'. According to the World Bank [1994: 40], 'the tremendous expansion of Soya bean production is partly attributed to EMBRAPA's development of new Soya bean varieties suitable for the acid soils of the West-Central [region]'. Also, Spehar et al [1991: 26] state that the increased Soya bean production in the *Cerrados* region was due to the subsidised credit used to acquire capital-intensive input, such as fertilisers and soil correctives and the agricultural technology support of EMBRAPA.

### 6.4.1. The *Doko* Soya bean Generation Process

The *Doko* Soya bean generation process did not come from the integrated demands of farmers, rural extension agents or consumers. It began in response to the following Soya bean geneticist's question: 'Is it possible to grow Soya beans under short-day conditions?'.

It is important to observe that, until the early 1970s, the Soya bean had been cultivated on a large-scale in the *traditional high latitude area* of the South - in the States of Paraná, Santa Catarina and Rio Grande do Sul. Afterwards, in 1975, through the POLOCENTRO programme the Federal government subsidised credit, agricultural research, technical assistance, modern inputs and so on for the *Cerrados* region. These incentives were significant to development of the Soya bean in the so-called *expansion low latitude area* [EMBRAPA, 1993I: 7].

The *expansion area* comprises of the *Cerrados*[18], and some areas of the Northern and the Northeastern regions where latitudes are lower than 30 degrees. The new Soya bean varieties became essential to the wide range of latitudes. This challenge was the motivating factor for the CNPSo geneticist's postgraduate training in America[19]. Thus, the initial motivation of the *Doko* Soya generation process was not concerned with farmers' needs. It was instead formulated in the scientific field[20] within the research organisation. EMBRAPA is

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[18]Spehar [1994: 1167], *Breeding Soybeans to the Low Latitude of Brazilian Cerrados (Savannahs)*, states that 'the progress in soybean breeding has led this low latitude region to contribute with more than 40% of the national production, pioneering modern large scale soybean cultivation'.

[19]Kiihl, R. A. S. (1976). *'Inheritance studies in soyabeans [Glycine max (L) Merril]: I. Resistance to soyabean mosaic virus; II. Late flowering under short-day conditions'.* Mississippi State University. p. 56 (Ph.D. Thesis).

[20]Pretty and Chambers [1993: 19], *Towards a Learning Paradigm: New Professionalism and Institutions for Agriculture*, argue that 'agricultural researchers are deterred from working in the field and with farmers by their conditioned attitudes and behaviour, by a reward system based on scientific papers derived from on-station research'.

a state-owned organisation dependent on government funds which interchanges with the environment in which they are located. Further, it can be perceived that the Soya bean has been cultivated on a large-scale in concentrated geographical areas[21], either in the *traditional* or in the *expansion* areas.

The previous Soya bean cross-breeding experiments which created the *Doko* Soya bean variety were undertaken in the early 1970s which had been led by the same geneticist since 1970. At the time of field-work he was still the leader of the Soya bean genetics programme in CNPSo. After the establishment of EMBRAPA, the *Doko* Soya bean testing, in the low latitude *Cerrados,* was carried out by CPAC as a part of the Soya bean national research network. This study concentrates on the *Doko* Soya bean generation by CPAC researchers and its adoption by farmers in the *Cerrados* region.

The *Doko* Soya bean generation process as part of the Soya bean national network was carried out within CPAC by a geneticist who was the research leader and two agricultural researchers. The research leader was born in São Paulo, the largest industrial city in Latin America and his father was an electrician. He had little work experience before being recruited to EMBRAPA - only three months with international corporation Shell, in 1974. He completed his undergraduate degree at the University of São Paulo (USP) the largest university in Latin America. His academic background included Masters and PhD degrees

[21]Pastore et al [1982], *Condicionantes da Produtividade da Pesquisa Agricola no Brasil,* found important empirical findings on agricultural technology generation and diffusion of export and domestic agricultural products, such as coffee, sugar-cane, cotton and rice, beans and maize, respectively, in Brazil. They [1982: 37-45] indicated that (1) export and industrial commodities, such as coffee, sugar-cane and cotton were geographically concentrated and, as a result, they constituted organised interests which increased the interaction between farmers and researchers; (2) this geographical concentration of export and industrial crops encouraged the standardisation of production systems and facilitated the generation and diffusion of agricultural technological 'packages' to attend to their demands; (3) in contrast, domestic foods such as rice and beans, were scattered throughout the country and did not constitute significant geographical concentration. They were grown by small farmers which made difficult the interaction between farmers and researchers. Further, the small farmers neither formed interest groups nor were they able to reap the benefits from the state agricultural technology generation and diffusion processes.

acquired at American and British universities. He was a typical member of the Brazilian middle class[22].

In addition, he believes that EMBRAPA is an excellent research organisation of the top-down type. Literature reviews are the main source of research problems and he spends about 5% of his research time in contact with farmers. According to him, technology's goals are to increase productivity and to reduce costs. This is useful for all types of farmers. His relationship with his former postgraduate supervisor and with various international research centres, such as the IITA (International Tropical Agriculture Institute) and the FAO (Food and Agriculture Organisation), are an important influence on his input into the agricultural generation process.

Further, the other researchers involved in *Doko* Soya bean development, emphasised that the current EMBRAPA research model has been very important for Brazilian agricultural modernisation because it has introduced new agricultural equipment and modern inputs[23]. This is typical of the EMBRAPA *Concentrated* research model[24]. Postgraduate courses are important elements in defining research problems. Agricultural modernisation with the use of modern inputs and high technology, is the dominant paradigm. Literature reviews are more

[22]Ribeiro [1995: 211], ibid., shows Brazilian social stratification as follows: (1) dominant class (the modern oligarchy - the productive and parasite entrepreneurs - and the political, military and national and transnational technocratic apparatus), (2) intermediary segment (liberal professionals, small entrepreneurs, state employees and clergy), (3) class subaltern (rural labourers, sharecrops, peasants, 'minifundios' and the proletariat) and (4) oppressed classes (domestic employees, prostitutes, beggars, seasonal rural and urban employees and delinquent people). Thus, it is possible to infer that EMBRAPA researchers are a part of the Brazilian middle class.

[23]Berland [1987], *Long Term Origins of the World Agricultural Crisis,* states that the 'Soya bean was at the centre of the post-war transformation of agriculture, and with it major shifts in the international division of labour'.

[24]According to Dagnino [1993: 9], *How European Science Policy Researchers Look At Latin America?,* this shows how, in Latin America, the adoption of technological innovation was based on the 'institutional package' and the 'linear innovation model'.

important as the source of research problem identification than a farmer's social reality and rural extension issues.

The *Doko* Soya bean generation process, which had taken about eleven years (1970-1980), entailed (1) the identification of the research problem, (2) the elaboration and execution of the research project and (3) the dissemination of the research results. As with the *Brasília* carrot, the *Doko* Soya bean research project involved the same paper work and was sponsored by EMBRAPA. However, the research problem identification came from the researcher's assumptions[25] in the context of the Soya bean national research program. Further, the *Doko* Soya bean breeding crosses began with the American Soya bean varieties in 1970, when the best Soya bean lineage was selected.

EMBRAPA's main aim was to develop an ideal Soya bean variety[26] adapted to the new agricultural frontier, the *Cerrados* region. In 1970s, the *Cerrados* development was a national priority. Rural extension agents and farmers were not active participants, either in the identification of the research problem or in the elaboration and execution of the research project. The researchers were not interested in farmers' local knowledge. The objective was to carry out Soya bean national research network tests in a range of environments. The experimental tests, under controlled conditions, were carried out in the farmers' fields. In this phase, that is after the technology had been generated, the technology diffusionists and the rural extension agents participated in the *Doko* Soya bean farm's trials under simulated conditions and in the diffusion technology activities.

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[25]Sphehar [1994: 1169], ibid., states that 'the success in selecting high yielding and stable cultivars of this breeding programme was based on the growing interchange among research centres, State research enterprises and other members of the research cooperative system '...' In the establishment of uniform trials, differences on day-length, soil and climate were considered, given the vastness of the region '...' the starting point of expansion of commercial cultivation of soybeans throughout the year in the low latitude savannahs was the generation advance from the breeding programme'.

[26]The botanical features of the *Doko* Soya bean are in appendix 5.

According to Farrington and Martin [1993: 30-31], and in accordance with Biggs' [1987] typology, the Soya bean researchers and farmers interaction resembles the 'contract' type. For them, this means that

> 'the farm's land services are borrowed or hired to provide more agro-ecologically diverse conditions for local verification of technologies developed on-station. This would not constitute participation by most definitions, but constitutes a useful farmer-researcher link in the view of many scientists'.

As a result, the *Doko* Soya bean was realised in 1980 and the seed had been multiplied by EMBRAPA's Basic Seed Production Service (SPSB) to attend to farmer's demands. The seed dissemination to farmers was done through co-operatives which produced the *Doko* Soya bean certificate seed. The research leaders did not deal directly with seed multiplication. In the short run, the *Doko* Soya bean was adopted by farmers and became the largest Soya bean variety cultivated in the *Cerrados* area.

### 6.4.2. The *Doko* Soya bean Adoption Process: The COOPERTINGA Case

The adoption case study dealt with the *Doko* Soya bean settlers of the COOPERTINGA co-operative[27]. The co-operative has had a technical relationship with CPAC, including a technical agreement.

> The COOPERTINGA[28] project began in 1989, supported by the PRODACER program. The project deals with financial resources from the Japanese and Brazilian governments. It is situated in the state of Minas Gerais in the *Cerrados* area, 248 km from Brasília, Federal District. Its total area is 23,000 hectares, divided as follows: preservation area, 8,000 ha; agricultural area, 15,000 ha; irrigated corn, 1,473.5 ha; area cultivated, dry corn, 1,053 ha; Soya bean, 8,789 ha; and irrigated bean 1,840.5 ha. COOPERTINGA settlement presents 53 modules. The average module is 620 ha. COOPERTINGA has 39 administrative and technical employees in its headquarters [COOPERTINGA, 1994].

[27]Goodman et al [1985: 43-44], *Agroindústria, Políticas Públicas e Estruturas Sociais Rurais: Análises Recentes sobre a Agricultura Brasileira,* write that a co-operative strategy was used by the Brazilian authoritarian government and could promote agricultural modernisation. They cite the case of the Soya bean staple as an example of the consolidation of the co-operative mechanism and state intervention in the 1970s.
[28]The COOPERTINGA location is shown in Appendix 18.

As in the case of the CEASA, with COOPERTINGA one seeks to understand, 'Why do Soya bean farmers grow the *Doko* Soya bean variety?' and 'How did the *Doko* Soya bean generation process influence its adoption by Soya bean farmers?'. It is important to note that COOPERTINGA's financial support came from the Brazilian and Japanese governments, through PRODAECER and JICA respectively. This shows the interests of the Japanese in Brazil, in EMBRAPA and in the *Cerrados* region. First, in agricultural technology development, through the agreements between JICA[29] and EMBRAPA-CPAC which involve capital, research equipment and training. And second, in agricultural production, through the PRODACER programme which comprises of the Ministry of Agriculture and Agrarian Reform, co-operatives and private companies. This suggests that Japan's lack of natural resources, especially food crops, makes it interested in Brazil's emergence as a powerful producer and exporter of food crops for the Japanese market.

The strategy for collecting data involved various initial contacts with COOPERTINGA's and CPAC's executives, researchers and technicians. Personal interviews were conducted and observations and visits to executives and settlers were made twice by the

[29]According to EMBRAPA [1994f: 16] *Plano Diretor do Centro de Pesquisa Agropecuária dos Cerrados - CPAC,* 'CPAC has maintained agreements with international bodies which involve financial support, such as JICA'. It is important to note that the *Cerrados* area is 4.8 times than Japanese territory. Further, Kubota [1996: 59-60], *Scientific Contribution of the JICA Project to Sustainable Agricultural Development in the Cerrados.* In: First International Symposium on Tropical Savannas: Biodiversity and Sustainable Production of Food and Fibres. Kubota is the Japanese expert on technical co-operation between JICA and EMBRAPA, remarks that 'the agricultural research cooperation project between JICA and EMBRAPA, consists mainly of the despatch of Japanese experts to the CPAC for cooperative studies, provision of equipment and materials, and research studies of Brazilian counterpart personnel in Japan. The cooperative studies have covered the fields of remote sensing technology, meteorology, crop science, soil management, agricultural machinery, entomology, plant pathology, agro-environmental sciences etc. to solve technical problems in Cerrados agriculture and to offer practical and useful technologies to the Cerrados farmers '...' The research cooperation projects intend to offer practical and useful technologies to farmers of settlement areas of PRODACER, the National Program for Agricultural Development of the Cerrados region in Brazil, as well as to support research activities to produce technology for a sustainable agriculture, and consequently, contribute to the increase of agricultural productivity in the region'.

author. Thirty-one settlers were interviewed (approximately 80%) using questionnaires and personal interviews[30].

Once again, additional data were collected (beyond the COOPERTINGA case) in the Barreiras[31] region of the state of Bahia in North-east. The Barreiras region has the largest Soya bean harvest in the North-east and is part of the *Cerrados* region. Agricultural modernisation began at the end of 1979. The Soya bean was the most important crop in the region. At the time, entrepreneurial groups and co-operatives from the South shifted the social and economic framework. Agriculture was based on modern inputs and irrigation, especially for Soya bean, rice, maize, and bean crops. Soya bean areas, planted in 1994, amounted to 440,013 hectares. The region was transformed and new agricultural methods were introduced. The Barreiras region has approximately 700,000 inhabitants, and an investment of U$ 70 million was made, almost entirely in agriculture. This promoted high growth of agricultural services and enabled the social and economic infrastructures to grow.

In the Barreiras area, questionnaires[32] were handed out by agronomists of the Agricultural Development Organisation of the State of Bahia - EBDA. There was no formal scheme for data collection and farmer interviews simply followed the EBDA selection, which is responsible for technical assistance and agricultural technology generation in the Barreiras region and which has technical agreements with CPAC. Farm visits and personal interviews were conducted by the author based on EBDA's informants. In this area, forty-one farmers and four agricultural development organisations' representatives were interviewed.

[30]Questionnaires are in appendix 7.
[31]The Barreiras location is shown in Appendix 18.
[32]Questionnaires are in appendix 7.

In the COOPERTINGA case, all the Soya bean farmers were male, 80% were between 26 and 43 years of age and 30% were born in urban areas. The *Doko* Soya bean production system had farmers with a high level of schooling, for instance 64% had reached secondary level education and 7% university level. It is important to bear in mind that 75% of all farmers were born in the south of Brazil, specifically in Rio Grande do Sul, Santa Catarina and Paraná. Sixty-five percent of them were born in the State of Rio Grande do Sul and they were thus identified as *gaúchos*[33]. The South is a rich region and has the lowest illiteracy level of 11%, in comparison to the 40% in the North-east and 20% in the whole of Brazil. This suggests that the young, skilled and trained farmers were able to open a new agricultural frontier. The Soya bean production system is based on high technology: productive varieties and capital-intensive inputs and commercialisation is connected with the international market as a part of globalised agriculture[34].

The COOPERTINGA Soya bean farmers also had previous agricultural experience and most of them farmed as their main occupation and the principal source of their income came from Soya bean cultivation. The farm area is a standard plot, that is, 620 hectares and is 248 km from Brasília. In a few cases some settlers have more than one module. The area planted, in theory, should be standardised as well (following co-operative rules), but in reality the settlers have a variety of minor crops, such as maize, rice and fruit. The Soya bean is the most

[33]Ribeiro [1985], ibid., writes that *gaúchos* come from German, Italian and Spanish stock. They arrived in Brazil in the imperial period (1822 to 1889) because of immigration incentives from European countries to shift slave labour. Today, they are concentrated in the Southern region - in the States of Paraná, Santa Catarina and Rio Grande do Sul.

[34]Souza [1990], *Condicionantes da Modernização da Soja no Brasil,* shows that the main factors that influenced the expansion and modernisation of Soya bean in Brazil were: Soya bean varieties from the United States, Soya bean mechanised production system, Soya bean agricultural technical support and the increasing demand for Soya beans from the meat agro-industry complex. Further, Troughton [1996: 451], *Globalized Agriculture; Political Choice, Richard Le Heron,* argues that 'especially during the most recent period, since 1945, capitalist agriculture has operated within a global context which has included widespread (and industrialized) socialist agriculture, a shift from overt colonial to neo-colonial control of key exports from the Third World'.

important crop of the COOPERTINGA. The COOPERTINGA settlers have a good standard of living - cars, holidays, and houses on the farm and in town. Farmers receive loans from the Bank of Brazil[35] and they maintain their national and international commercial relationships through the co-operative. The COOPERTINGA managers have university degrees and the organisation is a member of the Brazilian Co-operative Organisation (OCB), linked to the Rural Parliamentary Support (*bancada ruralista).*

Technical assistance comes from the farmer's private co-operative, that is, all farmers receive individual technical orientation by COOPERTINGA's agronomists. Further, 80% said that they had learnt of the *Doko* Soya bean variety through the co-operative as well. When farmers were asked: 'Why do you grow the *Doko* Soya bean?', 90% argued that they cultivated it primarily because of its resistance to disease and 10% identified other reasons, such as quality and regional adaptability. Forty-two per cent were happy with the *Doko* Soya bean and would continue to cultivate it, depending on harvest results. They stated that despite its resistance to disease, it was less productive and its cycle was later than other Soya bean varieties. Most of them had learnt that the *Doko* Soya bean was appropriate for the first *Cerrados* cultivation.

Secondly, in the Barreiras, similar to COOPERTINGA, Soya bean farmers were also asked: 'Why do you grow the *Doko* Soya bean?' 75% argued that the *Doko* Soya bean was

[35]Silva [1991], *O Sistema Financeiro e Participação e Difusão de Tecnologia Agropecuária*, and Martine [1990 and 1991], *Fases e Faces da Modernização Agrícola Brasileira and Frontier Expansion, Agricultural Modernization, and Population Trends in Brazil,* state that the concentration of subsidised rural credit was directed much more to export staples than to food crops. This view is supported by Matthews [1988], *Cash Crops and Growth: Growth and Employment Considerations in the Food vs. Export Crops Debate,* who says that 'there is a large agribusiness presence in the export sector', and that export and industrial crops in underdeveloped countries have been favoured in the allocation of subsided credit and other government policies. Also the Bank of Brazil is a state Bank, which has the largest agricultural credit line in Brazil. For instance, government subsidised credit used to support Soya bean cultivation in the Cerrados which amounted to about U$ 140 million between 1980 and 1987.

*disease resistant,* but that they were waiting for the harvest to decide whether to cultivate it. They also admitted that the *Doko* Soya bean presented some problems, such as *low productivity* in relation to other Soya beans varieties. However, the *Doko* Soya bean is the only variety tolerant to 'frog eye leaf spot' (*Cercospora sojina*) disease. Further, according to the farmers, the increase of Soya bean productivity continues to be the main aim, independent of any social or environmental consequences.

The farms in Barreiras had enormous areas devoted to single Soya bean cultivation - 75.6% of the farms had up to 500 ha. In some cases, there were farms with areas of around 6,000 ha. In Brazil, high land concentration is another facet of social class differentiation. For example, 62% of land is classified as unproductive *latifundium*[36] [Guanziroli, 1984 and INCRA, 1986 quoted in Silveira, 1992]. As a result, Hall [1990] remarks that high land concentration has been a significant factor contributing to rural poverty in Brazil. There is also the fact that in Brazil, farms larger than 50 hectares grow more than half of all the cocoa, coffee, rice, sugar-cane, Soya bean and wheat produced, whereas smaller farmers grow more than half of the national production of cassava and beans, the subsistence crops [Townsend, 1987].This is the result of the secular process of growth of an economy almost entirely based on large estates producing primary goods for export[37].

The predominant Soya bean farmers established in the Barreiras area were similar to the ones in the COOPERTINGA case, from the Southern region - the States of Paraná, Santa

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[36]Bryant [1996: 1542], *Strategic Change Through Sensible Projects,* writes that 'extreme concentration of land ownership in Brazil impedes efficient economic agricultural performance and productivity'. This also 'reinforces the power of large *latifundia*'.

[37]Fernandes [1996: 114], *Neoliberalism and Economic Uncertainty in Brazil.* In: Liberalization in the Developing World: International and Economic Changes in Latin America, Africa and Asia, shows that 'the roots of social inequality are to be found in the slavery of Brazil's colonial past, which emancipation did little to correct. Regional inequalities have been generated in the way the economy has been shaped, with exportation of primary goods and industry concentrated in the southern half of the country'.

Catarina and Rio Grande do Sul. They are also known as *gaúchos,* that is, 90.24% were born in the South and moved from their home states due to a shortage of land. Baiardi [1992: 45-46], states that *gaúchos* held between 5-10 hectares in their home land - the Southern region - but in the Barreiras they are large landowners with around 500 hectares. This shows that the Soya bean farmers are part of the middle class in Brazil. A Soya bean farmer from the North-eastern region said 'the *gaúchos* kept to their own community and that managers at the Bank of Brazil have more confidence in *gaúchos* than in *nordestinos*'[38]. Some loans from the Bank of Brazil are the result of political pressure aimed to benefit the *gaúchos.*

It is important to note that, according to the Secretary of Economic Development of the Barreiras Hall, who is a *gaúcho,* that the Barreiras occupation by *gaúchos* was a consequence of the establishment of ITAIPU[39] (International Paraguay River Hydroelectric Power), an expropriated area in the South, and led to the exodus of rural people from the Southern region to the Barreiras[40]. Table 6.3 shows the views of the development organisation's representatives with respect to the *Doko* Soya bean in the Barreiras region. The Secretary of Economic Development for Barreiras Town Hall, remarked that the relationships between farmers and CPAC, were in development in the 1980s. He agreed that EMBRAPA technology promoted the increase in Soya bean productivity. Technical agreements between CPAC and co-operatives, the Soya bean's new varieties trials and the farmers and the rural extension agents training took place in the Barreiras area. The *Doko* Soya bean variety has been cultivated because of its resistance to disease. The *Doko* variety was the *first Soya bean variety grown in the Cerrados area.*

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[38]The term *nordestinos* signifies the farmers from the Northeastern region.
[39]ITAIPU is the largest hydroelectric power situated on the Paraguay river between Brazil and Paraguay. It is a state-owned company.
[40]Baiardi [1992: 40-44], *A Moderna Agricultura do Nordeste,* states that *gaúchos* came from the South. They brought from their homeland some money and agricultural skills.

**Table 6.3 - The Barreiras Development Organisation Representatives' Attitudes to the *Doko* Soya bean**

| Attitudes / Representatives | MOTIVATION TO ADOPT THIS VARIETY | RELATIONSHIPS WITH EMBRAPA | ATTITUDE TO GOVERNMENT INCENTIVES | COMMENTS ABOUT EMBRAPA |
|---|---|---|---|---|
| **Secretary of Economic Development** | Disease resistance. Appropriate for the first *Cerrados* cultivation | EMBRAPA has been an important agricultural organisation since the 1980s | There are no agricultural policies in Brazil. Farmers depend on private and public credits and Soya bean oil industries. Government promoted new open frontiers | EMBRAPA promoted the increase of Soya bean productivity |
| **Rural Technical Assistant of the Bank of Brazil** | Disease resistance. First *Cerrados* cropping. '*Cristalina*' Soya bean variety is the most common Soya bean variety | The Bank of Brazil suggests that Soya bean farmers grow EMBRAPA's varieties for their resistance to disease. | The Bank of Brazil financed Soya bean cultivation according to the technical viability of the agricultural project. Some very expensive projects are approved at the General Board of Directors | Bank of Brazil follows EMBRAPA's technical results |
| **Manager of OLVEBASA (Bahia Plant Oil)** | Disease resistance | EMBRAPA's participation is weak. He does not know of EMBRAPA's activities | Shortage of resistant Soya bean varieties. Financial resources for farmers. High cost to Soya bean production system. Governmental subsidies | EMBRAPA has not worked in this region |
| **Agronomist of Private Technical Assistance** | Disease resistance. First *Cerrados* cultivation. It is less productive than other Soya bean varieties | EMBRAPA technology has been important for Soya bean cultivation | New technologies and financial resources are necessary to maintain high levels Soya bean productivity | EMBRAPA is an important organisation. He has never visited EMBRAPA |

According to him, farmers would continue to have many difficulties because there was no support from the government. They therefore continue to depend on private and public credits and Soya bean oil plants. The Government has not satisfied farmer demands for agricultural technology and State Government of Bahia has not developed serious agricultural research policies.

The technician at the Bank of Brazil, argued that the *gaúchos* were determined and interested in transforming the region. They had better qualifications and knew the Soya bean agricultural production system very well. They were more interested in the adoption of high technology. The Bank of Brazil has supported and lent money to Soya bean cultivation only for the variety which is disease resistant, such as the *Doko* Soya bean variety. According to him, Soya bean production systems in the Barreiras area have used all the available agricultural technology.

The OLVEBASA representative, who buys part of the Soya bean produced in the Barreiras region to be processed, argued that the main problems of Soya bean were the shortage of disease resistant varieties and high production costs. The *Cerrados* area needs high technology, such as fertilisers and modern inputs. EMBRAPA's participation in the Barreiras region has been limited and without great importance. He would like to see EMBRAPA in direct contact with farmers to solve Soya bean cultivation problems. Even through, EMBRAPA has not been in Barreiras in physical terms, it has technical agreements with co-operatives and with the Agricultural Development Organisation of the State of Bahia - EBDA. Further, through the CPAC, EMBRAPA has promoted technical meetings and technology transfer activities. He did not say that the *Doko* Soya bean is an EMBRAPA variety. This shows that the Soya bean adoption was a decision made by farmers independent of persuasion. The farmers adopted it for its resistance to disease and to increase profits or minimise risk.

Evidence shows that the *Doko* Soya bean generation process was not a 'collaborative' process between researchers, rural extension and farmers. The formulation of the research problem, and the elaboration and execution of the research project were developed within the research organisation by researchers, especially the geneticists, as part of the Soya bean national research network. This is confirmed by Spehar [1994: 1169] who was the *Doko* Soya bean generation process research leader. In Spehar's words, *Doko* Soya bean generation was 'a result of [the] integrated [research] programme of the research cooperative system, under the leadership of EMBRAPA'.

This means that the rural extension agents and farmers did not have active participation in 'what and why' to research and 'how' to disseminate the research results[41]. As stated before, and in accordance with Biggs' [1987], this resembles a 'contract' between researchers and farmers. In reality, researchers, rural extension agents and farmers participated in the trials in the farmer's' fields and in technology diffusion activities, such as field days, technology demonstration units and training and visiting after the *Doko* Soya bean variety had been developed.

It can be noted that there were strong 'invisible' links between the Soya bean researchers and farmers. Both had the same social status and similar goals. There was clear path between the generation process and the farmers' demands[42]. Thus, the technology flowed directly from the research organisation to the farmer's production systems which adopted it. The agreement of interests between the research organisation and its researchers and the farmers facilitated the generation and adoption processes. Further, the Soya bean chain comprises production, industrialisation, and export which deals with able and modern structures, like co-operatives, processing industries, parliamentary support and interest groups. All these have been available to promote the interests of the Soya bean complex

[41]According to EMBRAPA-CNPSo [n.d.], *CNPSo: Searching for Solutions - Commitment to Mankind,* 'high yielding and disease-resistant cultivars, economical levels of fertilzers, soil management, and integrated control methods for insects and weeds are some of the technologies that are continuously updated **and passed on to the extension agents and farmers**' (my emphasis).

[42]According to Hebette [1996: 39], *A Relação Pesquisadores-Agricultores. Diálogo, Parceria, Aliança? Uma Análise Estrutural*, the 'relationships between farmers and agricultural researchers are not really individual, interactive and personal relationships. However, they focus on relations between distinct social classes where the socially structured hierarchy was established'. For example, he argues that 'the agricultural researcher, as a middle class member, has a good standard of living and is part of the dominant culture. In contrast, the small farmers have no access to benefits of society, such as scientific knowledge and formal literacy'.

members. For instance, the government has supported the *Cerrados* and in particular the production and exportation of the Soya bean, especially through high subsidies which have minimised the risks of the technology adoption by Soya bean farmers.

It is evident that once again the State promoted the necessary support for Soya bean development. This is confirmed by a former EMBRAPA executive who argued that the government supported the agricultural technology process focused on the export and industrial staples. He also stated that *EMBRAPA was created to meet the needs of the new market forces, and the Soya bean fits these needs.* Also, Goodman et al [1985: 44] argue that the *gaúchos* are former small farmers from the Southern region who were unable to deal with the agricultural modernisation in the South. Thus, this marginal population supported by state incentives moved to the new agricultural frontiers, such as the Amazon and *Cerrados*.

As stated, the *Brasília* carrot and the *Doko* Soya bean varieties were developed respectively by CNPH and CPAC in collaboration with CNPSo researchers. It is important to understand how different their generation and adoption processes are. It is also worth investigating the relation between the generation processes and their adoption by farmers.

### 6.5. The *Brasília* Carrot and the *Doko* Soya bean Generation Processes

Table 6.4 shows the main procedures of the *Brasília* carrot and the *Doko* Soya bean generation processes, especially the identification of the research problem by geneticists who were the research leaders. The identification of the research problem is the main stage of the research project.

## Table 6.4 - The *Brasília* Carrot and the *Doko* Soya bean Generation Processes

| Varieties / Generation Process | THE *BRASÍLIA* CARROT[1] | THE *DOKO* SOYA BEAN[2] |
|---|---|---|
| **1. Identification of the research problem** | CNPH researchers under the leadership of the geneticist and based on information from the carrot farmers, the rural extension agents and carrot market, developed the ideal carrot. | The *Doko* Soya bean originated in the national Soya bean research network for the *Cerrados* led by CNPSo. The research project was elaborated as a result of CNPSo geneticist inspiration. |
| **2. Elaboration of the research project** | The research project was undertaken by geneticists, the plant pathologist and the technology diffusionists. The research project looked for an ideal carrot variety, that is, one adapted to summer, disease resistant and with the colour and root form suitable to Brazilian preferences. The initial breeding crosses used the native carrot varieties. | The *Doko* Soya bean research came from the CNPSo research network. The CNPSo geneticist looked for the best varieties to grow in the low latitude (the agronomic criteria) of the *Cerrados* region. The initial breeding crosses used American Soya bean varieties. |
| **3. The execution of the research project** | The initial carrot variety trials were tested in the experimental area. They engaged researchers, farmers and rural extension agents. Afterwards, the carrot varieties were tested in the farmers' fields. Farmers, researchers and rural extension agents evaluated the better carrot varieties in the farmer fields throughout the country. | The initial *Doko* Soya bean trial was done in the CPAC experimental area. It comprised solely of researchers. Afterwards, the *Doko* Soya bean tests were managed in the farmer fields. The rural extension agents, farmers and researchers participated in the validation tests. |
| **4. The dissemination of the new variety** | The *Brasília* carrot was released in 1981. The result was to be great *Brasília* carrot performance and high diffusion. The development of the *Brasília* carrot variety had taken around six years (1976-1981). | The *Doko* Soya bean was released by CPAC and CNPSo in 1980. The *Doko* Soya bean adoption by farmers was very quick because of a shortage of Soya bean varieties adapted to the *Cerrados* region. The development of the *Doko* Soya bean variety had taken around eleven years (1970-1980). |

[1]Source: Based on the * VIEIRA, 1996.
*Research leader of the *Brasília* carrot generation process.
[2]Source: Based on the SOMBRA, 1996; CROCOMO and **SPEHAR, 1981 and ***KIIHL, 1994.
**Research leader of the *Doko* Soya bean generation process at CPAC.
***Research leader of the *Doko* Soya bean generation process at CNPSo.

First, Table 6.4 reveals that the *Brasília* carrot generation process was led by a geneticist who took the social concerns of the agricultural research process into account. The generation process involved carrot farmers, rural extension agents and consumers in various phases of the research program. Experimental tests in the CNPH area and in the carrot farms adjoining rural extension agents were carried out. The carrot farmers, rural extension agents and agricultural researchers chose the best carrot seedlings during the plant breeding assessment inside the research centre's experimental area[43]. Technology validation in the farmers' fields and technology diffusion activities were dealt with by agricultural researchers in conjunction with rural extension agents and farmers. Further, the researchers participated in the multiplication of the basic *Brasília* carrot seed to be distributed to farmers.

The *Brasília* carrot generation process is not typical of the EMBRAPA research process which only involves agricultural researchers and resembles a top-down and technology-transfer approach. This is a supply-oriented research process[44], that is, at the *top* researchers theorise and create the technology and at the *bottom* farmers passively legitimise it. The researchers are the arbiters of the agricultural technology generation process. They generate the agricultural technology, the rural extension agents transfer it and the farmers adopt it. It is a linear, individual and isolated activity, which separates generation, transference and adoption of agricultural technology. According to Rogers' [1960: 418], this is 'the trickle-down process by which new farm practices [agricultural technologies] diffuse from scientists to farm people'.

In reality, the *Brasília* carrot generation process addressed the farmers' demands (farming in the summer season, disease resistance, and high productivity) and consumer exigencies as well (the carrot's colour, taste and shape). Carrot production was cultivated in small areas and the carrot farmers received technical assistance from the state rural extension agency and were not in debt to private and official banks. The carrot commercialisation process occurred in the CEASA (public market) or via intermediaries.

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[43]At the time of field-work, the research leader stated that during the experimental stages in the CNPH area, the *Brasília* carrot seedlings were stolen by the anxious adopters.

[44]Chambers [1993a: 182], *Reversals, and Change.* In: Farmer First: Farmer Innovation and Agricultural Research, shows that in this *modus operandi* 'scientists decide research priorities, generating technologies and passing on to extension agents to transfer to the farmer'.

Secondly, Table 6.4 shows that, in contrast, the *Doko* Soya bean generation followed a different schema. The research problem arose from the Soya bean geneticists' beliefs and the research project was a part of the national research network. The increase in productivity was the focus of the research. The research led by the geneticists that generated the *Doko* Soya bean are typical 'adoption-diffusion' researchers. They have specific concerns about the commodity-led research process. For them, technology is neutral and useful for all types of farmers. They focus the generation process on the agricultural product and not on *farm as a whole* issues. They are rewarded for the number of scientific papers published in journals and those given at specialised meetings. The rural extension programmes' relationship with the agricultural research organisation is not an important motivation.

It is important to note that the *Doko* Soya bean generation process was concerned with the viability of the Soya bean cultivation in the new agricultural frontier, in accordance with government developmental plans. The *Doko* Soya bean is the most profitable Soya bean variety, of the first *Cerrados* cultivation. The Federal Government created POLOCENTRO, PRODACER and PROFIR programs for the development of the *Cerrados*. Further, international assistance from the Japanese government through the JICA has supported agricultural production in the *Cerrados* area. Once again, the adoption by farmers of the *Doko* Soya bean had been assisted by factors beyond the 'technological circuit'[45]. This means other factors alter the generation, diffusion and adoption processes.

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[45]Rodrigues [1985: 308], *Difusão de Tecnologia: Uma Abordagem Além do Circuito Tecnológico,* simulated a situation in which all the requirements of the generation, diffusion and adoption processes were fulfilled. Afterwards, he asked: 'Would it be sufficient for farmers to adopt EMBRAPA technologies?'. He answered that technology would not be sufficient to promote social change, because technology was not neutral. On the contrary it was a product of social relations in which it has been generated. Further, government policies and priorities have influenced the direction of the generation and adoption of agricultural technologies. For example, he argued that government policies, such as price, credit, commercialisation, and tax policies have benefited export and industrial commodities more than the domestic crops. This shows that factors outside the 'technological circuit' influence the agricultural technology generation and adoption processes.

Furthermore, the Soya bean farmers' partners in Brazil are owners of large land areas[46] and use capital-intensive technologies. Soya bean production system demands high technology to be competitive in the global economy[47]. In fact, the *Doko* Soya bean research *modus operandi* conforms to EMBRAPA's research model. It was created to serve market principles, particularly the Soya bean international market. There is an unambiguous, one-way progression in *Doko* Soya bean research, extension and adoption process. The Soya bean National Research Centre was created a short time after EMBRAPA's creation. There is a one way path between the Soya bean generation process and the Soya bean farmer's demands.

From this perspective, it is important to note that the agricultural technology was generated in an organisation which is a part of a socio-technical system where internal and external influences interact. It is necessary to relate the background of its members, especially the research leaders to the generation process they were involved in. Thus, Table 6.5 indicates the beliefs and the theoretical frameworks of the researchers, particularly the geneticists who were involved with the *Brasília* carrot and the *Doko* Soya bean. For example, the *Brasília* carrot geneticist had a holistic approach to the agricultural research process. He focussed on client-oriented research and the integration of the agricultural research organisation, farmers

[46]In Brazil, Soya bean is a single crop for export which represents strong organised interests. For instance, in Brazil there is the 'Soya bean King'. He is a rich man and owner of around 50 thousand hectares of the area of Soya bean cultivation. Some years ago EMBRAPA developed experimental Soya bean trials on his farms and employed agricultural researchers full time on the 'Soya bean King's' farms. Similar support was not provided in the carrot farmer's case.

[47]According to Friedmann and McMichael [1989: 105-7], *Agriculture and the State System: The Rise and Decline of National Agriculture, 1870 to the Present,* the Soya bean is a part of the animal, industrial and human food chains. They state that 'the corporation of the meat, Soya bean, and maize complex later extended the transnational integration of the most dynamic agricultural production to certain peripheral countries '...' transnational restructuring of agricultural sectors through the intensification of agricultural specialisation - for both enterprises and regions - and integration of specific crops and livestock into agro-food chains dominated at both ends by increasingly large industrial capitals; and a shift in agricultural products from final use to industrial inputs for manufactured foods'.

and rural extension agencies. This resembles the FBTF (farm-back-to-farmer) research system[48].

**Table 6.5 - Characteristics of the Researchers Involved with the *Brasília* Carrot and *Doko* Soya bean Generation Processes**

| Researchers<br>Characteristics | THE *BRASÍLIA* CARROT RESEARCHERS (N = 3) | *THE DOKO* SOYA BEAN RESEARCHERS (N = 4) |
|---|---|---|
| **Researchers' Social Status** | The main researcher was born in a small town, studied in state schools and his father was a retired farmer. He was between 38 and 43 years of age. He was the leader of the *Brasilia* carrot research program. Other researchers, such as the plant pathologist and the technology diffusers had minor participation. | The main researchers involved were born in São Paulo, the richest Brazilian state. They studied in American and European universities. Their fathers had urban careers (e.g. electrician). They were over 44 years old. They were typical members of the middle class in the Brazilian social stratification. |
| **Researchers' Theoretical Background** | The main researcher was a geneticist. He undertook all his courses in the Viçosa University. This is an important Brazilian agricultural university. The other researchers' specialisations were in technology diffusion. | They undertook their postgraduate study in American and European universities, including masters and PhD courses. They had always worked with the Soya bean. There was no direct involvement of the technology diffusers. |
| **Agricultural Research Process** | The research project was based on market signals, product commercialisation and farmers and rural extension proposals. The *Brasilia* carrot was directed at the correct people, at the correct time. | Postgraduate study and supervisor relationships were important influences on the agricultural generation process. Strong links with some International Agricultural Research Centres. Productivity, cost reduction and capitalisation of the farmer were important influences. |
| **Technology Adoption Process** | Farmers' needs had to be clearly identified. Technology tests had to be carried out together with farmers and consumers. Technological validation had to be made in farm fields. Market demands and the consequences of the technology were considered. | Technology appropriate for large farmers. Most of the time was dedicated to scientific tasks. Scientific papers' publications and scientific meeting participation were valuable research activities. |
| **Comments About EMBRAPA** | EMBRAPA should take account of the effect of procedures on society. There was little surveillance of researcher results. Lack of managerial aptitude in general. EMBRAPA should be close to local society. | Top-down type. Relationship with the private sector. EMBRAPA's direction has not been chosen on the basis of technical merit. Research efficiency is not rewarded. |

N = number of researchers interviewed

[48]Rhoades and Booth [1982], *Farmer-back-to-farmer: A Model for Generating Acceptable Modern Technology,* identify this type of research process as the FBTF (farm-back-to-farmer) which consists of (1) diagnosis - common definition of problems by farmers and scientists; (2) interdisciplinary team - identification of a potential solution to the problem; (3) on-farm-testing and adaptation - better adaptation of the proposed solution to farmers' conditions and (4) farmer evaluation/adaptation - modification of technology to fit local conditions.

Even in 1994, thirteen years after the *Brasília* carrot was developed, it is still the most popular carrot in Brazil. One could infer that the *Brasília* carrot's generation case depended more upon the generation process strategies led by the geneticist than upon the organisation's research scheme. The research leader stated that several research projects developed by EMBRAPA researchers, neither *identified the research problem clearly,* nor *dealt with the farmers' needs.*

In reality, the research organisation, the rural extension agencies and factors beyond the 'technological circuit' such as government incentives, were important intervening variables in the *Brasília* carrot 'collaborative' research process. At the time these were common influences for all agricultural products researched by the research organisation in the *Cerrados* area. Although, they did not achieve similar success as the *Brasília* carrot case. It is important to bear in mind that the state rural extension agency also shared prestige from this successful case[49]. In some situations, the *Brasília* carrot case can be seen as a paradoxical one. The research model in accordance with Biggs' [1990: 1481-1484] schema[50], is of the 'central model' type, however, it developed the *Brasília* carrot variety in line with the opposite 'multiple source model' prescriptions.

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[49]Although it is not the aim of this study to evaluate rural extension performance, Lacy et al [1980: 469], *Clients, Colleagues, and Colleges: Perceived Influences on Extension Agents,* argue that the rural extension agents 'saw their respective client groups as having the most influence upon their programs'. Further, Eponou [1996: 8], *Partners in Technology Generation and Transfer: Linkages between Research and Farmers' Organizations in Three Selected African Countries,* believes that examples of the successful cases of agricultural technology adoption by farmers, plays an important role in the continuing existence of the rural extension agencies.

[50]Biggs [1990: 1481-1484], ibid., argues that 'in the central model, most major technical and innovations are seen to arise from the systematic work of international research centres. New innovations are then passed down to national research systems, extension agencies and finally to farmers. However, 'in the multiple source model, innovations are seen as coming from diverse sources of which international centers are just one', such as 'farmers, extension staff, non-governmental organisations, and national research systems. '...' In the central model, major emphasis is on the transfer of knowledge and technology form research centres to farmers. This mode is often [referred to] as the transfer of technology model, the bridge of agricultural research and extension model, [or] the lab-to-land model'.

In addition, the *Brasília* carrot research leader was not a special or unique EMBRAPA researcher whose sole belief was in agricultural technology generation as a 'collaborative' process in the 'multiple source model'. Yet, he was not a typical EMBRAPA researcher[51] either. It is possible to take into account a few examples of EMBRAPA agricultural technology generation and adoption successes as shown: the biological control of the Soya bean caterpillar, the nitrogen fixation of leguminous crops, the new variety of hybrid corn (BR-201) and the substitution of savannah pasturelands with rice. Though it should be noted none of these were similar to the *Brasília* carrot adoption rate of farmers[52] throughout the country. Further, Teixeira's et al [1990: 35] findings regarding the socio-economic evaluation of EMBRAPA technologies indicate that 'the net benefits from the *Brasília* carrot variety between 1983 and 1987 were about U$ 12 million since 80% of these benefits were due to the CNPH-EMBRAPA [research team]'.

In contrast to the *Brasília* carrot, Table 6.5 indicates that the most prominent CNPSo Soya bean geneticist admits that his technology generation is more appropriate for large farmers; he also argues that his postgraduate courses encompass the scientific knowledge required to create tropical Soya bean varieties adaptable to the *Cerrados*. Also, the CPAC geneticist's social and academic background led to research priorities more in tune with the scientific realm than with farmer's demands. His main concerns were referred to as agricultural

[51]Eponou [1996: 67], ibid., found in three selected African countries (Burkina Faso, Ghana and Kenya), that there were no 'explicit linkage policies [between the research institutions and the farmers' organisations]. The lack of effectiveness from the research side is due to the fact that the information of farms' needs and conditions of production are not always incorporated in the research agenda. **In most cases, incorporating this information is seen as the responsibility of the individual scientists because there is no corporate culture or mechanism for incorporating this information '...' A few isolated scientists may from time to time alter this model by involving farmers more intensively, but at the institutional level there has not been any effective change in the philosophy and the approach to technology generation and transfer'** (my emphasis).

[52]According to EMBRAPA [1991: 12], ibid., 'the *Brasília* variety of carrot, cultivated during the period between harvests, in summer, currently supplies 80% of the market'.

modernisation, such as, new agricultural equipment and modern inputs. This view was in line with EMBRAPA's research prescription.

It can said that the *Doko* Soya bean generation process followed the aims of the research organisation, that is, the technology-transfer approach, or in Biggs' [1990] view, the 'central model' concept. It focuses on capitalist agriculture, especially the increase in productivity of the export and industrial agricultural staples based on the growth of land and labour productivity. The *Doko* Soya bean generation process was also in line with government proposals on the development of the *Cerrados* frontier. Further, as stated earlier, other factors beyond the 'technological circuit' had a profitable influence on the *Doko* Soya bean generation process.

Despite the complexity of the agricultural technology generation process, the current EMBRAPA research model adopts the same procedures in evaluating different research approaches, whether they are food crop or cash crop research programmes, researcher's rewards, researcher's training and researcher's assessment. The research design is the same for every situation but each of these has distinct social, economic, environmental and political implications for farmers.

### 6.6. The *Brasília* Carrot and the *Doko* Soya bean Adoption Processes

The *Brasília* carrot and the *Doko* Soya bean adoption by farmers are complex social processes and embrace a wide range of influences. The first are influences from the researcher and the organisation which developed the new varieties and, as a result, affected the type of technology generated. The second are influences from the political, economic and social environment in which the farmers and the organisations are located. Thus, in practice, the generation and the adoption are correlated processes. There is not a simple, linear and physical separation between the research organisation (the source) and the farmers (receivers) bridged by the rural extension agencies. In reality, there are many connections between the agricultural technology generation process and its adoption by farmers. In these terms, Table 6.6 indicates some aspects of the *Brasília* carrot and the *Doko* Soya bean adoption by farmers in the CEASA and COOPERTINGA cases.

**Table 6.6 - The Description of the *Brasília* Carrot and the *Doko* Soya bean Farmers**

| Case studies<br>Characteristics | *BRASÍLIA* CARROT<br>CEASA CASE STUDY<br>(N=29) | *DOKO* SOYA BEAN<br>COOPERTINGA CASE STUDY<br>(N=31) |
|---|---|---|
| **Farmers' Gender** | 100% are male | 100% are male |
| **Farmers' Age** | 79.2% are under 49 years and<br>20.8% are over 50 years | 93.5 % are under 49 years and<br>6.5% are over 50 years |
| **Farmers' Schooling** | 55% reached primary and<br>45% reached secondary level education | 29% reached primary<br>64% reached secondary and<br>7% reached university level education |
| **Farmers' Birth Areas** | 82% were born in rural and 18% in urban areas | 70% were born in rural and 30% in urban areas |
| **Farmers' Birth Regions** | 31.0% were born in the South East;<br>27.6 % were born in the West-Central;<br>10.3% were born in Japan and<br>31.1% in other Brazilian regions | 75% were born in the South and<br>25% in other Brazilian regions |
| **Farm Area in Hectare** | 55.2% have up to 20 ha and<br>44.8 % have between 22 and 40 ha | All the farmers owned 620 ha - the standard plot) |
| **Farm Location**[1] | 100% are up to 50 km | 100% are 248 km |
| **Growing Time**[2] | 100% have grown between 7 - 12 years | 62% have grown for two years[3] |
| **Technical Assistance** | State Agency | Private Agency |
| **Future** | 100% will grow the *Brasília* carrot | It depends on harvest results[3] |

N= number of farmers interviewed
[1] Distance from farm to Brasília, Federal District
[2] Number of years that farmers have grown the *Brasília* carrot and/or the *Doko* Soya bean varieties
[3] The *Doko* Soya bean is suitable for the first *Cerrados* cultivation. Nowadays, its is farmed as a disease resistant variety

This table shows that the *Doko* Soya bean farmers have better education levels since 64% reached secondary school and 7% obtained university degrees. In the case of the *Brasília* carrot, no farmer had a university degree and 45% had reached secondary level education. Further, the COOPERTINGA *Doko* Soya bean farmers are younger than the CEASA *Brasília* carrot farmers, that is 79.2% are between 26 and 43 years and only 6.5% are over 50 years of age. Thirty per cent were born in urban areas, against 48% and 18%, respectively, of *Brasília* carrot farmers. Table 6.6 indicates that the Soya bean farms are located 248 km from the Brasília, the capital of Brazil which is the most important urban centre in the West-Central region. In contrast, the *Brasília* carrot farms are situated up to 50 km from Brasília. Normally, in Brazil, vegetables are grown in small areas in the *green belt* surrounding the big cities. It is important to note that the *Doko* Soya bean farmers in COOPERTINGA own 620 ha of land while all the CEASA *Brasília* carrot farmer's farms only up to 40 ha of land.

Another important finding is that 75% of all the COOPERTINGA farmers surveyed, were from the Southern region. In Brazil, the South is a traditional grain production area which has the lowest illiteracy level and other high levels of social well-being. It can be said that the South is a rich region. The *gaúchos* migrated to the *Cerrados* region were from the South, and brought some money, skill and experience to the Soya bean cultivation. In the CEASA case, carrot farmers came from different Brazilian regions and were born in different areas across the country. For example, 27.6 % were born in the West-Central region which is less developed than the South and 31.1% came from different Brazilian regions, such as the Northern, the Northeastern and the South.

These figures reveal that the *Brasília* carrot farmers and the *Doko* Soya bean farmers are socially[53] distinct and their agricultural production systems are different also. Evidence illustrates that with the Soya bean production system, particularly in an agricultural frontier,

[53]According to Ribeiro [1995], ibid., the *Brasília* carrot farmers could be members of the subaltern class in Brazilian social stratification and in accordance with Baiardi [1992], ibid., the Soya bean farmers in the *Cerrados,* could be part of the Brazilian middle class.

young and skilful farmers were important for the Soya bean cultivation in virgin land and large areas. From this perspective, Austin et al [1996: 466-472] found

> that the interaction between personality and management style is more complex than some classification models have suggested. [The young farmers had] patterns of success-oriented business attitudes. Farmers with larger farms tend to place more emphasis on instrumental values than those with smaller farms [and] farm size was found to be negatively correlated with the age of the farmer.

Table 6.6 shows that in the COOPERTINGA Soya bean production systems, private technical assistance came from the co-operative with which they were attached. Further, 90% of the COOPERTINGA farmers said that they cultivated the *Doko* Soya bean because of its resistance to disease and 10% for its quality and regional adaptability. Forty-two per cent were happy with the *Doko* Soya bean and would continue to cultivate it, depending on harvest results. Important facts can be drawn from these arguments. First, the Soya bean farmers identified that the *Doko* Soya bean is a unique variety tolerant to disease. Second, at the time of the field-work, they learnt that other Soya bean varieties were more productive than the *Doko* Soya bean, however, they were susceptible to disease. They also learnt that the best *Doko* Soya bean quality was its adaptability to the first cultivation in the Cerrados. As a result, only 42% of the farmers were happy with the *Doko* Soya bean. They hoped for a new Soya bean variety resistant to disease and highly productive.

It is important to note that in the CEASA case, 86% of farmers' income came from the *Brasília* carrot cultivation, although 79% also said that they cultivated minor crops. Further, 55.2% of all farms held less than 20 hectares and all farmers had up to 50 hectares. These were important points which characterised the small farmers and the domestic crop production systems. According to Austin et al [1996: 464-465], 'there is a tendency for [family] farmers to have smaller but more diversified farms that those of [the] entrepreneur' type. In contrast to the *Doko* Soya bean farmers, 93.0% of the *Brasília* carrot farmers had technical assistance from the state rural extension agency. It is necessary to note that free agricultural technical support, farmer specialisation and small land area characterised the *Brasília* carrot production system.

Furthermore, as stated before, 72% of the CEASA carrot farmers argued that they cultivated the *Brasília* carrot because of its resistance to disease, 18% considered its regional adaptability and 10% for other reasons, such as carrot quality and productivity. Another important point is that 66% of the carrot farmers followed the research organisation and rural extension agency recommendations. All the farmers said they would continue to grow the *Brasília* carrot

At the time of field-work, in contrast to the *Brasília* carrot farmers, the majority of the COOPERTINGA Soya bean farmers were in enormous debt to the Bank of Brazil, a government bank. In light of this, the Soya bean farmers, as members of the Brazilian Co-operative Organisation (OCB), constituted a strong pressure group to canvass Parliament and Government organisations about their private interests, for example, to acquire subsidised incentives and a reduction of debts. They hoped the government would postpone their debt payments or write them off.

It is important to note the data in Table 6.7 which indicates farmers' attitudes to the *Brasília* carrot and *Doko* Soya bean varieties and farmers' attitudes to EMBRAPA. The farmers' attitudes to the *Brasília* carrot and *Doko* Soya bean were similar to those of the researchers. The researchers' reasons for developing the ideal varieties were similar to the farmers' assessment. This was a coincidence of interests between the agricultural technology generation and the adoption processes[54]. Some farmers' disagreements were highlighted in relation to the EMBRAPA's *modus operandi*, for farmers, *EMBRAPA is itself very closed*[55].

**Table 6.7 - Farmers' Attitudes to the *Brasília* Carrot and the *Doko* Soya bean Generation Processes**

| Farmers / Attitudes | THE *BRASÍLIA* CARROT FARMERS (N = 72)[1] | THE *DOKO* SOYA BEAN FARMERS (N= 72)[2] |
|---|---|---|
| **Motivation to Adopt this Variety** | Disease resistance. Regional adaptation. Consumer preference. Quality and Productivity. Commercialisation. | Disease resistance. Suitable variety in the first *Cerrados* cultivation. |
| **Relationship with EMBRAPA** | Various farmers knew about EMBRAPA. | Few farmers know about EMBRAPA's proposals. |
| **Comments about EMBRAPA** | EMBRAPA was important to farmers. EMBRAPA must solve the *Brasília* carrot's recent problems. | EMBRAPA's contribution was useful for Brazilian farmers. There was a communication gap between EMBRAPA and farmers. |

N= number of farmers interviewed
[1]*Brasília* carrot farmers from the CEASA and the EMATER-DF
[2]*Doko* Soya bean farmers from the COOPERTINGA and the Barreiras area

In relation to the *Brasília* carrot case, the rural extension agents' views and farmers' questionnaires and interviews demonstrated that there were many common points made by researchers, farmers and rural extension agents. All parties agreed that the success of the *Brasília* carrot came from the correct generation process. That is, *the agricultural researcher*

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[54]Cornwall et al [1993], *Acknowledging Process: Challenges for Agricultural Research and Extension Methodology,* emphasise that in this case research priorities are determined in accordance with farmers' demands rather than by a decision of the agricultural researcher. For them, this is a similar approach to the Farming Systems Research and Extension (FSR/E).

[55]Busch et al [1983: 190-192], *Perceived Criteria for Research Problem Choice in the Agricultural Sciences: A Research Note,* state that this means an old view of 'science as an autonomous institution, creating knowledge that is an accurate representation of a unified natural world and, hence, not subject to external manipulation'. Also 'agricultural scientists make decisions based on their own projections of socio-economic needs rather than by engaging in dialogue with clients'.

*had identified an important research problem* and the *technology process considered the demands of production networks* i.e., the farmer and consumer oriented research.

In the *Doko* Soya bean case, it was evident during field-work that the possibility of the Soya bean being adaptable to a tropical climate would be very important for the farmers because of the potential of growing an important industrial and export crop. Another factor would be to increase land values. The farmers looked for a commercial and profitable crop highly subsidised by the government. It could be argued that the Soya bean farmers' decision to adopt the *Doko* Soya bean variety came from the adequacy of the agricultural technology generation process in line with their production system demands and their desire to maximise profits and to minimise the risks.

Additional data in Table 6.8 describes *Brasília* carrot and *Doko* Soya bean adoption in the EMATER-DF and the Barreiras cases. In a general sense, the EMATER-DF case is similar to that of the CEASA. For instance, all EMATER-DF carrot farmers are male and 74.42% are under 49 years old. The farms are located up to 50 km from Brasília, DF and all have up to 40 hectares. Technical assistance comes from the state agency and 93.02% of the farmers will grow the *Brasília* carrot in the future. However, in the Barreiras area (the *Doko* Soya bean additional information), technical assistance is private and 39.02% of the farmers have university degrees whereas no farmer has a similar level of education in the EMATER-DF case (the *Brasília* carrot case).

In reality, the Barreiras Soya bean farmers showed a high proportion of university degrees for the North-east. It can be argued that there was some 'bias' in the selection of the interviewees by the EBDA's technicians. As there was no formal farmer sample, it was possible that the selection reached the most educated Soya bean farmers. Although, the

Barreiras Soya bean farmer's education level had followed a similar trend to the COOPERTINGA case. Further, 60.46% of EMATER-DF carrot farmers were born in rural areas, whereas in Barreiras only 29.27% of the Soya bean farmers were born in urban areas and 75.6% of the farms have over 500 hectares.

**Table 6.8 - The Description of the *Brasília* Carrot and the *Doko* Soya bean Farmers (Additional Information)**

| Case studies / Characteristics | THE *BRASÍLIA* CARROT EMATER-DF's ADDITIONAL INFORMATION (N=43) | *THE DOKO* SOYA BEAN BARREIRAS's ADDITIONAL INFORMATION (N=41) |
|---|---|---|
| **Farmers' Gender** | 100% are male | 100% are male |
| **Farmers' Age** | 74.42% are under 49 years<br>25.58% are over 50 years | 92.6% are under 49 years<br>7.3% are between 50 -55 years |
| **Farmers' Schooling** | 60.46% reached primary education<br>32.56% reached secondary education<br>6.98% just read and write | 14.64% reached primary education<br>46.34% reached secondary education<br>39.02% reached university level education |
| **Farmers' Birth Areas** | 60.46% were born in rural and<br>32.56% in urban areas<br>6.98% gave no response | 70.73% were born in rural and<br>29.27% in urban areas |
| **Farmers' Birth Regions** | 32.56% were born in the South East,<br>32.56% in North and North-east,<br>11.63% in the Central-West,<br>11.63% were born in Japan and<br>11.62% in Other places[1] | 90.24% were born in the South,<br>7.32% in North and North-east and<br>2.44% in the South East regions |
| **Farm Area in Hectare** | 79.1% have up to 20 ha<br>20.9% have up to 40 ha | 24.4% have up to 400 ha<br>75.6% have over 500 ha |
| **Farm Location** | 100% are up to 50 km[2] | 100% are around 180 km[3] |
| **Growing Time[4]** | 44.19% up to 6 years<br>55.81% over 7 years | Dependent on the harvest results[5] |
| **Technical Assistance** | State Agency | Private Agencies |
| **Future** | 93.02 % will grow the *Brasilia* carrot<br>6.98% will not grow the *Brasília* carrot | Dependent on the harvest results |

N= number of farmers interviewed
[1] Southern region, Spain and no responses
[2] Distance from farm to Brasília, Federal District
[3] Distance from farm to Barreiras town
[4] Number of years they have grown the *Brasília* carrot and/or the *Doko* Soya bean
[5] The *Doko* Soya bean is suitable for the first *Cerrados* cultivation. Nowadays, it is farmed as a disease resistant variety

It is important to note that when EMATER-DF carrot farmers were asked: 'Why do you grow the *Brasília* carrot?, 76.74% argued that they grow it because of its disease resistance. Of the farmers, 88.37% and 93.02% said that they were happy and would continue growing it in the future respectively, while 11.63% responded that they were not happy and suggested that it was necessary to solve agricultural problems such as *precocious flowering* which led to a *decrease in productivity.*

In the Barreiras case, 75% of the *Doko* Soya bean farmers argued that the *Doko* Soya bean was *disease resistant,* but that they were waiting for the harvest to decide whether to cultivate it. They also admitted that the *Doko* Soya bean presents some problems, such as *low productivity* in relation to other Soya beans cultivated. Once again, this confirms that the researchers identified the research issues in line with farmers' needs.

Overall, evidence in this study suggests that in contrast to the behaviourist approach, agricultural technology adoption by farmers is a complex social process. There are various levels and degrees of influence from research organisations right through to society at large and these external and internal influences all affect both the generation and adoption processes. Busch [1991: 71] states in criticism of the 'adoption-diffusion' concept, that the

> diffuse model by Rogers, is undermined. Proponents of that model assumed a relative equality among farmers with respect to technical change. Moreover, they confined the model almost entirely to farm-level changes, rarely asking about either upstream or downstream changes. The early proponents mistook the peculiar circumstances in some areas for those of the world as a whole. In short, the world is not limited to any specific agricultural region.

In conclusion, two EMBRAPA technology generation and adoption successes - food and export crops - were analysed. Both were widely adopted by farmers. The important point to emphasise is that the *Brasília* carrot and the *Doko* Soya successes were a result of the correct identification of the research problem by the geneticists in accordance with farmers' and consumers' needs[56] in a region highly subsidised by the government. This research strategy is here described as the *adoption-generation* concept.

Evidence from generation and adoption processes differs between the carrot and the Soya bean cases, because of their own particularities. The researchers and farmers are part of distinct social classes in Brazilian social stratification. The researchers are part of the middle class[57], in contrast to the *Brasília* carrot farmers who are members of the lower class. In the *Doko* Soya bean case, the farmers are part of the middle class. Indeed, the agricultural research generation process is not an *on line* mechanical operation[58]. On the contrary, it is a complex social process which depends on the social, economic, political and organisational forces acting upon it[59].

As a result of the *Brasília* carrot generation and adoption processes, some policy implications for agricultural technology generation for small farmers are apparent. In a general sense, small farmers in Brazil grow food crops. They are risk-prone farmers, owners of small land plots and do not adopt capital intensive technologies[60]. They are not organised and do not

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[56]Biggs [1990: 1481], ibid., explains that the agricultural technology adoption by farmers is a result of the integration of agricultural research and technology diffusion into the social, political, economic, institutional and cultural milieu in which the research process is developed.
[57]Goldthorpe [1995], *The Service Class Revisited.* In: Social Change and the Middle Classes, revisiting the service class dimension, writes that the middle class is a homogeneous, unitary and conservative class.
[58]Biggs and Clay [1981: 332], *Sources of Innovation in Agricultural Technology*, mention that farmers only adopt technology innovation within the limits of their production system, in other words, in accordance with their social structure.
[59]Silverman [1983], ibid., writes that in the socio-technical system perspective, the environment is conceptualised as a source of meaning for organisational members. Further, Lacy et al [1980: 470] argue on 'the nature of environmental influences on the functions and goals of the organization. From its inception, an organization is constantly interacting with its environment and developing ways of maintaining a dynamic equilibrium'.
[60]According to Brasil [1996b: 8], *Program Nacional de Fortalecimento da Agricultura Familiar,* the small farms of up to 100 hectares comprise 5,220,000 production units based on the domestic and multiple crops and intensive and productive land use. Further, the number of small farmers amounts to around 17% of the Brazilian population. However, large farms deal with 580,000 estates focused on the single crops, using specialised and standardised technology and unused and unproductive land, the so-called 'unproductive latifundium'. IBGE [1985] shows that the small farmers produced about 87% of the nation's cassava, 79% of the nation's beans and 69% of the nation's maize.

form interest groups to fight for their demands within the government and Parliamentary domains. From this perspective, important lessons have emerged from the successful *Brasília* carrot case:

The first relates to the commitment to the agricultural technology generation process: The research multidisciplinary team dealt with the 'what', 'how' and 'for whom' questions in the generation the *Brasília* carrot. These were influential factors in its adoption by farmers. The researchers chose the research problem from the farmers' perceived demands, and the results indicate the effectiveness of 'demand-pull' in the process of generation and adoption, rather than the 'supply-led' generation model. As a result, the generation of agricultural technology led to the farmers' production systems. Technology is not a 'neutral' tool for social change. Technology is generated and adopted under specific constraints and contradictions[61].

Secondly, in relation to the researchers' background: It was shown that the research team, especially the research leader who outlined the *Brasília* carrot generation process, played a strategic role. This was so in the definition of the research problem, the research itself, and the relationship between the research team, farmers and rural extension agencies. The research leader came from a small town and his father was a retired farmer. He went through primary and secondary education and gained university degrees, including his Masters and PhD, in Brazilian state universities. He had some agricultural experience before being recruited by the research organisation. He saw the agricultural technology generation process as a social process connected to the farmers' needs.

[61]Rammert [1997: 173], *New Rules of Sociological Method: Rethinking Technology Studies*, writes that 'technologies are social facts and sociological subjects in so far as they are products of previous social activity and producers of future social activity. They should be considered more generally as 'techno-structures' within the stream of social action rather than single and separate means outside of society'.

According to him, the research organisation should be opened up to meet the farmers' demands. These are assumed to be influential components of agricultural technology generation and consequently of technology adoption by farmers. This shows that the researcher's social background influenced the technology generation and adoption processes, this indicating that the relationship between researchers and farmers is not an interpersonal one. Rather, it is a social relationship between distinct social classes, where each has its particular demands.

Thirdly, the *Brasília* carrot was not the result of an isolated researcher's work. The research team involved geneticists, plant disease specialists and diffuser technologists (social researchers). Although the research process was co-ordinated by the geneticist, it was a 'collegial' research process. The researchers were involved in the diagnosis, planning, execution and assessment of the *Brasília* carrot generation and adoption processes. It is important to note that one member of the research team was of Japanese origin. This was considered by the research leader to be an effective ethnic factor which facilitated the relationship between the researchers and the carrot farmers of Japanese descent.

The research leader had a clear understanding of the challenges to be faced in the development of an appropriate carrot variety for the farmers. It became necessary for the multidisciplinary research team to solve a whole range of carrot farmer's research problems, such as diseases, seasonal adaptability, high productivity, colour and root form. All of these were tested to meet farmers' production systems. This was not the simple inclusion of disciplines, but the active participation of various researchers' backgrounds in the research process. The agricultural, social and anthropological aspects of the farmers and their production systems were considered. The research project focused on the carrot farmers' needs instead of the carrot itself or the carrot's particular characteristics. This was not a research project based on the plant (carrot) but on the carrot farmers' needs.

The fourth lesson concerns the mode of research: The *Brasília* carrot generation process was not a closed process in the research organisation itself. The research team, in particular the research leader, chose the research problem jointly with the rural extension workers, based on the farmers' needs. Meetings, field days, visiting and farmer field tests were carried out by the researchers, farmers and rural extension workers. Also, the research process, either in the research organisation or in the farmers' fields, was a 'collaborative' process shared among researchers, rural extension agents and farmers. The action involving the researchers, the farmers and the rural extension staff started from the choice of the research problem and led to adoption by farmers. The experimental research activities, such as plant selection, technology validation and the multiplication of seed also involved 'collaborative' participation. This was real participation from the beginning of the generation process, which is when the research problem was chosen, to adoption by farmers' production systems.

The fifth lesson relates to the result of the research: The *Brasília* carrot was a visible result of its generation process. It was neither an abstract idea nor a theoretical model published in a scientific paper. Instead, it was a new type of carrot produced from a new carrot seed. The 'collaborative' research process neither concluded with the seedling selections in the research organisation nor in the researcher's publication. The research process ended with the multiplication of the *Brasília* carrot on a large scale and its being made available to the farmers for cultivation. For the small farmers 'seeing is believing'. Also, the production of the *Brasília* carrot was dominated by farmers, rural extension workers and the seed companies. In short, the product was tangible and of use to farmers. The publication and dissemination of the research results in journals or magazines and their presentation in seminars or scientific conferences were, in this sense, of secondary importance.

The lessons from the *Brasília* carrot case are not typically learned by the great majority of researchers who follow the dominant agricultural research model co-ordinated by EMBRAPA. As mentioned before, in Chapter 4, EMBRAPA was established with other aims. EMBRAPA was created to support capitalist agriculture and agricultural modernisation in Brazil. Demands from small and subsistence farmers and rural extension workers have never shaped the EMBRAPA agenda.

The case of the *Brasília* carrot suggests a need for EMBRAPA to reorientate its policies towards the interests of small farmers. This need may be even more urgent in the light of possible restrictions introduced by government.

As a commodity-led organisation, EMBRAPA is currently oriented towards the large, capitalised, and highly specialised farmers. It needs to undergo a transformation[62] to cater to a mass of new users and partners, such as the small farmers. During the field-work period (from August 1994 to February 1995), EMBRAPA appeared as a consolidated and prosperous organisation. However, today the Brazilian government, with a neo-liberal perspective, is trying to reduce the role of the state in society, in particular by closing down state-owned companies[63].

[62]Berdgué and Escobar [1995: 16 ], *New Directions of the Systems Approach for the Modernization of Latin American Peasant Agriculture,* analysing the new directions of agricultural modernisation in Latin America, argues that 'numerous governmental institutions are undergoing modernisation processes, [for example] EMBRAPA [as a] basic framework for dealing with the [new agricultural technology demands]'.

[63]This is showed by Calvert [1994: 33:34], *The International Politics of Latin America,* who states that according to neo-liberal strategies the 'states enterprises are seen as being overstaffed and inefficient'.

EMBRAPA is a part of the state apparatus. Drawing 85% of its costs on government funds, it is thus a target of government cuts. Three possibilities arise: First, EMBRAPA could simply become extinct. This is unlikely, as it has strong links in national and international spheres. In effect, it is a part of the Brazilian elite. Second, EMBRAPA could be completely privatised. This is undesirable. Agricultural research in the underdeveloped countries has always been supported by the state[64]. Also, society has some needs which should be catered to by the state, such as environmental and food controls and agricultural technology to grow domestic crops.

Third, Parliament could include EMBRAPA among state organisations partially subsided by the government. This is the most likely alternative to the current position of EMBRAPA. In this case, EMBRAPA would change its legal status to meet government policy, ceasing to be a state-owned organisation and becoming, instead, a 'research institute'. This could imply a change to its bureaucratic, organisational, political and administrative designs[65].

The important point is that if government support for the EMBRAPA budget were cut, EMBRAPA would have to look for complementary funds. This is a part of the 'liberal modernisation scene'[66], which would also have implications for the privatisation of some research centres, such as the Soya bean, Maize, Wheat, Biotechnology and Wheat National

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[64]According to Goldthorpe [1993: 243], *The Sociology of the Third World: Disparity and Development,* 'in most poor countries the state is unequivocally the most important and powerful institution [to deal with the agricultural technology research process]'. Ehrensaft [1997: 2], *International Perspectives on Rural Employment: Introductory Propositions,* mentions that 'analyses of the long run indicate that government policy is a key [to technology innovation development]'. Calvert [1994: 32], ibid., also remarks that in Latin America, 'the state has been as the ultimate beneficial owner and hence as the prime motor of economic development'.

[65]Further discussion of future scenarios is far beyond the scope of this thesis.

[66]EMBRAPA [1992a: 12-13], *II Plano Diretor da EMBRAPA 93-97,* states that in the 'liberal modernisation' scene 'the governmental agencies join private groups and address agricultural research priorities based on the criteria of research efficiency in accordance with international agreements'.

Research Centres. Such a deregulation process would encourage well-trained EMBRAPA researchers to move to private companies in Brazil or abroad. However, research on the domestic crops, environmental and strategic issues, such as natural and genetic resources, would still be supported by the government. It is evident that this transformation would shape a new research organisation, with a change of research priorities and organisational design. If this was to emerge, the support of the small farmers would be crucial.

The lessons learnt in the *Brasília* carrot case reflect on the agenda of a transformed research organisation and would have implications for organisation, research, recruitment, and training. It would entail a move from a top-down type[67] of organisation to one with the following characteristics:

(1) - The organisation would focus on agricultural technology generation and adoption processes, dealing with them as a single process[68]. The proposed organisation would be holistic and open to local influences, encouraging researcher-farmer partnerships and taking into consideration consumer preferences and market signals. The result would be a flexible organisation which facilitates the participation of farmers, rural extension workers, and society at large, in the agricultural technology generation and adoption processes.

(2) Recruitment policy would be a response to demands from clients and users and the holistic environment in which they are located. As a consequence, the emphases on highly specialised researchers would be shifted in accordance the complex demands of the 'farm as a whole'. This raises two issues. First, a new researcher recruitment policy could be based on a wide range of requirements, among which academic training is just one. For example, the researcher's experience in human sciences and the farm as a whole would be considered.

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[67]Scoones and Thompson [1993: 3], *Challenging the Populist Perspective: Rural People's Knowledge, Agricultural Research and Extension,* discuss this type of 'rational science' as 'derived almost exclusively from the findings of research stations and transmitted to farmers through hierarchical, technically-oriented extension services. Farmers are seen as either 'adopters' or 'rejecters' of technologies but not as originators of either technical knowledge or improved practice'.

[68]Rammert [1997: 174], ibid., stresses that 'technology studies start by describing how new technological schemata are carved out of everyday routine action by inventors, researchers, and users'.

Second, the elements of a researcher's social background, such as origin, education and professional experience, would be key factors and would count as equally important as the researcher's ability to produce scientific papers. This means a research organisation[69] oriented to meet the farmer's and society's needs and not a highly specialised organisation whose aim is the dissemination of scientific papers and for whom researcher promotion is only based on scientific publications and participation in conferences and specialised seminars.

(3) The research organisation agenda would focus on small and subsistence farmers, especially those who grow domestic crops. The current research, oriented mainly to export and industrial commodities, would give way to regional and ecological issues. A new model would meet the needs of all types of farmers[70], including export-oriented ones, because this should no longer be based on specific agricultural products, but on the 'farm as a whole' and on distinct ecological areas. Tangible research results, such as a new variety (visible in a new seed accessible for use by farmers) or new control of insects or diseases (visible in a new product available to farmers) would be sought. These are relevant social aspects that build up organisational visibility and strengthen the organisation's future.

(4) The relationship between researchers, farmers and rural extension agencies would not be driven by interpersonal links[71]. It is suggested that this relationship could be based on a formal 'adoption and generation research project'. This could clearly define the functions of each social actor, such as financial support, research activities and work time-table.

The picture that has emerged is of a new agricultural technology generation process, attending to different farmers' demands under distinctive social relations of production. The technology generated would be part of the farmers' production systems instead of lying idle in a researcher's file or in the research organisation's reports. A different relationship between

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[69]According to Rammert [1997: 174], ibid., organisations are not 'neutral' places, however 'social [organisations] and installations, are constructed collectively. Once installed and institutionalized they exert constraints on the individual's thoughts and actions'.
[70]Collion [1995: 1], *On Building a Partnership in Mali between Farmers and Researchers,* note that the first lesson to be drawn from the farmer-researcher partnership 'is that farmers must be involved at all levels of the [research] decision-making process'.
[71]According to Berdgué and Escobar [1995: 24], ibid., 'the agricultural research and rural development organisations [the rural extension agencies] must learn to build inter-institutional strategic partnerships, but also that public-private cooperation is a sine qua non condition for success'.

farmers and rural extension agencies is required. Researchers, as the most important members of EMBRAPA's research process, have not changed their values, beliefs or perceptions very much. Most of them have been in EMBRAPA since its establishment in the early 1970s.

However, Brazilian society has undergone deep social, political and economic changes. In a democratic society, social groups are allowed to pressure for their demands and to seek the fulfilment of their interests. By contrast, during the period of military rule, when EMBRAPA was established, no mechanism existed for social movements to exert pressure and the government controlled almost all social and political sectors. This suggests that EMBRAPA faces an enormous challenge for the future, that is, to fulfil different social demands, especially those from the small and subsistence farmers.

### 6.7. Summary

This chapter analyses agricultural technology adoption by farmers and how it is related to the generation process. One hundred and forty-four farmers and seven agricultural researchers were interviewed in two successful EMBRAPA agricultural technology case studies; Case study 1, the *Brasília* carrot variety and Case study 2, the *Doko* Soya bean variety. In both cases, farmers in the *Cerrados* region, the Brazilian Savannahs, a new agricultural frontier highly subsidised by the government, were interviewed. Both varieties were adopted by farmers. Both increased productivity and controlled some diseases. Both were developed by agricultural researchers, particularly geneticists. Both were launched in the same period and in the same region - the *Cerrados* - and both contributed to farm profits. However, the results of the carrot and Soya bean cases differ and the influences on the research process are distinct too. The carrot is a popular food in the Brazilian domestic market. The agricultural generation process of the *Brasília* carrot led by a geneticist, was a 'collaborative' one between agricultural researchers, farmers and rural extension agents and attended to farmers' and consumers' needs. In contrast, the Soya bean is an export and industrial staple and Soya beans are grown by large and capitalised farmers. The agricultural generation process of the *Doko* Soya bean, also led by geneticists though a 'transfer-technology' research type, met the farmers' demands, too. There was a one-way process between the Soya bean researchers and the farmers. Both were part of the middle class. Evidence shows that the link between the agricultural generation process of the *Brasília* carrot, and the *Doko* Soya bean and the adoption by farmers, was independent of communication between the source (agricultural research organisation) and the receivers (farmers). The common factor of the *Brasília* carrot and the *Doko* Soya varieties was the pertinent technology generation process developed by the researchers. From this successful *Brasília* carrot case the following implications are drawn: First, there is a relationship between the agricultural technology generation and adoption processes. Second, the multidisciplinary research team including the social and ethnic researchers' backgrounds, are influential factors in technology generation and adoption. Third, the 'collaborative' research process among researchers, rural extension workers and farmers, the result of which was the generation of a carrot variety widely adopted by farmers. These implications should be understood with regard to the formulation of agricultural policies for small farmers and in research organisational change in the future.

# CHAPTER 7

# AGRICULTURAL TECHNOLOGY, ATTITUDES AND INTERESTS

## 7.1. Introduction

In this chapter, analyses of individuals and organisations within and outside EMBRAPA are put forth. The attitudes[1] of clients, users, policy-makers, managers and unions related to agricultural technology and its generation process are presented. They comprise representatives of the Federal government, the large and small farmer organisations, the agricultural parliamentary committee, the rural extension agencies, unions and managers. It is important to note that these different individuals and organisations have pursued their own particular interests[2] whilst they have been involved in the agricultural technology generation process. Although the unstructured interviews varied somewhat in context, two key questions were asked[3]: 'Has EMBRAPA generated agricultural technology to meet the majority of Brazilian farmers' needs?' and 'Is EMBRAPA's organisational structure appropriate for meeting the demands of different types of Brazilian farmers?'

The individuals and organisations surveyed have a national network in the states where the research centres are located. EMBRAPA is linked[4] in numerous ways to external and internal interests. On this point, Silverman [1983: 114] remarks that an organisation, operating as a socio-technical system has 'the characteristics of the organisation's environment

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[1]According to Beal and Sibley [1967: 8-9], *Adoption of Agricultural Technology by the Indians of Guatemala,* 'attitudes are defined as the relatively enduring sets of positive or negative evaluations, emotional feeling and pro or con tendencies to act towards physical or social objects'.
[2]Morgan [1986: 149], *Images of Organization,* writes that interests are 'a complex set of predispositions embracing goals, values, desires, expectations, and other orientations and inclinations that lead a person to act in one direction rather than another'.
[3]The check list with the questions and the groups surveyed are in appendices 9 and 10 respectively.
[4]According to Eponou [1996: 6], ibid., 'linkages are defined as channels for the two-way flow of knowledge, information, and resources between the research [organisation] and its [clients, users and others interested in agricultural technology]'. For him [1996: 2], these linkages 'are not free of costs. Farmer's organizations, [other clients and users] and research [organisations] have different strategies, procedures and interests'.

(especially those associated with the nature of the market in which it operates), shaping what would be the most appropriate organisational structure'. Busch [1980: 31-32 and 40] argues that

> the interactions between client groups, administrators, extension staff, support staff, and researchers, through which research problems are delimited and acted upon, involve negotiations, the outcome of which are to some degree problematic. In the case of highly authoritarian organisations, such outcomes are highly predictable '...' Moreover, it is important to not that negotiations within the agricultural sciences are not merely 'internal', but are frequently dependent upon the resolution of other negotiations within other institutional structures'.

Further, Biggs [1982: 209 and 1990: 1487], states that the power of interest groups and their interaction with political-bureaucratic structures of the top-down type determines which new technologies are generated. It is difficult to characterise interest groups and their role in the political process because of the various definitions of *interest groups, pressure groups* and *lobbies.* All terms including *organised groups* and *organised interests* are used interchangeably [Ball, 1971]. Weber [1978: 342] shows that 'the interest group has developed into a *legally privileged group* and the participants have become *privileged members*'. According to Heywood [1994: 188], interest groups are 'sectional pressure groups representing a section or part of society, trade unions, professional associations, employer's groups and so on. Each sectional group has a distinctive interest, which it seeks to advance though a process of campaigning and lobbying'. In Kershaw's [1990: 62] views, 'organised business groups have been able to capture resources from the economy as a whole through state-owned enterprises, and these groups are generally small, privileged and dynamic'.

This means, in accordance with Ehrmann [1967: 6], that *pressure groups* concentrate their best efforts on those governmental organs which are responsible for decisions directly affecting their clientele. In Brazil, Kinzo [1996] remarks that the *pressure group* business is facilitated by political parties' weakness and heterogeneity. 'the parliamentary arena and the political parties are institutions of political negotiation whose main goal is consensus construction'[5]. Payne [1995: 241] also argues that

> In Brazil, urban and rural business leaders have used their financial and organisational resources to elect sympathetic government officials, shape popular opinion, and lobby for their demands. Their social status gives them more influence than other social sectors over key appointments in the ministries of Finance and Agriculture and Development.

Byerlee [1992] analysing the wheat trade, shows that

> A number of influential demands from interest groups have been important in biasing policy interventions toward wheat consumption and importation '...' Indeed, the wheat-processing sector in developing countries is a cartel and a powerful interest group able to influence the wheat grain and flour supply '...' In Latin America, the milling and baking industry is owned or closely linked to the grain industry of the exporting countries, where flour mills and large bakers or other manufacturing industries based on wheat, are frequently owned by multinational corporations with links to the grain export business.

Contrary to this, in Brazil, there are no pertinent government policies to support subsistence and food crops. For instance, the productivity of cassava has decreased and there are no government incentives to promote the production, commercialisation and industrialisation of cassava. EMBRAPA [1994c: 84] shows that in the last twenty years, the cassava crop has had negative growth rates. Cassava production has fallen from 29.5 thousand tonnes in 1970 to 24.3 thousand tonnes in 1990. In the same way, cassava productivity fell by 2 tonnes in this period. In Brazil, particularly in the North-east, the cassava crop has been cultivated by small and poor farmers to feed people and animals. Cassava cultivation, research, extension, development policy and business are characterised by loosely structured networks.

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[5]Cardoso [1991: 137-138], *The crisis of development in Latin America.* In: Eight Essays on the Crisis of Development in Latin America, argues that in Latin America there is no commitment to political parties. They react to emerging problems and people try to see which party fits the situation at a given time. The population does not trust politicians since politicians belong to the ruling class and the ruling class has failed to meet people's demands. Also, Flynn [1996: 407], ibid., argues that in the 'Brazilian political system there is neither party loyalty nor party discipline'.

They have not formed a strong interest group. The attitudes, views and interests towards agricultural technology are shown next.

### 7.2. Government Authorities' Attitudes

In this group five Ministers and representatives of two public organisations were surveyed. All are connected in some way with EMBRAPA's matters.

#### 7.2.1. The Ministers' Attitudes

Five ministers were interviewed. They were the Ministers of Cabinet to the President of the Republic; Strategical Issues; Planning; Industry, Commerce and Tourism and Science and Technology. The Minister of Cabinet to the President of the Republic was an EMBRAPA employee and linked to EMBRAPA's affairs. He was a friend of the President of Republic. At the time of the research, he had appointed EMBRAPA's executives, but not the President. The Minister of Strategical Issues was responsible for national macro polices. He was the father of the President of EMBRAPA. This is an indication of a powerful elite, showing the EMBRAPA network within Brazilian bureaucracy. Although neither the Minister of Cabinet to the President of the Republic nor the Minister of Strategical Issues were affiliated to a political party, they had close personal ties to the President of the Republic.

In Brazil, the ministers have little executive power, but exert economic, political and strategic influence[6]. The executive organisations are attached to them. For instance, EMBRAPA is attached to the Ministry of Agriculture and co-ordinates the national

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[6]Blondel [1985: 3], *Government Ministries in the Contemporary World,* states that 'Ministers are visible, glamorous and important '...' they come to office after an intense competition which can take the most bizarre and indeed the most brutal forms'.

agricultural technology research system. In theory it follows both national agricultural and science and technological priorities. Further, the Minister of Planning and the Minister of Science and Technology were interviewed. They co-ordinated the national budget and the national science and technology policies respectively. The Minister of Planning was a senator linked to the central left wing party - the Brazilian Social Democratic Party (PSDB). The Minister of Science and Technology was a prominent chemist and university lecturer well known within national and international scientific institutions. He was also a friend of the President of Republic. Both the Minister of Cabinet to the President of the Republic and the Minister of Science and Technology came from the same state as the President.

The fifth Minister interviewed was the Minister of Industry, Commerce and Tourism. This Ministry co-ordinated the industrial policies related to agro-industries (fertilisers, pesticides, agricultural machinery) and to export crops, such as Soya bean, cotton, coffee and sugar cane. He was also a senator linked to a right wing party - the Liberal Front Party (PFL). It is important to explain that at the time of the research, the Vice President was acting as the President of Republic due to the President's impeachment. At that time, the Federal government ruled under a wide political consensus, which was reflected in a political coalition at parliamentary and government levels. At the time of the field-work, the Minister of Agriculture, a former governor of the State of Rio Grande do Sul and previously the executive director of the *Banco do Brasil*, did not agree to be interviewed. The interview was postponed several times. In Brazil, Ministers are part of the technocratic apparatus and members of the dominant class. They comprise the social groups which benefit from the political position of the government or represent vested interests in the organised groups[7].

[7]Blondel [1985: 50], ibid., writes that 'civil servants seem particularly rare among ministers in Latin America'.

Apart from the Ministry of Agriculture, the links between EMBRAPA and the other ministers are indirect. The links could influence the direction of agricultural technology through political parties and regional or local lobbies. In these cases, the demands come through the Ministry of Agriculture. The Minister of Agriculture may put pressure on EMBRAPA, either by direct financial control or though solicitation from his advisers or organised interests linked to him. EMBRAPA executives are subordinate to the Ministry of Agriculture.

Table 7.1 shows that the ministers did not have in depth knowledge of agricultural technology issues. They agreed that technology was useful for all types of farmers, which was the main factor in increasing agricultural productivity. The ministers had a scientifically neutral view of the agricultural technology generation process and considered EMBRAPA an example of credibility and competence[8]. For them, it needed much more financial assistance from the Government. This was one demonstration of State support for agricultural modernisation, such as subsidised rural credit, technology diffusion, agricultural technology and technical assistance.

The Ministers were asked: 'Has EMBRAPA generated agricultural technology to meet the majority of Brazilian farmers' needs?', Table 7.1 shows that, with the exception of the Minister of Cabinet to the President of the Republic and the Minister of Strategic Issues, who argued that the *model supplied was not appropriate to the reality of Brazilian farmers*, and that *EMBRAPA was far removed from small farmers*, all the other Ministers interviewed

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[8]For example, the former Minister of Federal Secretariat of Administration (SAF) said that EMBRAPA is one of the more serious and effective state organisations in Brazil. A similar view was expressed by the Tribunal de Contas da União [1991], ibid., which is responsible for the audit and control of government accounts and its organisations.

believed in the profitable links between agricultural technology and farmer's needs. The Minister of Planning argued that *EMBRAPA had not met small farmer interests.*

**Table 7.1 - Minister's Attitudes**

| Attitudes / Ministers | CHARACTERISATION OF EMBRAPA'S TECHNOLOGY | EMBRAPA RELATIONSHIPS | TECHNOLOGY ADOPTION PROCESS | EMBRAPA'S ORGANISATIONAL STRUCTURE | COMMENTS ABOUT EMBRAPA |
|---|---|---|---|---|---|
| **Minister of Trade and Industry** | Technology was useful for many types of farmers | It had a good image in Brazil | Technology had been adopted by all types of farmers | It was dependent upon Government funding | It had national credibility |
| **Minister of Planning** | It had increased national agricultural productivity | It had weak links with the state research systems | It had not met small farmer interests | It needed a great deal of government financial support | It had developed agricultural technology for Brazil |
| **Minister of Science and Technology** | In the past, technology prioritised specific agricultural products | The research had been directed much more towards cash crop demands | The Soya bean, maize and *Cerrados* research results were examples of technology success | The research model was based on researchers trained in higher education, mainly overseas | It was important for Brazil |
| **Minister of Strategic Issues** | The technology supplied model was not appropriate to the reality of Brazilian farmers | Small farmer's organisations had been concerned with land distribution and not land productivity | The technology had not met small farmers' needs. The agricultural transfer process had failed | Applied research type. EMBRAPA depended on financial support from government sources | It may fail in the future |
| **Minister of Cabinet to the President of the Republic** | In the past technology increased national productivity | There were few social groups that knew of EMBRAPA's importance. EMBRAPA was an inaccessible elite | It was far removed from small farms and from ordinary people | It had a lot of social and political prestige. It was very remote from society | It may be closed down in the future |

The next question asked was: 'Is EMBRAPA's organisational structure appropriate for meeting the demands of different types of Brazilian farmers?'. Once again, except for the Minister of Cabinet to the President of the Republic and the Minister of Strategic Issues, the ministers agreed on its organisational structure. They saw EMBRAPA as a source of national pride, highlighting its well trained-research team and its relevant technological contribution. For them, EMBRAPA was beyond ideological and political battles. The problems of farmers adopting new technology were due to the transfer process, and not because of the technology itself. This was a coincidence of interests between EMBRAPA proposals and ministers attitudes.

Table 7.1 indicates that apart from the Minister of Cabinet to the President of the Republic, and the Minister of Strategic Issues, who both stated that it *may fail in the future*, ministers defended EMBRAPA in its current form. The Minister of Cabinet to the President of the Republic was critical of EMBRAPA's role, particularly of its social and technical importance in relation to small farmers and ordinary people. For him, EMBRAPA was *a closed and elitist organisation and had survived because of its previous public image*. The technological results had not been adopted by farmers and it runs the risk of being closed down in the future.

It is important to note that according to Hadwiger [1992], ministers are influential in virtually all governments. For him 'two officials, the president/prime minister and the chancellor of the exchequer are generally important'. For instance, FAO [1996: 9] states that 'the mobilisation of the agricultural ministers to support international agricultural goods research through the renewal of the CGIAR system is an important point for widening the dialogue to eventually extend to the ministers of finance and heads of states'. Also, Horn

[1995: 132] writes that ministers often interfere in public enterprises to serve government priorities. Ministers have political and economic power and, as a consequence, following Martins [1996: 196 and 206], they 'act as firm supports for political legitimacy in Brazil. '...' it is this widely disseminated practice linking patrimony and power '...' and the continuous renewal of what can be called the culture of the appropriation of what is public by what is private'.

**7.2.2. The Attitudes of the Public Organisations' Representatives**

Two bureaucratic officials in higher office of two public organisations were selected. The first was the Financial Co-ordinator of the Agriculture Ministry, mainly responsible for the transference of money from the Government through the Agricultural Ministry to EMBRAPA. In reality, there was a direct link between this official and EMBRAPA. In Brazilian bureaucracy, medium-level officials are very powerful and have control over public management. They are civil servants and members of the middle class. They remain in public office for a long time and manage rules, laws and bureaucratic issues. Thus, in practice, the bureaucratic officials have defined important actions and priorities in state organisations[9].

The second official to be interviewed was the executive director of the Applied Economy Research Institute, (IPEA) the main planning official of the Ministry of Planning, responsible for Brazilian planning and the budget. There was an indirect link between IPEA's executive and EMBRAPA. Thus, this study dealt with the influential bureaucratic officials related to EMBRAPA's routine. Normally, in Brazilian state bureaucracy, these positions are recruited through political negotiation between parliament and the government.

[9]Miliband [1987: 107], ibid., writes that 'higher civil servants do play an important part in the process of governmental decision-making, and therefore constitute a considerable force in the configuration of political power in their societies'.

The attitudes of the public organisations' representatives in Table 7.2, as distinct from the ministers, had more practical judgement of agricultural technology. They were concerned with the social consequences of technology, including the contrast between cash and food crops and export and subsistence farmers. Further, they showed some awareness of the social costs of agricultural technology, the relationships between federal and state research systems, power centralisation and the implications of the size of EMBRAPA headquarters.

**Table 7.2 - The Attitudes of the Public Organisations' Representatives**

| Attitudes / Representatives | CHARACTERISATION OF EMBRAPA'S TECHNOLOGY | EMBRAPA RELATIONSHIPS | TECHNOLOGY ADOPTION PROCESS | EMBRAPA'S ORGANISATIONAL STRUCTURE | COMMENTS ABOUT EMBRAPA |
|---|---|---|---|---|---|
| **Financial Co-ordinator of the Agricultural Ministry** | Food crops had not been prioritised for EMBRAPA | It must communicate with the private sector to invest in agricultural research | Poor farmers had not adopted the technologies | The headquarters were too large and the organisational structure was inflexible. The Agricultural Ministry had transferred financial resources from the Finance Ministry to EMBRAPA | It had repeated its research proposals for a long time |
| **Executive Director of the Economic Planning Research Institute (IPEA)** | Brazil needed practical agricultural research results, especially for agribusiness | It should decentralise its activities and expand to the states and regions in Brazil | The agricultural results did not reach the farmers. There was an important crisis in rural extension | It was a centralised organisation | It was not expensive for Brazil |

When asked: 'Has EMBRAPA generated agricultural technology to meet the majority of Brazilian farmers' needs?', Table 7.2 shows that the Financial Co-ordinator admitted that *food crops had not been prioritised* and that *poor and small farmers had not adopted EMBRAPA technology*[10]. He also argued that *EMBRAPA had repeated its research proposals*

[10]This is confirmed by Sorj and Wilkinson [1990: 35], *Biotechnology and Developing Countries Agriculture,* who state that EMBRAPA's creation was a consequence of the restructuring of state agricultural research in Brazil to meet modernisation principles in the early 1970s. EMBRAPA's model is based on specific agricultural products instead of agricultural and rural disciplines.

*for a long time*. Further IPEA's representative believed that *EMBRAPA's agricultural technology results did not reach the farmers*.

It is worth noting the officials' responses to the question: 'Is EMBRAPA's organisational structure appropriate for meeting the demands of different types of Brazilian farmers?'. For the Financial Co-ordinator, *EMBRAPA headquarters were too big, and the organisational structure was inflexible*. Also IPEA's executive said that *EMBRAPA was a centralised organisation*. At the time of the research, 570 employees were located at EMBRAPA's headquarters. This shows the degree of power concentrated in the central administration. Therefore a great deal of power lies in the hands of EMBRAPA's President. What is more important is that some of these employees are researchers but undertake bureaucratic activities instead of scientific ones.

The ministers' and the bureaucratic officials' attitudes towards agricultural technology reflect the governmental position. The ministers were not concerned with social assessments of the effects of agricultural technology. As members of the dominant social class, they are part of the powerful Brazilian elite. They regarded EMBRAPA as the largest agricultural research organisation in Latin America which comprised well-trained researchers and had the best agricultural research centres across the country. The officials' concerns were related to social aspects of agricultural technology and the centralisation of its research process.

**7.3. The Agricultural Congressional Committee's Attitudes**

After military rule and in accordance with the Federal Constitution of 1988, Brazilian Parliament became more powerful. One result of this was that the budget needed its approval. Therefore, the agricultural budget and particularly EMBRAPA's budget needed to be debated.

Thus, Parliament become the sphere of decision-making, a suitable place for *lobbying* and action from *interest groups*.

In relation to agricultural matters, the agricultural congressional committee is a legislative board of Parliament. It does the analysis and elaborates proposals and matters regarding agriculture and husbandry. It is a political arena rather than one concerned with technical and scientific issues. The Federal parliamentary team deals with the agricultural congressional committee, but its formal representation lies in the Presidency. Further, the power and control over political negotiation and tactical manoeuvres lie in the President's hands.

*Interest groups* seek to influence the decision-making process at the executive and the parliamentary levels. The methods used depend on the political and institutional structure, the party system and the political culture. For example, in the underdeveloped countries in general and in Brazil in particular, the fragility of the party political culture permits *pressure groups* to influence members of Parliament without disrupting Parliamentary or political work[11].

The links between EMBRAPA and the Congressional Agricultural Committee take at least three forms. First, direct action from the committee's individual members involves the pursuit of their individual, local or regional interests. For instance, EMBRAPA created an agricultural experimental station in the town of the former President of the Congressional Agricultural Committee to support local farmers. Secondly, the committee demands technical and specialised advisers to support their parliamentary work. Thirdly, the committee seeks support through the Minister of Agriculture. This is the most powerful lobbing action. In this

[11]Durverger [1972: 117], *Party Politics and Pressure Groups: A Comparative Introduction,* states that in this case 'the political parties are more or less subordinate to pressure groups'.

case, the recommendations from the Minister of Agriculture may prioritise new research programs and regions following committee pressure.

The President and Vice President of the Congressional Agricultural Committee were interviewed. They were members of different political parties. The President was a member of the Brazilian Labour Party (PTB), a right wing party, while the Vice President, on the other hand, was a Brazilian Democratic Movement Party (PMDB) member. This was a centre-left party and had a majority in Parliament. At the time of the field-work both political parties supported the President of the Republic. For a long time, the Congressional Agricultural Committee had been ruled by conservative parties.

The Agricultural Congressional Committee had supported the large farmers' demands, such as rural credit, the tax system, agricultural subsidies and land-tenure system. Table 7.3 shows that, on the one hand, the President defended EMBRAPA's status because it had been useful for organised interests, and had helped the Congressional Agricultural Committee to influence agricultural research policy within the Agricultural Ministry. On the other hand, the Vice President criticised it, arguing that this research model had been directed towards export products. Both support *Rural Parliamentary Support (bancada ruralista)*. This was Parliament's strongest team, and was allied to conservative proposals, such as land concentration by the conservative rural elite[12]. This another facet which illustrates the powerful Brazilian elite.

The President and Vice President were asked: 'Has EMBRAPA generated agricultural technology to meet the majority of Brazilian farmers' needs?'. Table 7.3 indicates that, in agreement with the President of the Congressional Agricultural Committee, the agricultural

[12]Fernandes [1996: 114], ibid., argues that in Brazil land reform 'has not been pursued and the extension of the labour rights to the rural areas expelled thousands of workers to the urban concentrations'

research process was based on a scientifically neutral view. For him, *EMBRAPA's technology was useful for the majority of farmers.* He stated that the main problem with technology adoption by farmers was that *the agricultural transfer process had failed,* and *farmers had resisted adopting modern technology.* He also mentioned the appropriateness of the agricultural technology to the farmers' needs. On the other hand, the Vice President responded that the technological *results had been adopted by export farmers* and *did not attend to the regional farmer's demands.*

**Table 7.3 - The Congressional Agricultural Committee's Attitudes**

| Attitudes / Parliamentarians | CHARACTERISATION OF EMBRAPA'S TECHNOLOGY | EMBRAPA RELATIONSHIPS | TECHNOLOGY ADOPTION PROCESS | EMBRAPA'S ORGANISATIONAL STRUCTURE | COMMENTS ABOUT EMBRAPA |
|---|---|---|---|---|---|
| **President of the Congressional Agricultural Committee** | The technology was useful for the majority of farmers | The financial sector, particularly the FEBRABAN had interfered significantly in agricultural production. | The agricultural transfer process had failed. Farmers had resisted adopting modern technology | The organisational structure was appropriate for Brazil | It was a useful agricultural organisation |
| **Vice President of the Congressional Agricultural Committee** | The technology results had been adopted by export farmers | EMBRAPA was much closer to export and industrial farmers than to poor farmers | There was no link between EMBRAPA and rural extension agencies | The organisational structure must meet regional agricultural needs and not specific agricultural products | The Congressional context was against agricultural research proposals. It may be closed down in the future |

During the interview, the President of the Congressional Agricultural Committee stated that financial and interest groups, such as the Brazilian Bank Federation - FEBRABAN, has had a strong influence on agricultural policy and has appointed important executives to public office, such as the Agricultural Ministries. And some important crops had been grown from

EMBRAPA seeds, for example rice, wheat, Soya bean, and maize. He ended the interview by saying that *EMBRAPA and its organisational structure were appropriate to Brazilian farmers' needs.*

The Vice President's attitude was quite different. In his opinion, the congressional stance was against agricultural research proposals because it had been more influenced by agribusiness and financial lobbies than by small farmers' interests. There was no link between farmers, rural extension and agricultural research organisations. For him, EMBRAPA had prioritised specific industrial and export products rather than domestic crops. He also mentioned that it must change its organisational structure to *meet regional agricultural needs and not national and specific agricultural products*. He emphasised that EMBRAPA could be closed down in the future.

**7.4. Large Agricultural Farmers Organisations' Attitudes**

The Brazilian landowner's organisation consists of the National Agriculture Confederation (CNA), the Brazilian Co-operatives Organisation (OCB), the Brazilian Rural Society (SRB), the National Agriculture Society (SNA), and the Rural Democratic Union (UDR) [Baltar, 1990: 145]. These encompass the broader concerns of the large farmers, such as rural employer's unions, agricultural policy, and organisational, economic and political issues.

Thus, the CNA's[13], SRB's[14], OCB's[15], and ABEPA's (Private Technical Assistance Association)[16] Presidents were interviewed. They were effectively connected with agricultural

[13]CNA is the most powerful landowner representative in Brazil. It was established in 1964 and comprises of twenty-seven state agricultural federations and 2,000 unions. All these involve about one million large farmers across the country.

[14]SRB was established in 1919. In the past it was a powerful landowner organisation. Although it is no longer as powerful as CNA, it is an influential organisation with 5,000 members. For example, at the time of the field-work the SRB's President, a landowner, was a member of the National Monetary Council (which advises

technology and in particular with EMBRAPA. The President of the Rural Union of Bagé in the State of Rio Grande do Sul in the South and the largest goat farmer, in Sobral, in the State of Ceará in the North-east were also interviewed. Both were pinpointed by the heads of the Sheep and the Goat National Research Centres. They paid more attention to large farmers than to small ones. The research centres heads certainly intended to show the importance of EMBRAPA and the adoption of its technologies by farmers.

In Brazil, the large farmers' organisations have a great capacity to organise and promote common interests. They are characterised as conservative organisations and have not supported land reform programmes or rural labour laws. They have strong political power in Parliament used to defend their interests and make their demands. Aside from this, they have their own parliamentary lobby, the *Rural Parliamentary Support (bancada ruralista).*

The large farmers' organisations maintain various links with EMBRAPA. First, they pursue the Federal government, in particular the Ministry of Agriculture and Planning and encourage Parliamentary support for EMBRAPA. They are behind the Congressional Agricultural Committee and the *Rural Parliamentary Support*. They have gained appointments for their representatives within the state apparatus in accordance with their vested interests.

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the government on economic macro policies). He was also the Secretary of Agriculture in the powerful State of São Paulo.

[15]OCB was created in 1969 and comprises of 4,350 co-operatives throughout the country. Although, the OCB is not as powerful as CNA, it represents the organised co-operative interests who are about 4 million farmers, especially in the South, South Eastern and West-Central regions. For instance, the actual OCB's President is a landowner who was previously a Minister of Agriculture and is a Parliament member linked to the *Rural Parliamentary Support (bancada ruralista).* Nascimento [1997: 72-73], *Mamata do Cooperativismo,* states that the OCB had benefited from government privileges, including financial support for 'personnel training, and information dissemination'. For him, 'the co-operative programme in Brazil is synonymous with business amongst friends'.

[16]ABEPA was established in 1976 as the national representative of 1,300 private technical assistance agencies. Normally, the role of private technical assistance agencies is to attend to large farmers. ABEPA constitutes an influential group to pressure the government in line with its own interests. It tends to target the organs related to subsidised credit.

Secondly, they hold positions on EMBRAPA's national advisory committee and on other research centres' advisory committees. Thirdly, they have adopted EMBRAPA technology in two ways: through the usual technology diffusion process and through the researcher's private advisers. Fourth, there is a connection between the large farmers' demands and EMBRAPA technology goal-attaining. This is the increase of agricultural productivity independent of its social and political consequences. Also, the large farmers and the researchers are part of the dominant and middle social classes respectively.

Likewise, the large farmers' organisations promoted mechanisms to maintain its organisational structure and research profile. They pressured the legislative power to approve the budget and appoint executives. Furthermore, they sustained EMBRAPA in terms of its competence and credibility in Brazilian society. This meant tactful action by the *interest groups*. However, the large farmers had not supported EMBRAPA in financial terms[17].

Table 7.4 shows that the large farmers' representatives endorse EMBRAPA's research process which is based on increasing the productivity of crops and cattle-raising. When the large farmers' representatives were asked: 'Has EMBRAPA generated agricultural technology to meet the majority of Brazilian farmers' needs?', Table 7.4 reveals that the CNA's representative responded that agricultural technology may be directed towards private profits and offer high technology to increase the productivity of crops and husbandry, mainly in export and industrial crops. In CNA's words *the private sector only thinks of profits*. The OCB's President said that *the technologies were useful for all farmers*, and according to the ABEPA's President, *EMBRAPA was a leading agricultural organisation in Brazil*.

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[17]Etxezarreta [1994: 74], *Integration de Mercados y Privatizacion de la Investigacion. Impacto sobre la Estructura y la Dinamica Organizacional de los INIAS,* shows that, in the United Kingdom, the government share for the research and development of the Ministry of Agriculture, Fisheries and Food was 13.8% in 1992-1993. In contrast, Alves [1992*], Getting Beyond the 'National Institute Model' for Agricultural Research in Latin America*, remarks that in Brazil the government share was 82% in 1991 for agricultural research.

# Table 7.4 - Large Agricultural Farmers Organisations' Attitudes

| Attitudes / Representatives | CHARACTERISATION OF EMBRAPA'S TECHNOLOGY | EMBRAPA RELATIONSHIPS | TECHNOLOGY ADOPTION PROCESS | EMBRAPA'S ORGANISATIONAL STRUCTURE | COMMENTS ABOUT EMBRAPA |
|---|---|---|---|---|---|
| **President of National Agriculture Confederation (CNA)** | The results were evident, for example the case of the wheat's increase of productivity | It was starting to link to the productive sector. Some of the advisory councillors were from the private sector | The private sector only thought of profits. It adopted technology to increase its profits | It should be decentralised. EMBRAPA's research plan had concentrated on specific social groups | He supported EMBRAPA. He did not believe that it should be closed down in the future |
| **President of Brazilian Co-operatives Organisation (OCB)** | The technologies were useful to all farmers | It had some agreements with co-operatives. It was not true that the technologies just reached export farmers | A serious problem was Brazilian rural extension corporation failure. The technology did not meet the farmers' needs | There was little financial funding for EMBRAPA. It should develop links with entrepreneurs | Urban society may pressure EMBRAPA. It could be closed down in the future |
| **President of the Brazilian Rural Society (SRB)** | In theory, the research system was a suitable model. It has addressed some agricultural problems. | There was no rapport between research centres and other institutions. The relationships depended much more on personal contacts | It was not an elitist organisation, but there was a commitment to the relationship between costs and benefits in EMBRAPA | It must prioritise its research for productive networks which are less profitable. The organisational structure was efficient in theory | He was an EMBRAPA consultant. He supports it. |
| **President of Private Technical Assistance Association (ABEPA)** | The technologies were for all types of farmers. EMBRAPA was the leading agricultural organisation in Brazil | It had weak links with private technical assistance. | It was necessary to have more technology diffusion. | The organisational structure was in line with farmer demands | The Brazilian government did not prioritise agricultural research |
| **President of Rural Union of Bagé, RS** | The technology was adequate for standard farmers but not for advanced ones | When it needs funding it can go to large farmers | The main problem was the technology transfer process | It could work for specific and regional farmers | It could create agricultural technology only for Bagé |
| **The largest goat farmer in Sobral, Ceará** | The technologies were appropriate for all types of farmers | It advised goat farmers | Goat farmers did not use the technologies because they were lazy | The Goat Research Centre could be a powerful research organisation in the future | The researchers were efficient |

There was no assessment of environmental issues, land reform, income distribution, or even the social distribution of agricultural benefits by the large farmers' representatives. The

President of the Rural Union of Bagé said that *EMBRAPA should generate high productive technology only for Bagé's farmers*. According to the largest goat farmer in Sobral, in the State of Ceará *EMBRAPA has been advising goat farmers*. These were examples of EMBRAPA technological benefits for large farmers.

During the interview, it came to light that large farmers' representatives, like the President of SRB, were advisory committee members in EMBRAPA. Table 7.4. shows that the President of SRB supported EMBRAPA's current research model. It is also important to note that though the private sector had not financially supported state agricultural research, the President of the Rural Union of Bagé and OCB's representatives argued that the government should invest much more money in it. They admitted that the private agricultural sector had not invested much money in the EMBRAPA agricultural technology generation process. For the CNA's representatives, *this was a result of Brazilian culture*. Only 15% of EMBRAPA's budget was not from governmental sources. Once again, this was another way in which the State protected to elite private interests.

When asked: 'Is EMBRAPA's organisational structure appropriate for meeting the demands of different types of Brazilian farmers?', the large farmers' representatives were in agreement. Table 7.4 shows that, according to the President of the Private Technical Assistance Association (ABEPA), *EMBRAPA's organisational structure was in line with farmer demands*. The main difficulty in farmers adopting technology was the failure of the diffusion process and the shortage of government resources for the generation of agricultural technology.

A similar argument was made by the President of the SRB who argued that *EMBRAPA was not an elitist organisation*. The technology itself and its social distribution were not discussed. On the contrary, the President of the Rural Union of Bagé suggested that the technology should serve his own town, at the expense of regional or national farmers. He had adopted EMBRAPA agricultural technologies. The Sheep Research Centre is located in Bagé town in the State of Rio Grande do Sul, on the border with Uruguay. In fact, his farms were located in the Bagé region. He was the owner of a large slaughterhouse in Brazil and of ten thousand hectares of agricultural land. This is another example of privatised interests.

According to Baltar [1990], the rural elite's organisations had always pursued capital accumulation. Throughout the history of Brazil, from the proclamation of the Republic in 1889 and the post Revolution period of the 1930's, to the post Second World War period, the import substitution era in the 1950s and the post military coup in 1964 (the agricultural modernisation era), the State had operated as a moderator and controller of the conflict between social classes.

Baltar [1990: 44-55] points out that the SRB (founded in 1919), the SNA (founded in 1897) and the CNA (founded in 1964 under military rule), had historically influenced Parliament's decisions through laws and amendments. Their pressure involved specific interests related to land-tenure and agricultural polices - mainly public policy incentives for export and industrial staples. He cites as historical examples government support of coffee crops and the maintenance of the archaic land-tenure system.

Further, Gomez [1987] states that the SNA in Brazil had in the past formed a powerful *pressure group*. For him the Ministry of Agriculture was often managed for the benefit of SNA's representatives. Normally, the large agricultural farmers' organisations, such as SRB, CNA, and SNA articulate their demands and interests as a single group, in for example, the fight to maintain rural subsidised credit, the land-tenure system[18], and the need for agricultural modernisation. Bryant [1996: 1545] shows the relatively recent capacity of the large Brazilian farmers to pursue their vested interests. In 1995, they lobbied Parliament which 'passed a law revoking the reformed interests rates on rural debt and pegged them instead to a much lower rate determined in part by the price of farm products'. This means that the State absorbed a debt of about U$1,8 to 2,5 billion.

### 7. 5. EMBRAPA Employees Union's Attitudes

The presence of EMBRAPA employees in the union movement is recent. After democracy was established in Brazil, civil servants became affiliated to unions. The EMBRAPA employees' union was founded in 1989[19]. It has its central headquarters in Brasília (the Federal District) with branches throughout the country where research centres are located. The President of the SINPAF and of the Employees Union of the research centres surveyed[20] were interviewed.

At the time of the research, there was great enthusiasm among employees for pursuing their civil rights and for engaging in political debates. However, in practice the EMBRAPA employees' union had focused its political strategies around internal issues, such as wages and internal power, not with agricultural technology generation, its social benefits and its relation

[18]For instance, Caminoto and Piveta [1996: 80], *Os Donos da Terra,* argue that there remains '153 million hectares of uncultivated land (the *latifundium unproductive*) in Brazil, that is, 18% of Brazilian territory. This is the same size of France, Germany, Spain, Switzerland and Austria altogether'. In contrast, according to MST [1994: 17], *A Dívida Externa e a Fome,* 4.8 million rural families have no land, since 44% of Brazilian agricultural land is concentrated in 1% of the population's hands. Further, 100% of landowners with over 500 thousand hectares had not paid the Rural Property Tax (ITR), in contrast with 68% of landowners with up to 100 hectares who had.

[19]The employees union's legal representation lies with the National Agricultural and Forestry Research's Employees Union - SINPAF. Most of SINPAF's members are EMBRAPA's employees. SINPAF has about eleven thousand members.

[20]CNPA and CNPC (the Cotton and the Goat National Research Centres) in the Northeastern region and CNPSo and CNPO (the Soya bean and the Sheep National Research Centres) in the South.

to society at large. The employees' union had a strong *espirit de corps*, shown in its increase in the percentage of EMBRAPA's budget devoted to salaries, at the expense of research activity.

It is worth observing the percentage of EMBRAPA's budget allocated to salaries which was increased after 1985. In this period, democracy returned to Brazil and some pressure from employees' organisations was possible. For instance, in 1984, 46.84% of EMBRAPA's entire budget was devoted to employees' wages and financial support for research activities was 37.44%. By contrast, in 1992, 81.19% of EMBRAPA's entire budget was allocated to employees' wages and only 12.09% was directed to research activities [EMBRAPA, 1994 and 1994d]. This financial redistribution was most probably the result of union pressure[21].

The union's attitudes towards the agricultural technology generation process is shown in Table 7.5. Except for the headquarters' representative, the President of the National Employee's Union (SINPAF), all expressed attitudes linked to their own research centres, i.e. local opinion was favoured rather than a general concern with agricultural technology benefits and farmers' technology adoption. According to SINPAF's President, *EMBRAPA's competence and credibility was a myth*. He stated that EMBRAPA had no social concerns in its agricultural research generation and that *the technology had no social function.* EMBRAPA's research model was not appropriate to Brazil.

The union had no consistent opinions on the agricultural technology generation process as illustrated in Table 7.5. With the exception of the President of the Soya bean Research Centre Employees' Union, all others argued that the agricultural technology was

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[21]Kersham [1990], *'Production Under Pressure: Interest Groups and State Enterprises in Brazil'*, argues that in Brazil the labour unions have a 'major interest in increased real wages'.

useful for all types of farmers. The President of the Sheep Research Centre's Employees' Union said that *the agricultural technology generation process was appropriate for the majority of farmers.* Moreover, all the Presidents of the unions in each research centre supported EMBRAPA's current position.

**Table 7.5 - Employees Union's Attitudes**

| Attitudes / Union | CHARACTERISATION OF EMBRAPA'S TECHNOLOGY | EMBRAPA RELATIONSHIPS | TECHNOLOGY ADOPTION SUCCESS | EMBRAPA'S ORGANISATIONAL STRUCTURE | COMMENTS ABOUT EMBRAPA |
|---|---|---|---|---|---|
| **President of National EMBRAPA's Employees Union (SINPAF)** | The technology had no social function. EMBRAPA was not familiar with farmers' production networks | The research model did not permit public participation | Specific social and economic groups needed the technology | It did not consider territorial and social differences in Brazil | Its efficiency and productivity was a myth |
| **President of Cotton Research Centre's Union Employees (CNPA)** | Cotton technology was useful for all farmers in Brazil | The researchers only thought about their own social '*status quo*' | The technology was not relevant to unorganised social groups | The organisational structure was not appropriate to rural reality | It had a lot of social and political prestige in Brazil |
| **President of Goat Research Centre's Union Employees (CNPC)** | The technology was useful for medium sized and large farmers | It had not been concerned with social issues | He did not remember any goat technology generated by EMBRAPA | The postgraduate training only maintained the researcher's individual '*status quo*' | It must change its priorities |
| **President of Soya bean Research Centre's Union Employees (CNPSo)** | It was hard for the Soya bean technology to reach small farmers | Co-operatives were EMBRAPA's main clients | It was not competent enough to meet small farmers' needs | The organisational structure only satisfied Soya bean plant concerns | It would never be closed down |
| **President of Sheep Research Centre's Union Employees (CNPO)** | The technology was useful for all types of farmers | The Bagé region was the first to adopt new sheep technology | The type of farmer adopter: farm (400 hectares ) and mixed productive system (cattle and sheep) | Identification of demands would be in accordance with regional and not national demands | The generation process was appropriate for the majority of farmers |

It was observed during the interviews that there was a clear conflict between staff and researchers, particularly in the North-east. The Presidents of the Cotton and Goat Research

Centre's Employees' Union argued that *the postgraduate qualifications of researchers were only to enhance their status.* In fact, the Presidents of Research Centres' Unions did not discuss in a consistent way the relationship between EMBRAPA and society, rural extension agencies and small farmers' organisations. They did not talk about technological and ideological approaches or the differences between cash and food crops. Indeed, most of the opinions expressed were about the internal research centre's power, salary demands, employee representation and so on. In other words, they did not consider demands from outside the research organisation.

Apart from the President of the National Union (SINPAF), all the Presidents of the Unions saw EMBRAPA as the most important agricultural organisation in Brazil. According to the President of Cotton Research Centre's Union, *EMBRAPA had a lot of social and political prestige in Brazil.* They did not have a critical view of EMBRAPA's social role. The focus was on the inside of the research organisation and on employees staffing demands.

Table 7.5 shows that most of EMBRAPA union's representatives did not propose to change the agricultural research model. On the contrary, they wished to maintain its privileges. For instance, the EMBRAPA employee's union had strongly opposed EMBRAPA joining rural extension services[22] and pressured for increases in employee salaries much more than other state organisations. The employees' union had gained more benefits for staff than for researchers. Administrative employees supported the union and were reliable in political battles; technical and scientific employees did not support the union, even though they were directly responsible for the agricultural technology generation process.

[22]In 1992 after EMBRATER was closed, the President of the Republic ordered that rural extension issues would be co-ordinated by EMBRAPA. This provoked a strong reaction from the majority of EMBRAPA members, including the union movement. This reaction may have been due to the feeling that this procedure could weaken EMBRAPA's national and international prestige.

## 7.6. The Attitudes of Rural Extension Personnel

Historically, the state rural extension agencies have been closed to small and medium sized farmers. In contrast, the private ones have worked for large farmers. In reality, the rural extension agencies are nearer to addressing to farmer's demands than the agricultural research organisations are.

In Brazil, the agricultural technology generation and technology transfer processes work separately. They form two different organisations[23]. EMBRAPA only generates, and rural extension agencies only transfer agricultural technology to farmers[24]. There is no formal connection between agricultural research, rural extension and farmers, particularly small and subsistence farmers.

In this thesis, the rural extension personnel comprise the former EMBRATER Presidents and the previous EMBRAPA Rural Extension Secretary[25], the Head of the Rural Extension and Technical Assistance Department (DATER)[26], the President of the Brazilian Rural Extension Association (ASBRAER)[27] and the President of the National Federation of

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[23]Schlottfeldt [1991: 102], *Difusão de Tecnologia e Extensão Rural na EMBRAPA: Reflexões Conceituais e Práticas,* mentions that as EMBRAPA, EMBRATER programme was focused on specific agricultural products. The target was the dissemination of technological packages in accordance with the Green Revolution recipe.

[24]Eponou [1996: xiii and 43-44], ibid., calls this model 'the linear model of technology generation and transfer '...' [in which] there is a clear division of labor: research generates technology; technology transfer delivers technology to farmers; and farmers use technology '...' one of the key effects of the linear model is the 'gap' between researchers and farmers which makes any form of collaboration between two groups difficult'.

[25]After EMBRATER was closed down in 1990, the rural extension programme was co-ordinated by EMBRAPA through the Rural Extension Secretary (SER).

[26]Since the middle of 1993 the rural extension programme has been co-ordinated by the Ministry of Agriculture through the Rural Extension and Technical Assistance Department (DATER), as an organ of the state administration.

[27]ASBRAER was created in 1990 as the national representative of twenty-seven state rural extension agencies. It is the lobbying arm of the public rural extension agencies and normally exerts pressure on parliamentary and governmental bodies.

Association and Unions of Rural Extension Workers (FASER)[28]. Other interviewees were the Presidents of the State Rural Extension Agencies[29] where the research centres are located, specifically the states of Paraíba and Ceará in North-east and Paraná and Rio Grande do Sul in the South, as well as the oldest rural extension agent working and some regional advisers to rural extension agencies.

As with EMBRAPA, the former EMBRATER (Brazilian Technical Assistance and Rural Extension) comprised SIBRATER (the Brazilian Rural Extension and Technical Assistance System) and co-ordinated rural extension procedures all over the country[30]. EMBRATER focused on farmer education and farmers' living-standards and on increasing agricultural production.

In the early 1990s, EMBRATER failed and between 1992 and 1994 rural extension activity was poorly co-ordinated by EMBRAPA. There was a clear conflict between the aims of agricultural research and those of the rural extension programmes. Moreover, the input of rural extension activities into EMBRAPA was rejected by EMBRAPA members and the rural extension programs were transferred to the Ministry of Agriculture.

The links between EMBRAPA and state rural extension agencies have been based on a particular rhetorical discourse. In theory, the research model sees rural extension as the

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[28]FASER was established in 1986 as the political representative of Brazilian rural extension workers. It has a national mandate and pressures on parliamentary and governmental organisations. FASER is the lobbying apparatus of thirty-two rural extension worker unions.

[29]The rural state agencies surveyed are attached to the government's Agricultural Secretariat and its mandate is attend to small and medium farmers. They are situated in the same State as the research centres sampled. In 1996, EMATER-PB attended to 54,000 small and medium farmers in the State of Paraíba and EMATER-CE attended to 92,500 small and medium farmers in the State of Ceará in the North-east. Further, EMATER-PR attended to 195,000 small and medium farmers in the State of Paraná and EMATER-RS attended 232,500 small and medium farmers in the State of Rio Grande do Sul in the South.

[30]EMBRATER [1989: 15], *Diretrizes para o Sistema EMBRATER em 1990,* shows that 1,119,939 farmers received technical assistance nation-wide. Of these 1,038,246 were small scale farmers; 63,597 were medium-sized and 18,096 are large ones. Also, 24,884 rural communities were assisted.

preferred route. There exists an enormous gap between the agricultural technology generation process and its transfer and adoption by farmers. EMBRAPA technology has not been adopted by many farmers, especially small and medium scale farmers. Also, rural extension agencies do not support it and for them EMBRAPA could face closure in the future.

Indeed, Table 7.6 shows the rural extension personnel attitudes towards EMBRAPA's agricultural technology generation process. Data in the Table 7.6 reveals that the rural extension personnel had been critical of EMBRAPA research process. They believed it to be a closed organisation concerned only with the increase in productivity of specific agricultural products. They also said that EMBRAPA technologies were directed towards capitalised farmers, most of whom were only interested in agricultural cash products.

When asked: 'Has EMBRAPA generated agricultural technology to meet the majority of Brazilian farmers' needs?', Table 7.6 shows how a former EMBRATER President with left-wing sympathies, argued that *EMBRAPA's agricultural technology met the needs of capitalised farmers*. However, for a previous EMBRATER President with right-wing sympathies, *EMBRAPA highlighted a new phase in Brazilian agriculture* and *agricultural technology adoption depended on the farmers and the communication process.* This meant that the agricultural technology itself and its generation process were not discussed.

## Table 7.6 - The Attitudes of Rural Extension Personnel

| Attitudes / Representatives | CHARACTERISATION OF EMBRAPA'S TECHNOLOGY | EMBRAPA RELATIONSHIPS | TECHNOLOGY ADOPTION SUCCESS | EMBRAPA'S ORGANISATIONAL STRUCTURE | COMMENTS ABOUT EMBRAPA |
|---|---|---|---|---|---|
| **Former President of Rural Extension Corporation (left-wing) (EMBRATER)** | The EMBRAPA model was based on biological productivity, capitalised farmers and technological discourse | Little articulation with state and regional organisations | In practical terms the technology was directed towards the competitive agricultural groups | The specific agricultural products' research process was not appropriate to rural extension agencies | It did not have rural development as its main objective |
| **Former President of Rural Extension Corporation (right-wing) (EMBRATER)** | The EMBRAPA technology was a historical mark in Brazilian agricultural technology development | It did not have suitable communication with farmers | The technology adoption process depended on farmers | Specific agricultural products were promoted very objectively. Emphases on the training program | It highlighted a new phase in Brazilian agriculture |
| **Former National Rural Extension Secretary (SER)** | The technology was in accordance with Green Revolution principles | There was no interest in doing research and rural extension programs | The technologies were mostly for organised economic groups | The most important research strategy was not through agricultural products, but through agricultural systems | It had a strong marketing strategy. It maintains its social and political prestige |
| **Head of Rural Extension and Technical Assistance Department (DATER)** | Technology was not appropriate to the market | It was too elitist | There was no participation of clients and users in the generation process | The agricultural research process must be appropriate for consumers | It was too PhD oriented |
| **President of Brazilian Rural Extension Association (ASBRAER)** | Research plans were for specific agricultural products | There were no common points between EMBRAPA and agricultural technology clients | It had only met the demands of the organised farmers | The EMBRAPA organisational structure did not facilitate the relation with its clients and users | It must seek social support from civil society |
| **The oldest active rural extension agent** | It was appropriate for cash crops | The researchers kept away from rural extension agencies | It had a mass of well-trained researchers but it is very distant from social concerns | The model was the top down type, offering technology. It is too centralised | It was not appropriate for food crops |
| **President of rural extension agency of Paraíba (EMATER-PB)** | The technology was appropriate for medium sized and large farmers | The researchers were not familiar with rural reality | The technology adoption by small farmers was difficult | It should plan its research priorities in accordance with the production unit | EMBRAPA's image was elitist |
| **President of rural extension agency of Paraná (EMATER-PR)** | The technology followed the Brazilian development strategy | It was a closed organisation | It did not address the demands of small farmers | Evaluation of the specific agricultural product research centres' costs and benefits | There was some doubt about the survival of EMBRAPA |

(Continued)

**Table 7.6 - The Attitudes of Rural Extension Personnel - (Continued)**

| Attitudes / Representatives | CHARACTERISATION OF EMBRAPA'S TECHNOLOGY | EMBRAPA RELATIONSHIPS | TECHNOLOGY ADOPTION SUCCESS | EMBRAPA'S ORGANISATIONAL STRUCTURE | COMMENTS ABOUT EMBRAPA |
|---|---|---|---|---|---|
| **President of rural extension agency of Ceará (EMATER-CE)** | Large farmers had adopted technology | It was closed. He does not know of the Goat Research Centre program | It should transfer technology to small farmers | It should include food crops and climate research proposals | It was an expensive organisation |
| **Executive Director of rural extension agency of Rio Grande do Sul (EMATER-RS)** | The technology met the farmers demands | There was no relationship between EMBRAPA and rural extension agencies | The technology for Soya bean, pigs and poultry was being adopted by farmers | The contacts between EMBRAPA and rural extension agencies were at the personal level | It was progressing very well |
| **Regional adviser of rural extension agency in the city of Campina Grande (EMATER-PB)** | The technology was appropriate for medium sized and large farmers | There was no relationship between EMBRAPA and rural extension agencies | Cotton researchers created technology in accordance with their own interests | It should be concerned about rural development | It was elitist. It was useful for large farmers |
| **Regional adviser of rural extension agency in the city of Bagé (EMATER-RS)** | The technology was appropriate for medium sized and large farmers | It had a relationship with rural extension agencies and farmers | It was pure rhetoric for EMBRAPA to say that it created technology for small farmers | It was worth joining EMBRAPA and rural extension corporations | It was important for it to continue creating agricultural technology |
| **Regional adviser of rural extension agency in the city of Londrina (EMATER-PR)** | Technology was ideological | The farmers that have the capacity to assume risks had adopted the technology | There were some demands from production systems that EMBRAPA has not addressed | The organisational structure was not appropriate to the demands of production units | It must attend to the farmer's demands |
| **President of National Federation of Association and Unions of Rural Extension Workers (FASER)** | It only worked to increase agricultural productivity | It was a closed organisation | The technology did not attend to small farmers needs | It did not attend to interests of farmer's production units | It may be declared a failure in the future |

The following question was asked: 'Is EMBRAPA's organisational structure appropriate for meeting the demands of different types of Brazilian farmers?'. With the exception of the Executive Director of the Rural Extension Agency in the State of Rio Grande do Sul (where the CNPO is located) and the former right-wing President of EMBRATER, all other personnel agreed that EMBRAPA is a top-down and centralised organisation.

For them, the organisational structure did not encourage the relationship between researchers and rural extension agents. In reality, rural extension agencies' strategies come from the farmers' demands and include social, economic and environmental issues. There is a conflict between EMBRAPA and rural extension strategies. On the one hand, EMBRAPA uses the commodity-led model focused on specific agricultural products independent of social and farmer's production system concerns. On the other hand, in this study the rural extension representatives concentrated their arguments on the farmers' production units demands.

The President of ASBRAER's response was that *EMBRAPA had only met the demands of organised farmers* and its *organisational structure made its relations with clients difficult*. Moreover, the President of FASER said that *EMBRAPA was a closed organisation*, and *did not attend to small farmers' demands.* The oldest rural extension agent employed in the state rural extension agency, said that *EMBRAPA's research model was appropriate for cash crops, and the organisation was centralised and top down*.

Except for a President of the former EMBRATER and an Executive Director of the state rural extension agency, who both support the research model, all other representatives of the national and state rural extension agencies, of the Brazilian Rural Extension Association, and of the rural extension workers made strong criticisms of EMBRAPA agricultural technology and its research model. They argued that its technology was not appropriate for small farmers and its research strategy did not consider the farm as a whole at all. The organisational structure did not consider that small farmers might want to participate in identifying agricultural research problems.

At the time of field-work, important facts emerged in the towns where the research centres were located. For example, the EMBRAPA researcher responsible for the relationship between the research organisation and rural extension (the technology diffusionist), did not know the whereabouts of the rural extension office. In addition, the research centre's head did not learn anything about small farmers' organisations. In contrast, they suggested interviewing the large farmers who had adopted the research centres' technology.

### 7.7. The Attitudes of Small Agricultural Farmers Organisations

Historically, the small farmers' movement in Brazil has concentrated on land reform. Agricultural technology was never on the small farmers' agenda[31]. The Brazilian agricultural worker's movement comprises small, landless and worker farmers.

The most vocal small farmer representative includes the Agricultural Worker's Confederation (CONTAG), founded in 1964 under military rule and with a mandate for the whole country. Around twelve million rural workers are affiliated to CONTAG [CONTAG, 1993] and the Landless Workers' Movement (MST), formed in the 1985 to raise issues of land reform. Navarro [1994: 142], writes that 'the MST is one the most fascinating stories of popular organising in Brazil. Seeking mainly to change long-standing patterns of land ownership, the MST has penetrated a social sphere in which domination is mere deeply rooted that in any other'[32].

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[31]Houtzager [1996: 12], *The Rural Workers' Union Movement in Brazil.* In: Quantifying Indigenous Knowledge: A Rapid Method For Assessing Crop Performance Without Field Trials, mentions that in response to the generalised crisis in the agricultural sector, the most representative small farmers organisation in Brazil, that is, CONTAG has 'prioritised the small farming sector and is developing an alternative model of 'family agriculture' that is economically competitive and environmentally sustainable'.
[32]Santa Cruz and Filho [1996: 69-70], *Vontade Radical,* state that the 'MST is a successful organisation which operates in twelve Brazilian states through the fifty-five [agricultural] co-operatives. The MST claims that 139,000 settled landless families are on the 7.2 million land hectares'.

The most representative rural farmers' organisations as well as other organisations and individuals devoted to small farmers' needs were sampled. Most of these are linked to the left-wing parties and have had an important role in opposing the military dictatorship. Data collection was from the CONTAG's National President, the Brazilian Agrarian Reform Association (ABRA)[33], and the Organic Agricultural Association's (AAO)[34] Presidents, and the Workers' Party's [35] (PT) Adviser. The Agricultural Workers Federation (FETAG)[36] Presidents and some small farmers allies, such as the Catholic church[37], NGOs' and MST's representatives were interviewed as well.

The small farmers' representatives do not have strong *organised group interests*[38]. For instance, only in 1994, 22 years after the creation of EMBRAPA, was the first technical agreement with CONTAG made. This is the largest Brazilian small farmers' and rural

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[33]ABRA was created in 1967 as a civil organisation which has no financial aims, since its purpose is promote land reform. Further, ABRA has supported land distribution and equal land agricultural production.

[34]AAO is a non-governmental organisation established in 1989. It comprises 1,200 members and a national mandate whose the headquarters are located in São Paulo city. Its aim is to promote organic agriculture programmes. Further, the NGO Caatinga's representative and the NGO Christian Association of Base's representatives were interviewed. They have acted upon the rural small farmer's projects respectively in the States of Pernambuco and Ceará in the North-east.

[35]According to Brandford and Kucinski[1995: 7-8], *Brazil: Carnival of the Oppressed,* the PT 'is a party of Marxists, but not a Marxist party' which 'operates as a mass party' and comprises of 'intellectuals, workers, Catholics, agnostic activists, members of the Landless Peasant Movement [MST] or organisers of women's rights groups'. Moreira Alves [1993: 231], *The Latin American Left: From the Fall of Allende to Perestroika,* argues that the PT 'had to politically channel all of the experience gained in the years of organization of the grass-roots social resistance to the military governments'.

[36]FETAGs are the CONTAG's branches situated throughout the country. In this study those surveyed were FETAGs in the states where the research centres sampled are located, respectively the FETAGs in the States of the Paraíba, Ceará in North-east and Paraná and Rio Grande do Sul in South.

[37]Wiarda [1996: 131], *Brazil: The Politics of 'Order and Progress' or Chaos and Regression?* In: Latin America Politics and Development, states that 'Brazil is the most Catholic country in the world in terms of the church members and the church has a special position as an interest group'. For example, Santa Cruz and Filho [1996: 73], ibid., remark that among other movements, the Catholic Church has sponsored the radical MST. Further, CONTAG [1993: 8], *CONTAG: 30 Anos de Luta,* states that the Catholic Church has historically supported the small rural farmers and land reform issues through the catholic agrarian youth movement, the catholic university, the catholic proletariat and land shepherdess movements.

[38]Although, according to Hebette [1996], ibid., the small and subsistence farmers know that part of society is fed by their agricultural production, they nevertheless remain poor. Also CONTAG et al [1993: 7], *Ações Permanentes para o Desenvolvimento do Nordeste Semi-Árido Brasileiro,* write that small farms (up to 100 ha) have produced about 60% of basic food, such as cassava, beans and maize.

workers' organisation[39] and it was officially founded in 1964. This shows the divergence between EMBRAPA's plans and small farmers' needs. In contrast, several agreements have been made with the large farmers' organisations, industrial and processing sectors, and other private organisations.

Most of the agricultural technology generated has not been adopted by small and food crop farmers. They have not been the main inspiration for researchers. Small farmers would like EMBRAPA's research model to change its priorities from a *Concentrated Model*, based on specific agricultural products, to the *farm as whole* research model. The current organisational structure does not encourage small farmers to participate in the definition of research priorities. In reality, small farmers are not part of EMBRAPA's agenda.

Table 7.7 shows the attitudes of small agricultural farmers organisations' representatives towards EMBRAPA agricultural technology generation process. When the following question was asked: 'Has EMBRAPA generated agricultural technology to meet the majority of Brazilian farmers' needs?'. Table 7.7 indicates CONTAG's President responding that *technology was appropriate for large farmers and for export agricultural products*. Further, he said that *researchers had to listen to the small farmers particularly with respect to their history. Thus, the researchers would develop agricultural technologies more appropriate to the farmer's abilities and their social and economic realities.* The NGO Christian Association, said that *EMBRAPA had focused on the interests of large farmers*. A similar assessment was made by the PT's adviser and a lecturer at the University of Campinas, State of São Paulo, who argued that *traditional EMBRAPA efficiency concentrated on private interests*.

[39]Houtzager [1966: 11], ibid., shows that CONTAG 'claims to represent several labour categories '...' it is made up of approximately 3,200 unions that cover the entire country'.

# Table 7.7 - The Attitudes of Small Agricultural Farmers Organisations

| Attitudes / Representatives | CHARACTERISATION OF EMBRAPA'S TECHNOLOGY | EMBRAPA RELATIONSHIPS | TECHNOLOGY ADOPTION SUCCESS | EMBRAPA'S ORGANISATIONAL STRUCTURE | COMMENTS ABOUT EMBRAPA |
|---|---|---|---|---|---|
| **President of the Agricultural Worker's Confederation (CONTAG)** | The technology was appropriate for large scale farmers and for the export of agricultural products | The large economic groups controlled agricultural politics | The technology had never been adopted by small farmers | A few research centres had developed agricultural research for small scale farmers | It must change its research program to food crops and to small scale farmers demands |
| **President of the Agricultural Worker's Federation of Rio Grande do Sul (FETAG-RS)** | It had been very important for large scale farmers | It must link to rural extension agencies. He knew very little about EMBRAPA technology | The researchers had not considered the demands of small scale farmers | The research model had excluded small scale farmers | He had never visited EMBRAPA. It must change to serve small scale farmers |
| **President of the Agricultural Worker's Federation of Paraná (FETAG-PR)** | So far the technology had been directed towards large scale farmers | It had been influenced by the Federal Government because of its financial support | The technology did not attend to small scale farmers' productive units | The technology for specific agricultural products did not meet small scale farmers' needs | If it did not change its priorities, it may be declared a failure |
| **President of the Agricultural Worker's Federation of Paraíba (FETAG-PB)** | The technology did not reach small scale farmers | The researchers must learn to talk to small scale farmers | Large scale farmers had the social and economic conditions to adopt the technologies | The technology was not appropriate for production units | He had never visited EMBRAPA. It must change its research plans |
| **President of the Agricultural Worker's Federation of Ceará (FETAG-CE)** | It only works for large scale farmers. Productivity was its focus | Public policies were developed to exclude small scale farmers | Small scale farmers had no confidence in agricultural researchers | Regional agricultural research generation was more appropriate to the farmer's reality | It must make its research appropriate to small scale farmers demands |
| **President of Brazilian Agrarian Reform Association (ABRA)** | It was been a great advance for Brazil | Small farmers had not pressured EMBRAPA. | The industrial sector had pressured for technology more than the food crops sector | The organisational structure was as great as the Ministry of Agriculture. EMBRAPA is a public organisation | It was changing its priorities too slowly |

(Continued)

**Table 7.7 - The Attitudes of Small Agricultural Farmers Organisations - (Continued)**

| Attitudes / Representatives | *CHARACTERISATION OF EMBRAPA'S TECHNOLOGY* | *EMBRAPA RELATIONSHIPS* | *TECHNOLOGY ADOPTION SUCCESS* | *EMBRAPA'S ORGANISATIONAL STRUCTURE* | *COMMENTS ABOUT EMBRAPA* |
|---|---|---|---|---|---|
| **Regional Co-ordinator of the landless movement (MST)** | It had not reached the landless movement | He had ever visited it. | It was not expensive, provided that its technology is of benefit | The organisational structure should consider the importance of small scale farmers | The technology may increase agricultural harvests |
| **Organic Agricultural Association and Representative of NGOs (AAO)** | Brazilian agriculture was linked to the state bureaucracy and industrial capitalism. Biology approach | It must open itself to public scrutiny | Government measures agricultural development based on modern inputs and consumption | The research model was too centralised | It controlled financial resources and its research priorities, too |
| **NGO Caatinga, Ouricuri, Pernambuco** | The technology did not meet poor farmers needs | It had not demanded NGO priorities | It was too distant from society | The organisational structure was not open to small scale farmers | It was a strategic organisation |
| **NGO - Christian Association of Base** | It had attended to the interests of large scale farmers | It had not attended to NGO demands | The researchers had no link to social reality | It must change its organisational structure to survive | The image could change if it met with small scale farmers |
| **Parish Priest of Catholic church** | The technology must be transformed to suit the reality of small scale farmers | It must direct its research programs to small scale farmers' demands | It did not work close to the reality of poor farmers | It must transform its structure to reach small scale farmers | It was very closed |
| **PT's adviser** | Traditional EMBRAPA efficiency concentrated on private interests | It had been a private organisation | Agricultural technology had not played an important role for poor and small scale farmers | It should take the form of privatisation, for example councils and private foundations | It had technological potential |

The President of the Agricultural Worker's Federation of the State of Rio Grande (where the CNPO is located) responded that the *EMBRAPA model had excluded small farmers*. The research model was commodity-oriented and ignored the small farmers' needs. The MST's representative mentioned that *technology had not reached the landless movement* and that *EMBRAPA would consider the importance of small farmers.* Once again, PT's adviser said *agricultural technology had not played a significant role for poor or small farmers*, and that EMBRAPA in practice *had been a private organisation.*

When asked: 'Is EMBRAPA's organisational structure appropriate for meeting the demands of different types of Brazilian farmers?', Table 7.7 reveals that a Catholic church representative suggested that EMBRAPA should shift its research model to target small farmers and more food crop research programs. In addition, it should get closer to small farmers and poor peasants. He mentioned that *EMBRAPA was a very closed* organisation. For example, the Goat Research Centre in conjunction with the Catholic church in the Sobral, Ceará, in North-east had developed projects to help the poor community. This had been more of a humanitarian aid approach than an agricultural technology one. However, only a few researchers had participated in this activity. Normally, agricultural researchers did not involve themselves in social research programs.

The NGO and the organic agricultural movements also believed the research model should change. As with other small farmers' representatives, they had had some difficulty in adopting EMBRAPA's technologies. For them, technology was based on modern inputs and concentrated on specific agricultural products and not in response to NGO demands. The NGO *Caatinga's* representative said the *organisational structure was not open to small farmers* and that *EMBRAPA had not targeted NGO priorities.* The Organic Agriculture Association's President argued that *EMBRAPA must open itself up to public scrutiny.* The NGO works together with rural communities and production units as a whole, not on specific agricultural issues. The NGO strategies were focused on local farmers' necessities and their indigenous knowledge.

Furthermore, very few of the small farmers' representatives were part of EMBRAPA's committees, whilst those of the large farmers have been present on most of them. In fact, large farmers made up the majority of the membership on many committees. According to the small farmers' representatives, if *EMBRAPA did not alter its agricultural research strategy and organisational structure, it would be closed down in the future.*

Following this focus, the interests of the organised and economic groups had been an important factor in the standardisation of agricultural technology. According to the Workers' Party adviser, EMBRAPA's advisory committees and private foundations had been a form of private organisation serving large farmers and agricultural export products much more than small farmers, food crops and subsistence farmers.

*EMBRAPA was a great advance for Brazil*, according to the President of ABRA (Brazilian Agrarian Reform Association), who was a former EMBRAPA's employee and a former adviser of the Ministry of Agriculture during the establishment of EMBRAPA. All the small farmers', as well as the rural extension's representatives were strongly critical of EMBRAPA's agricultural technology and its rhetorical theme that *research starts and ends with farmers*. In reality, the small scale farmers neither participated in research decisions nor constituted influential *interest groups*. For them, EMBRAPA had generated agricultural technology to serve large farmer interests and economically-oriented and organised groups, especially those involved in export and cash crops.

### 7.8. The Attitudes of EMBRAPA Personnel

Chapter 4 described EMBRAPA's formation, its organisational structure and its research process. Researchers are only involved in research and staff support them. It is a modern organisation according to Weber's [1969] bureaucratic principles[40]. It is important to highlight the management team's view on the agricultural technology generation process.

The personnel interviewed were distinctive in three ways. First, EMBRAPA's founding theorist and President were selected along with its former Presidents. Secondly, EMBRAPA's President and departmental heads at the time of the research (1994) were interviewed. Thirdly, particular subjects were raised with EMBRAPA's management team in the research centres surveyed. In their opinion, the difficulties for farmers in adopting agricultural technology were due to the failure of the diffusion and technology transfer process. The agricultural technology generation process was not in itself an active factor in the adoption by farmers. EMBRAPA had the right organisational structure and an appropriate research model.

With the exception of the research centre's managers, all the others (the executives, the department and the adviser heads located at headquarters) had no direct contact with farmers or rural extension agents. Management and scientific careers were separated and each had their own guidelines. As a consequence, the managers were concerned more with bureaucratic matters than with the agricultural technology generation, transfer and adoption processes. There were no proactive links between EMBRAPA managers and the farmers or rural extension agencies. Rhetoric and bureaucratic agreements at the top level had monopolised the relation between *agricultural research and rural extension*[41]. From the manager's viewpoint, EMBRAPA was the best agricultural research organisation in the Third

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[40]Weber [1969], *Bureaucratic Organisation.* In: Reading in Modern Organisation, identifies six key characteristics of modern bureaucracies: the specific services regulated by law; the hierarchical organisation of functions; recruitment based on individual competence and competitive examination; the remuneration paid in salary in accordance with the hierarchical structure of the official's functions and their level of activities.

[41]For instance, see the protocol agreed between EMBRAPA and EMBRATER [1982], *Diretrizes para Articulação Pesquisa-Extensão.*

World. It had paid better employee salaries[42] and had had social and political prestige and excellent work conditions.

EMBRAPA theorist attitudes in Table 7.8 indicate that *EMBRAPA was created, in the past, according to the International Agricultural Research Centre (IARC) model*[43]. Its creation was influenced by the International Centre for the Improvement of Maize and Wheat - CIMMYT - and the International Rice Research Institute - IRRI. Moreover, it is important to bear in mind, that the Inter-American Development Bank - IDB - and the American International Institute of Agricultural Sciences - IICA (both international organisations that operate in the global economy) provided financial resources, especially for overseas training[44].

The founding President argued that EMBRAPA was created to support market demands, especially the new economic markets such as Soya bean, wheat and new agricultural frontiers, such as the *Cerrados* and Amazon areas. Once again, the IARC was the standard for the initial research model and international aid agencies supported the creation of EMBRAPA, especially its overseas training program. Referring to DNPEA (previous EMBRAPA) *he said that it was closed in on itself.* Furthermore, he argued that *EMBRAPA had not facilitated change in its organisational structure.*

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[42]Quirino [1989], *Human Resource Management for Agricultural Research: Review of an Experience,* states that in the 1970s when EMBRAPA was created, jobs in the public sector offered a combination of salary and various fringe benefits.
[43]This is confirmed by Sorj and Wilkinson [1990: 35], ibid., who argue that EMBRAPA's research model is strongly linked to the International Agricultural Research Centres' (IARC) networks.
[44]Wiarda [1996: 139], ibid., writes that 'after 1972 the U.S. aid efforts emphasized, among other programs, the training of young Brazilian technicians and social scientists in graduate schools in the United States'.

## Table 7.8 - The Attitudes of EMBRAPA's Personnel

| Attitudes / Representatives | *CHARACTERISATION OF EMBRAPA'S TECHNOLOGY* | *EMBRAPA RELATIONSHIPS* | *TECHNOLOGY ADOPTION SUCCESS* | *EMBRAPA'S ORGANISATIONAL STRUCTURE* | *COMMENTS ABOUT EMBRAPA* |
|---|---|---|---|---|---|
| **EMBRAPA's Founding Theorist** | It was created according to the IARC model. It would have attended to market demand. The DNPEA did not work very well | IICA and IDB offered financial resources, especially for overseas training | It was concerned with Brazilian agricultural demands | It had been very ritualistic. Normally, ritualistic organisations end in failure. EMBRAPA had been dependent on the government | It was an example of deviation from the initial objectives |
| **EMBRAPA's Founding President** | The generation research model which fitted external demands, market signals and new agricultural areas | IARC influenced the EMBRAPA research model. EMBRAPA had negotiations with large scale farmers and private corporations | The EMBRAPA technology promoted Soya bean, wheat and *Cerrados* in Brazil | The DNPEA was too closed in on itself. EMBRAPA has not permitted change in its organisational structure | It had not permitted new ideas in its research model |
| **Former EMBRAPA President (right-wing)** | It was created to concentrate on Brazilian agricultural modernisation | The focus was not on rural poverty, but on urban areas | It had addressed the main Brazilian agricultural problems. The most important aims had been achieved | The research model was based on specific products like the IARC. Advisory councils were very important for EMBRAPA | It would be declared a failure. EMBRAPA was not interested in sociologists |
| **Former EMBRAPA President (left-wing)** | It was created to follow Green Revolution principles | It was not concerned with environmental issues and small farmers' demands | It satisfied the Green Revolution principles in Brazil | The state owned organisational type was to facilitate recruitment without public selection. The research centre model promotes the increased use of modern inputs | The main challenge for the future was its privatisation |
| **President of EMBRAPA** | The technology contributed to an increased supply of foodstuffs | It needed external pressures to change its research priorities | Small scale farmers did not have a management structure suited to adopting technology | It would change its organisational structure in two ways: food and cash crops | It was important in the opening of new agricultural areas |

**(Continued)**

# Table 7.8 - The Attitudes of EMBRAPA's Personnel - (Continued)

| Attitudes / Representatives | *CHARACTERISATION OF EMBRAPA'S TECHNOLOGY* | *EMBRAPA RELATIONSHIPS* | *TECHNOLOGY ADOPTION SUCCESS* | *EMBRAPA'S ORGANISATIONAL STRUCTURE* | *COMMENTS ABOUT EMBRAPA* |
|---|---|---|---|---|---|
| **Head of the Development and Organisational Department (DOD)** | Scientific neutrality | Large farmers had had a lot of success in pressuring EMBRAPA | There was no investigation on the technology generation versus adoption process | It was based on the individual research model | The researchers had a specialist view |
| **Head of the Financial Department (DOF)** | It would develop much more useful agricultural technology | Research centres followed the Research Department's suggestions more than farmer's demands | Small scale farmers did not adopt the technology | It did not have its own financial resources | It must avoid waste |
| **Head of the Personnel Department (DAP)** | The technologies were useful for all types of farmers | The researchers must move close to rural reality | He did not understand why EMBRAPA technologies had not been adopted by farmers | EMBRAPA employed its personnel according to its aims. There was some homogeneity of personnel contracted. EMBRAPA was better than the DNPEA | He did not believe that it would be declared a failure |
| **Head of the Strategic Administration Secretariat (SEA)** | The supply oriented technology model was not appropriate to Brazilian reality | EMBRAPA was closed and centralised in its headquarters | The technology diffusion process called for a new paradigm | It was centralised in the federal sphere in accordance with Military dictatorship proposals | Brazil did not need a centralised and commodity-led agricultural research model |
| **Head of the Project and Studies Department (DEP)** | It was a 'Concentrated' research model for specific products | Society must pressure EMBRAPA | Agricultural research must be public. Technology for poor farmers was not a good solution | It was difficult for regional research centres to show research results | It must define new research priorities |
| **Head of Department of Research and Technology Diffusion (DPD)** | Agricultural researchers had developed agricultural technology considering only farmer networks | Relationships with consumers were important | Advisory councils may represent productive networks | Consider consumers as the main agents for agricultural technology generation | The production sector network was important for institutional sustainability |

**(Continued)**

**Table 7.8 - The Attitudes of EMBRAPA's Personnel - (Continued)**

| Attitudes / Representatives | *CHARACTERISATION OF EMBRAPA'S TECHNOLOGY* | *EMBRAPA RELATIONSHIPS* | *TECHNOLOGY ADOPTION SUCCESS* | *EMBRAPA'S ORGANISATIONAL STRUCTURE* | *COMMENTS ABOUT EMBRAPA* |
|---|---|---|---|---|---|
| **Management Team of the Cotton Research Centre (CNPA)** | The research model was elitist and was not appropriate for Brazilian farmers | The cotton research centre had been more influenced by the scientific community than by the production system | The research results did not reach small farmers | Regional research | It needed to renew itself as soon as possible |
| **Management Team of the Goat Research Centre (CNPC)** | Some technologies did not meet goat farmer interests | Goat farmers were semiliterate, have little money and are unorganised | It had paid little attention to technology diffusion | The researchers would create and diffuse technologies. Postgraduate courses and managers have influenced researchers | It had credibility in Brazil. It would never be declared a failure |
| **Management Team of the Soya bean Research Centre (CNPSo)** | It increased the national agricultural productivity. Soya bean technologies reached all types of farmers including unorganised farmers | The Soya bean Research Centre had created technology in accordance with farmers' demands | The Soya bean farmers were better prepared to adopt Soya bean technologies | The Soya bean Research Centre had a suitable organisational structure | It will never be closed down. It was necessary for EMBRAPA to have some partnerships with states and regions |
| **Management Team of the Sheep Research Centre (CNPO)** | Technology was useful for all types of farmers. The focus was on increasing productivity | The early adopters were pressuring EMBRAPA to attend to their demands | It was difficult to address demands from small farmers | The regional research centre model was a more appropriate structure than a national research centre | In the past the Sheep Research Centre was a closed organisation |

Today, a former executive who continues to be influential holds the view that EMBRAPA does not need sociologists[45]. For him, EMBRAPA must not concern itself with

[45]Maxwell [1984], *The Social Scientist in Farming System Research,* argues that this assumption contrasts with the real social scientist's role in the agricultural research system. Moreover, according to Hall and Midgley [1988: 3], *Introduction*, In: Development policies: Sociological Perspectives, 'in some cases, the under-utilisation of sociologists is due to ignorance about the sociologist's technical abilities and potential value, and in some cases it is because of a mistaken belief that sociologists are purveyors of left-wing ideologies. Indeed, the term 'sociology' is often confused with socialism'. Biggs and Grosvenor-Alsop [1984: 108], ibid., also remark that 'the skills of sociologists help not only in diagnosing problems but also in forecasting the socio-economic circumstances' which farmers 'might expect to face in the future'.

rural poverty. It *was created to support Brazilian agricultural modernisation* and must create technology in order to increase production and productivity mainly for export and cash products. The most important goal was to increase agricultural productivity in order to produce an agricultural surplus. This comes from the Green Revolution recipe and promotes the concentration of capital by the large and export farmers. Further, this was the agricultural modernisation strategy used by the Brazilian authoritarian government of the 1970s. In fact, both the founding EMBRAPA President and the first executive have had strong relationships with international organisations, such as the World Bank, IDB (Inter-American Development Bank), IICA (Inter-American Agrarian Sciences Institute), IARC (International Research Centres) and the former military rule in Brazil.

Table 7.8 confirms that EMBRAPA consolidated its research model in two ways. First, it promoted strong overseas training. The Founding Theorist stated that the international sources *offered financial resources, especially for overseas training*. Secondly, the main objective was to transfer technology developed in the advanced countries, such as the United States and the European countries, to Brazil. This was the strategy used to promote the so-called modernisation of agriculture. For a former EMBRAPA President of left wing sympathies, *EMBRAPA was created to follow Green Revolution principles*, and *EMBRAPA was not concerned with environmental issues or small farmers demands*. According to him, to cope with these aims, the *state-owned type organisation was chosen to facilitate recruitment without public competition*.

This is supported by the Head of the Personnel Department, an executive and influential bureaucratic official. EMBRAPA recruited its members without the need for public competition until 1985. This was thirteen years after its creation. In that period democracy was established in Brazil. The recruitment process concerned itself only with the Scientific Technical Department's (DTC) analysis of a candidate's curriculum vitae, so there could have been a degree of homogeneity in the personnel contracted.

Thus, EMBRAPA did not encourage any discussion of its research procedure. According to the Founding President, *EMBRAPA did not empower new ideas in its research model*, and, according to the Founding Theorist *EMBRAPA was an example of deviation from the initial proposals*. It was linked to the military dictatorship's doctrine and in particular followed the doctrine of national security[46].

It is important to state that the only former EMBRAPA President with-left wing sympathies gave the elitist evaluation. For him, the research scheme is designed to increase the productivity of crops and husbandry, independent of environmental and social issues. Productivity, rational and neutral science are characteristics of the research agenda.

Much of the evidence collected from the interviews in the research centres' management team in Table 7.8 show that there was a great deal of common ground, such as the scientific neutrality of agricultural technology. Although the Management Team of the Cotton Research Centre argued that the *research was elitist and was not appropriate to Brazilian reality*, the management team of the Soya bean Research Centre, in contrast, emphasised that *EMBRAPA technology increased national agricultural productivity. Soya bean technologies reach all types of farmers, including unorganised farmers.*

The adviser and departmental head's attitudes shown in Table 7.8 do not form a standard assessment. Their attitudes ranged from the view that *technology was neutral and*

[46]Goldthorpe [1993: 266], ibid., emphasises that the 'Escola Superior de Guerra' [War School] in Brazil imbued its students with the necessity for the moral and economic redemption of their country to enable it to take its rightful role in the struggle for the Christian West against the Communist East'.

*useful for all types of farmers* to EMBRAPA considered as a *closed and centralised organisation*. The Head of Strategic Administration Secretariat stated that Brazil did not need an agricultural research organisation focused on the supply-oriented model. In contrast, the Head of the Project and Studies Department defended it. It is important to note that the advisers and departments constitute the intermediary bureaucratic levels between executives and research centres. They centralise much power in headquarters and dictate norms and controls to the research centres. Almost all the departmental and advisory heads had a strong corporate ethos with regard to EMBRAPA matters.

For example, with the establishment of democracy in Brazil in 1985, EMBRAPA experienced its first internal political crisis. After tough political negotiation, an outside lecturer and non-EMBRAPA member was appointed president. It appeared to be an opportunity for new agricultural research priorities and new projects, which examined marginal and poor farmers were suggested. Debates about technology and social and political roles were also initiated. At that moment, severe criticisms were made of EMBRAPA's links to Green Revolution principles. The *Concentrated Model,* the hierarchy and centralised organisational structure were all debated as well.

The research program changed from export products to food crops such as beans, rice, cassava, corn and milk. Research projects were to give more support to sustainable agriculture. Alternative movements, such as NGOs and organic agricultural organisations, were to be consulted about their needs. It was a confusing time for EMBRAPA. Employees, especially researchers lobbied to fire the President of EMBRAPA. The agricultural chemical companies and conservative politicians also lobbied to remove him from office. After eleven months, the President was sacked and replaced by a representative of the previous ideology.

Further, in the early 1990s, criticisms of the new EMBRAPA research strategy have been made. Political pressures from outside, the employees union's critical analysis and boycotts from older leaders had made the implementation of the new research strategies difficult.

According to Ávila [n.d.] this exemplifies the various difficulties which hinder change in EMBRAPA and stem from the relationship between EMBRAPA's 'parallel power' (hidden power) and economic and political groups. 'Parallel power' is invisible, formed by conservative people who, in the past, were linked to military rule and its main function is to protect the old leadership and frustrate the new one. Thus, in many respects, EMBRAPA's research model has remained the same since it was created.

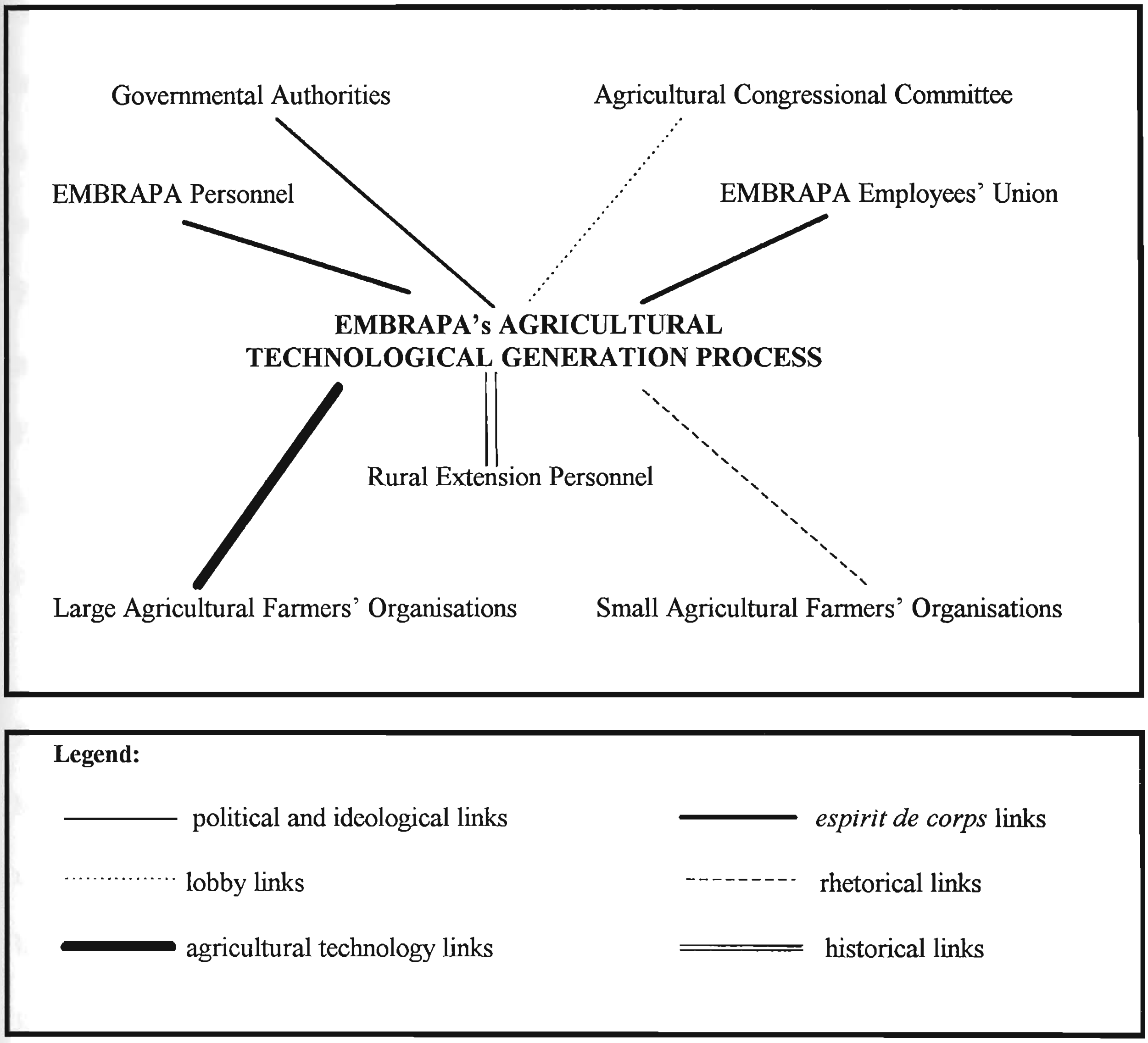
Therefore, evidence in this thesis shows the links between EMBRAPA and several individuals and organisations. This indicates that organisations were not closed systems, and were on the contrary, a part of the wide socio-economic environment. Influences came from the segments which led to the agricultural technology generation process. From this perspective, it is possible to note how organisations function as a socio-technical system, which focus on the concentration and distribution of power within the organisation, interest groups and those social players who make up the system.

It was not a 'collaborative' and harmonious process however, it was shared by private interests. Also, the attitudes towards and pressures on the agricultural technology generation process came from the political arena, and address the scientific realm where the technology was developed. In other words, in accordance with Biggs [1995a: 8] these links were called 'coalitions and negotiations of Science and Technology in different arenas'[47]. From this

[47]Biggs [1995: 8], *Farming Systems Research and Rural Poverty: Relationships between Context and Content*, recognises that in the 'contending coalitions, organisations and individuals have to decide which ones to be a part of in different political arenas. Some groups have a comparative advantage to contribute to those coalitions'. Also, Biggs and Smith [1995: 7], *Contending Coalitions in Agricultural Research and*

perspective, Figure 7.1 indicates the links between EMBRAPA's agricultural technology generation process and the groups surveyed.

**Figure 7.1 - Links Between EMBRAPA and Surveyed Groups**




It is important to note that influences came from the government, parliament, the farmers' organisations, the rural extension agencies, unions and EMBRAPA's members themselves. All of these pursued their interests and the most powerful ones had influenced the

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*Development: Challenges for Planning and Management*, argue that 'there is a network of formal and informal linkages within the coalition, and between members of the coalition and outsiders'.

organisation's output. This means that EMBRAPA's form, structure and goals had been associated with the demands from the interest groups in which the organisation was located[48].

In light of Figure 1, EMBRAPA as a state-owned, bureaucratic and top-down organisation did not have proactive links with small scale and subsistence farmers. On the one hand, the EMBRAPA supply-led model which focused on specific agricultural products did not attend to the rural extension service needs as well. On the other hand, government authorities' and large farmers' formed strong interest groups and profitable links with EMBRAPA. They shaped the organisational design and influenced its ends. It was not a neutral organisation serving all types of farmers but was a selective and discriminating one. EMBRAPA was connected in different ways to each group surveyed (for instance, rhetorical, historical and political links) and at the same time, it was inter-related with the social and political context in which it operated.

Further, there were direct ties between EMBRAPA and large farmers. The EMBRAPA generation process attended to the needs of the large farmers. In contrast, the links between EMBRAPA and small farmers and rural extension agencies were rhetorical and unprofitable ones. Also, the agricultural technology generation process maintained exclusive links with conservative politicians, such as the Agricultural Congressional Committee and the government representatives. They represented the interests of the archaic rural elite, for instance in the highly concentrated land-tenure system and subsidised rural credit. Once more,

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[48]For instance, according to Portugal [1996: 86], *Proceedings of the Science and Economic Development Seminar,* who is the actual President of EMBRAPA, 'EMBRAPA has established co-operation [linkages] with national and international companies such as Agroceres, Ciba Geigy, Dow Chemical S.A., Union Carbide, Pfeizer Chemistry, Monsanto and others. Also important associations with institutes and foundations such as the Rockefeller Foundation, Pasteur Institute, Gerdat, INRA, CIRAD, USDA and recently, **research projects has been negotiated with the participation of private groups** '....' for resolving a scientific problem'. (my emphases).

this showed that EMBRAPA technology was suitable for capitalist agriculture based on modern inputs and industrial or export commodity-led.

Moreover, Figure 7.1 indicates that EMBRAPA's members and their union constituted a strong *espirit de corps*. They pursued salary and internal matters rather than the relationship between EMBRAPA and society. These links show in a different way a *corporate ethos* within EMBRAPA. Further EMBRAPA's organisational structure of the top-down and commodity-led research model, did not encourage participation of rural extension agencies and small farmers. For example, the links between EMBRAPA and the landless movement, the Catholic church, NGOs and other alternative rural movements remained unprofitable ones. EMBRAPA's research agenda had not included social or environmental issues or considered the requirements of the farm as a whole.

All these demonstrate that EMBRAPA was created to serve a new Brazilian agricultural pattern designed by the rule of the military dictatorship. First, the aim was capital accumulation by the economic organised groups through the modernisation of agriculture focused on single crops, large areas and capital-intensive technologies. Secondly, it has been supporting agricultural exportation and the production of cheap food to feed the urban and industrial proletariat. These have been the government's proposals since the 1970s. This model has been considered the most appropriate economic model for Brazil, particularly with respect to the internalisation and standardisation of agriculture.

Finally, it is important to say that EMBRAPA has a number of ways forward. First, it can maintain its present research strategy and risk closure. Secondly, it can maintain a part of its research strategy, mainly in relation to strategic issues and privatise other agricultural research activities. Thirdly, it can change its research strategy and, in particular, the agricultural research process in order to serve all farming segments through the farm as a whole research model. In this case the majority of farmers would support EMBRAPA.

**7.9. Summary**

This chapter has investigated the links between users, clients, politicians, unions and other segments interested in agricultural technology and EMBRAPA. In other words, how the representatives of the government, farmers' organisations, politicians, unions, rural extension personnel, policy-makers, assessed and influenced EMBRAPA's agricultural technology generation process. Negotiations and organised interests addressed the links in the scientific and political arenas. Eighty representatives of several bodies were surveyed. Unstructured interviews were carried out and observations made. In reality, the agricultural technology generation process is a socio-technical process open to several influences: from the researcher, from the organisation and from society. Thus, the technology generated was not neutral, there were instead several ties linking it to specific users. On the one hand, larger farmers formed interest groups and contributed in various ways to the type of agricultural technology developed and they influenced the organisation's output. On the other, the agricultural technology had not attended to small sized farmers and rural extension agencies needs, who operated as a powerless interest group. EMBRAPA's managers and the employees union have been concerned with the organisation's internal issues, such as staff and scientific careers matters and wage levels. They constituted a powerful *espirit de corps*. Government representatives and the agricultural congressional committee supported EMBRAPA's current status. Most assumed that the effectiveness of the agricultural technology was correlated to the transfer process and not the technology itself and its generation process. Evidence also shows that EMBRAPA has targeted capitalised farmers instead of small and subsistence farmers. The agricultural research model and its organisational structure of the supply-led and top-down type did not facilitate rural extension or small farmer participation. Further, the research model focusing on specific agricultural products rather than on the *farm as a whole*, did not meet the demands of the majority of Brazilian farmers.

# CHAPTER 8

# CONCLUSIONS

## 8.1. General Summary

Conventional studies of agricultural technology have focused on diffusion and adoption. Behaviourism is the dominant framework of these studies where the adoption of agricultural technology by farmers depends more on technology transfer, i.e. the communication between source and receiver than on the technology itself. The source generates the technology and each receiver makes a decision about adoption according to individual and occupational values.

From this perspective, the process of agricultural technology generation is not active, nor does it influence its diffusion and adoption by farmers. Technology in the 'adoption-diffusion' schema is neutral and is useful to a wide range of potential adopters. Social, political and organisational differences are not considered. There is no effective link between those that generate agricultural technology and those that adopt it. Diffusion and generation are thought to be independent and unconnected processes. In Brazil, the *diffusionist* approach has led to a great volume of empirical research and findings, but this has not promoted social change. Pastore et al [1982] state that empirical evidence of the successes of agricultural technology innovation has been in the area of commercial staples rather than in subsistence agriculture. According to Macêdo [1984: 2], in reality the emphasis on commercial staples is an imposition of technology which is generated to serve a specific type of adopter.

It is however imperative to understand how the agricultural technology generation process works, and its implications for the adoption process. Technology is usually developed in state organisations operating in a particular social context and is the result of the social contradictions through which it is generated. According to Goldsmith [1993: 197], organisations 'are complicated, unpredictable and subject to multiple influences '...' agricultural research organisations are not an exception'. In this thesis, the agricultural generation process based on specific commodities was developed by agricultural researchers in a state-owned organisation - EMBRAPA. This organisation has a nation-wide mandate through the national research centres and is affiliated to the Ministry of Agriculture. At the time of the field-work, EMBRAPA had around ten thousand employees, two thousand of whom were researchers. Eighty-eight per cent of them have Masters or PhD qualifications.

In the context of agricultural globalisation, modernisation and underdevelopment theories are the most appropriate theoretical frameworks for this thesis. The difference between traditional and modern society is the basis of modernisation theory. Technology diffusion from Western (modern) society to the underdeveloped world (traditional society) is considered to be a *one way* process. In other words, modernisation was the result of Western culture spread to the Third World countries. In contrast, underdevelopment theory (dependency, world system, 'urban bias' and 'putting the last first') indicated who the winners and losers were in the global economy. From this perspective, industrialisation and economic growth were seen as a cause of social inequality, poverty, exploitation and the degradation of urban and rural populations. According to Whiston [1996: 47], the global division between developed and underdeveloped countries or between North and South, led to the 'considerable exclusion' of underdeveloped regions from economic, scientific and technological progress.

From this empirical study, primary and secondary data were collected in Brazil from August 1994 to February 1995. These were obtained through questionnaires, unstructured interviews, official reports and archives. The population researched were EMBRAPA agricultural researchers actually involved in the agricultural technology generation process, representatives of users, policy makers, politicians, managers and others interested in agricultural technology across the country. The research strategy consisted of three stages. First, the agricultural technology generation process was investigated in which four National Research Centres were surveyed. Two of these were from the North-east, the poorest region, the National Cotton and Goat Research Centres and two were from the rich Southern region, the National Soya bean and Sheep Research Centres. In total, eighty-seven agricultural researchers were interviewed, accounting for almost 90% of the research population.

Secondly, two strategies were used to examine the relationship between agricultural technology generation and its adoption. Two case studies involving two agricultural technology successes were considered. These were the *Brasília* carrot and the *Doko* Soya bean varieties adopted by farmers in the *Cerrados* region, the Brazilian Savannahs. One hundred and forty-four carrot and Soya bean farmers were interviewed. Thirdly, approximately eighty representatives of the users, policy-makers, politicians and managers associated with the agricultural technology were sampled. These involved the representatives of the government, of the large and small farmers, of rural extension, of Congress, and finally those of the agricultural research managers and unions. The objective was to comprehend the attitudes of these social actors towards the agricultural technology generation process, particularly to see whether the agricultural technology matched their needs and demands. In a general sense, these constituted a wide *social audit* of the Brazilian agricultural technology generation process.

A wide range of information relating to the agricultural technology generation process and its implications was obtained. First, the empirical findings show how the agricultural technology generation process in Brazil works and its social implications. It is a socio-technical process in which the technology generated is a function of the organisation's goals, the agricultural researcher's social class and their social values. Influences also come from the national and international environment with which the organisation is connected.

Secondly, in relation to the theoretical contribution, the major findings contrast with the 'adoption-diffusion' approach and support Biggs' [1982] arguments that another approach for analysing agricultural technology is through the research organisations which generate it and Busch's [1991: 71] criticism that the 'adoption-diffusion' concept 'is undermined'. As well as this, the findings are in accordance with Silverman's [1983: 109 and 121] explanation that the prime task of organisations is to examine 'the inter-relationships of technology, environment, the sentiments of the participants and the organisational form'. For Silverman, 'technology and the pressures of the market determine organisational form'. Further, Busch and Lacy [1981: 124] noted 'that organisational, structure, interpersonal relationships, and methodological, as well as the scientist's disciplinary concerns, shaped the [research] problem choice'.

Also, empirical data shows the disconnection between the EMBRAPA agricultural technology process and the majority of farmers' needs. The organisation targets the organised and powerful farmers much more than the small and subsistence farmers. This process focuses on a few agricultural products and not on the *farm as a whole*. In this vein, Guzinán and Molina [1996: 158] write that the agricultural technology research organisation in specific disciplines focuses on the maximisation of one particular factor of production. The social, political, economic and environmental interactions are not part of the research agenda.

Finally, suggestions are presented for a new agricultural technology research model, in the light of the findings of the thesis and in accordance with the Brazilian reality. The implications of the study, including the thesis hypotheses, land reform and agricultural policy, the focus on agricultural innovation, the training of researchers and future research are also explored.

### 8.2. The Major Findings

The presentation of the major findings follows a schema. First, the data is related to the agricultural technology generation process and, secondly, the adoption of and attitude towards agricultural technology is presented. Both address the thesis research questions and the thesis hypotheses.

#### 8.2.1. The Agricultural Technology Generation Process

The agricultural technology generation process was developed by agricultural researchers within a research organisation. They were civil servants linked to a state-owned organisation - EMBRAPA - which worked as a socio-technical system.

The description of the agricultural technology generation process follows a framework. First, a profile of the agricultural researchers including factors such as, gender, age, origin and education is presented. Secondly, their research process is outlined. This comprises the recruitment process, the research lines, the researchers' corporate ethos, their involvement in the local community and the research project. Thirdly, the way in which the agricultural researcher selects research issues is demonstrated. The research problem is the most important stage of the agricultural technology generation process and leads on to all the phases of the research activity. All these factors, in different ways, influence the technology generation process.

The agricultural technology generation process was controlled by urban, mainly male agricultural researchers, aged between 44 and 49 years old. The majority of them were born in the South, South Eastern and Central-Western regions which are richer than the North-eastern and Northern ones, and the majority of their fathers were not employed in agriculture or livestock. The researchers were awarded their primary and university degrees in state schools. However, most of them reached secondary level in private schools. It is important to say that in accordance with Brazilian social class stratification, civil servants, such as EMBRAPA researchers, are members of the middle social class. In contrast, the small and subsistence farmers constitute the lower social class, and the landowners, politicians and technocratic representatives are the dominant social class.

In Brazil, university recruitment is selective and prospective candidates compete in a public examination. Thus, the quality of the secondary school is crucial for getting a place at university. Today, in Brazil, the best primary and secondary schools are private ones, although the best universities are state ones. However, before the 1970s, the best primary and secondary schools were state ones. The Brazilian government, particularly the military rule, prioritised higher education instead of basic education at primary and secondary levels. In reality, the basic education system is the principal ground upon which national technology development is based. Nowadays, Brazil's illiteracy rate is about 20%.

The agricultural researchers' background had a degree of homogeneity. Seventy-two per cent of all the researchers interviewed took an agronomy course. In the CNPA and the CNPSo cases, 84% and about 96% of all agricultural researchers respectively, undertook an agronomy course. Breeding and genetics was the dominant research line. This is associated with the development of new varieties and new animal stocks and is an important Green Revolution principle. Moreover, 96.55% of all researchers took Masters courses, normally in the same region that they were born and in which they undertook their undergraduate degrees. They also generate agricultural technology in the research centres situated in the same region. Thirty-eight per cent of the researchers hold PhDs from American or European universities. This shows a mass of well-trained researchers. Sociology and humanities specialisation did not receive much attention. The social consequences of the agricultural technology generation and adoption processes was thus difficult for the research organisation to integrate into their way of thinking. The subtle aim was the standardisation of agricultural technology.

The agricultural researchers' recruitment method was not, at first, through competitive exams. Only 19.5% of researchers were recruited by public competition. This was selective recruitment in accordance with the organisation's requirements. Academic evaluation was the main requirement of researchers. Researchers who had recently graduated were recruited by EMBRAPA. In the case of the researchers surveyed, 69% were recruited after the completion of their first university degree. Professional experience beyond *university degrees* was not considered. This suggests that it was easy for EMBRAPA to impose its ideological preferences on researchers. Moreover, a strong corporate ethos developed within it.

For instance, 91% of all researchers believed that *EMBRAPA was the best Brazilian agricultural organisation* and 100% said that they *very much enjoyed being an EMBRAPA researcher*. Also, all the research centres surveyed rejected links with agricultural organisations, such as NGOs, universities and co-operatives. The researchers believed that to improve its agricultural technology generation process EMBRAPA needs money and not intensive relationships with universities, rural extension agencies, co-operatives and NGOs. For instance, the highest CNPSo's mean of 4.08 was for *EMBRAPA only needs money* and, the lowest mean was the CNPSo's mean of 1.17 indicating the EMBRAPA *link with rural extension agencies*. ANOVA outputs were only statistically different for *EMBRAPA only needs money*, among CNPSo's mean of 4.08 and CNPA's mean of 2.60 and CNPSo's mean of 4.08 and CNPO's mean of 2.86. This reflects a different side to the researchers' corporate ethos.

In fact, in various ways these were reflected in the researchers' scientific practice. First, *literature reviews* were the main activity of the researchers prior to defining the research project. Farmers and rural extension issues were not the researchers' main inspirations. Secondly, the research project approval process involved isolated and closed decision-making in the scientific realm, and the research project was seen much more as *a solution to national problems* than *a solution to local problems*. Thirdly, the researchers spent much more time on research project *rituals* than on farmers and rural extension demands. For instance, they stated that they preferred publishing their research findings in national and international scientific and specialised publications rather than in the form of information for the purpose of rural extension. These findings illustrate the research organisation's subtle rules, as researcher promotion is based on the publication of scientific papers.

It is important to bear in mind that agricultural technology generation is a much more complex process than it would initially seem. It is associated with various sources of influence stemming from the researcher, the organisation and society at large and works like a socio-technical system. Influences come from the organisation, the researchers and the national and international arenas. An effort to collect empirical evidence specifically related to the influences on the choice of the research problem by agricultural researchers was successfully made. Thurstone's coefficient was applied to measure, in decreasing order, the researcher's attitudes towards the choice of the research problem. For example, in the four research centres surveyed the principal agricultural researcher's collaboration with the agricultural technology generation process was linked more to views of *scientific peers in Brazil* than to the collaboration with *farmers' organisations*. This is clear evidence that the agricultural technology research process is significantly more identified with the scientific realm than with farmers' needs. This is another facet of the research organisation's procedure.

Further, empirical data shows that the choice of research problem by agricultural researchers was strongly influenced by factors from the scientific field. For example, *professional experience* had the highest Thurstone's coefficient, though 69% of all the researchers completed their undergraduate courses either before 1973 or between 1973 and 1976. In reality, apart from their academic life, the researchers did not have any other professional experience (EMBRAPA was created in 1972). Thurstone's coefficient for *scientific background* came fourth and *scientific literature* came eighth. *Rural extension demands* was placed between the thirteenth and twentieth in order of importance. In relation to *farmers' demands*, the coefficient was ordered from second to seventieth place in decreasing order. Once again, these are illustrations of the organisation's goals.

### 8.2.2. The Adoption and Attitudes Towards Agricultural Technology

EMBRAPA's official mandate is that the *agricultural technology process starts and ends with farmers*. This is the rhetoric incorporated into agricultural researcher practice. Presumably this means just a few, organised farmers and not the great majority of Brazilian farmers. The evaluation of the rural extension programmes does not make up part of this study. In Brazil, agricultural technology generation and transference are two distinct and separate processes. In reality, there is a huge gulf between the amount of agricultural technology generated and that which is effectively incorporated into the farmers' production systems, especially by the small and subsistence farmers.

The best organised groups have been able to pressure and negotiate for their interests and so to influence the agricultural technology generation process. These groups form strong and skilful interest groups at various levels of the state apparatus - government, Congress, funding supporters and the research organisation. Here, two case studies related to the two agricultural technologies adopted by farmers were sampled. And the attitudes towards agricultural technology were examined, too.

#### 8.2.2.1. The *Brasília* Carrot and the *Doko* Soya Bean Adoption Cases

In Brazil, most of the agricultural technology or knowledge of agricultural technology is either appropriate only to the scientific sphere or lies idle in the researchers' files. This is a continuing criticism of the agricultural technology generation process in Brazil. There is an enormous gap between the agricultural technology generated and that which is incorporated into productive farming systems. There has been no effective social assessment of the technologies generated and its consequent adoption by farmers.

To understand why farmers adopted agricultural technology and the relations between the generation and adoption processes, case studies of two EMBRAPA technology successes were analysed. Case study 1, the *Brasília* carrot variety and Case study 2, the *Doko* Soya bean variety. In both cases, one hundred and forty-four farmers in the *Cerrados* region, the Brazilian Savannahs, a highly subsidised agricultural frontier, were interviewed.

Perceptions differed between carrot and Soya bean farmers because of their particular demands, standard of living and social class. Researchers and farmers were from different social classes. In a broad sense, researchers came from the middle class, whilst Soya bean and carrot farmers were members of middle and low social classes respectively. The influences on the research process were different, too. Researcher values were divergent and research proposals were distinct. These differences contributed to the agricultural generation process *modus operandi*. Indeed, the agricultural research generation process was not an assembly line or a mechanical operation. On the contrary, it depended on the social, economic, political and organisational forces acting upon it. However, the common factor was that both agricultural researcher teams led by geneticists, successfully developed the research process. They responded to farmers' and consumers' needs.

The agricultural generation process of the *Brasília* carrot led by a geneticist - a domestic food grown by small farmers and dispersed throughout the country -, was a 'collaborative' process between agricultural researchers, farmers and rural extension agents and attended to farmers' and consumers' requirements. It was not a typical EMBRAPA research schema. In contrast, the Soya bean was an export and industrial staple highly subsidised by the government and grown by large and capitalised farmers in concentrated geographical areas. The agricultural generation process of the *Doko* Soya bean was also led by geneticists though a 'transfer-technology' research type met the farmers' demands, too. There was a one-way process between the Soya bean researchers and the research organisation and farmers. Further, Soya bean production and export was subsidised by the government (by factors outside the 'technological circuit'), which could reduce the risk of farmers' adoption of the technology.

It is plausible to think that the generation of the *Brasília* carrot depended much more on the agricultural research leader's personal sensibilities than upon the EMBRAPA research scheme. Researchers, rural extension agents and farmers participated in the generation, validation and adoption of the *Brasília* carrot. The *Brasília* carrot farmers did not constitute strong interest groups able to 'negotiate' for their interests with the state apparatus. In a different way, the *Doko* Soya bean's *modus operandi* looked for increased productivity and disease resistance, independent of social and environmental factors. Rural extension agents and farmers were not active participants in its generation, validation and adoption. The *Doko* Soya bean farmers, however formed a powerful organised pressure group which exerted pressure through its demands. Productivity based on capital-intensive inputs was the principal research focus. This is illustrative of EMBRAPA's research model.

Also, in the *Brasília* carrot case, the diffusion of the experiment results was not theorised in a scientific paper published in a journal or given at a seminar or conference. The research team grew the *Brasília* carrot on a large-scale to be distributed to farmers. This is called the *production of the basic carrot seed*. Afterwards, the *Brasília* carrot seed production technology was transferred to private companies and farmers. However, in the case of the *Doko* Soya bean, the commercial seed multiplication was carried out by the co-operatives or the SPSB (Basic Seed Production Service). The researchers were not directly involved in this phase.

Evidence shows that both varieties were adopted by farmers. Both technologies increased productivity and controlled some diseases. Both were developed by agricultural researchers, particularly geneticists. Both were launched in the same period and in the same region - *Cerrados* - and both contributed to farmers' profits. In reality, the link between the agricultural generation process of the *Brasilia* carrot and the *Doko* Soya bean, and the adoption by farmers, were independent of communication between the source (agricultural research organisation) and the receivers (farmers). The crucial factor in both cases was the relevance to farmers of the agricultural technology generation process addressed by the researchers.

#### 8.2.2.2. Attitudes Towards Agricultural Technology

In Brazil, the agricultural research system consists of four groups of organisations: universities and schools of agriculture (most of which belong to the federal government); state organisations (research institutes and companies); organisations of the Ministry of Agriculture and private sector organisations. At the time of the research, EMBRAPA co-ordinated 3,200 agricultural research projects throughout the country. EMBRAPA was created in 1972 during the agricultural modernisation era when Brazil experienced a high index of economic growth; with GDP growing at about 10% per year, it was called the *Brazilian economic miracle*. In that period, State intervention was mainly through state-owned organisations in the various fields of economic development. Parliamentary and civil organisations were closed down by the military order. At the same time, the State became an attractive target for pressure from organised and allied groups.

This thesis investigates EMBRAPA as a socio-technical organisation, whereby the agricultural technology generation process is open to the internal and external influences in the research organisation's immediate vicinity. Most of these influences are subtle and go unnoticed by the agricultural researchers. For instance, the influences from the organisation's aims and goals, from government policies, from the researchers' origins and their social class, and from the organised interests. All of these provide inputs for the agricultural technology generation process. Based on this, attitudes, interests and links towards agricultural technology were investigated; around eighty representatives of users, clients, government, Congress and unions responded to sets of questions in personal interviews.

The attitudes of the small farmers' agricultural organisations' representatives contrasted with the aims of EMBRAPA's current agricultural technology process. From their perspective, the present commodity-led generation process did not address the small farmers' production systems' needs nor did it facilitate small farmers' participation in the agricultural research process. They did not adopt EMBRAPA agricultural technology. Thus the links between EMBRAPA and the small farmers were purely rhetorical. The small farmers did not constitute an interest group influential enough to pressure for their interests. They predicted that if EMBRAPA did not change its agricultural research strategy, it would be declared a failure from their point of view. A similar opinion was given by the state rural extension representatives. Further, the current links between EMBRAPA and rural extension agencies were historical and passive ones.

However, the representatives of the large farmers' organisations and their allies supported the current agricultural technology and its research model. They were members of EMBRAPA's advisory councils, influencing Congress and the public on the maintenance of EMBRAPA's status. For instance, they believed in the *Agricultural Parliamentary Support (bancada ruralista),* which was the most powerful support in Congress in political terms, even though they did not support EMBRAPA financially. For them, *agricultural technology may be adopted if it increases profits*. This showed that environmental issues and the social consequences of technology did not form part of the agenda of large farmers' organisations.

The agricultural congressional committee of the Federal Deputy Chamber is the Parliamentary body in charge of agricultural matters. In fact, this committee is much more appropriate for lobbies from *interest groups* than for technical and scientific issues. Agricultural technology matters did not take up a great deal of the parliamentary agenda. Land reform, subsidised rural credit and government taxes were the most significant subjects for parliamentary agricultural interest. They also supported the current EMBRAPA research model. In practice, they represented the interests of capitalist agriculture and the rural elite[1] which constitute EMBRAPA's main clients.

EMBRAPA personnel (executives, advisor and managers) and the Employees' Union generally were linked to EMBRAPA through *espirit de corpus*. They were concerned much more with internal affairs, such as internal power and wage distribution than with the relationships between the agricultural research organisation, farmers and rural extension agencies. Also, they did not take into account agricultural technology's social benefits.

Apart from the President of the National Employees' Union, who declared that *EMBRAPA was a myth of efficiency and productivity* and that *it did not have a social function,* the interests of the President of the Research Centres' Union were limited to internal matters (for instance, the conflicts between researchers and staff, strikes and pay arises). From this perspective, it is worth noting the percentage of EMBRAPA's budget spent on salaries which increased from 1985. During this period, democracy was established in Brazil, allowing for some action to be taken by the employees' organisation. For instance, in 1984, 46.84% of the budget was spent on employees' salaries, whilst financial support for research activities accounted for 37.44%. In 1992, 81.19% of the budget was spent on employees' salaries and

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[1]In this way, Payne [1995: 234-5], *Brazilian Business and the Democratic Transition: New Attitudes and Influences,* shows that the landowners' interests are represented in Parliament through the large farmers' organisations, such as CNA and SRB.

only 12.09% was directed towards research activities. This financial distribution can be seen as a result of union pressure.

The view of those representing the government towards agricultural technology came from five Ministries with two higher civil officials linked to two state organisations. They had political and administrative links with agricultural technology in general and with EMBRAPA in particular. In Brazil, Ministries have a great deal of political power. The executive and administrative power lies with the organisations attached to them. An example of the elite's power in Brazilian society is the fact that, at the time of the research, the Minister of Cabinet to the President of the Republic was an EMBRAPA employee and greatly involved in EMBRAPA administrative issues and the Minister of Strategic Issues was the father of EMBRAPA's President. The Ministers of Cabinet to the President of the Republic and of Strategic Issues had some knowledge of the agricultural technology organisation and knew *EMBRAPA was far removed from small farmers and from ordinary people* and that the *technology had not met small farmers' needs.* Also, both Ministers predicted that EMBRAPA may be unsuccessful in the future.

The other ministers, specifically the Minister of Trade and Industry, the Minister of Planning, and the Minister of Science and Technology saw EMBRAPA as an important part of Brazilian agricultural development and as part of their national pride. They did not have sound knowledge of agricultural technology matters. They focused on the relationship between EMBRAPA and the state agricultural research systems and the failure of the Brazilian agricultural transfer process as an illustration of the inadequacy of agricultural technology for the farmers' production system. The ministers had different links to government power. Some had personal ties to the President of the Republic (such as the Minister of Cabinet to the

President of the Republic and the Minister of Strategic Issues, a former Minister of the Navy). Others were affiliated to the political parties which supported the President. For example, the Minister of Trade and Industry, who was a senator linked to the right-wing Liberal Front Party - PFL -, and the Minister of Planning, who was a senator linked to the centre-left party, the Social Democracy Party - PSDB). The Minister of Science and Technology was a well-known chemistry scientist and a friend of the President of the Republic as well.

The representatives of government organisations included the Executive Director of the Economic Planning Research Institute (IPEA), an adviser to the Ministry of Planning, and the Financial Co-ordinator of the Agricultural Ministry, who is an adviser to the Ministry of Agriculture. In theory, the IPEA's executive is the main Ministry of Planning's adviser in matters related to the budget and the Financial Co-ordinator was the principal in charge of money transfer from the Ministry of Agriculture to EMBRAPA. They later voiced some concerns about the size of EMBRAPA's headquarters stating that *it had not prioritised food crops*. According to the Financial Co-ordinator, *poor farmers had not adopted the technologies*. Finally, the IPEA representative said that *EMBRAPA was a centralised organisation and that its results did not reach the farmers.*

### 8.3. Implications of the Study

The wide variety of empirical and theoretical findings in this thesis indicate important implications for sociological understanding, for the Brazilian agricultural research system and for society in general. First, evidence shows the influence of the agricultural technology generation process on the adoption by farmers. This indicates a correlation with the thesis' hypothesis formulated in Chapter 1 - section 1.3.

Secondly, a large amount of evidence indicates that the current EMBRAPA agricultural technology generation process and its organisational structure are not pertinent to the majority of Brazilian farmers' needs. Pastore [1995: personal communication] mentioned that *EMBRAPA was a ritualistic organisation*, and consequently *the ritualistic organisation tends to be a failure*. Moreover, Rosseto [1975] states that the EMBRAPA agricultural technology research process, based in the specific agricultural research centres and on a few products, was an authoritarian and technocratic model. This was a top-down research model which authoritatively separates those that generate and those that adjust to the agricultural technology. This resulted in a process of subordination, rather than a process of agricultural technology co-operation and co-ordination.

Thirdly, nowadays the technology generation process tends to build on new bases. The Cartesian, experimental, vertical (top-down type) and formal research method that separates those that know everything (knowledge owners) and those that know nothing (knowledge receptors) is a failure. From this perspective, Gibbons et al [1995: 3] distinguish between two types of knowledge production. 'Mode 1 where problems are set and solved in a context governed by the disciplinary, hierarchical, homogenous, largely academic interests of a specific community'. And 'Mode 2 where knowledge is carried out in a context of application, is transdisciplinary, heterogeneous, heterarchial and transient and more socially accountable and reflexive'. The EMBRAPA agricultural technology process resembles Mode 1.

As a consequence, the evidence in this thesis calls for a new Brazilian agricultural technology research model. In this way, Ruttan and Hayami [1990: 106] argue that 'the process of transforming institutions in response to technical and economic opportunities generally involves time-lags, social and political stress, and in some cases disruption of social and political order'. Also, in Brazil, bureaucratic transformations inside the state's apparatus need broad political negotiation at various levels - Congress, government and at the level of the civil servants' unions. Today, the government proposes to re-design the state's role. Privatisation and a reduction of the state apparatus are the goals. The focus is on a neo-liberal orientation. Land reform and agricultural policy, including the agricultural technology generation to meet the small and disadvantaged farmers' needs are not part of the government's agenda.

### 8.3.1. The Need for Land Reform

Agriculture and land reform have been treated under the same ministry in Brazil, (the Agricultural and Land Reform Ministry) except during periods either of democratic enthusiasm or of social pressure, for instance in the 'New Republic'[2] era and, currently, the 'Landless Workers' Movement (MST)'[3]. However, for analytical purposes, land reform and agricultural matters are separately presented here.

Land reform, particularly the problem of land concentration, is not a new issue. It is a renewed topic that has evolved over the years in the light of political and social demands. To understand land reform today, it is necessary to put it into the context of Brazilian history which embodies complex interpretations. It is also necessary to note the circumstances of the initial settlement of Brazil five centuries ago. The Portuguese Crown exploitation system was based on the hereditary captaincies (huge areas of land) given by the prominent European

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[2]This term was coined by the first civil Brazilian President after 21 years of military rule.

[3]Today, the 'Landless Worker's Movement' is the most organised and effective social movement in Brazil, having managed to press the government to deal with the problems of land reform. The movement uses a network of decentralised agents all over the country, under informed and well-trained leadership. They are able to gather and organise thousands of landless families for overnight occupation of unused land.

families which have moulded Brazilian society[4], including the territorial divisions. Also, the 1850 Land Law, the Abolition of Slavery in 1888, the Proclamation of the Republic in 1889, the first republican constitution in 1891, the 'Tenentistas' movement in 1920, and other important historical developments brought important social transformations in the country. But the problem of land ownership remained unresolved over the years.

From the late 1950s and 1960s land reform debates were witnessed either as a political banner of the left-wing parties and other social movements or as part of the academic agenda[5]. At that time, land reform was presented as one of the 'basic reforms' and in 1964, under military rule, a Land Statute (*Estatuto da Terra*[6]), which addresses of the question of land ownership and land use, was presented as a land reform proposal. Land reform was also a part of the agenda of the rural worker's organisations, mainly the *Ligas Camponesas* of the North-east, which struggled for an end to the unproductive *latifundium*. In the 1970s and early 1980s, still under military rule, social movements, political parties and increasing popular participation were highly repressed by the military dictatorship. Land reform was off the agenda.

By contrast, the government focused on the modernisation of agriculture and the colonisation programmes instead of land reform. Rural worker's organisations became bureaucratic and philanthropic bodies, in accordance with government development

[4]According to Prado Júnior [1967: 20], *The Colonial Background of Modern Brazil,* 'the colonization of the tropics appears as one vast commercial enterprise, more complex than the old trading stations but retaining the flavour of these, the foremost objective being the exploitation of the natural resources of a virgin land for the benefit of European commerce'.

[5]Guimarães, A. P. [1968], *Quatro Séculos de Latifúndio*; Prado Júnior, C. [1960], *Contribuição para a Análise da Questão Agrária no Brasil;* Rangel, I. [1962], *A Questão Agrária Brasileira* and Furatdo, C. [1963], *Formação Econômica do Brasil.*

[6]The Land Statute (Law 4504 of 30/11/1964) defines the *módulo rural* (the minimum legal size of a farm) as the area explored directly by the farmer and his family, which absorbs the family workforce and guarantees family subsistence. Also the social, technical and economic progress with a fixed area for each region and the type of farm exploration are considered.

programmes[7]. Agricultural research organisations were created, rural extension and technical assistance agencies were established, a healthy programme of subsidised rural credit instituted and the state colonisation programmes[8] were implemented. New agricultural frontiers were opened. In this way a modern agricultural research system co-ordinated by EMBRAPA contributed to intensive growth of agricultural production and productivity and weakened the pressure for land reform[9]. Yet a wave of rural workers, released by modern agriculture and attracted by the industry's demands for labour, migrated[10] to the big cities where they formed a mass of unemployed people living in shanty towns.

In the 1980s and 1990s land reform has been a long-standing element of Brazilian politics. Land reform was a part of the agenda of the 'New Republic' in 1985, and the National Constituent Assembly in 1986 respectively. However, the battle to achieve real land reform was again lost. As a result of these social and political contradictions, the combative MST was formally set up in 1985 to fight for land reform. This also exerted pressure on the government to intensify land reform programmes.

[7]For instance, the Northeastern Small Farmer Support Progrmme (PAPP) which was supported by the Brazilian government and the World Bank.
[8]For example, the National Integration Programme (PIN) created in 1970; the Land Redistribution and North and North-east Agricultural Industry Programme (PROTERRA) established in 1971; the São Francisco River Valley Special Programme (PROVALE) initiated in 1972; the Amazon Agricultural and Mineral Polo Programmes (POLOAMAZÔNIA) placed in 1974 and the North-east Integrated Areas Development Programme (POLONORDESTE) started in 1974.
[9]Graziano da Silva [1996: 147], *A Nova Dinâmica da Agricultura Brasileira*, and Graziano da Silva [1988: 29-30], *As Possibilidades e as Necessidades da Ciência e da Tecnologia na Área das Ciências Agrárias,* write that in the 1970s the technological innovations (mechanical, chemical, biological and agricultural innovations) generated and adapted by EMBRAPA, such as mechanisation, fertilisers, high-yielding seeds and new farming systems increased agricultural production and productivity and capital accumulation by the large and capitalised farmers. Also, the so-called modern inputs saved land, that is increased 'land productivity' and sustained the traditional landtenure system and the unproductive *latifundium*.
[10]In 1940 the Brazilian population was 41 million inhabitants (70% of them lived in rural areas and 30% in urban ones). In 1980, ten years after the modernisation had been consolidated, the population was 121 million, 68% of them living in urban areas. Nowadays, the population is around 160 million and 75% of the inhabitants live in urban areas.

In 1996, the government, led by a conservative alliance[11], established the Ministry of Land Reform to foster a land reform programme. It is important to note that, throughout Brazilian history, land reform as a strategy in pursuing capitalist development has been misunderstood by the conservative middle class. However, according to recent material in The Guardian [1997: 16], nowadays the MST enjoys 'the support of up to 90% of the Brazilian population'. This signals a new era, a shift in persistent, excessive and unproductive land concentration. However, according to Moraes [1993: 3], from the start of Portuguese colonisation to date, there has been no in-depth disruption of the *status quo* in Brazilian society, especially with regard to land concentration[12].

The 1990s land reform debate has added new features. On the one hand, the backwardness of land ownership, which survives from the colonial era, has attracted the attention of Brazilian society and the international community. Also, rural workers' empowerment, mainly through the nation-wide action of the MST[13], has exerted pressure on the land reform agenda. MST action is found all over the country. The movement's leadership takes its theoretical base from the Catholic Church, mainly Liberation Theology and the Brazilian educator Paulo Freire (participation and '*conscientização*'). Internationally the MST avowed the principles of the Cuban, Mexican and Chinese revolutions. An important factor is

[11]The Guardian [1997: 16], *The Long March Home,* states that in Brazil 'land reform is important, everyone agrees, but the landowners who control 180 of the 513 seats in Congress have retained their grip'.

[12]Petry [1997: 50], *Parado Por 500 Anos,* also remarks that 'in five hundred years of history, Brazil is the only continental country all over the world where the land tenure system remained its colonial format'. According to Flynn [1993: 23], *Brazil: Conflict or Conciliation?*, 'landowners still exercise a virtual monopoly of power in rural Brazil and give every indication that they intend to maintain it, as they have always done in the past. As long as this is so, and the state remains either powerless or unwilling to intervene, conflict and rural violence will continue'.

[13]According to The Sunday Times Magazine [1997: 27], *The War on Land,* 'the [Landless Workers' Movement] - MST - is an organisation of landless workers who seek to gain access to land that is not being used and to promote the idea of agrarian reform. By the end of the 1990s, the MST had become one of the largest and strongest movements in Brazil this century'.

the social origins of the MST leadership. They come from small farmers' families and some were themselves landless rural workers.

On the other hand, the present government claims that a wide national land reform programme has been designed to cater to the rural workers' demands. Also, the government stresses that it has settled more landless people than any other government in the last thirty-five years. However, according to rural workers' representative bodies such as CONTAG and MST, the government initiative has not been enough to attend to the mass of the landless people nor to change the archaic institution of the unproductive *latifundium*[14], the basic reason for concentration of income and power. Violence against the disadvantaged poor landless people is now unparalleled[15].

Land is not always regarded as an agricultural factor of production which needs to be preserved for the future. Land is also related to economic, political and ideological interests. Rural oligarchy measures its power through the amount of land that the so-called colonels

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[14]According to Brasil [1997: 21], *Reforma Agrária: Compromisso de Todos,* 'the Gini coefficient to land distribution among landowners in Brazil range from 0.731 (1960), 0.858 (1970) to 0.867 (1975). However, in the case of the landless families, the Gini coefficient range from 0.879 (1960), 0.938 (1970) to 0.942 (1975)'. This is high land concentration. The Gini coefficient range from 0 to 1 to measure inequalities, 1 being the highest inequality. In the same vein, The Sunday Times Magazine [1997: 27], ibid., writes that 'the landless in Brazil number is almost 20 million. They are men and women who have been replaced by machinery on the farms, or the children of small farmers who cannot afford to divide their land. According to The Guardian [1997:15], ibid., they are also the croppers, casual pickers, farm labourers and people thrown off the land by mechanisation and by land clearances] '...' there is enough farmland for everyone, but in Brazil almost half the land (43.5%) is in the hands of the 53,000 largest landowners, although they own just 0.83% of the farms. Although the mobilised poor are a peaceful movement, they are often met by hostile landowners and hired gunmen or by private security firms. Between 1985 and 1995, only 47 out of 922 rural killings came to trial. There is little threat of punishment for the perpetrators. The Guardian [1997: 15], ibid., remarks that 'unused land on the biggest farms - 'the latifundios' - would be enough for three million hungry peasant families to live on. Around 32 million people in Brazil - half the population of Britain - go hungry every day'.

[15]This is confirmed by Hall [1991: 147], *A Crise Agrária na Amazônia,* who writes that there is an association between rural violence and land concentration in Brazil. Flynn [1993: 21 and 23], ibid., mentions that 'hundred of rural poor have died in conflict over land, which remains one of the most serious and intractable problems facing modern Brazil '...' the rising violence and number of killings over land, from 39 in 1975, for example, to 222 in 1985, have outstripped the capacity, and often the will, of the judicial authorities to cope with them'. Reydon [1995: 1340], *The Unsolved Agrarian Problem in Brazil: An Economic Explanation and some Propositions,* also believes that 'the growth of the poverty and the violence in urban areas is also a consequence of the agrarian problems: the rural-urban migration is mostly made of expulsion of small landowners in Brazil'.

*(coronéis)* dominate. At this point, it is important to show the current trends on land reform in Brazil, in view of the academic literature, the rural worker's movement (the MST) and government action.

To start with, Gomes da Silva,[16] sees land reform as a recurrent theme in the national debate. The problem is indeed serious, due to excessive land concentration in the country: 10% of the larger farms occupy 79% of all land while the remaining 90% are concentrated on 21% of the land [1994: 180]. The government, Congress and the Judiciary are not committed to land reform in Brazil. Gomes da Silva stresses that the government land reform programme rests on land taxation and the colonisation projects. As a result, the Government initiative is not able to break down the structure of the unproductive *latifundium*. For him, the Judiciary has neither a special branch to deal with agrarian problems nor are the judges trained in land reform matters. Moreover, Congress, through the powerful Rural Parliamentary Support Group *(bancada ruralista)*, have barred the approval of a land reform bill of a progressive nature. Centre and right-wing parties, formed of politicians prone to maintain the *status quo*, filled 80% of parliamentary seats.

Therefore, Gomes da Silva [1994: 184-189] highlights as a programme for land reform the following strategies[17]: the democratisation of the use of land to cater for 3 million rural working families in 15 years' time; the provision of technical, financial and social support for

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[16]José Gomes da Silva has been present for a long time in the national discussions on land reform either as a diligent writer who has published various books and articles on land reform matters, or as a politician connected with rural worker's demands. He was the creator of the Brazilian Agrarian Reform Association (ABRA) in 1967 and he was also the President of the National Colonisation and Agrarian Reform Institute (INCRA) in 1985.

[17]Although not a monolithic and finished land reform proposal, these principles argued by Gomes da Silva are generally accepted by those committed to land reform in Brazil, such as the Catholic church, the rural workers' organisations and the left wing parties. Also, as Gomes da Silva [1994], ibid., Graziano da Silva [1993], *Por um Novo Programa Agrário,* and Abramovay [1995], *La Liaison Incomplète: Réforme Agraire et Démocratie,* support a land reform programme based on the small farmers, rural workers and landless people demands.

agricultural production in order to increase the living standards of the rural workers and their families; the control of violence against rural workers as a result of conflict over land. He also proposes the establishment of urban settlements or agricultural villages (to absorb the casual pickers and other rural workers who were victims of the disorganised migration in the 1970s); the extractive reserve settlements (to fit the forestry workers and the rubber tappers) and the individual exploration settlements (comprised of rural family farms).

Other academic propositions on land reform debate have arisen. Sampaio[18] [1988: 126] argues a rather conservative approach, in which land reform in Brazil should focus on agricultural incentives and management of the productive factors: First, the occupation of the new agricultural frontiers; second, the productive use of land which was previously supported by expensive state investments, such as the irrigation areas; third, the unproductive land, but here including both the unoccupied family and capitalist farms which should be part of a land reform programme. In Sampaio's views agricultural backwardness is a result of a lack of the introduction of technology in the farmers' systems of production.

Another important intellectual contribution to the land reform debate is found in Romeiro [1994] who analyses agriculture and land reform in the light of labour demand and supply in the economy as a whole[19]. For him the most important contribution to land reform would be the growth of employment in rural areas. He states that the concentration of land ownership is not *per se* an obstacle to economic growth. However, it is a severe obstacle to

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[18]As Sampaio's views [1988], Alves [1996], *Especulações a Respeito da Agricultural Brasileira,* and Rodrigues [1997], *Um Novo Modelo para a Agricultura Brasileira,* see land reform as part of government programmes and conducted by government agencies.

[19]Similar to Romeiro [1994], *Reforma Agrária e Distribuição de Renda*; Cardoso et al [1996: 168], *Inflation and Unemployment as Determinants of Inequality in Brazil: The 1980s,* although they recognise the backwardness of the land tenure system in Brazil, they believe 'that unemployment increases inequality and that inflation widens inequality by pushing the middle-income groups into poverty'. Also, Furtado [1977], *Furtado Defende Reforma Agrária Contra Desemprego,* suggests a land reform programme in Brazil as a way of absorbing a mass of unemployed urban and rural people.

social development and to improving the living standards of the rural population, mainly the small farmers and the members of the lowest social class.

According to Romeiro [1994: 131-133], it is possible to envisage a land reform programme that would not affect the dynamic sectors of the economy. For him, land reform achievement lies in the high taxation of large Estates through the Rural Property Tax (ITR). It is politically complex, though sound, to make the ITR an effective instrument of social justice. However, Romeiro stresses that his proposal to shift land structure through land taxation is a complementary approach which does not exclude land reform on the unused and unproductive *latifundium*.

It is important to turn to an analysis the Landless Workers' Movement (MST) views as well as its proposals and strategies to push for land reform. In fact, the MST's approach is novel to land reform in Brazil. The target is to settle 20 million landless people scattered throughout the country, be they indigenous people, rubber tappers, those dispossessed by dam projects, rural workers who live in the shanty towns and others. It is not a sectoral movement to tackle specific problems in a specific region or a particular field. On the contrary, this is a wide social action which involves the Brazilian landless people[20].

The MST is a movement which has empowered the small, disadvantaged and poor farmers to argue on the social role of the most powerful and backward institution in Brazil, that is the ownership of land, including the unused *latifundium*. The MST has applied innovative methods to gather a huge mass of landless people all over the country to fight for

[20]According to INCRA [1996], *Instituto Nacional de Colonização e Reforma Agrária - Dieretoria de Assentamento,* which is the technical and executive arm of the Land Reform Ministry, the landless people who have been in the rural settlements had on average 17 years of agricultural experience. In the North-east settlers had 21 years of experience on agriculture. Also, 45.6% of settled landless had never had land and 41% were rural workers, sharecroppers or casual pickers. This means that in total 86.6% of settlers were previously land workers dispossessed of land.

the right to use and take possession of a large amount of the idle land. There are good connections between leadership and base and vice-versa. The movement is able to gather overnight thousands of landless families to squat on unused land. This is not an easy task considering, among others factors, the size of Brazil. The movement's action is not violence, but requires courage due to the country's historical record of rural violence, especially on the part of powerful landowners against the weak peasants. The aim is not to solve problems in the short term, as this is a structural problem for Brazilian society. The conflict it is not between equals, but between the powerful rural elite and the powerless rural workers. The MST's force comes from collective action. Thus, this is not a neutral movement. It is a political and ideological organisation[21].

From this perspective, Stédile [1993 and 1994] argues on the factors which must lead to a fair and successful land reform in Brazil in the light of the landless families needs. For him, the 1990s land reform debate is not centred on capitalist versus socialist agricultural relations of production, however, it is assumed that the format of capitalist agriculture is the consolidated means of the agricultural development. What is questioned are different, specific aspects of this development model and the way in which the appropriation of its results occur. In his view, the most important question is land reform in its more political context, mainly its *modus operandi*. For this reason, it is crucial to know: 'who will drive land reform?'.

According to Stédile [1993:20-25], land reform in Brazil will only be feasible if, beyond the government plans and a favourable political perspective, the objective and concrete

[21] According to Stédile [1994: 320], *A Questão Agrária e o Socialismo*, the silent leader of the MST, 'because of the features of capitalist agriculture in Brazil the proposed land reform may be a socialist agrarian reform '...' if property rests on bourgeois class interests, obviously, the proposed agrarian reform [by the landless people] has to be a socialist agrarian reform'.

conditions for the real participation of the rural and urban worker's organisations are created. In this way, land reform should deal with the following demands.

(1) The desired land reform should consider the regional differences where the landless families live and use land. Social, anthropological, economic, cultural, climatic and agricultural differences need to be appreciated. The distinctive production systems developed by farmers should be considered. The new agricultural technological research model may also consider the farmers' aversion to risk and the objectives of agricultural production. The land reform programme may deal with the utilisation of the unproductive *latifundium*; land used by multinational companies; the demarcation of Brazilian Indian land; the prioritisation of family agriculture and punishment for crimes against rural workers.

(2) Land reform should target the high level of land concentration and other factors of production in few landowners' hands, such as machines, rural credit, technology, etc. The aims of agricultural production (for a farmer's subsistence, for the internal market, industry or export), the actual utilisation of land (domestic or cash crops and intensive or extensive grazing) and the water available (mainly in the North-east and semi-arid areas) should be discussed. It is also important that land reform also involves the rural workers and the small farmers who migrated from the rural areas and live in the shanty towns and, finally, the improvement of the living standards of the rural people.

From a different view, the current government has brought to the fore a land reform programme *'Reforma Agrária: Compromisso de Todos'* under strong pressure. First and foremost, pressure comes from the MST which enjoys overwhelming popular support throughout the country. Last but not least, pressure comes from the government-backed conservative alliance in Congress with strong ties to the landowners' interests. Still the government recognises the perverse effects of land concentration[22]. In fact, the present government's land reform proposal is superficial. It neither attends to the rural workers and

[22]According to Brasil [1997: 19 and 7], ibid., 'instead of distributing land, capitalism embraced by the military rule (1964-1985) sustained the unproductive *latifundium* through subsidised and abundant rural credit '...' [consequently land became further concentrated]'

landless families nor attacks land concentration. The government tries to manage the conflict between landless and landlords through bureaucratic procedures. The causes of land concentration, mainly the unoccupied *latinfundium*, remain untouched. According to Brasil [1997], the main points of the governmental land reform programme are:

(1) The government claims to have settled more landless families in 1995 and 1996 than any previous governments, that is, 104,956 landless families were settled. The government goal is to settle another 180,000 landless families in 1997 and 1998 [Brasil, 1997: 25-27].

In fact, land reform is not only a quantitative goal, it is a qualitative transformation towards social change. The government figures are still considerably short of the landless workers' demands of nearly 4.5 million families. Furthermore, most settlements were not achieved in the unused *latinfundium*, but in state land and in land previously occupied by the landless families[23]. It is important to consider that during the period of military rule land reform was a forbidden subject on the governmental agenda.

(2) The government argues that it is first necessary to clear bureaucratic barriers, which have made the administrative process difficult. Brasil [1997: 81-89] shows the government's efforts towards facilitating land reform issues, such as the Rural Property Tax (ITR), the Summary Ritual Law (*Lei do Rito Sumário*) and the Gun Protection Law (*Lei do Porte de Arma*).

It is important to note that the first challenge to meet land reform is not the fulfilment of judicial or administrative norms[24], but the political determination to do it. Furthermore,

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[23]For example, Brasil [1997: 79], ibid., shows as land available to land reform that which belongs to the Bank of Brazil (a government bank), the Army (which comprises around 1,8 million hectares) and other government bodies.

[24]David [1995: 166], *La Modernisation 'Perverse' de l'Agriculture et la Structure de la Propriété de la Terre au Brésil,* states that for more than thirty years the Brazilian Parliament has promulgated laws on land reform, such as the Decree No. 11 of 1962 - the creation of the SUPRA; the Lei No. 4,214 of 1963 - the Rural Worker Statute; the Act Constitutional No. 10 of 9th November 1964 - to make possible the expropriation of farms by the titles of agrarian debt; the Lei No. 4,504 of 30th November 1964 - the Land Statute; the Decree No. 554 of 25th April 1969 which specifies the mode of payment of land expropriations; the Lei No. 8,629 of 25th February of 1993 - Agrarian Law; the Lei No. 76 of 6th July of 1993 - the Summary Ritual Law and the Law No. 8,847 of 28th January 1994 which refers to the Rural Property Tax (ITR).

Brazilian society is aware of the high number of laws which, in practice, have never been enforced.

(3) The government's land reform programme includes many development programmes with their respective financial support for the rural settlements, for instance the '*PROCERA*' Programme, the '*Lumiar*' Programme, the '*Emancipar*' Programme, the '*Cédula da Terra*' Programme and the '*Casulo*' Programme.

The important point is that these programmes are planned to support the established settlements after the acquisition of land. However, the crucial action is the initial distribution of land for the landless families which precedes the useful development programmes. Land is the most important factor of agricultural production, but technical, political and economic support are also important ingredients. As with any agricultural production system, the settlement of the landless requires government support. To be successful, this should include suitable agricultural technology, technical assistance, rural credit, commercialisation and marketing, storage, education, health care, social stability, housing as well as other social benefits.

It is important to note that land reform in Brazil is a complex matter and will remain as an issue for future debate and a problem for future generations. Land reform has not been properly debated as a factor of social justice or of economic progress. However, it has been a political banner of socialist ideology or a mechanism of power for the politically archaic rural elite. From this perspective, the present agricultural development model has been sustained among others by governmental agricultural technology research system co-ordinated by EMBRAPA which saves both land and labour. However, both land and labour are abundant in Brazil. Behind this contradiction, under American hegemony, there are the vested interests of the World Bank, the IBRD and the CGIAR to be seen in the light of Brazil's role in the global economy.

On the one hand, the aim of the current agricultural policy was the growth of agricultural production and productivity and the liberation of cheap labour for the industrial sector. As a consequence, land reform became 'unnecessary'[25]. Environmental concerns, small farmers' social and cultural values and *farm as a whole* issues were not considered. On the contrary, modern technological inputs, such as fertilisers, high-yielding seeds, irrigation, pesticides and agricultural machinery were highlighted as the main agricultural production factors. On the other hand, agricultural production has increased, mainly the industrial and export commodities, such as Soya bean and orange, and land continued to be highly concentrated. The archaic *latifundium* remained protected.

As well as land reform, agriculture has been a critical issue in the country's political agenda throughout the years. It is common in the non-specialised and lay literature to see Brazil as an *essentially agricultural country.* In fact, before the 1960s, Brazilian exports were still mainly of agricultural products and agricultural production was centred on extensive exploitation of abundant land. Food crops and family agriculture played secondary roles[26]. From the 1970s, agricultural production came increasingly to be based on capital-intensive technology. Industrial development needed a modern and competitive agriculture to sustain the development process. Agriculture is no longer a leading and independent sector in the

[25]As Romeiro (1994: 123), *Reforma Agrária e Distribuição de Renda,* mentions, land concentration did not make economic growth difficult, however it was a serious limitation to social development. The rural exodus, environmental issues, rural unemployment, domestic food production and the agricultural technology research system related to the small farmers' needs were not at the heart of agricultural development policy.
[26]According to Linhares and Silva [1981: 36], *História da Agricultura Brasileira: Combates e Controvérsias,* this meant that the Brazilian 'agricultural vocation' focused on agricultural production for export without commitment to the production of the domestic crops for the internal market.

Brazilian economy, but it is a part of the so-called 'agro-industrial complex'[27]. From this perspective, agricultural research[28] and rural extension organisations were replaced by new organisational structures and the subsidised rural credit programme took place to cater for the growth of production, and productivity of agricultural export staples focused on capital-intensive technologies (e.g., machinery, agricultural chemicals[29], irrigation equipment, etc.).

In the late 1980s and the early 1990s, this productivist model showed signs of failure. On the one hand, the country gained in economic terms and became the tenth largest world industrial nation. On the other hand, due to problems of redistribution of income and wealth, including land, the country accumulated social problems[30]. Brazil became one of the most unequal countries in the world[31]. The new millennium calls for solutions and new perspectives. Questions arise such as: 'What is to be the format of agricultural policy in the future?' and 'Will agriculture be the leading force in the realm of national development?'.

[27]In Graziano da Silva's views [1996: 4-5], ibid., this means that the dynamic of agriculture follows the dynamic of industry which, that is agriculture will be subordinated to industrial and financial capital in the context of the global capital accumulation. This 'integration' involves agrarian, industrial and financial vested interests.

[28]Baer [1995: 319], *The Brazilian Economy: Growth and Development*, writes that 'in 1973, the government decided that a breakthrough in productivity could be achieved by a massive investment in research. To that end the Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA) was created. Under its auspices a substantial foreign training of specialists in the agricultural sciences [took place]; there was a new emphasis on research to improve productivity. These were efforts to make technological innovations leading to increased yields in the acidic soils of the frontier regions (the *cerrado*) of the southeast and central-west'.

[29]According to Zupiroli [1991: 125], *O Veneno Nosso de Cada Dia,* Brazil comes third in the world as a consumer of agricultural chemicals (including pesticides, fungicides and herbicides) with 120 thousand tons per year followed by the United States and Japan.

[30]Landono [1996: 3-4], *Poverty, Inequality, and Human Capital Development in Latin America, 1950-2025,* writes that 'Latin America is notorious for high income inequality and the widespread poverty that comes from it. Brasil is the country that gets the most attention in this regard - pictures of *favelas* clinging to the hillsides around Brazilian cities are familiar to people throughout the world'. Cardoso et al [1996: 151], ibid., also states that 'the benefits from growth in the 1960s went disproportionately to the rich, and the costs of the 1980s stagnation fell disproportionately on the poor. The income of the richest 10% of the active population divided by the income of the poorest 10% of the population increased from a factor of 22 in 1960, to 40 in 1970, 41 in 1980, and 80 in 1989'.

[31]Cardoso et al [1996: 155], ibid., remarks that Brazil (with a Gini coefficient equal to 0.6 in 1990) has one of the most unequal income distributions in the world. Social indicators look worse than in any other country with the same per capita income'.

These questions have given birth to inflamed debates in Brazil. According to Graziano da Silva [1996: 147-148 and 1993: 7], a new modernisation model is emerging in the 1990s. However, this sadly seems to be more exclusive and unequal than the 'conservative modernisation'. The new model will focus on biotechnology, genetics engineering, microelectronics, telecommunications, computer science and intellectual property rights[32]. Once again, the State is the most important social actor in consolidating this new agricultural development model. In Brazil, this has been named 'State modernisation', basically involving privatisation of state functions, dismantling of trade barriers and thus further opening of the Brazilian market to private and foreign capital.

To cope with these aims, the government's agricultural policy, as set in the '*Plan Plurianual 1996 - 1999*'; proposes a wide range of neo-liberal measures which do not meet the small farmers' needs, being in line with the large and export farmers' demands. According to Brasil,

> agricultural development should be based on irrigation; growth and modernisation of the transport system; agricultural research; diffusion of technological innovations and rural extension issues; training of rural workers; environmental issues and control of agricultural diseases. Attention to the internal and external markets depends on the incentive to agricultural industrialisation and reduction of [state taxes] '...' increasing participation of the private sector to cope with agricultural demands will be allowed. The settlement of 280,000 rural families and support to family agriculture will be a government priority [1996: 57-58].

The government expects the *'Plano Plurianual'* to meet the planned targets for the agricultural sector by means of the following strategies: (1) high gains in agricultural productivity; (2) reduction of agricultural losses and costs; (3) training of the rural workforce;

[32]In June 1996, under a heated political debate and American pressure, the Brazilian Congress approved a patent law. According to Buscaglia and Long [1997: 16], *U.S. Foreign Policy and Intellectual Property Rights in Latin America,* 'Brazil now has the highest level of intellectual property protection in Latin America '...' the scope of subject matter that could be patented and granted pipeline protection for pharmaceuticals [and implicitly include most agricultural inventions]. But in so doing, it came under fire from the Roman Catholic Church, which objected to patenting living organisms created by biotechnology'.

(4) adoption and adaptation of technological innovation by farmers; (5) control of agricultural diseases and insects; (6) agroecological zone mapping; and, finally, agricultural production in line with new development paradigms. Once again, income distribution, small farmers' research system and land reform are not a government priority within the proposed agricultural policy. However, the government also claims to have given priority to family agriculture[33] and land reform programmes.

In practice, the government agricultural policy has contributed to agricultural income and land concentration[34]. The government plan shows, for example, that the goals of controlling and eradicating agricultural diseases and insects are highlighted the export and industrial agricultural commodities, such as cotton, Soya bean, orange and cocoa [Brasil, 1996: 23]. In a similar fashion, Porto Neto [1996], the present Agricultural Minister, who is a Senator linked to the right-wing Labour Party, highlights the success of Brazilian agriculture. For him, the main example is the record 1996/97 harvest of 81 million tons[35]. However, he does not explain that agricultural performance has been subordinated to the neo-liberal policy

[33]For Rodrigues, [1989], *Política Agrícola e Pequena Produção: Um Discurso Ilusório*, despite its importance in the production of domestic crops, the agricultural family continues to be discriminated against by government policies. For him, proposed government policies towards family agriculture are purely rhetorical. This can easily be proved in the light of the insignificant participation of family agriculture in relation to state agricultural policies, in particular in subsidised rural credit and minimum price regulation. For example, according to Brasil [1996c: 1 and 4], *Política para o Ano Agrícola 96/97*, 'the government rural credit for small farmers (the family agriculture programme) is about US$ 1 billion. [However,] for the production of grains [which targets medium and large farmers] the government rural credit is more than US$ 5 billion'.
[34]According to Hoffman [1991: 159-160], *Distribuição da Renda na Agricultura,* 'from 1983, there has been a growth of income inequality [in Brazil], with a Gini coefficient of 0.67. The income received by the richest 10% increased by 52% and the income received by the richest 5% reached almost 40% of real income'. Hoffman also remarks that income inequality is affected by government economic policy. For him, in relation to the distribution of agricultural income the influence of land distribution is crucial.
[35]According to Graziano da Silva [1996: 157-158 and 161], ibid., this means that the hungry in Brazil is not related to the agricultural production. However, this refers to low purchase power of population. The income is highly concentrated in a few hands and the high cost of the basic food.

drawn out by the Ministry of the Economy[36] and so relates to international trade rather than the well-being of the Brazilian population.

Porto Neto [1996: 8-11], also mentions that the government's agricultural policy focuses on the elimination of State intervention in the agricultural market and should be directed to economic globalisation and the international trade. The government thus aims at: (1) the restructuring of the agricultural research and technological diffusion systems (the decentralisation of EMBRAPA and the definition of research targets focused on economic comparative advantages); (2) the expansion and diversification of the transport system (including the rail and river systems); (3) the restructuring of the system of control of agricultural diseases and insects (to meet the international recommendations from the World Trade Organisation - WTO and the Southern Common Market - MERCOSUR[37]); and finally, (4) to expand the participation of the private sector in agricultural commercialisation (transfer to the private sector of the regulation of agricultural market stocks).

Today, beyond government proposals outlined above, other agricultural issues, such as food shortage, agricultural technology, new agricultural frontiers, international markets and rural poverty have attracted the attention of respected experts.

Eliseu Alves has been a prominent supporter of Brazilian agricultural modernisation since the 1960s[38]. In a recent article [Alves, 1996], he addresses what he called 'speculations

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[36]In a recent report, the government has responded to some criticisms its agricultural policy. However, of strangely, this response was made by the officials attached to the Ministry of the Economy and not by the Ministry of Agriculture's sponsors. According to Mendonça de Barros and Miranda [1997], *O Que Está Acontecendo com a Agricultura?,* who are at the Secretariat of Economic Policy of the Ministry of the Economy, agricultural development is going very well. They present agricultural performance in sophisticated economic language. Overall, they claim that the actual agriculture harvest of 81 million tons of grains means a positive balance of US$ 2 billion in international agriculture trade balance. As a result, agriculture is contributing to the equilibrium of Brazilian external accounts.

[37]This is a common trade among Argentina, Brazil, Paraguay and Uruguay.

[38]He was a policy-maker during the military governments, managing rural extension, agricultural research and irrigation organisations (respectively, the Brazilian Rural Credit and Assistance Association - ABCAR, the

in respect of Brazilian agriculture'. Alves analyses the problems of agriculture in the light of economic development and starts his approach by arguing for the control of inflation and the environment. He refers to the food shortage in the future. The Brazilian market for agricultural products, the increase of food importation from Asian countries, mainly China, and the growth of world population by 2 billion 'food consumers' are the likely scenario in twenty years' time. He also considers the reduction of subsidies and the decreasing flow of investments in agricultural research by the rich countries with serious repercussions to food supply. Environmental protection could also restrict the use of cultivated areas.

It is worth noting that the environment is put into Alves' argument as an economic variable. On the one hand, this was the logic of agricultural modernisation, which did not consider environmental protection as a social issue[39]. On the other hand, in Brazilian government bureaucratic organisation, the environment and water resources are not under the Ministry of Agriculture's umbrella, but under the co-ordination of the Ministry of the Environment, Water Resources and Legal Amazon.

Alves [1996] also mentions the new agricultural production areas[40] in Brazil, such as the States of Maranhão, Piauí, Tocantins, Pará, Mato Grosso, Rondônia and Acre, could become competitors of the traditional South and Central regions. The new routes of commercialisation from the State of Maranhão to Europe and from the North region via the Pacific ocean are factors which could exacerbate competition between regions. Also, the São Francisco Valley, in the North-east, is becoming a fruit and juice export region. Finally, Alves argues rural poverty is a Northeastern issue and that the government priority for this region should be based on a wide agricultural irrigation programme.

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Brazilian Agricultural Research Organisation - EMBRAPA and São Francisco Valley Development Company - CODEVASF) and has been an informed analyst in the field of agriculture and irrigation.

[39]According to Baer and Mueller [1995:349], *Environmental Aspects of Brazil's Development,* the Brazilian colonial pattern of agricultural production and the 'conservative modernisation' were not committed to the environment. They write: 'the policymakers responsible for the agricultural strategy since the late 1960s gave almost no thought to the environmental impact of new technologies'. They also remark that 'in the 1970s, Brazil adopted the position that pollution and environmental degradation were a price worth paying for development. Until recently this view remained fairly common among the country's policymakers'.

[40] According to Grinbaum [1997: 144], *O Novo Eldorado Verde,* this new agricultural frontier comprises of 45 million hectares of unused land.

Similar to the government agricultural policy [Porto Neto, 1996; Brasil, 1996 and 1996c and Mendonça de Barros and Miranda, 1997], Alves [1996] believes that agricultural development should be established in the light of the modernisation recipe in the context of the global economy. The focus should be on agricultural production based on capital-intensive technologies, such as fertilisers, mechanisation, pesticides and irrigation. Environmental concerns, land reform, rural exodus and rural poverty are not variables of the neo-classic production function.

From a different point of view, Graziano da Silva[41] and Saly [1996], who called their comments 'more speculations in respect of Brazilian agriculture', believe that the reduction of the grain stocks is a result of the increase of income and the use of grain to feed animals and also of the reduction of the agricultural stocks in the rich countries in view of the new forms of agricultural production, transport and processing, such as 'just-in-time,' which eliminate agricultural shortage. The 'reduction of the agricultural subsidies can bring more effects on world prices than on participation in trade'. Also, the trend in the developed countries will be for a new diet based on fresh and organic food. Further, Graziano and Saly comment on the importance of land reform as a means of reducing rural and urban poverty. According to them, 'a regional and modern land reform calls for an agricultural policy directed to the peasants and small farmers'.

According to Graziano da Silva [1993: 8-9] the formulation of government agricultural policy, is not neutral. It is an ideological procedure to cater for the dominant sectors and manipulate the weaker ones. In other words, the state is a conductor of agricultural development to promote capital accumulation by the large farmers' agricultural production over the years, in spite of the fact that the official discourse usually insists on placing the small

[41] José Graziano da Silva is a recognised professor and well-known agricultural specialist in Brazil who has been a critical of the government agricultural policies. He is also an adviser of the Workers' Party a left-wing party linked to rural and urban grassroots movements.

farmers as a preferred option in the definition of its strategies, including the small farmers' agricultural technology.

From this perspective, farmers are demanding distinct agricultural policies. On the one hand, as indicated by Furtado [1997], Graziano da Silva [1996], Graziano da Silva and Saly [1996] and Stédile [1994] the small farmers' representatives (mainly CONTAG and MST) have centred their fight on the land reform programme. They also argue that, in parallel to land reform, it is necessary that some state agricultural policies, such as a renewed and holistic agricultural research model to support the small farmers and the emerging settlements[42]. On the other hand, the large farmers' representatives, for example CNA, SRB and UDR representatives, support the current land-tenure system, highly concentrated in the landowners' hands, as well as agricultural policies which include state privileges, such as subsidised rural credit, free agricultural technology and the total privatisation of services and businesses[43].

### 8.3.2. The Need for a Greater Focus on Innovation

As a support to the present agricultural policy, dominated by large-scale farmers' interests and capitalised farming, the federal government's agricultural research system, which is the focus of the thesis, has been co-ordinated by EMBRAPA[44]. EMBRAPA neither had a

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[42]According to Urbano [1997], *Conflitos na Luta pela Terra,* who is the President of CONTAG, the immediate demand for attention to small farmers' needs is an effective land reform programme which also includes support for agricultural production.

[43]According to Salvo [1997], *Produtores São Abandonados,* who is the President of the powerful landowner confederation - the CNA -, the agricultural subsidies are the 'price that society pays for the food security and to maintain in the rural areas people who have agricultural occupations'. Also, Rodrigues [1997: 12-13], ibid., who during the field-work was the President of the landowner association - the SRB -, highlights as important elements in agricultural production: agricultural technology and the state infra-structure (roads, communication systems, harbours, etc.). Also, he sees as extremely necessary state reforms leading to privatisation of state functions in the agricultural sector.

[44]According to the Law Number 8,171 of 17th January 1991 which adjusts agricultural policy in Brazil, Chapter IV (The Agricultural Research) in the Art. 11 is thus written: 'The Ministry of Agriculture is authorised to establish the National Agricultural Research System - SNPA, under the co-ordination of the Brazilian Agricultural Research Organisation - EMBRAPA, and in agreement with the States, Federal District,

monopoly of agricultural research development nor was a monolithic organisation. Along the way contradictions, alternative and innovatory agricultural technology systems, even small in scale, become apparent. As was shown in Chapter 4, the most significant part of Brazilian agricultural technology has been generated by EMBRAPA. Usually, there is a gap between the feasibility of new technology adoption in the light of the researchers' assessment and its widespread incorporation in the farmers' production systems. In the last ten years, after the military left, a democratic Brazil saw many social transformations which have taken place in EMBRAPA and in society.

Consequently, to some extent, the state organisations have shifted their programmes, strategies and priorities. EMBRAPA is not an exception, though, time, determination and political perspectives are required to consolidate the qualitative change. However, the EMBRAPA agricultural technology generation process was still focused on the national research centres, in few agricultural staples, scattered over the country and the research process was based on well-trained and highly specialised researchers.

It is worth further considering that science and technology in Brazil have basically been supported and developed by the federal and state governments[45] and involve hundreds of organisations and thousands of research projects nation-wide. Generally speaking, non-governmental organisations, operating throughout the country, have not dealt with the

Municipalities and state and private entities, universities, co-operatives, unions, foundations and associations'. It is important to note that, as mentioned before, around 85% of the EMBRAPA budget has been funded by the Federal government; it is an over-financial dependency.

[45]According to Brazil [1996a: 18-19], *National Indicators of Science & Technology,* the national science and technology budget in 1994 was around US$ 3.85 billion. The federal government, the private sector, the state-owned companies and the state government shared: 57%; 18%; 8% and 17% respectively.

generation of agricultural technology as a major priority. They have devoted their actions to grassroots movements and local problems and operate under restricted conditions[46].

The NGOs focus on the empowerment of disadvantaged people[47] in order to meet their needs. In the agricultural field, the NGOs preferential client comprise poor and landless farmers, indigenous people and small rural farmers' families. Also, NGOs cope with environmental matters, such as preservation of forests and ecosystems, organic agricultural production, a clean environment free from pollution of soil, rivers and air[48].

By contrast, the major achievements of agricultural technology generation of the federal agricultural research system co-ordinated by EMBRAPA rely on genetics (the generation of high-yielding and disease resistant varieties), soil science (the different doses, sources and application modes of fertilisers) and insect pest and disease control (biological and integrated pest management) matters. This means that secondary technological results relate to the so-called innovatory agricultural technologies, such as biological control of the Soya bean caterpillar, the biological nitrogen fixation by leguminous crops, the new variety of hybrid corn

[46]According to Baer and Mueller [1995: 350], ibid., 'since the early 1970s Brazil experienced a rapid growth of nongovernmental organisations (NGOs) concerned with the environment. By 1990 there were some 700 NGOs, of which 90 percent were located in the urban centres of the Southeast and South. Many are amateurish and ineffective, but a few are highly professional and had an impressive impact on domestic public opinion'. Costa and Campanhola [1997], *A Agricultura Alternativa no Estado de São Paulo,* write that in the State of São Paulo alternative agriculture has been developed by the different types and conceptions of NGOs. They also remark that around one hundred NGOs have evolved in activities of organic agricultural production, processing, commercialisation and technology validation. According to them, the NGOs have not assumed the organic agricultural technology generation process.

[47]According to Wils [1995: 3 and 5], *NGOs in Latin America,* 'in contrast to Africa and Asia, most Latin American NGOS are very interested in the political dimension, and they perceive the power and empowerment of the poor as a condition *sine qua non,* both for development activities in the area of basic needs and economic situation, and for a far-reaching social transformation'.

[48]Kaimowitz [1993: 1147], *The Role of Nongovernmental Organizations in Agricultural Research and Technology Transfer in Latin America,* argues that the traditional 'public research institutes still have relatively little to offer in the way of new appropriate technology. These institutions have concentrated most of their efforts on developing new plant varieties'.

*BR-201* and the substitution of savannah pasturelands. These will be further discussed in turn, as follows:

(1) The biological control of the Soya bean caterpillar. As shown in Chapter 6, Soya bean serve agro-industry and as export crop. The Soya bean production systems are based on capital-intensive technologies. Thus, Soya bean profitability has been focused on increasing productivity instead of growth of the land area of production. The high level of technological inputs required by Soya bean in the traditional areas (Southern region) or in the areas of expansion (mainly on the agricultural frontier of the *Cerrados)* has raised environmental concerns, such as soil erosion, water contamination and air pollution[49].

To cope with these challenges, Soya bean researchers, mainly insect biological control experts, developed a biological insecticide using a soluble powered with *Baculovirus anticarsia*. This is cost-effective, technically efficient and environmentally safe. According to EMBRAPA [1991, 1991a, 1992 and 1993j] the integrated insect pest management programme fostered by EMBRAPA combines biological and chemical insecticides. The application of pesticides has been reduced by up to 70%, with a reduction of importation of agrochemicals by US$ 114 million. However, during the field-work, the rural extension representative argued that only 15% of Soya bean farmers have adopted this new technology that is, the biological insecticide.

It is worth considering this matter further. First, private chemical companies, by use of marketing strategies, have persuaded Soya bean farmers to adopt chemical insecticides. Second, pesticide effects are faster than that of the biological insecticide. This gives the impression that the chemical insecticide is more effective than the biological one. Third, according to Lehwing [1994: 232], who analysed the use of the 'baculovirus' by farmers, some elements in the management of the 'baculovirus' - that is, 'collecting and handling of dead caterpillars' and 'the adequate storage of baculovirus in a freezer' - were not easily accepted by Soya bean farmers. The point is that these factors were not considered by the researchers as active elements in the generation and adoption of the 'biological insecticide'. Consequently, according to Lehwing

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[49]Flores and Nascimento [1992: 12], *Desenvolvimento Sustentável e Competitividade na Agricultura Brasileira,* mention that the Soya bean intensive production system, has contributed to soil degradation, mainly through soil mechanisation.

> studies on the adoption of innovations should take into consideration the changes that are taking place in the generation of new technologies and the characteristics of these technologies. Programmes of technological modernisation in agriculture should not neglect the production systems in which farmers operate and the elements of risk that can influence their decisions [1994: 239].

(2) The biological nitrogen fixation by leguminous crops. As in the previous case, this technology has been initially adopted by Soya bean farmers. In theory, the procedure should be reliable for any 'leguminous crops', such as beans and peanuts, although the success of such adoption has only been highlighted in Soya bean crops. The technological generation was made by the specialised researchers in the soil biology field inside highly equipped research laboratories. After the researchers identified the exact bacteria, the technology was transferred to private companies for processing on a commercial scale. EMBRAPA [1991a: 47] shows that the biological nitrogen fixation increase Soya bean productivity by up to 30%.

The development of bacteria of the genus *Bradyrzobium,* adapted for Brazilian soils, particularly in Soya bean cultivation, has eliminated the application of nitrogen fertiliser. The technological novelty makes for environmental preservation and reduced expenditure while being cost-effective and technically efficient. It is important to bear in mind that this innovative technology has just substituted the nitrogen fertiliser in the leguminous crops and to be effective it is necessary that there be other components of the technological package, as shown by EMBRAPA:

> the identification of strains with greater capacity for tropical soils, together with optimisation of factors such as correction of fertility, irrigation and the control of pests and disease, will permit increase in yields from 600 to 1,000 kg/hectare with the Rhizobium alone. Thus, the benefits of nitrogen for the economy already reached US$ 240 m in addition to later profits from harvest increases, reduction of imports and the lessening of water pollution through the use of nitrogenous fertiliser [1993i: 43].

As a continuation of this agricultural technological research process, the same research team, led by the most famous Brazilian agricultural researcher, Mrs. Johanna Dobereiner, nominated for the Nobel Prize in 1996, had discovered the association of bacteria *Acetobacter diazotrophicus* with the sugar cane stems and roots. This was an original invention which could, in theory, reduce the use of nitrogen fertilisers in yet another export and industrial crop. By the time of field-work the invention was still on trial and not available for commercial use.

(3) The hybrid *BR-201* corn. This is the first hybrid corn with high tolerance to acid soils and with high productivity from 8.5 to 15 tons per hectare. In fact it is a technological innovation for the *Cerrados* ecosystem. As shown in Chapter 6 the *Cerrados* is an agricultural frontier which has been highly subsidised by the federal government. To become productive the *Cerrados* needs a huge technological package, such as mechanisation, soil correction, fertilisation and irrigation. *Cerrados* soils are flat and suitable for agricultural production but are poor and acid. According to EMBRAPA [1993j: 7], 'the hybrid BR 201 corn share in the Brazilian harvest grains of 1992-1993 was 14% of national corn production'. At the same time, EMBRAPA earned the amount of US$ 1.5 m. Questions arise as to the hybrid *BR 201* corn.

First, the hybrid *BR 201* corn was a result of conventional generation process led by a geneticist who designed the corn architecture to be adapted to the *Cerrados*. Long roots, late initial growing, a medium life cycle, tolerance to acid soils, high capacity for absorption of solar energy and high productivity are some of its genetic qualities. As with other high-yielding varieties, this makes use of capital-intensive technologies, such as mechanisation, soil correction, fertilisers and irrigation which are typical to *Cerrados* agricultural production.

Second, the corn crop in Brazil is not a typical domestic crop grown by small farmers. Corn is a modern crop which needs technological innovation to achieve high productivity. Corn is a part of the animal feed chain and also plays a part in the 'agro-industrial complex' and international trade. Gains in productivity are required to allow the low costs of production of poultry, pork meat and the animal feed.

(4) The substitution of savannah pasturelands in *Cerrados* - the '*Barreirão*' system. The *Cerrados,* or the Brazilian savannah, are ecosystems which require special attention to the intensive use of soil. As seen earlier, *Cerrados* soils are chemically poor, with gently rolling topography. Another important characteristic is the seasonal distribution of rain with two well-defined seasons. Beyond grain production, the *Cerrados* have been used for cattle ranching. Extensive cattle raising with little use of technology, is still predominant in the region. This combines with the intensive agricultural production systems, threatening the environment. Negative impacts include soil erosion, degradation or environmental pollution. According to

EMBRAPA [1994: 13], almost 117 m hectares of grazing in the *Cerrados* are degraded. These effects are more common in areas of large agricultural projects.

As mentioned before, contradictions appear. On the one hand, government supported capitalist agriculture focused on capital-intensive technologies which is a threat to the environment. On the other hand, it is up to the government to create the mechanisms to solve the environment problem. For example, EMBRAPA, through the Beans and Rice National Research Centre (CNPAF), located in the *Cerrados* region, developed agricultural technologies for the recuperation of degraded pastures in the *Cerrados*. The researcher's inspiration was the recuperation of the eroded soil and profitable gain made by large farmers. The research proposal dealt with the association of renewed pasture and simultaneous rice or corn crops production. According to EMBRAPA [1993j: 15], in the 1992-1993 harvest, the so-called '*Barreirão*' system was implanted in 50,000 hectares of degraded pasture. However, the actual demand is for around 117 m hectares of degraded soil.

The picture that emerged of these innovative agricultural technologies is the strengthening of the current agricultural research system in Brazil. The selected examples show that, the focus of this innovative research system has been on the maximisation of profits. Even environmental concerns have not been considered as the major issue. The agricultural generation process is still based on specific commodities. This does not involve the farmers' whole production systems. Its approach is not a 'collaborative' agricultural technology generation and adoption process, integrating researchers, farmers and rural extension workers. The idea of agricultural technology generation is based on a given researcher's cognitive values focused on specific agricultural products[50]. It is important to note that, as a result of the technology adoption of so-called innovatory research systems, a

[50]Fresco and Westphal [1988: 403], *A Hierarchical Classification of Farm Systems,* show a hierarchy of agricultural systems which range from the 'plant system', such as EMBRAPA research model which focuses on specific agricultural products, to the 'complex system'. According to him, the 'plant system' is focused on the 'ecological individual level' and the 'components' involve the plant organs (roots, leaves, etc.). By contrast, the 'complex system' embraces the 'complex ecosystem' and its 'components' deal with 'climate, soils, vegetation, primary sector, secondary sector, tertiary sector and human resources'.

high amount of cash has been saved by the farmers. However, the adoption rate of the so-called innovative technologies is still low, that is around 15%, when compared with the fantastic rate of adoption of 80% of the *Brasília* carrot by carrot farmers all over the country, as shown in Chapter 6.

Finally, EMBRAPA official reports have not highlighted, as major achievements some social innovative research systems which targeted small farmers. The '*Silvânia Project*' in the State of Goiás in the *Cerrados* region is an example. This was established in 1987 by EMBRAPA through the *Cerrados* Agricultural Research Centres (CPAC) which is not a commodity research centre, in association with the Goiás Rural Extension Agency (EMATER Goiás) and the small farmers. The research objectives were to identify and evaluate the social, economic and technical factors which obstructed small farmers' agricultural achievements. The focus was on the locality and on 'collaborative' involvement among researchers, rural extension workers and farmers. The farmers were organised in co-operatives and associations. Many concrete results have been obtained, among others, the adoption of suitable agricultural technologies, the installation of domestic food processing, the production of high-yielding seeds and the implementation of community vegetable gardens, with vegetables being worked collectively by farmers.

Overall, as follows, the thesis proposes a different approach to deal with the agricultural technology generation process. This points to a 'collaborative' method focused on farmers and farms and seen as a holistic system, rather than the present research model based on specific commodities and particular disciplines.

### 8.3.3. The Need to Adapt a *Whole Farm* Framework

An important implication of this study is to suggest a general framework for the formation of a new agricultural technology generation model. The proposed model should consider the majority of farmers' concerns, the rural extension work's strategies, environmental issues, consumer requirements and the social consequences of agricultural technology, all in the context of the Brazilian society. To start with, the suggested agricultural research model should be supported by the federal and state governments, municipalities, co-operatives and the private sector. The government-based organisations are and will continue to be the cornerstone of the agricultural research system in developing countries.

In this context, Sachs [1996: personal communication] mentions that a new agricultural technology generation process in Brazil may focus on the *farm as a whole*, on the factors of production available on the farms and on the collaborative and participatory agricultural technology generation processes. This may deal with farmers, rural extension agents, researchers, and other interested parties. For Ravnborg [1996: 13], this means that farmers are active '*partners* rather than *clients*, *users* or *adopters*' of agricultural technology.

The suggested agricultural technology generation model can be based on Biggs' [1990] proposals, the 'Multiple Source Model', in which the flow of new ideas and innovations are seen as coming from diverse sources - farmers, extension, NGOs, national and international research centres'. In other words, Biggs and Clay [1981: 325-326] refer to the 'Informal Processes of Research and Development' in which the 'great strength lies in the users of the technology innovating to meet their own needs by drawing on detailed knowledge of their environment and exploiting the opportunities offered by natural selection'. According to Tyrrell [1997: 394] 'many social and natural scientists are moving away from deterministic and reductionist stances for their disciplines '...' they are accepting that the future is plural'.

From this perspective, Trigo and Kaimowitz [1994] suggest an in-depth organisational and programmatic change to the Latin American agricultural technology generation and transfer processes. For them, the research organisations may be decentralised and collaborative with the various levels of the productive sector. Okali et al [1994: 47-70], Asby et al [1993: 127-132] and Fernandez and Salvatierra [1993: 151-156] show many cases of 'farmer participatory research in practice' and farmer involvement in the research process in several countries throughout the world. Chambers [1994 and 1994a] also mentions that the participatory approach (PRA) is an emerging voice of small and poor farmers, which has 'proved to be of direct value for policy-makers' in various countries all over the world[51].

As a result the *farm as a whole* research model is recommended, embedded in the context of the Farming Systems Research (FSR) and the Farmer Participation Research (FPR) 'paradigms'. These are not new approaches; on the contrary, they came from the 1970s and were initially sketched out in Freire's [1970] pioneering work on participation. According to him, participation carries *'conscientização'* as a political and exploitative relationship between 'oppressor and oppressed'[52]. It is important to note, that FPR and FSR have produced an

[51]Chambers [1994b: 1437], *Participatory Rural Appraisal (PRA): Challenges, Potentials and Paradigms,* shows that 'PRA has evolved and spread from beginning in Ethiopia, India, Kenya, Sudan, Bangladesh, Botswana, Indonesia, Nepal, Nigeria, Pakistan, the Philippines, Sri Lanka, Uganda, Vietnam and Zimbabwe. Chambers and Blackburn [1996: 2], *The Power of Participation: PRA and Policy*, also mention that PRA has emerged in Jamaica, Gambia, Morocco, Zambia, Honduras, Panama, Guinea and the United Kingdom'. Also, FAO [1996: 32], ibid., writes that 'in countries such as Chile, Kenya, Senegal, and some parts of India, farmers have played an important role in articulating their demands from the research systems'. Pretty [1995a: 1253-1254], *Participatory Learning for Sustainable Agriculture*, states that there are more than thirty different participatory methods, some more widely used than others. What most of them have in common is the so-called 'participation' - research activity working closely with local people.

[52]Freire [1970], shows in the *Pedagogy of the Oppressed*, that 'the oppressor is [in solidarity] with the oppressed only when he stops regarding the oppressed abstract category '...' deprived of their voice, cheated in the scale of their labor'.

immense literature on 'participation' with several typologies and denominations. For example, Farrington and Martin [1993: 8] mention that 'considerable confusion has arisen over the relationship between FSR and FPR'. In the same way, Cornwall et al [1994: 103-104] present twenty-nine types of farm participatory approaches and argue

> that despite the rhetoric of some approaches, they have brought significant innovations and challenges to mainstream. Often heralded as 'new' directions '...' many draw on methods developed in community development for empowerment, yet only a few acknowledge or respond to the challenges of a 'deep and wide' participatory process '...' in many of these approaches, rural people's participation is limited to providing information to researchers, who do the analysis and generate solutions for farmers.

In spite of extensive discussion on farmer participation and the farming systems research, the authors are unanimous in arguing that both were mechanisms for the defence of small and poor farmers against the highly specialised agricultural technology from the Green Revolution of the 1970s. This is confirmed by Farrington and Martin [1993: 8] who show that

> the more immediate origins of interest in [farmer research participation] lie in the realisation that resource-poor farmers stand to gain little from the process of development and transfer of technology characteristic of the Green Revolution, namely the breeding of early maturing fertiliser-responsive semi-dwarf varieties and their diffusion into environments enhanced by irrigation and agro-chemicals.

Although the farmers participating in the agricultural research process embrace various methods and designations, the literature has universalised the FPR and the FSR approaches as the better-known and effective contributors to farmer participation and the realms of farming systems, mainly the early contributions by Mellor [1966], Collinson [1972] and Norman [1974]. In this thesis, the recommended *farm as a whole* research model has drawn its ideas from the FPR and the FSR approaches.

According to Okali et al [1994: 5-6] 'farmer [participation] research is implemented through a wider range of institutions [not necessarily through the research organisations]'. In Farrington's and Martin's [1993: 8] views, the proponents of farmer participation research 'seek to distance themselves from the conventional agricultural research institutes which are seen as defending the *status quo* [in the relation] between researcher and farmers, and, ultimately, in the imbalance between rich and poor farmers'. In the same vein, Chambers [1993] considers that farmer research participation advocates the change of roles and the relationships between researchers, extensionists and farmers. For him, this should be based on mutual and egalitarian interests.

From this perspective, Chambers [1994: 953 and 1994a] presents the Participatory Rural Appraisal (PRA) as the appropriate approach for farmer participation in the 'reversals from top-down to bottom-up, from centralised standardisation to local diversity, from blueprint to learning process'. Another illustration is showed by Sumberg and Okali [1997: 27-28] who argue the farmer research participation through the farmers' experiments. For them, farmers' experimentation 'offers the potential for direct empowerment of rural people increasing their self-reliance and by bolstering their position vis-á-vis the bureaucratic organs of the state, such as formal agricultural research institution'.

The FPR neither is a perfect or complete approach, nor is a substitute for FSR. However, FPR and FSR are complementary methods and according to Farrington [1988: 276-277] there are some 'unsolved issues' on FPR procedures. First, there are the 'institutional issues' (the 'decentralization of institutions' and the correct application of the funds). Secondly, there is 'the role of extension'. For him, in 'the literature [there is a lack] of detailed discussion of the role that extension personnel should fill, and the necessary organization, qualifications and training' of the extensionists. Finally, the 'economic issues', [that is] 'the farmer participation approach does not take into account the substantial costs of researcher time necessary to achieve those results which, in most cases, were met by external funding'.

Focusing more on agricultural technology experimentation, the FSR according to Byerlee and Tripp [1988: 137-138] provides 'a farmer orientation to agricultural research '...' [and] too much attention has been devoted to considering FSR as a type of research when, in reality, it is an approach or even an attitude to research'. For Sutherland [1987: 53] the 'FSR methodology focuses on individual farmers rather than communities'. According to Norman et al [1988:321] the farming systems approach is focused on the client involvement in the institutional agricultural technology research system. They also stress that the 'bottom-up perspective (FSR) approach shares much in common with farmer participation research (FPR)'.

From this perspective, FSR resembles the agricultural technology diffusion process[53] articulated by the agricultural research organisation whose objective is the testing and the validation of the technology innovations with the farmer participation[54]. According to Cornwall et al [1994: 105] in the FSR approach 'researchers, and extensionists were encouraged to work with farmers to design, test and modify improved agricultural technologies to suit local conditions'. Collinson [1987: 365] writes that Farming Systems Research 'involves interdisciplinary cooperation between production agronomists, farm economists '...' in close cooperation with other production specialists and with farmers'. FSR is also centred in the agricultural technology on-farm tests and linkages between researchers and farmers. For instance, Merril-Sands and Kaimowitz remark that studies on the farmers-oriented research show

[53]Byerlee and Tripp [1988: 137], *Strengthening Linkages in Agricultural Research Through a Farming Systems Perspective: The Role of Social Scientists,* state that 'most activities that are described as FSR have been devoted to methods of improving communications between researchers and farmers as a basis for developing technology appropriate to farmers'.
[54]According to Biggs [1989: 1], *Resource-Poor Farmer Participation in Research: A Synthesis of Experiences From the Nine National Agricultural Research Systems,* 'participation in this context is seen as the involvement of farmers in research activities as clients, colleagues, partners, planners, and evaluators in the research process'.

> that, to be effective, research depends on several sets of key institutional links. The most important of these are the links between the following groups: on-farm researchers and farmers; on-farm researchers and technology transfer agencies; researchers conducting adaptive research on farm and those working in applied research on experiment stations '...' the study on research-technology links focuses on technology transfer agents as the clients of research [1990: 1-2].

From a critical perspective, Chambers and Jiggins [1986: 10-12] mention that FSR does not concern itself with the poor and small farmers and it is dominated by a transfer-technology process, as a one-way flow of agricultural technology from the researchers to the farmers. They state that in the FSR approach, the researchers dominate the phases of the farming systems tests, for example the trial design, conduction and evaluation, in other words the farming research systems' responses 'retain power in the hands of scientists'. In this way, the farmer's role is to endorse the agricultural technology generated by the formal agricultural technology organisation.

In the light of FPR and FSR approaches the farmers are the main actors of the agricultural technology process. The farmers' involvement in the research process, the relationship between farmers and researchers and the farmers' local knowledge are argued as strategies of transformation of the conventional agricultural research systems.

However, the problem of the agricultural technology generation process was not presented as an active factor in technology adoption by farmers and the transformation of the conventional agricultural research process. Thus, the recommended *farm as a whole* research model brings about a new issue to be considered for the FPR and the FSR approaches. The crucial point is the role of the agricultural technology generation process by the agricultural researchers in a state research organisation of the top-down type as an influential factor in the farmer's adoption. It is important to note that this is not considered by the FPR and the FSR literature as a major focus. The research organisation is a part of the state apparatus and has moulded its functions in line with state ideology, including the researcher's practice and the research process. The recommended model assumes that the agricultural technology generation process, based on the *farm as a whole*[55] and not in a specific agricultural product or monodisiciplinary scientific area, are influential and active factors in the technology adopted by farmers. In other words, the generation leads to adoption (the *adoption-generation-led* concept). Agricultural technology is generated by specific social actors and focuses on particular targets[56].

In this way, the first implication of the proposed research model is the re-orientation of the research organisation and the researchers[57] cognitive values to attend to a range category of users and facilitate the participation of the disadvantaged farmers and the rural extension workers. Some of these issues are beyond the scope of the suggested model. For example, the political perspective to guarantee the process of organisational transformation and the funding support[58] aimed for. Also, there is the role of important players, such as the rural extension organisations. In the federal sphere, research and rural extensions are separate activities and each has its own interests and constraints[59], although, in many Brazilian states they comprise a

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[55]According to Fresco and Westphal [1988], ibid., the researcher's focus and the research process shift from the 'individual plant system' to the 'complex ecosystem and regional system'.

[56]Merril-Sands and Kaimowitz [1990: vii and 71], *Linking Farmers, Technology Transfer Agents, and Agricultural Researchers,* argue that 'perceived status difference between researchers and technology transfer workers, or even on-farm workers can obstruct researchers from accepting input and feedback from lower-status groups, such as a technology transfer workers or on-farmer researchers'.

[57]According to Busch and Bingen [1994: 3], *Restructuring Agricultural Research: Some Lessons from Experience,* most successful [organisations] involve a measure of versatility in combining three perspectives on organisational issues: structural [organisational structure], people-oriented (human resource), and political matters.

[58]Busch and Bingen [1994: 4], ibid., write that 'the political perspective reminds managers of the importance of self-interest and power in the process of organizational change and development'.

[59]Farrington [1988], *Farmer Participatory Research: Editorial Introduction,* identifies the rural extension's role in the farmer participatory research, as an 'unresolved issue'. Furthermore, Collinson [1987], *Farming Systems Research: Procedures for Technology Development,* consider the rural extension's role in the participatory approaches as a huge and ambiguous component.

sole organisation which joins research and rural extension issues. This is an important support for the recommended research model.

It is important to note that the proposed research model is broadly inspired by the thesis findings and is a response to an understanding of the elitist Brazilian federal agricultural research system. The current agricultural research model has targeted large and capitalised farmers rather than small and subsistence farmers. The *farm as a whole* model, as here indicated, is not a rhetorical model unable to meet the majority of the Brazilian farmers; it is proposed as a real alternative to be fully developed to replace the existing model. The aim highlighted here is to indicate some empirical and theoretical arguments concerning the final decisions of the policy-makers. Resistance, vested interests and *espirit de corps* are some of the challenges to replacement. This is not a simple task[60]. Time, political determination, national and international fund-donors assistance, the mobilisation of urban and rural segments and convincing and well-prepared proposals are the elements required to sustain the change. Some conceptual features of the recommended model, such as the organisational and the methodological matters, are as follows:

(1) The leading bureaucratic level in the organisational structure of the *farm as a whole* model is the research centre based on the macro-environmental regions across the country - macro-environmental region implies the different large areas across Brazil. For instance, the *Amazon*, the *Cerrados*, the *Caatinga*, the *Agreste*, the *Litoral*, the *Pantanal* Areas, and so on which have very different cultures, needs, problems and challenges. Tables 5.9 and 5.10 show that the researchers and the research centres located in different regions have distinct social, political, economic and organisational perceptions. For example, CNPO researchers which were located in the rich South were concerned with co-operative movements and regional matters, rather than the CNPC researchers who were situated in the poorest Northeastern

[60]Byerlee [1990: 432], *Technological Challenges in Asian Agriculture in the 1990s*, write that 'a new research strategy, focusing on incremental changes, will be more difficult to organize and manage'.

region where the poor smallholding farmers were disorganised. Also, the researchers shown have different views on the links between the research organisation and rural extension agencies, NGOs, Universities and co-operatives. Once again CNPSo researchers who came from the South, had a higher rejection than CNPA and CNPC researchers, who were located in the North-east and related to *EMBRAPA's link with rural extension agencies and with NGOs*. It is necessary to infer that, on the one hand, Soya bean is a national export and industrial product, normally cultivated as a single crop in large areas by rich and powerful landowners. On the other hand, rural extension agencies and NGOs are devoted to small and local farmers' demands.

The second bureaucratic level is the experimental stations. Following the same research logic, they must be located in the micro-environmental regions. In addition to this, experiments or trials may be located when possible in the farmers' fields under farmer's local conditions[61]. These are characterised as low-cost and low-risk trials and support farmer research participation[62]. This strategy could reach the whole country in the macro and in the micro environmental perspective. The farm's agricultural production and its ecological and economic equilibrium need to be emphasised. In this case, according to Busch [1991: 81], the agricultural research system 'would feature agroecology as the central discipline. This would be based on the realisation that agriculture is a form of ecosystem management'.

(2) The proposed agricultural research model explores the whole production system. This is not an agricultural research system which is commodity-led. On the contrary, it comprises the social, anthropological, political and economic values of the farmers. The research process, particularly the research project, may consider the farm as a whole as its priority, single or multiple crop production systems, large and small farms, rich and poor farmers, high potential and 'marginal areas' and producers and products. The significant research problem is neither the agricultural product nor the agricultural producer, but the *farm as a whole*. Thus,

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[61]Hattopadhyay [1993: 98], *Technology Generation - Role of Farmers, Extension and Scientists,* argues that 'two sets of factors have been recognised to establish the appropriateness of technology: (a) adaptability or suitability of technology in a given locality (location specificity) and technology suited to specific groups with limited resources and capacity resource specificity'. Also, Sumberg and Okali [1997: 155], *Farmers' Experiments,* remark that 'farmers' experiments clearly remain essential for overcoming the all-important, site- and situation-specific dimensions of farming. This constant and widespread experimentation, which takes place within the context of existing production practices, is one important source of the information and knowledge that supports the evolution of agricultural practice and systems'.

[62]Sumberg and Okali [1997: 154], ibid., mention 'that strengthening farmers' experiments will allow a shift in the power relations between farmers and formal agricultural researchers and institutions'.

'transdisciplinarity knowledge', a 'holistic systems approach', and 'farmer knowledge' are parts of the model, replacing the monodisciplinary knowledge, crop-oriented approach and formal knowledge which constitute the old theoretical framework.

(3) The hierarchical organisational structures of the suggested agricultural technology generation process (research centres, experimental stations and farms) must be equalised: that is, all agricultural research actors (researchers, farmers and rural extension agents) are situated at the same level of the decision-making processes. Also, the research model networks comprise both formal and informal organisations, such as NGOs, farmers' organisations and other state or private organisations. Integration and horizontal levels change the emphasis from a top-down approach to a more holistic and general-systems-responsive form[63].

(4) Finally, *the farm as whole* model focuses on the correct definition of the research problem (including the agricultural, social, political, economic, anthropological values of the farmers and the unit production) by the researcher and the subsequent phases of the agricultural technology generation process. The researcher's and the research organisation's influences on the agricultural technology generation and adoption processes are the cornerstones of the model. The actors involved in the research model (researchers, farmers and rural extension workers) may join in a deal with the stages of the process of generation and adoption of agricultural technology. According to Norman and Douglas [1996: 113-121], these stages comprise the generation and technology diffusion as a sole process, which involves: First, the description/diagnosis (the planning and the preliminary researches). Secondly, the experimental design (the development of the potential recommendations). Thirdly, the implementation of the recommendations (implementation of the rural extension and agricultural research activities), as described in the suggested *farm as whole* model as follows.

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[63]In accordance with Long [1996: 39, 56-57], *Globalization and Localization: New Challenges to Rural Research,* the encounter between so-called 'expert' and 'local' modes of knowledge '...'. This type of work can draw upon the sociology of knowledge and on cognitive anthropology to analyse how farmers or other relevant actors generate, reproduce, transmit and transform knowledge relating to agricultural practice '...'. Understanding the encounters between various types of knowledge and ideology is central to the analysis of rural development'.

First, in the diagnosis[64], the renewed agricultural researchers, the rural extensionists and the targeted farmers who are representatives of the region and ecological environment jointly constitute the actors in the definition of the research agenda. This includes: 'what is the research problem?', 'what is the process by which the research is undertaken? and 'who is going to appropriate the research results'. These are crucial points for the success of technology generation and its adoption by farmers. The links among researchers, farmers and rural extension workers may be based on concrete mechanisms rather than interpersonal links, such as the 'research and adoption project', which deals with mutual duties (funds, work-time, research activities and so on) instead of informal and personal association.

Secondly, the 'planning' and implementation of the trials. Once again, the joint participation of the researchers, rural extension and farmers is desired. Questions arise, such as 'what are the tests?', 'where will be they located?' and 'who manages them?'. It is important to identify the farmer's background, including the social and economic constraints and the endowment and allocation of the factors of production. This means understanding what are the conventional (land, capital and labour) and non-conventional factors of production (the technology and its social and environmental consequences) to be managed in the trials. Also, it is important to assess how farmers can afford the trial results[65]. The point it is to find out solutions appropriate to the farmer's production units. When possible, the trials could be implemented in the farmer's fields. This strategy allows the technology tests to be done under uncontrolled circumstances, such as climate, soil, temperature and other controls normally used by the researchers in the experimental stations, in the laboratories and in the greenhouses.

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[64]It is assumed that the researchers and the rural extension workers have already made the detailed 'diagnosis' of the region, the farmers and the systems of production in terms of the social, economic, anthropological, political and agricultural issues.

[65]Collinson [1987: 371], ibid., writes that 'the planning process brings together two information streams; the understanding of the target group '...' and technical information from past and present research'.

This is a way to reduce the 'gap between theory and practice'. The target is the generation of appropriate[66] agricultural technology to supply the farmer's demands.

Thirdly, the 'assessments' and collection of the trial results. Similar to the last procedures, this involves the researchers, rural extensionists and farmers. This is the last stage of agricultural technology tests. It is the materialisation of the 'diagnosis', the 'planning' and the 'assessments' and of the trials under the control of the researchers, the farmers and the rural extension workers. The active involvement of the farmers in the evaluation of the results is crucial. The main objective is not the publication of the findings in scientific journals, but the concrete incorporation of the findings in the farmer's production systems. When possible, the trial results may be shown in visible terms and on a large scale, for example, the seed multiplication process to be used by a wide number of farmers. In the *farm as whole* model, the traditional recommendation of the rural extension agencies [the 'trickle down' process from the research organisation to the farmers bridged by the rural extension] is not necessary. The extensionists and farmers are active participants in the agricultural technology generation. It is assumed that they are convinced of the importance of the technology generated (the adoption or rejection of the agricultural technology). Furthermore, they are partners in the whole process and not simply the bridge or the receptors of agricultural technology from the research organisation.

### 8.3.4. The Need to Review Training and Education of Researchers

It is important to bear in mind that training and education processes are powerful strategies to sustain the *farm as a whole* proposals. From this perspective, researchers'

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[66]According to Graziano da Silva [1994: 9], *Agricultura Sustentável - Entrevista,* the alternative technology does not mean low-quality technology with insignificant productivity which makes the improvement of the small and subsistence farmers difficult.

backgrounds based on multidisciplinary knowledge should be taken into account, instead of the monodisciplinary and over-specialised knowledge[67] focused on either a specific agricultural product or a single scientific area. *De-socialisation and re-socialisation* thus become necessary[68]. This has certain implications. First, an understanding of the researchers' social background is required. In addition, the researcher's career, prestige and economic reward is presented as a function of the farmers' technology adoption. Thus, in the suggested approach, the researcher's assessment, actually related to publications and researchers' specialisation, should be changed.

Secondly, the education and training of agricultural researchers[69] may follow new methods. For instance, multidisciplinarity focusing on whole systems instead of separate parts is also necessary to understand the concrete social relations of production. Also, a massive training (formal or informal, short or long-term and on-the-job or off-the-job) programme may focus on holistic approaches, the agricultural, anthropological and social aspects of the producer and the production process. Training proposals may also concentrate on regional[70]

[67]According to Graziano da Silva [1988: 50], *As Possibilidades e as Necessidades da Ciência e da Tecnologia na Área das Ciências Agrárias,* 'today one part of scientific knowledge is acquired either in the international research centres or in the postgraduate courses in the American or European universities. The complexity of research equipment and the amount of financial resources necessary to reproduce this scientific knowledge in the Latin American countries as well as the shortage of financial resources in the national research centres, have made the independence of the agricultural research creation difficult'. Also, he argues 'that the researcher from a public agricultural research organisation, after concluding his postgraduate training, should radically change his research line. It looks like 'brain washing'. In fact it means that the research priority will be developed in line with the [training] organisation'.

[68]Chambers [1997: 210], ibid., argues that 'professional change needs new concepts, values, methods and behaviours, and new curricula and approaches to learning'. Analoui [1996: 1], *A Socio-Technical Framework for the Effective Transfer of Training,* also stresses that 'the traditional approach to training is mainly concerned with task which has placed substantial emphasis on the cognitive and behavioural aspects of the learning in training situations. These include processes involved in the acquisition of new skills, knowledge, attitudes and behaviour'.

[69]According to Chambers and Jiggins [1986: 4], *Agricultural Research for Resource Poor Farmers: A Parsimonious Paradigm,* 'agricultural scientists are conditioned by training '...' [and] the hierarchical learning of school and university implants the idea of learning form above and teaching to below. Agricultural science syllabuses are concerned with scientific detail and scientific research methodology, not with technology development or how to learn from farmers'.

[70]According to Kitamura et al [1989: 40-41], ibid., a strong contradiction is revealed by the current agricultural research model. In theory the EMBRAPA research model is focused on the multidiciplinary research approach.

and local ecosystems, connected with the researchers' regional activities, instead of 'neutral' or national-led aspects, disconnected from the reality of where the research organisation and its users and partners are located. As far as possible the training strategy should be achieved on-the-job as an interactive operation which involves the trainees and trainers in the social context where the acquisition and the utilisation of knowledge occur. So, it is desirable that there be an agricultural researcher concerned with the macro interactions of the whole farm, instead of a specialist, such as a geneticist or a seed physiologist, for a specific agricultural product.

This transformation is not a simple task[71]. It has profound implications for the organisation itself and for the education system. The training methods should shift from the micro and highly specialised to the macro and holistic matters. Furthermore, important implications for the Brazilian education and training process as a whole are noted with respect to the Universities. The current educational system was built in the 1970s by military rule, when a mass higher education[72] programme at University and postgraduate levels took place.

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However the researchers are trained on monodisciplinary proposals. Consequently, EMBRAPA agricultural technologies are not adopted by farmers who demand technologies for the system of production as a whole. They also suggested that agricultural technology generation should be focused on the regional and ecological demands where the farmers are located. They showed several examples of agricultural technologies that were not adopted by farmers, for instance the new varieties of corn, rice and beans.

[71]According to Cornwall et al [1993: 28-30], ibid., 'change takes place over time: it takes time. Radical revisions of existing forms of practice may be desirable, but they too take time to germinate and take root '...' if [agricultural research] is to be treated as the social process it is, several key areas [education and training] will need to be considered '...' changing the mould of conventional approaches also involves challenging the nature of interactions between rural people, and researchers or extension agents. The key role that training plays in a shift towards recognising the political and personal dimensions of agricultural development will need to be addressed'. Also, according to Innis [1997: 11], *Intercropping and the Scientific Basis of Traditional Agriculture,* 'it is difficult to imagine scientists, who are trained to test painstakingly the influence of one factor at a time, being enthusiastic about a holistic system which integrates a dozen factors at once to produce a highly productive, socially advantageous, non-destructive type of agriculture'.

[72]Alves [1980: 58], ibid., writes that in 1971 the DNPEA (previous EMBRAPA) comprised only 93 trained (Masters and PhD) agricultural researchers. No-one was trained in the social sciences. However, Quirino et al [1980: 5 and 37], *Recursos Humanos, Conhecimento e Tecnologia: Avaliação do Programa de Pós-Graduação da EMBRAPA no Brasil e Sugestões de Melhorias,* stress 'that EMBRAPA in 1973, the year of its installation initiated the formal postgraduate training sponsored by the Inter-American Agrarian Sciences Instate (IICA), an organisation of the United Nations. In 1974, was sent 287 agricultural researchers to the postgraduate training in Brazil and overseas', and between '1974 and 1979 these amounted 887 agricultural

Primary education was not a priority[73]. Education with national security was the essence of the Brazilian university system. Also, the insertion of Brazil into the global economy and the standardisation of procedures and the importation of education models occurred, following, in particular, the American[74] pattern. For instance, the semester instead of the annual calendar, a national curriculum instead of a regional one, departments instead of schools, massive and fragmented courses instead of selective ones, and technology transfer instead of indigenous knowledge were some of the characteristics of the university system.

At that time, Brazil lacked a strong science and technology apparatus to support capitalist agriculture which focused on modern capital intensive technologies. Traditional training in higher education in Brazil and overseas was the cornerstone of the then current agricultural research model. However, since the end of the 1980s, the productivist development model has been failing. Agricultural quality, environmental and social issues, agricultural diversification, distribution, decentralisation, participation and regionalisation became part of the agenda. All these call for rearrangement of the agricultural research system and as a result a new kind of agricultural researcher is required. According to Pretty

> It is clearly time to let go of some the old paradigm of positivism for science and embrace the new alternatives. This will not be easy, as many professionals will resist. But it is only when some of these new professional norms and practice are in place that widespread change in the livelihoods of farmers and their natural environments is likely to be achieved [1995: 203].

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researchers'. Also, Camilleri and Falk [1992: 94], *The End of Sovereignty?: The Politics of a Shrinking and Fragmenting World,* state that 'the World Bank, the FAO (Food and Agricultural Organization) and other United Nations agencies have become important elements of compatibility of training and educational systems, the flow of technical and managerial expertise, taxation agreements and treaties for investment protection'.

[73] Meyer-Stamer [1997: 78], *Technology, Competitiveness and Radical Policy Change : The Case of Brazil,* writes that 'primary education is in the midst of a deep crisis. The extent of the crisis is made plain by the several statistical indicators: only 34% complete primary school, i.e. eight years of schooling'.

[74]Today, the majority of Brazilian scientists are still trained by the American universities. According to Vargas [1996: 9], ibid., 'for the human resources development program there are at present 320 Brazilian students on doctorate and post-doctorate courses in England. This represents 15% of the total number of students abroad, after the US (40%) and France (17%)'.

This means the 'de-socialisation' of the current monodisplinary agricultural researchers and at the same time, their 're-socialisation' and insertion into a pluralist and holistic model[75]. For instance, as mentioned before, 72% of all the researchers interviewed took an agronomy course[76]. Also, in the current agricultural research model, around 91% of all agricultural researchers consider *EMBRAPA as the best Brazilian agricultural organisation* and 94% very much *enjoy being an EMBRAPA researcher.* The CNPSo and CNPO researchers were the most content researchers. Also, the research centres surveyed rejected the association with NGOs, rural extension agencies and co-operatives. The lowest mean was CNPSo's mean of 1.17 to the EMBRAPA *link with rural extension agencies* which are organisations linked to the farmer's production units. The following mean was CNPSo's mean of 1.65 to EMBRAPA *association with NGO* which are decentralised and oriented to the small farmers' organisations.

The highest mean was CNPSo's mean of 4.08, followed by CNPC's mean of 3.25 pointed to *EMBRAPA only needs money* to improve the agricultural generation process. In this matter, ANOVA outputs showed statistical differences among CNPSo's mean of 4.08 and CNPA's mean of 2.60 and between CNPSo's mean of 4.08 and CNPO's mean of 2.86 respectively. These indicated a high corporate ethos within EMBRAPA, mainly in the CNPSo and CNPC. Furthermore, it is important to note that 76.62% of the researchers sampled believed that *EMBRAPA is researching the most important problems in Brazil.*

[75]In Chambers' [1993:1], ibid., views this will be the reverse of the 'normal professionalism (the thinking, values, methods and behaviour dominant in a profession or discipline - is stable and conservative), to put 'people first and poor people first of all'. According to Biggs and Grosvernor-Alsop [1984: 4], ibid., this means that 'priorities for research reflect the holistic perspective of the whole farm/rural household and the natural and human environments'.

[76]According to Pretty and Chambers [1994: 199], *Towards a Learning Paradigm: New Professionalism and Institutions for a Sustainable Agriculture,* 'agricultural faculties are often the most conservative of agricultural organisations '...' most have developed structures that reflect the proliferation of disciplines which have emerged over the past thirty years'.

CNPSo has the highest degree of consensus with 91.67%. However, as stated before, this was not confirmed by the small farmer's organisations and the rural extension representatives.

Once again, but following a different method, education and training will be the main tools to reverse the present research model, especially the strong corporate ethos. A renewed human resource is the key strategy which may involve the agricultural researchers, the managers and the rural extension workers. Local and regional demands, social, anthropological and environmental issues will be the elements to indicate the training priorities which will sustain the *farm as a whole* research model. According to Analoui

> the effectiveness of the training methods [should be] based on the extent to which the [trainees] are enabled to become an effective member of [the organisation's demands] '...' it has been observed that management trainees from public sector organisations, by and large, find the process of adjustment to new ideas and coping with change as a whole, difficult and painful [1996: 3 and 18].

The principal factors to establish the recommended agricultural research model are as follows: First, the political and social context (government, political parties, social movements, urban and rural grassroots movements) and organised pressure will provide the basis for establishing the suggested approach[77]. Second, the transformation of the education structure, based on strategic planning to meet the new demands from the researchers, rural extension workers and their managers[78] will be called into question. As seen, these embody an enormous challenge to be faced by the whole of society[79].

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[77]Busch and Bingen [1994: 2], *Restructuring Agricultural Research: Some Lessons from Experience,* argues that 'national agricultural research is not solely a public expense, but it is also an investment in a nation's future'.

[78]Borges-Andrade [1992], *Gerência de Pesquisa na EMBRAPA*, writes that the managers may understand that the management of the generation and transfer technology process involves three dimensions: the socio-political, scientific investigation and organisational matters.

[79]According to Busch and Bingen [1994: 1], ibid., 'change is more likely to be effective if it embraces a multifaceted approach that involves a combination of structural, human resource, and political perspectives'. For Analoui [1996: 26], ibid., 'it is widely acknowledged that the individual's values structure and to a large extent the organisational culture are influenced, if not shaped, by the powerful structural factors such as legal,

The universities in Brazil are the main channels of knowledge transfer through teaching (formal and informal training) activities[80]. These are organisations, on the one hand, characterised by a *strong espirit de corps,* social status, hierarchy and red tape. On the other hand, they have been moulded for a discourse on freedom, autonomy, democracy and social importance. The Brazilian universities have successive budget cuts, so that it has become difficult to deal with the functions of research and technology diffusion. Universities have been teaching organisations. They have a huge network throughout the country which facilitates their meeting regional demands made by the new research system. It is important to note the difference between Universities that deal with multidiciplinary specialities and the isolated agricultural faculties focused only on agricultural and biological matters. Pearson and Ison cited by Pretty and Chambers [1994: 199] argue that the agricultural faculties 'remain in the conceptual strait-jacket of positivism and modernization, arising partly out of the functional demarcation of research and teaching, and the focus on teaching rather than learning'. The proposed training programme should be achieved in the regional and multipurpose universities.

In fact, the education and training required for the suggested agricultural research model[81] can be targeted:

(1) The multipurpose universities will supply the undergraduate degrees centred on the demands of the regional and ecological research centres, including the social and ecosystem realities of the farmers and their systems of production. The region and, when possible, the municipality should be the targets of the training.

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political, socio-economic and cultural issues, which are present and operating within the context of the wider society. The presence of these factors, the degree and extent of their impact on the training programme and the eventual transfer of that programme ought to be recognised and their role as inhibitors and facilitators for the transfer of learning should be taken into consideration'.

[80]This is confirmed by Gibbons et al [1995: 137], *The New Production of Knowledge,* who argue that 'the universities are the institutions mainly responsible for the training of specialists'.

[81]Gibbons et al [1995: 140-141], ibid., affirm that 'because knowledge production is becoming more dynamic and open-ended, its modes of organisation are less stable and permanent '...' for them 'the most significant changes, however, are not connected with size but with function'.

(2) Formal training, such as postgraduate degrees (specialisation, Masters and PhD), may follow the same route as the previous strategy. The priority should be on-the-job training. When necessary, the researchers should be trained overseas, since the holistic approach should be maintained. Throughout the world there are research and teaching centres which deal with these matters. Moreover, the agricultural researchers could seek co-operation with experts from other fields to solve specific problems.

(3) Short-term and informal training, such as visiting, field-days, field trips and interactions among researchers, farmers and rural extension workers should be undertaken in Universities, research centres, farms and rural extension areas, following the regional and ecological perspective. The researcher's and the rural extension worker's training will be prioritised where the farmers are located[82].

(4) Finally, the availability of funding[83] is a crucial factor in the implementation of the suggested research model, mainly the training programme which is fundamental to the suggested model. State, national, and international aid agencies and private consultancies will be some of the financial sources. Also, non-governmental and governmental co-operation, formal and informal agreements (with farmer's organisations, co-operatives, rural extension agencies, etc.) and donations will make up alternative ways of getting financial support[84].

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[82]Pretty [1995: 199], *Regenerating Agriculture: Policies and Practice for Sustainability and Self-Reliance,* states that the agricultural researchers training 'is not [only] in knowledge, in the formal sense, but in attitudes, behavioural changes and facilitation skill. Training is [also] centred on learning by doing and bringing scientists, extensionists and farmers together to negotiate and learn from each other' on personal experiences'.

[83]Since EMBRAPA was established, the postgraduate training programme overseas has been sponsored by the international agencies, such as the World Bank, the Inter-American Development Bank (IBRD) and the Inter-American Agrarian Sciences Institute (IICA). At the field-work time, 131 researchers were in postgraduate training (D.Phil. courses) in foreign universities, who were total or partially sponsored by IBRD and the World Bank. Also, it is important to show that the World Bank and the IBRD have supported EMBRAPA research programmes to acquire laboratories, equipment and computers, to train researchers overseas etc. [EMBRAPA, 1994: 10, *Relatório de Atividades 1994,* and EMBRAPA, 1993f: 8-9, *Relatório de Atividades 1993*].

[84]According to Gibbons et al [1995: 145], ibid., 'currently, success in attracting funds for research depends on meeting a complex set of extra-scientific criteria related to social priorities, relevance and accountability'.

## 8.4. Closing Remarks

Inevitably, the thesis' findings do not cover the entire agricultural technology generation field. This is only part of the subject, but it is a suitable research area for future work. The objective is to improve the Brazilian agricultural technology system performance in relation to the majority of Brazilian farmers, especially the small and subsistence farmers. For instance, research programmes involving the social aspect of technology evaluation and agricultural technology innovation are required. Also, further investigation related to the food chain, and its implications for the agricultural technology generation process require further investigation. Studies related to the small farmers' needs and rural patrimony valorisation, such as agricultural land and its relation to agricultural technology, are to be encouraged. The influences of the government, Congress, land-reform settlements and urban consumers are also factors to be considered in the agricultural technology generation process.

It is not a simple procedure to change the nature of the current agricultural technology generation model, which is focused on specific agricultural products and led by EMBRAPA. However, the evidence from the thesis shows the disapproval of a significant portion of policy-makers, and users, such as ministries and governmental organisations, small farmers, state rural extension agencies and non-governmental organisations. From this perspective, a new agricultural technology framework based on technology generation and adoption as a sole process is suggested: the so-called *farm as a whole* model which involves farms and farmers and is centred on ecological differentiation; farmers' social, cultural and economic values and the demands of the various social groups interested in agricultural technology. The *farm as a whole* research agenda, mainly the choice of the research problem and the research process, should be a cohesive consensus amongst the renewed multidisciplinary agricultural research team, the rural extension agents and the empowered farmers.

Finally, I hope that, at the end of the process of generating this thesis, which I have done with great enthusiasm and passion, I have made a useful and concrete contribution towards Brazilian social transformation.

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# APPENDIX 1

UNIVERSITY OF SUSSEX
SCHOOL OF SOCIAL SCIENCES
FALMER, BRIGHTON - UK

## QUESTIONNAIRES

## THE PROCESS OF AGRICULTURAL TECHNOLOGY GENERATION IN THE BRAZILIAN CASE

**Manoel Moacir Costa Macêdo**
**D. Phil. Student**

**Dr David Harrison**
**Supervisor**

**IMPORTANT**

**This questionnaire is being circulated to support the collection of the primary data of the DPhil thesis in the Social Sciences, by Manoel Moacir Costa Macêdo.**

**All individual answers and comments will be treated as strictly confidential and non-attributable.**

**Thank you in advance for taking the time and trouble to complete this questionnaire.**

## PERSONAL DETAILS

**1. Interview number:** ____

**2. Research centre:** ( 1) National Cotton Research Centre
( 2) National Goat Research Centre
( 3) National Soya bean Research Centre
( 4) National Sheep Research Centre

**3. Your age:** ( 1) Under 26 ( 2) 26 - 31 ( 3) 32 - 37
( 4) 38 - 43 ( 5) 44 - 49 ( 6) 50 - 55
( 7) 56 - 61 ( 8) Over 61

**4. Sex:** ( 1) Male
( 2) Female

**5. Where were you born?** City __________ State ________

**5.1.** Country: Brazil ( 1) ( 2) Other. Specify: ________
**5.2.** Region: ( 1) North-eastern ( 2) Southern ( 3) Other. Specify: ________
**5.3.** Rural area ( 1) Urban area ( 2)

**6. What are the main occupation of your father?**

( 1) public servant
( 2) liberal professional. Specify: __________
( 3) business
( 4) farmer. Farm area _______ha
( 5) other. Specify ___________________

**7. In what type of school did you attend?**

**7.1.** Primary school: ( 1) Public ( 2) Private
**7.2.** Secondary school: ( 1) Public ( 2) Private
**7.3.** University: ( 1) Public ( 2) Private

**8. Academic background:**

| | Course | University | Country | Start (year) | Conclusion (year) |
|---|---|---|---|---|---|
| BS | | | | | |
| MSc | | | | | |
| PhD\Dr | | | | | |
| Post Dr | | | | | |

Could you tell me the title of the theses

| Course | Title of the theses |
|---|---|
| MSc | |
| PhD\Dr | |

**9. Please, indicate your previous professional experience**

| | Organisation (s) | Position (s) | Main Activity (ies) | Period (s) |
|---|---|---|---|---|
| 1. | | | | |
| 2. | | | | |
| 3. | | | | |

**10. When did you join EMBRAPA?** Month__________ Year 19____

**11. When did you start work in your current research centre?** 19____

**12. How were you recruited by EMBRAPA?**

( 1) recruited from DNPEA (diffuse model)
( 2) recruited from the Ministry of Agriculture
( 3) recruited from an undergraduate course, because of high academic achievement
( 4) recruited from a graduate course, because of high academic achievement
( 5) selected by a supervisor or lecturer
( 6) selected by EMBRAPA's President
( 7) selected by EMBRAPA's Director
( 8) selected by head of the research centre
( 9) recommended by a colleague or friend
( 10) recommended by a politician
( 11) public recruitment
( 12) other. Specify ______________

**13. What do you do when you are not working at EMBRAPA**

| | Very Unimportant | | ------ | Very Important | |
|---|---|---|---|---|---|
| **13.1.** personal study | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **13.2.** I am a consultant | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **13.3.** I have a farm | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **13.4.** I teach in the university | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **13.5.** nothing specific | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **13.6.** I connected with my job | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **13.7.** other. Specify: _________ | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |

**14. Which of the following describe your involvement in the local community?**

| | Very Unimportant | | ------ | Very Important | |
|---|---|---|---|---|---|
| **14.1.** rotary and/or lions club member | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **14.2.** Masonic movement | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **14.3.** church membership | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **14.4.** adviser to development bank | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **14.5.** council activities | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **14.6.** occasional speaker at schools | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **14.7.** co-operative movement | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **14.8.** friendship links with prominent people | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **14.9.** other. Specify: ________________ | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |

## RESEARCH PROJECTS IDENTIFICATION

**15. How many research projects are you developing?**

Main responsible _______ projects
Collaborator ___________ projects

**16. Please specify the five most important research projects, in the last three years, indicate the titles, and the time from the start to conclusion.**

| Title | Start (year) | Conclusion (year) | Time spent | Budget (U$) | Funding (agencies) |
|---|---|---|---|---|---|
| 2. | | | | | |
| 3. | | | | | |
| 4. | | | | | |
| 5 | | | | | |

**17. Has any project you have been interrupted or terminated?** ( 1) yes
( 2) no

**18. If 'yes', say the main reasons.**

( 1) disapproved in the PNP (National Research Programme) meeting
( 2) bad climatic conditions
( 3) insufficient financial resources
( 4) changing EMBRAPA priorities
( 5) changing governmental priorities
( 6) insufficient equipment
( 7) other. Specify: ______________________

**19. What is your research line?** ____________________

**20. Have you maintained the same research line since you joined EMBRAPA?**

( 1) yes    If 'yes' go to question '22'
( 2) no    If 'no' go to question '21'

**21. Why did you change?**

( 1) because of my masters course
( 2) because of my PhD\Dr course
( 3) because of my post doctorate
( 4) because of the research centre is facilities
( 5) because of new bibliographical literature
( 6) because of the possibility of publishing
( 7) because of professional prestige
( 8) because of political pressure
( 9) because of economic interests
( 10) because of extension agents' suggestions
( 11) because of farmers' interests
( 12) because of greater opportunities for promotion
( 13) other. Specify: ________________________

**22. How would you characterise your research project?**

| | Very Unimportant | | ----- | | Very Important |
|---|---|---|---|---|---|
| **22.1.** to the solution of local problems | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **22.2.** to the solution of national problems | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **22.3.** to the solution of international problems | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **22.4.** to the advancement of scientific knowledge | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **22.5.** to satisfy scientific curiosity | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **226.** to fulfil funding requirement | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **22.7.** other. Specify: ____________________ | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |

**23. How did you develop an interest in the solution to your research problem?**

| | Very Unimportant | | ----- | Very Important | |
|---|---|---|---|---|---|
| **23.1.** through professional experience | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **23.2.** through scientific background | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **23.3.** through new scientific literature | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **23.4.** through government programmes | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **23.5.** through funding facilities | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **23.6.** through contact with extension agents | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **23.7.** other. Specify: ____________________ | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |

## ORGANISATIONAL INFLUENCES

**24. Do you know EMBRAPA's research model?**

( **1**) yes  If 'yes' go to question '25'

( **2**) no  If 'no' go to question '26'

**25. Please, describe its main characteristics:**

1 ______________________________________
2 ______________________________________
3 ______________________________________

**26. Do you know EMBRAPA's previous research model?**

( **1**) yes  If 'yes' go to question '27'
( **2**) no  If 'no' go to question '28'

**27. Please, describe its three main characteristics:**

1. ______________________________________
2. ______________________________________
3. ______________________________________

**28. In your opinion why did EMBRAPA replace the DNPEA research system?**

| | Very Unimportant ----- Very Important | | | | |
|---|---|---|---|---|---|
| **28.1.** because DNPEA was an unproductive | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **28.2.** because DNPEA did not have well-trained researchers | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **28.3.** because DNPEA had the diffuse system | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **28.4.** because DNPEA had a bureaucratic structure | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **28.5.** other. Specify: ____________________ | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |

**29. Do you know the summary diagram below?**

Research Centre
↓
Technology Generated
↓
State Agriculture System
↓
Technology Adaptation
↓
Farmer

( 1) yes
( 2) no

**30. Do you agree with it?**

( 1) yes
( 2) no

**31. Please, if 'no' could you suggest another summary diagram for the agricultural research generation process**

**32. How would you describe your research centre's technology generation process?**

( 1) participation (bottom up) If 'participation' go to question '33'
( 2) hierarchical (top down) If 'hierarchical' go to question '34'

**33. Who or what influences your choice of research problem in your research project?**

| | Very Unimportant | | ----- | Very Important | |
|---|---|---|---|---|---|
| **33.1.** head of research centre | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **33.2.** scientific colleagues | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **33.3.** EMBRAPA's executive | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **33.4.** financial sources | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **33.5.** farmers | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **33.6.** governmental priorities | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **33.7.** extension agents | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **33.8.** other. Specify:______________ | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |

**34. Who approved your research project?**

( 1) head of research centre
( 2) EMBRAPA's executive
( 3) scientific pairs - PNP meeting
( 4) other. Specify: ____________________

**35. How long did it take for your research project to be approved after submission?**

Specify: _______months

**36. What of the following activities do you undertake before choosing the research project?**

| | Very Unimportant | | ----- | Very Important | |
|---|---|---|---|---|---|
| **36.1.** a complete literature review | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **36.2.** consult scientific colleagues | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **36.3.** farmer's meetings | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **36.4.** extension agents' meeting | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **36.5.** investigate financial sources | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **36.7.** follow up government priorities | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **36.8.** other. Specify: ___________ | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |

**37. Do you receive feedback on the technology generated?**

( 1) yes    If 'yes' go to question '38'
( 2) no    If 'no' go to question '39'

**38. Who has given you feedback?**

| | Very Unimportant | | ----- | Very Important | |
|---|---|---|---|---|---|
| **38.1.** head of research centre | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **38.2.** EMBRAPA's executive | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **38.3.** scientific pairs | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **38.4.** farmers | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **38.5.** extension agents | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **38.6.** industries ( e.g. fertilisers) | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **38.7.** ecological movements | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **38.8.** other. Specify: ___________ | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |

**39. Have you participated in any public campaigns to control diseases, insects, or to increase productivity?**

( 1) yes    If 'yes' go to question '40'
( 2) no    If 'no' go to question ' 41'

**40. In your opinion what happened to the technology generated by yourself in these campaigns?**

| | Very Unimportant | | ----- | Very Important | |
|---|---|---|---|---|---|
| **40.1.** it was adopted by farmers | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **40.2.** it resulted in an important contribution | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **40.3.** the problem was about political priority | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **40.4.** I participated, but these matters are more appropriate for rural extension agencies | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **40.5.** other. Specify: ______________ | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |

**41. Do you have the necessary administrative support for your research project?**

( 1) yes
( 2) no

**42. Please list the main problems in getting administrative support**

1.____________________________________
2.____________________________________
3.____________________________________

**43. Some people say that EMBRAPA does not supply sufficient research material for research projects. Do you**

( 1) agree strongly
( 2) agree
( 3) disagree
( 4) disagree strongly
( 5) no opinion

**44. Is EMBRAPA organised like a private enterprise?**

( 1) yes. Justify: ______________________________________

( 2) no. Justify: ______________________________________

**45. Some people say that EMBRAPA is the best research organisation in Brazil. Do you agree?**

( 1) agree strongly
( 2) agree
( 3) disagree
( 4) disagree strongly
( 5) no opinion

## INTERNAL INFLUENCES

**46. Some people say that EMBRAPA's researchers have freedom in the choice of research problem. Do you**

( 1) agree strongly
( 2) agree
( 3) disagree
( 4) disagree
( 5) no opinion

**47. Some people say that EMBRAPA is researching the most important agricultural problems in Brazil. Do you**

( 1) agree strongly
( 2) agree
( 3) disagree
( 4) disagree strongly
( 5) no opinion

**48. Do you enjoy being an EMBRAPA's researcher**

( 1) very much
( 2) quite a lot
( 3) not much
( 4) not at all

**49. How do you divide your time in research activities. Please indicate the relative importance of the following activities in the research process. Answer with percentages.**

%
( 1) literature review
( 2) write up the research project
( 3) participation in scientific meetings
( 4) write up the scientific papers
( 5) farmer's meetings
( 6) extension agents' meetings
( 7) bureaucratic activities
( 8) sight upon financial resources
( 9) other. Specify: ________________

100

**50. Is there any collaboration between your and any other organisation or individual**

( 1 ) yes If 'yes' go to question '51'
( 2) no If 'no' go to question '54'

**51. Who have you collaborated with?**

| | Very Unimportant | ----- | | Very Important | |
|---|---|---|---|---|---|
| **51.1.** my previous supervisor | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **51.2.** scientific pairs in an foreign country | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **51.3.** scientific pairs in Brazil | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **51.4.** farmer's organisations | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **51.5.** extension agents | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **51.6.** international research centre | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **51.7.** other. Specify: ________________ | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |

**52. How much communication do you have with colleagues and collaborators?**

( 1) once a day
( 2) once a week
( 3) once a month
( 4) once a year
( 5) other. Specify: _______

**53. Which kind of communication?**

( 1) visits
( 2) telephone
( 3) correspondence
( 4) other. Specify: ________________

**54. Do you have regular contact with any international research centre(s)?**

( 1) yes If 'yes' go to question '55'
( 2) no If 'no' go to question '57'

Please specify which
1.____________________________________________
2.____________________________________________
3.____________________________________________

**55. What type of collaboration have you maintained with any international research centre(s)?**

( 1) short training
( 2) changing of genetic material
( 3) publications of scientific papers
( 4) research project funding
( 5) other. Specify: _________________________

**56. Which the three domestic scientific periodicals do you read regularly?**

1.__________________________________
2. _________________________________
3. _________________________________

**57. Which the three foreign scientific periodicals do you read regularly?**

1. _________________________________
2. _________________________________
3. _________________________________

**58. Why do you read foreign literature?**

( 1) more appropriate to my research line
( 2) because of more advanced scientific knowledge
( 3) because of information about new scientific development
( 4) because of information about new methods
( 5) other. Specify: ______________________

**59. Which three authors do you refer to the most?**

| Author | Research Area | Organisation | Country |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |

**60. Where do you prefer to publish research results?**

( 1) foreign scientific publications
( 2) national scientific publications
( 3) EMBRAPA's publications
( 4) extension agencies' publications
( 5) scientific meetings
( 6) other. Specify: __________________

**61. What percentage of your papers are published in the following?**
%
( 1) speciality publications
( 2) farmer's publications
( 3) extension's publications
( 4) scientific meetings
( 5) other. Specify: ______________

100

Please, list the titles of your five most important publications:

1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________

**62. Normally, do you publish**

( 1) alone
( 2) roughly equal alone and joint
( 3) other. Specify: ______________

**63. Which of the following motivates you most?**

( 1) scientific curiosity
( 2) problems in agricultural practice
( 3) other. Specify: ______________

<u>If your answer is 'problems in agricultural practice', go to question '65'</u>

**64. Your scientific curiosity developed from**

( 1) graduate training
( 2) scientific literature
( 3) contact with scientific pairs
( 4) supervisor
( 5) problems in practising agriculture
( 6) extension agents' suggestions
( 7) funding facilities
( 8) other. Specify: ______________

**65. Are there consequences to the technologies you develop?**

( 1) yes    If 'yes' go to question '66'
( 2) no    If 'no' go to question '67'

**66. Could you describe some the consequences of technology generation**

economic consequences: ____________________

social consequences: ____________________

environmental consequences: ____________________

**67. Do you follow through the process of technology adoption?**

( 1) yes    If 'yes' go to question '69
( 2) no    If 'no' go to question '68'

**68. Why not?**

( 1) because normally my research has positive effects
( 2) because the most important consideration is increasing the productivity
( 3) because that is the responsibility of the rural extension agencies
( 4) because EMBRAPA has not evaluated the adoption process
( 5) other. Specify: ____________

**69. In your opinion has EMBRAPA developed the most appropriate agricultural technologies for the majority of Brazilian farmers?**

( 1) yes
( 2) no

**70. Please say why**

____________________________________________________________
____________________________________________________________
____________________________________________________________

**71. Some people say that export products and food products are treated differently in EMBRAPA's research programmes. Do you**

( 1) agree strongly
( 2) agree
( 3) disagree
( 4) disagree strongly
( 5) no opinion

**72. Please say why**

( 1) because export products' programmes have more funding
( 2) because export products' researchers have more relationships
( 3) because export products' researchers have more scientific status
( 4) because export products' researchers gain more promotion
( 5) there is no difference
( 6) other. Specify: ____________________________

<u>**EXTERNAL INFLUENCES**</u>

**73. Some people say that EMBRAPA has been very important in the modernisation of Brazilian agriculture. Do you**

( 1) agree strongly
( 2) agree
( 3) disagree
( 4) disagree strongly
( 5) no opinion

**74. If you agree, please you say why?**

| | Very Unimportant --- Very Important | | | | |
|---|---|---|---|---|---|
| **74.1.** because it has introduced modern equipment | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **74.2.** because it has trained agricultural researchers | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **74.4.** because it has increased agricultural exportation | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **74.4.** because it has helped the introduction of the use of modern input (e.g. seeds and fertilisers) | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **74.5.** other. Specify: ____________________ | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |

**75. Some people say that EMBRAPA is irrelevant to the majority of Brazilian farmers. Do you**

( 1) agree strongly
( 2) agree
( 3) disagree
( 4) disagree strongly
( 5) no opinion

**76. Who do you think EMBRAPA develops technology for?**

| | Very Unimportant ----- Very Important | | | | |
|---|---|---|---|---|---|
| **76.1.** extension rural agencies | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **76.2.** scientific publications | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **76.3.** scientific meetings | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **76.4.** knowledge advancement | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **76.5.** farmers | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **76.6.** other. Specify: __________ | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |

**77. In your opinion how is the technology generated by you best defined?**

( 1) appropriate for a specific type of farmer
( 2) neutral and of general application
( 3) appropriate for the development scientific knowledge
( 4) other. Specify: ______________________________

**78. Could you tell me which sectors will use the technology you have generated?**

( 1) agricultural input industry (fertilisers, seeds, so on)
( 2) machinery and agricultural implements industry
( 3) food processing industry
( 4) agribusiness
( 5) other. Specify: ______________________________

**79. How could EMBRAPA improve its agricultural technology generation?**

| | Very Unimportant --- Very Important | | | | |
|---|---|---|---|---|---|
| **79.1.** EMBRAPA could join with Rural extension | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **79.2.** EMBRAPA could associate with NGOs | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **79.3.** EMBRAPA could associate with co-operatives | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **79.4.** EMBRAPA could join with universities | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **79.5.** EMBRAPA only needs money | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |
| **79.6.** other. Specify: _______________ | [ 1] | [ 2] | [ 3] | [ 4] | [ 5] |

**80. Do you have you contact with the users of the technology that you generate?**

( 1) yes
( 2) no

**81. Who are them?**

( 1) agricultural input industry (fertilisers, seeds, so on)
( 2) agricultural implements industry
( 3) food processing industry
( 4) agribusiness
( 5) other. Specify: ________________________

**82. Please, can you indicate the results achieved through the technology that you have generated (e.g. scientific award, adoption by farmers, discovered new research methods, etc. )**

| Technology | Results |
|---|---|
| 1. | |
| 2. | |
| 3. | |

**83. Do you know the budget of your research project?**

( 1) yes
( 2) no

**84. Normally, who finances your research ?**

( 1) EMBRAPA
( 2) international sources
( 3) national sources (private sector)
( 4) other governmental sources
( 5) other. Specify: ________________

**85. In your opinion should be important development close links is between EMBRAPA and political parties**

( 1) agree strongly
( 2) agree
( 3) disagree
( 4) disagree strongly
( 5) no opinion

**86. Who do you think gives political support to EMBRAPA?**

( 1) all political parties, because of the importance of EMBRAPA
( 2) political parties of the left
( 3) political parties of the right
( 4) political parties of the centre
( 5) EMBRAPA does not need political support
( 6) other. Specify ______________________

**87. Since the Military dictatorship, EMBRAPA's budget has to be approved by the Parliament?**

( 1) true
( 2) false

**88. Some people say that is necessary for EMBRAPA to have a political lobby. Do you**

( 1) agree strongly
( 2) agree
( 3) disagree
( 4) disagree strongly
( 5) no opinion

**89. In your opinion what does EMBRAPA have to offer its political supporters?**

( 1) support some parliamentarian's interest according to regional political interest. EMBRAPA is a country-wide organisation
( 2) competence to help the Parliamentarian's political future
( 3) nothing, EMBRAPA is independent of political affairs
( 4) other. Specify: ________________________

**90. Some people say that some EMBRAPA research projects or programme are formulated according to political priorities. Do you**

( 1) agree strongly
( 2) agree
( 3) disagree
( 4) disagree strongly
( 5) no opinion

**91. How can EMBRAPA contribute to the formulation of Brazilian agriculture policy?**

( 1) EMBRAPA can offer technical suggestions to the Ministry of Agriculture
( 2) EMBRAPA can offer technical suggestions to Parliament
( 3) EMBRAPA can offer technical suggestions to the Ministry of Economy
( 4) EMBRAPA can wait for an invitation to offer technical suggestions
( 5) EMBRAPA cannot offer anything because it only develops agricultural research
( 6) other. Specify: ____________________

**93. If you have any further comments to make regarding EMBRAPA's agricultural generation process, please use the space below**

____________________________________________________________
____________________________________________________________
____________________________________________________________
____________________________________________________________
____________________________________________________________

**THANK YOU VERY MUCH FOR YOUR CO-OPERATION**

# APPENDIX 2

## The Process of Agricultural Technology Generation in the Brazilian Case

## The Description of Variables

### 1. Choice of Research Problem by the EMBRAPA Agricultural Researcher

The choice of research problem is expressed as a research question which, in turn, describes the purpose of the researcher in his agricultural investigation. Choosing the problem is the first and most important step in each project and defines the path of all further research.

### 2. The Researcher's Personal Details

a) Sex.
b) Age.
c) Place of birth. Rural or urban areas. State and regions.
d)Academic background. Dates and places of undergraduate and postgraduate study.
e) Research area and specialisation.
e) Recruitment. When and how joined EMBRAPA. Previous professional experience.

### 3. Identification of Research Project

a) Time. How long the researcher effectively spends on the research project. This includes all phases of research, including the publication of results.
b) Stage. The current stage of the research project, that is, whether it is concluded, given up, or temporarily paused.
c) Participants. Who is involved in the research project, their specialisation and qualifications.
d) Area. The scientific area of the research project.
e) Importance. The significance of the research project to the researcher. That is to say, its main aims, which could be, for example, the publications of scientific papers or to work out specific agricultural problem from social circumstances.

**4. Organisational Influences**

These variables identify some influences of the organisational structure in the agricultural generation process:

a) Research system. This explains the logic of the 'concentrated' and 'diffuse' models, according to modernisation theory.
b) Hierarchical structure. This refers to hierarchy of the agricultural generation process and the top-down type of the organisational structure.
c) Feedback signifies the mechanisms of articulation between research centres and society.
d) Administrative support refers how to the bureaucracy of EMBRAPA influences the research area.
e) New organisation. According to respondents, how should a research organisation best be structured to benefit the majority of farmers?

**5. Internal influences**

From this point of view, science is independent. It attempts to create knowledge free from external manipulation. This suggests that the research problem choice is influenced only by the theoretical perspective of the researcher. The main variables in this group are:

a) Academic socialisation. The researcher's academic background and the continuity of relationships between researcher and scientific colleagues.
b) Training. The orientation of the educational programs in the long and short terms.
c) Bibliographical and information resources. The scientific literature, that is, the books, magazines and periodicals used in scientific practice.
d) Development of new theories and methods. The increase of basic knowledge from developed countries. Normally, this involves the use of modern and expensive equipment.
e) Scientific curiosity. The researcher develops his investigation and theoretical approaches according to this curiosity. In this context, he aims to acquire specific
knowledge for the advancement of science.
f) Technological consequences. The researcher monitors the researcher of the social effects of the technology he generates.

## 6. External influences

In contrast to the internal view, the externalist position is that science holds a product of the social environment. It is open to social, economic and political interests. Unlike the internalist position, this perspective regards the state as a servant of class interests. The main variables in this group are:

a) Economic orientation. The intimate relationship that the commodity groups (which financially and politically support selected aspects of agricultural research) have with the research organisations.

b) Social and political movements. Influences and pressure from social, political and ecological groups in agricultural technology generation.

c) Prestige and functional promotion. How the researcher takes into account the norms and principles of the organisation and the scientific community when choosing the choice of the research problem.

d) Funding. The research project is always dependent on funding. The researcher develops his investigation according to the availability of finance, independent of the source.

e) Technological demand. What is the inspiration for the choice of the research problem? Is it from the farmers' needs, or a result of the researcher's theoretical background.

f) Personal aims. Is the choice of research problem affected by particular interests and life-style of the researcher?

# APPENDIX 3

## The Botanical Features of the *Brasília* Carrot

---

The *Brasília* is a new variety of carrot suitable for summer planting and developed by the National Vegetable Research Centre (CNPH), belonging to EMBRAPA in Brasília. It was evaluated by farmers for three years with excellent results. At present, it is known all over Brazil and feedback has been positive for all climates tested.

### ORIGIN

The *Brasília* is an open-to-pollen cultivar selected from the National carrot, collected by EMBRAPA researchers in 1976 in the Rio Grande county in the state of Rio Grande do Sul. The selection method used to obtain this new variety was a recurrent one based on the performance of half brother progeny with four selection cycles tested and the product was then placed on the market.

### DESCRIPTION

The *Brasília* has a vigorous leafy coverage, deep-green colour and average stature of some 25 to 35 cm high. The root is cylindrical with a light orange colour. It measures some 15 to 20 cm in length and 2 to 3 cm in width. After sowing, some 85 to 100 days pass before harvesting begins. Heat resistant and reasonably resistant to *Alternaria dauci,* this cultivar yields an average of 30 tonnes per hectare.

### USE AND ADAPTATION

The *Brasília* carrot is recommended for planting from May to October in the North, Centre West and North-east and from December to April in the South East and the South of Brazil.

### SEEDS

EMBRAPA-CNPH will maintain and multiply genetic stocks of seeds for this new cultivar and some authorised firms are producing seeds of the *Brasília* carrot which can be obtained on the special seed market.

---

Source: Based on EMBRAPA - CNPH n.d.

# APPENDIX 4

## The National Vegetable Research Centre's - CNPH - General Information

A former EMBRAPA regional research unit, CNPH was created in May 1981. Its main objective is the development of vegetable technologies for several Brazilian regions. Its secondary objectives are to promote and articulate scientific and technological activities for the development of vegetable productive systems in Brazil.

The CNPH experimental area comprises 115 irrigated hectares. The area covers 20,000 square metres, including laboratories, green houses, seed processing area, a library, refectory, research rooms and so on.

The CNPH technical team comprises of 52 researchers trained in several scientific areas. The technical support team includes 164 employees while 39 employees work in the administrative area.

The principal vegetable research themes are as follows: biotechnology, plant protection, diffusion and transfer of technology, soil fertility,, irrigation, organic residues, integrated control of pests, diseases and weeds, plant breeding, plant nutrition, food technology, the soil-water-plant relationship and seed technology.

The CNPH has developed 11 vegetable research projects within the EMBRAPA research program. These are as follows: the development of varieties and hybrids of tomatoes for industrialisation, rotation of tomato cultivation, the development of potato varieties resistant to multiple diseases and pests and the development of new onion populations and the technology of production of garlic seeds.

CNPH activities can be separated into the following results: new varieties of carrot, sweet corn, potato, tomato, onion, sweet potato, aubergine, pea, and lentil. In all 35 new genetic materials have been launched.

CNPH offers services such as chemistry and physical soil analysis, disease diagnostics, courses and training, advice, publications and so on.

Source: Based on EMBRAPA - CNPH n.d.a.

# APPENDIX 5

## The Botanical Features of the *Doko* Soya bean

---

The *Doko* is a Soya bean variety launched by the *Cerrados* Agricultural Research Centre in 1980. It was selected because it presented better results than other Soya bean varieties.

### ORIGIN

The *Doko* originated in the RB 72-1 population, from six breeding (E 70-46 X Viçoja; E 70-47 X Viçoja; Hill X E 70-47; E - 70-46 X Pickett; E 70-47 X F 65-1376; Davis X IAC 70-308), carried out in the Campinas Agriculture Institute by researcher Romeu Kiihl.

In 1973, plants were selected from the population RB 72-1, in Pindamonhagaba, São Paulo by Romeu Kiihl and Geraldo Magalhães. After 1974, the selection was made in the IAC by Manoel Miranda, and in IAPAR by Romeu Kiihl and Leones Almeida.

In 1974 and 1975 the lineage LO 75-2760 was obtained. After 1976, responsibility for the breeding program passed to EMBRAPA.

### DESCRIPTION

The *Doko* has increased productivity, late cycle, good plant height, and a nice height for the first fruit. It presents white flowers, brown pubescence and black 'hilo'. It is more aluminium tolerant than UFV-1, and consequently has more root depth.

### RESULTS

The *Doko* produced 12% to 20% more than other Soya bean varieties. The first fruit height reduced harvest losses. It permits mechanical harvesting. The *Doko* promises to increase the harvest period as well.

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Source: Based on CROCOMO and SPEHAR 1981.

# APPENDIX 6

## The *Cerrados* Agricultural Research Centre's - CPAC - General Information

CPAC was created in 1975 in accordance with the directives of the Government, which considered development of the *Cerrados* region a major priority.

The objective of the Centre is to co-ordinate and promote the necessary research for the profitable and permanent utilisation of the natural resources of the region.

The Centre collaborates with other research units, state extension services, universities, private enterprises, regional organisations and international and foreign institutions to avoid unnecessary duplication of effort.

From 1975 to 1979, 2 million hectares were brought into agricultural production; 280,000 hectares were planted or replanted with trees; storage capacity for 262,000 tonnes of grain was built; 2,203 km of road constructed and 1,213 km of electricity lines were installed. This was only possible because the Federal government created a special program in the *Cerrados* area.

CPAC is located in the Federal District. The Federal District and the surrounding areas are typical of the *Cerrados*. Brasília is situated at the geographical centre of the *Cerrados* region, constituting a focus for development within it. The Centre has 3,500 hectares of land, 27,000 square metres of buildings, including laboratories, a library, seed and fertiliser stores, refectory, and approximately 3,000 m of open canals irrigating 200 hectares.

A disciplinary team of 96 researchers conducts research in the areas of genetics, plant pathology, entomology, climatology, soils, ecology, plant physiology, soil microbiology, crop agronomy, fruit, economics, forestry, pasture and animal production.

The research program at CPAC is oriented towards resolving the problems of agriculture in the *Cerrados*. In this context, three major research projects have been formulated: the evaluation of natural and socio-economic resources, the utilisation of soil-climate-plant resources and the development of management systems.

As a result, CPAC has created various technologies. These include natural resources evaluation, identification of native species of the *Cerrados* area; irrigation methods, introduction of new pasture varieties, dairy system production; the introduction of annual Soya bean and wheat cultivation, integrated control of pests, diseases and weeds, and nitrogen absorption.

Source: Based on EMBRAPA - CPAC n.d.

# APPENDIX 7

**UNIVERSITY OF SUSSEX**
**SCHOOL OF SOCIAL SCIENCES**
**FALMER, BRIGHTON, ENGLAND**

## QUESTIONNAIRES

## EMBRAPA's TECHNOLOGIES ADOPTED BY FARMERS: THE *BRASÍLIA* CARROT AND THE *DOKO* SOYA BEAN CASES

**MANOEL MOACIR COSTA MACÊDO**
**PhD student**

**DR DAVID HARRISON**
**Supervisor**

**OCTOBER**
**1994**

**Number: _____**

**FARMER IDENTIFICATION**

**1. NAME:** ______________________________________

**2. EDUCATION:**

( ) Primary ( ) High school ( ) University
( ) Other Specify: _______________

**3. AGE:**

( ) Under 26 ( ) 26 - 31 ( ) 32 - 37
( ) 38 - 43 ( ) 44 - 49 ( ) 50 - 55
( ) 56 - 61 ( ) Over 61

**4. SEX:**

( ) Male ( ) Female

**5. PLACE OF BIRTH:**

( ) Urban area ( ) Rural area

**5. 1.** Municipality: __________________
**5.2.** State: ___________________

**6. PROFESSIONAL EXPERIENCE:**

( ) farmer ( ) public/private employee
( ) liberal professional ( ) businessman
( ) other Specify: ____________

**7. SOURCE OF INCOME ( If more that one, please indicate)**

( ) cultivation of only the *Brasília* carrot / *Doko* Soya bean
( ) other varieties cultivation of carrot /Soya bean
( ) agriculture and livestock
( ) business
( ) liberal professional
( ) public/private employee
( ) retired
( ) other Specify: ________

**8. MAIN OCCUPATION ( If more than one, please indicate)**

( ) cultivation of only the *Brasília* carrot / *Doko* Soya bean
( ) other varieties cultivation of carrot/Soya bean
( ) agriculture and livestock
( ) businessman
( ) liberal professional
( ) public/private employee
( ) retired
( ) other Specify: __________

**FARM IDENTIFICATION**

**9. ADDRESS: ________________________________**

**10. DISTANCE FROM BRASÍLIA / BARREIRAS**

| | | |
|---|---|---|
| ( ) 1 - 10 km | ( ) 11 - 20 km | ( ) 21 - 30 km |
| ( ) 31-40 km | ( ) 41 - 50 km | ( ) Above 50 km |

**11. AREA OF THE FARM**

| | | |
|---|---|---|
| ( ) 1- 20 ha | ( ) 21-50 ha | ( ) 51 - 100 ha |
| ( ) 101 - 200 ha | ( ) 201 - 300 ha | ( ) 301 - 400 ha |
| ( ) 401 - 500 ha | ( ) Over 500 ha | ( ) other Specify: ____ha |

**12. CULTIVATION**

(      ) only the *Brasília* carrot / *Doko* Soya bean
(      ) other varieties
(      ) agriculture in general
(      ) no cultivation
(      ) livestock
(      ) other Specify: ___________

**13. CULTIVATED AREA ( If more than one, please indicate)**

(      ) only the *Brasília* carrot / *Doko* Soya bean _____ha
(      ) other varieties _____ha
(      ) livestock _____ ha
(      ) agriculture _____ ha
(      ) other Specify: ______ ha

**14. DO YOU RECEIVE ANY TECHNICAL ASSISTANCE?**

(      ) yes      (      ) no

**15. IF YOUR ANSWER IS 'YES', PLEASE TELL ME WHO ADVISES YOU ( If more than one, please indicate)**

(      ) technical assistance agencies
(      ) EMBRAPA
(      ) co-operatives
(      ) private professionals
(      ) other Specify: _______________

**16. ARE YOU THE OWNER OF THE LAND?**

(      ) yes      (      ) no

**17. IF YOUR ANSWER IS 'NO', PLEASE TELL ME HOW THE LAND HAS BEEN OBTAINED**

(      ) rented
(      ) borrowed
(      ) share cropper
(      ) other Specify: ______________

## AGRICULTURAL PRODUCT IDENTIFICATION

**18. HOW LONG HAVE YOU CULTIVATED THE *BRASÍLIA* CARROT / *DOKO* SOYA BEAN?**

( ) under 1 year
( ) 1 - 5 years
( ) 7 - 12 years
( ) other Specify: _______

**19. WHY DID YOU GROW THE *BRASÍLIA* CARROT / *DOKO* SOYA BEAN?**

( ) high productivity
( ) consumer preference
( ) industry preference
( ) other specify: _________
( ) resistant to insects and diseases
( ) adaptability to local conditions
( ) disposability of the seeds

**20. HOW DID YOU LEARN ABOUT THE *BRASÍLIA* CARROT / *DOKO* SOYA BEAN? (If more than one, please indicate)**

( ) through technical assistance agencies
( ) EMBRAPA
( ) through neighbours
( ) seeds distributors
( ) by radio, television, newspaper
( ) other Specify:_________________

**21. HOW LONG DID IT TAKE YOU TO DECIDE TO CULTIVATE THE *BRASÍLIA* CARROT / *DOKO* SOYA BEAN?**

( ) 1 month ( ) 2 months ( ) 3 months
( ) 4 months ( ) 6 months ( ) Over 6 months

**22. ARE YOU HAPPY WITH THE *BRASÍLIA* CARROT / *DOKO* SOYA BEAN?**

( ) yes ( ) no

Why? ______________________________
______________________________
______________________________

**23. WILL YOU CULTIVATE THE *BRASÍLIA* CARROT / *DOKO* SOYA BEAN IN THE FUTURE?**

( ) yes ( ) no

Why? ______________________________

**24. COMMENTS:**

**THANK YOU VERY MUCH**

# APPENDIX 8

## EMBRAPA's Technologies Adopted by Farmers: The *Brasília* Carrot and the *Doko* Soya bean Cases

## The Description of Variables

### 1. Adoption of EMBRAPA's Agricultural Technology

This is the most important variable. This indicates the main reasons why farmers have adopted the *Brasília* carrot and *Doko* Soya bean varieties and for how long they have grown them.

### 2. Farmers' Personal Details

a) Sex

b) Age

c) Schooling. Primary, secondary or university education level.

d) Place of birth. Rural or urban areas. States and regions.

e) Professional background. Previous professional activities.

f) Sources of income. Agriculture, livestock, public or private employment and so on.

g) Occupation. Agriculture, livestock, state or private activities.

### 3. Farm's Details

a) Farm's location. The distance from the farm to the most important region town.

b) Area in hectares of the farm.

c) Land-tenure system. Land owners, land hirers or sharecrops.

d) Crops. The main crops that farmers have grown and its crop areas.

### 4. Technical assistance

This refers to whether the farmers have any technical assistance, from state, private or co-operatives agencies.

### 5. EMBRAPA's technologies characterisation

This shows the *Brasília* carrot and *Doko* Soya bean varieties advantages in relation to other carrot and Soya bean ones.

a) Cultivation time. How long in years the farmers have grown the *Brasília* carrot and *Doko* Soya bean varieties.

b) Cultivation reasons. This identifies the reasons which motivated farmers to grow the *Brasília* carrot and *Doko* Soya bean varieties.

c) Learning process. How farmers learnt about these varieties.

d) The future. Farmers' decisions about the next crop cultivation.

# APPENDIX 9

## Attitudes Towards Agricultural Technology

## The Check List

**Number: _____**

**Date: ___/___/___** **Time: Start: _____ End: ____**

**Name: ____________________________**
**Position: _________________________** **Organisation: __________________________**

**Introductory questions:**

1. Has EMBRAPA generated agricultural technology to meet the majority of Brazilian farmers' needs?

2. Is EMBRAPA's organisational structure appropriate for meeting the demands of different types of Brazilian farmers?

**Additional questions:**

3. Do you know EMBRAPA's organisational structure?

4. Do you know any of EMBRAPA's technologies?

5. Have you been invited to any EMBRAPA events?

6. Could EMBRAPA be declared extinct?

7. Do you believe EMBRAPA should be privatised?

8. What do you suggest for the future of EMBRAPA?

9. How did the International Research Centres (IARC) research model influence EMBRAPA's creation?

10. Could you give some suggestions about EMBRAPA?

11. Final comments

**Notes:**

# APPENDIX 10

## Attitudes Towards Agricultural Technology

## The Groups Surveyed

### 1 - Government Authorities

#### 1.1. Ministers

Beni Veras - Ministry of Planning
Elcio Alves - Ministry of Industry, Commerce and Tourism
Israel Vargas - Ministry of Science and Technology
Mário Flores - Ministry of Strategical Issues
Mauro Durante - General Secretary - Office of the Republic President

#### 1.2. Bureaucratic Officials

Antonio Guerra - Executive Director of IPEA
Gustavo S. Filho - Financial Co-ordinator of Agricultural Ministry

### 2 - Agricultural Congressional Committee

Nelson Marquezelli - President of Congressional Agricultural Committee
Valdir Colato - Vice President of Congressional Agricultural Committee

### 3 - Agricultural Large Farmers' Organisations

Antonio Ernesto Salvo - President of National Agriculture Confederation - CNA
Emiliano P. Botelho - Acting as President of Brazilian Co-operative Organisation - OCB
Ildo M. de Souza - President of Private Technical Assistance Association
Roberto Rodrigues - President of the Brazilian Rural Society - SBR
Gedeão S. Pereira - President of Rural Union of Bagé, RS

## 4 - Agricultural Small Farmers' Organisations

| | |
|---|---|
| Aloísio Carneiro | - Acting as President of CONTAG |
| Alberto E. Broch | - President of FETAG - RS |
| Carlos A. Dellay | - Regional Co-ordinator of the Landless Movement - MST |
| Francisco de Lucena | - President of FETAG - CE |
| Felipe Jalfim | - NGO Caatinga, PE |
| João Batista Frota | - Parish Priest of Catholic church, Sobral, CE |
| Jose Graziano Silva | - Lecturer at Campinas University, and PT adviser |
| Liberalino de Lucena | - President of FETAG - PB |
| Luiz Carlos G. Pinto | - President of ABRA |
| Manuel Baltazar Batista | - President of AAO, and Representative of NGOs |
| Mário Pleka | - President of FETAG - PR |
| Rolan Schneider | - NGO - ACB |

## 5 - Rural Extension Personnel

| | |
|---|---|
| Átila Siquera | - Regional Adviser of EMATER - RS |
| Geraldo Brown | - The Oldest Rural Extension Agent in Activity |
| Ismário Oliveira Silva | - Former EBDA's Regional Manager in Barreiras |
| José Costa | - President of EMATER - PB |
| José Rui Ferreira | - President of FASER |
| Jose Tarcisio Fialho | - President of EMATER - PR |
| Lauro Mendes | - Regional Co-ordinator of EMATER - PR |
| Nazareno D. Cavalcanti | - President of EMATER - CE |
| Renato Simplicio Lopes | - Former President of EMBRATER |
| Ricardo Capeli | - Executive Director of EMATER - RS |
| Romeu Padilha de Figuereido | - Former President of EMBRATER |
| Tarcisio Siqueira | - Public Rural Extension Department Head |
| Terezinha Moreira | - Regional Adviser of EMATER - PB |
| Valdir Giusti | - President of ASBRAER |
| Verneck A. de Souza | - Regional Adviser of EMATER - PB |

### 6 - EMBRAPA Employee's Union

| | |
|---|---|
| Alípio C. Filho | - President of SINPAF |
| Auro Silva Acevedo | - President of CNPO's Union Employees |
| Caetano S. Filho | - President of CNPC's Union Employees |
| Jânio Moreira | - President of CNPA's Union Employees |
| Luiz de Paula Rocha | - President of CNPSo's Union Employees |

### 7 - EMBRAPA Personnel

| | |
|---|---|
| Alberto Duque Portugal | - EMBRAPA Executive Director |
| Aurino Simplício, José Machado, and Maria E. Silva | - CNPC's Management Team |
| Eliseu Alves | - Former EMBRAPA's President |
| Elza B. Brito Cunha | - EMBRAPA Executive Director |
| Flavio Moscardi, Aureo Lantman, and Sérgio Dotto | - CNPSo's Management Team |
| Gerson S. Barreto | - Financial Department Head |
| Gonçalo Farias | - President of IAPAR |
| Hélio Tolini | - Trade Department Head |
| Irineu Cabral | - The founding EMBRAPA's President |
| Joal Brazzale, José Gonçalves, and Roberto Collares | - CNPO's Management Team |
| José de Souza Silva | - Strategic Administration Secretary Head |
| José Roberto Peres | - EMBRAPA Executive Director |
| José Pastore | - EMBRAPA's Theorist |
| Luiz Antonio M. Machado | - Law Advisory Head |
| Luiz C. Pinheiro Machado | - Former EMBRAPA's President |
| Militão de Almeida | - President of EMPARN |
| Murilo Xavier Flores | - President at EMBRAPA |
| Raimundo Araujo | - Personnel Department Head |
| Raimundo S. Martins | - Adviser Internal Auditing Control Head |
| Robson Macêdo, Napoleão Beltrão, and Roberto Cabral | - CNPA's Management Team |
| Romeu Kill | - Soya bean Research Centre geneticist |
| Susana M. Valle Lima | - Development and Organisational Department |
| Wenceslau Goedert | - Research and Technology Diffusion Department Head |

# APPENDIX 11

## Acronyms for EMBRAPA's Decentralised Units - 1993

| **1) REGIONAL AGROFORESTRY AMAZONIAN CENTRES** | **LOCATION (CITY, STATE AND REGION)** |
|---|---|
| CPAA - Agroforestry Research Centre for Western Amazonia | Manaus, AM, North |
| CPATU - Agroforestry Research Centre for Eastern Amazonia | Belém, PA, North |
| **2) STATE AGROFORESTRY RESEARCH CENTRES** | **LOCATION (CITY, STATE AND REGION)** |
| CPAF-AC ACRE Agroforestry Research Centre | Rio Branco, AC, North |
| CPAF-AP AMAPA Agroforestry Research Centre | Macapá, AM, North |
| CPAF-RO RONDONIA Agroforestry Research Centre | Porto Velho, RO, North |
| CPAF-RR RORAIMA Agroforestry Research Centre | Boa Vista, RR, North |
| **3) REGIONAL RESOURCE CENTRES** | **LOCATION (CITY, STATE AND REGION)** |
| CPAC *Cerrados* Agricultural Research Centre | Brasília, DF, Western-central |
| CPAP Pantanal Agricultural Research Centre | Corumbá, MS, Western-central |
| CPATSA Semi-arid Agricultural Research Centre | Petrolina, PE, North-east |
| CPAMN Middle-North Agricultural Research Centre | Teresina, PI, North-east |
| CPATC Coast Land Agricultural Research Centre | Aracaju, SE, North-east |
| CPACT Temperate Agricultural Research Centre | Pelotas, RS, South |
| CPPSul South Agricultural and Husbandry Research Centre | Bagé, RS, South |
| CPAO Western Agricultural Research Centre | Dourados, MS, Western-central |
| CPPS South East Husbandry Research Centre | São Carlos, SP, South East |
| **4) NATIONAL RESEARCH CENTRES** | **LOCATION (CITY, STATE AND REGION)** |
| CNPA National Cotton Research Centre | Campina Grande, PB, North-east |
| CNPAF National Rice and Bean Research Centre | Goiânia, GO, Western-central |
| CNPAT National Agricultural Tropical Industry Research Centre | Fortaleza, CE, North-east |
| CNPC National Goat Research Centre | Sobral, CE, North-east |
| CNPDIA National Agricultural Equipment Research Centre | São Carlos, SP, South East |
| CNPGC National Beef Cattle Research Centre | Campo Grande, MT, Western-central |
| CNPGL National Dairy Cattle Research Centre | Coronel Pacheco, MG. South East |
| CNPH National Vegetable Crop Research Centre | Brasília, DF, Western-central |
| CNPS National Soil Research Centre | Rio de Janeiro, RJ, South East |
| CNPAB National Biology Agriculture Research Centre | Rio de Janeiro, RJ, South East |
| CNPMA National Environment Impact Research | Campinas, SP, South East |
| CNPMS National Maize and Sorghum Research Centre | Sete Lagoas, MG, South East |
| CNPMF National Cassava and Tropical Fruit Research Centre | Cruz das Almas, BA, North-east |
| CNPTIA National Agricultural Information Research Centre | Campinas, SP, South East |
| CNPSA National Pig and Poultry Research Centre | Concórdia, SC, South |
| CNPSo National Soya bean Research Centre | Londrina, PR, South |
| CNPT National Wheat Research Centre | Passo Fundo, RS, South |
| CNPUV National Grape and Wine Research Centre | Bento Gonçalves, RS, South |
| CTAA National Agroindustrial Food Technology Centre | Rio de Janeiro, RJ, South East |
| **5) NUCLEI AND SERVICES** | **LOCATION (CITY, STATE, REGION)** |
| NMA Satellite Environment and Monitoring Nucleus | Campinas, SP, South East |
| SPI Information Production Service | Brasília, DF, Western-central |
| SPSB Basic Seed Production Service | Brasília, DF, Western-central |

Source: Based on EMBRAPA 1993d: 58-61.

# APPENDIX 12

## Distribution of EMBRAPA's Expenditures, 1973 - 1993

| YEAR | WAGES | | OPERATING EXPENSES | | INVESTMENT | | TRANSFER | | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|
| | U$ | % | U$ | % | U$ | % | U$ | % | U$ | % |
| 1973 | | | 5,221.69 | 100.00 | | | | | 5,221.69 | 100.00 |
| 1974 | | | 59,527.22 | 95.00 | | | 3,133.01 | 5.00 | 62,660.23 | 100.00 |
| 1975 | 52,947.90 | 41.02 | 60,467.13 | 46.84 | | | 15,665.06 | 12.14 | 129,080.08 | 100.00 |
| 1976 | 76,285.19 | 43.25 | 70,820.64 | 40.15 | 8,087.54 | 4.58 | 21,202.47 | 12.02 | 176,395.85 | 100.00 |
| 1977 | 99,075.08 | 50.35 | 54,853.39 | 27.88 | 10,785.78 | 5.48 | 32,049.17 | 16.29 | 196,763.41 | 100.00 |
| 1978 | 113,009.58 | 50.37 | 45,225.95 | 20.16 | 16,807.69 | 7.49 | 49317.29 | 21.98 | 224,360.50 | 100.00 |
| 1979 | 133,683.20 | 46.39 | 87,338.73 | 30.31 | 24,365.19 | 8.45 | 42,801.76 | 14.85 | 288,188.88 | 100.00 |
| 1980 | 142,467.68 | 49.24 | 58,671.67 | 20.28 | 48,838.83 | 16.88 | 39,331.35 | 13.59 | 289,309.53 | 100.00 |
| 1981 | 135,373.65 | 47.99 | 77,619.50 | 27.51 | 39,179.86 | 13.89 | 29,935.75 | 10.61 | 282,108.77 | 100.00 |
| 1982 | 170,555.53 | 46.46 | 88,798.00 | 24.19 | 72,085.67 | 19.64 | 35,686.41 | 9.72 | 367,125.61 | 100.00 |
| 1983 | 146,906.50 | 57.10 | 61,145.49 | 23.77 | 27,179.22 | 10.56 | 22,031.15 | 8.56 | 257,262.36 | 100.00 |
| 1984 | 108,180.04 | 46.84 | 86,468.97 | 37.44 | 20,826.71 | 9.02 | 15,484.95 | 6.70 | 230,960.66 | 100.00 |
| 1985 | 142,521.77 | 55.89 | 74,751.32 | 29.31 | 24,505.41 | 9.61 | 13,226.57 | 5.19 | 255,005.07 | 100.00 |
| 1986 | 136,736.91 | 52.94 | 74,659.73 | 28.91 | 28,565.40 | 11.06 | 18,319.41 | 7.09 | 258,281.45 | 100.00 |
| 1987 | 158,814.10 | 58.26 | 66,143.62 | 24.27 | 30,924.21 | 11.34 | 16,704.32 | 6.13 | 272,586.25 | 100.00 |
| 1988 | 127,600.42 | 53.69 | 51,733.53 | 21.77 | 45,447.73 | 19.12 | 12,886.48 | 5.42 | 237,668.16 | 100.00 |
| 1989 | 179,533.14 | 76.89 | 34,847.87 | 14.92 | 16,985.63 | 7.27 | 2,226.42 | 0.95 | 233,593.06 | 100.00 |
| 1990 | 202,310.13 | 76.34 | 34,958.74 | 13.19 | 9,288.51 | 3.50 | 18.454.60 | 6.96 | 265,011.98 | 100.00 |
| 1991 | 228,167.15 | 73.71 | 38,209.86 | 12.34 | 7,243.48 | 2.34 | 35,937.11 | 11.61 | 309,547.60 | 100.00 |
| 1992 | 188,585.17 | 81.19 | 28,081.65 | 12.09 | 3,456.79 | 1.49 | 12,165.69 | 5.24 | 232,289.30 | 100.00 |
| 1993 | 199,967.51 | 76.79 | 36,173.56 | 13.89 | 10,337.37 | 3.97 | 13,946.18 | 5.36 | 260,424.61 | 100.00 |

Source: EMBRAPA 1994d.

# APPENDIX 13

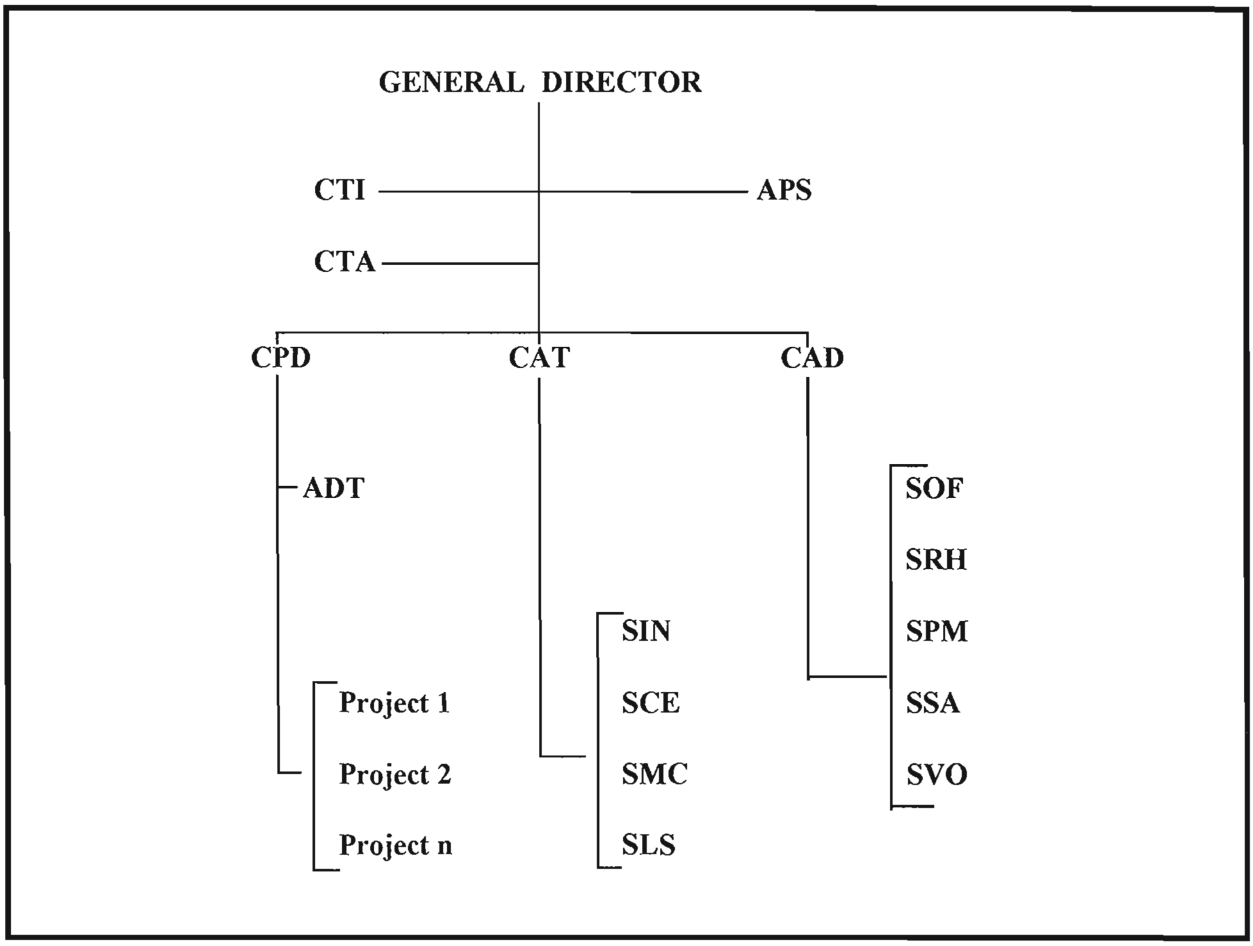
## EMBRAPA's Employees, 1973-1993

| YEAR | RESEARCH | STAFF | TOTAL |
|---|---|---|---|
| 1973 | 12 | 54 | 66 |
| 1974 | 872 | 3,118 | 3,990 |
| 1975 | 1,037 | 3,772 | 4,809 |
| 1976 | 1,328 | 4,375 | 5,703 |
| 1977 | 1,311 | 4,374 | 5,685 |
| 1978 | 1,336 | 4,698 | 6,034 |
| 1979 | 1,448 | 5,497 | 6,945 |
| 1980 | 1,553 | 5,830 | 7,283 |
| 1981 | 1,576 | 6,150 | 7,681 |
| 1982 | 1,597 | 6,328 | 7,925 |
| 1983 | 1,610 | 6,374 | 7,984 |
| 1984 | 1,619 | 6,553 | 8,172 |
| 1985 | 1,650 | 6,793 | 8,443 |
| 1986 | 1,724 | 6,748 | 8,472 |
| 1987 | 1,870 | 7,008 | 8,878 |
| 1988 | 1,911 | 6,957 | 8,868 |
| 1989 | 2,166 | 8,502 | 10,668 |
| 1990 | 2,146 | 8,064 | 10,210 |
| 1991 | 2,105 | 7,756 | 9,861 |
| 1992 | 2,088 | 7,649 | 9,737 |
| 1993 | 2,077 | 7,610 | 9,687 |

Source: Based on EMBRAPA 1993h.

# APPENDIX 14

## CNPA's Organisational Structure



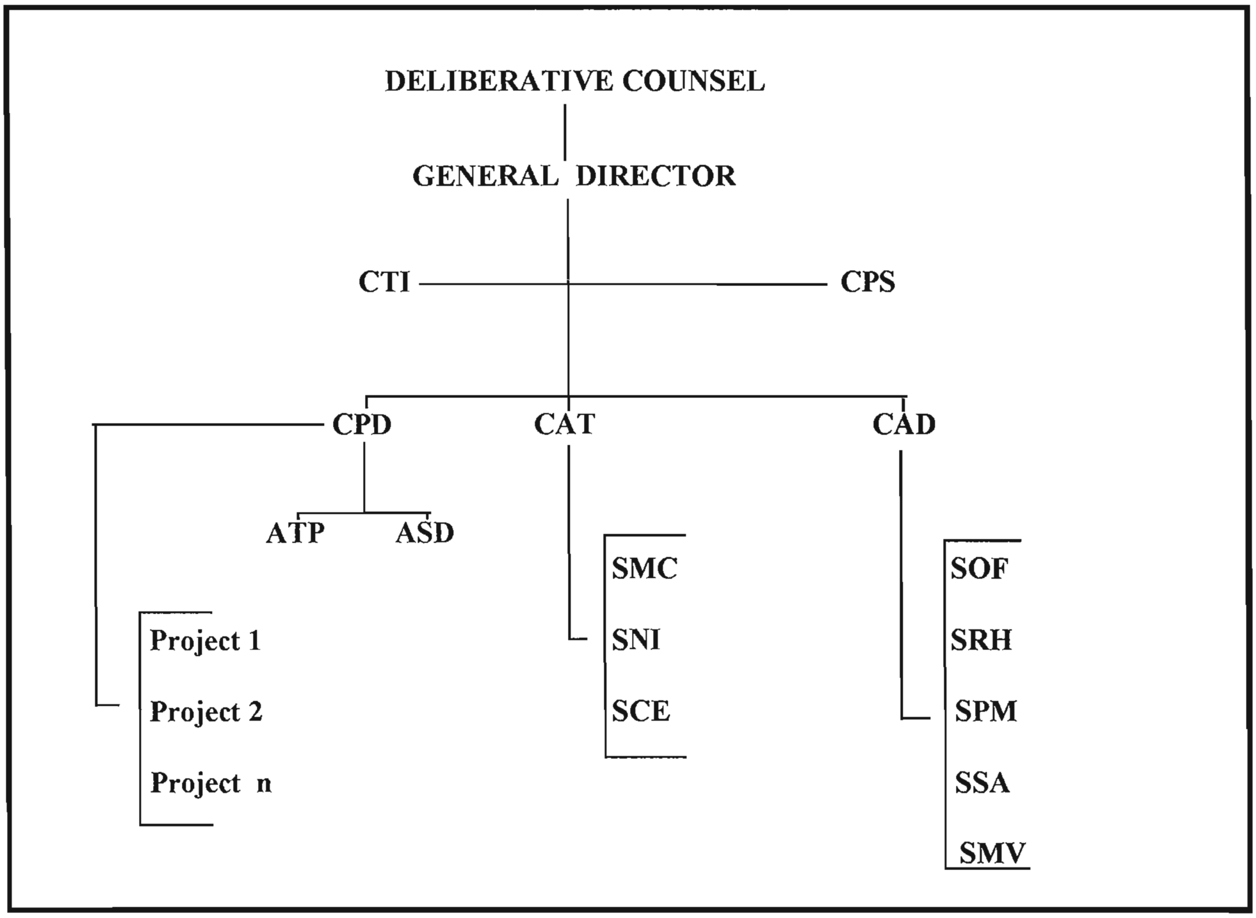

**LEGEND:**

CTA - Technical-Administrative Advisory Counsel
CTI - Internal-Technical Committee
APS - Planning and System Area
CPD - Associate Director of Research and Development
ADT - Technology Diffusion Area
CAT - Associate Director of Technical Support
SIN - Information Sector
SCE - Experimental Stations Sector
SMC - Marketing and Commercialisation Sector
SLS - Laboratories and Services Sector
CAD - Associate Director of Administration
SOF - Finance and Budget Sector
SRH - Human Resources Sector
SPM - Material and Patrimony Sector
SSA - Support Services Sector
SVO - Machines and Vehicles Sector

Source: Based on EMBRAPA 1993.

## APPENDIX 15

## CNPC's Organisational Structure




**LEGEND:**

CTI - Internal and Technical Committee
CPS - Planning and Systems Committee
CPD - Associate Director of Research and Development
ATP- Technology and Products Area
ASD - Socio-economic, Transfer and Diffusion Area
CAT - Associate Director of Technical Support
SMC - Marketing and Commercialisation Sector
SIN - Information Sector
SCE - Experimental Stations Sector
CAD - Associate Director of Administration
SOF - Finance, Accountancy and Budget Sector
SRH - Human Resources Sector
SPM - Material and Patrimony Sector
SSA - Support Services Sector
SVO - Machines and Vehicles Sector

Source: Based on EMBRAPA 1993a and EMBRAPA 1994e: 30-31.

# APPENDIX 16

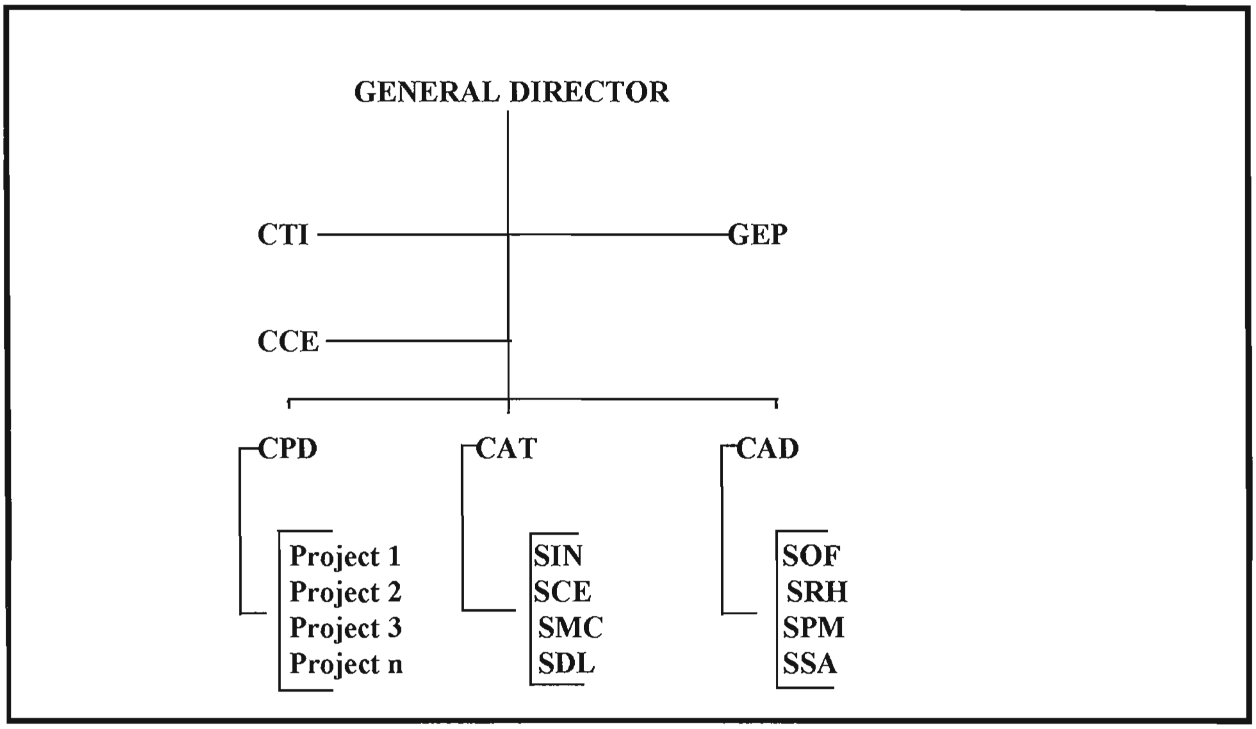
## CNPSo's Organisational Structure

- **GENERAL DIRECTOR**
  - Law Service Area
  - Journalist Advice
  - Public Relation Advice
  - **ASSOCIATE ADMINISTRATIVE DIRECTOR**
    - Operational Administrative Area
      - Finance and Budget Sector
      - Human Resources Sector
      - Material and Patrimony Sector
      - Support Service Sector
    - Machine and Vehicles Sector
    - Maintenance and Building Sector
    - *Londrina* Experimental Station Sector
    - *Balsas* Experimental Station Sector
    - Laboratories Sector
      - Laboratory One
      - Laboratory Two
      - Laboratory Three
      - Laboratory Four
    - Computer Sector
    - Information Area
    - Greenhouse Sector
    - Publication Sector
      - Composition and Revision
      - Record
      - Distribution and Sale
      - Video Production
  - **ASSOCIATE TECHNICAL DIRECTOR**
    - Publication Committee
    - Entomology
    - Fitopatology
    - Cultivation Manoeuvre
    - Fertilisation and Biology Soil
    - Economics
    - Genetics and Breeding
    - Seeds
    - Technology Diffusion
    - Biometrics
    - Seminars
    - Training

Source: Based on EMBRAPA 1993b.

# APPENDIX 17

## CNPO's Organisational Diagram



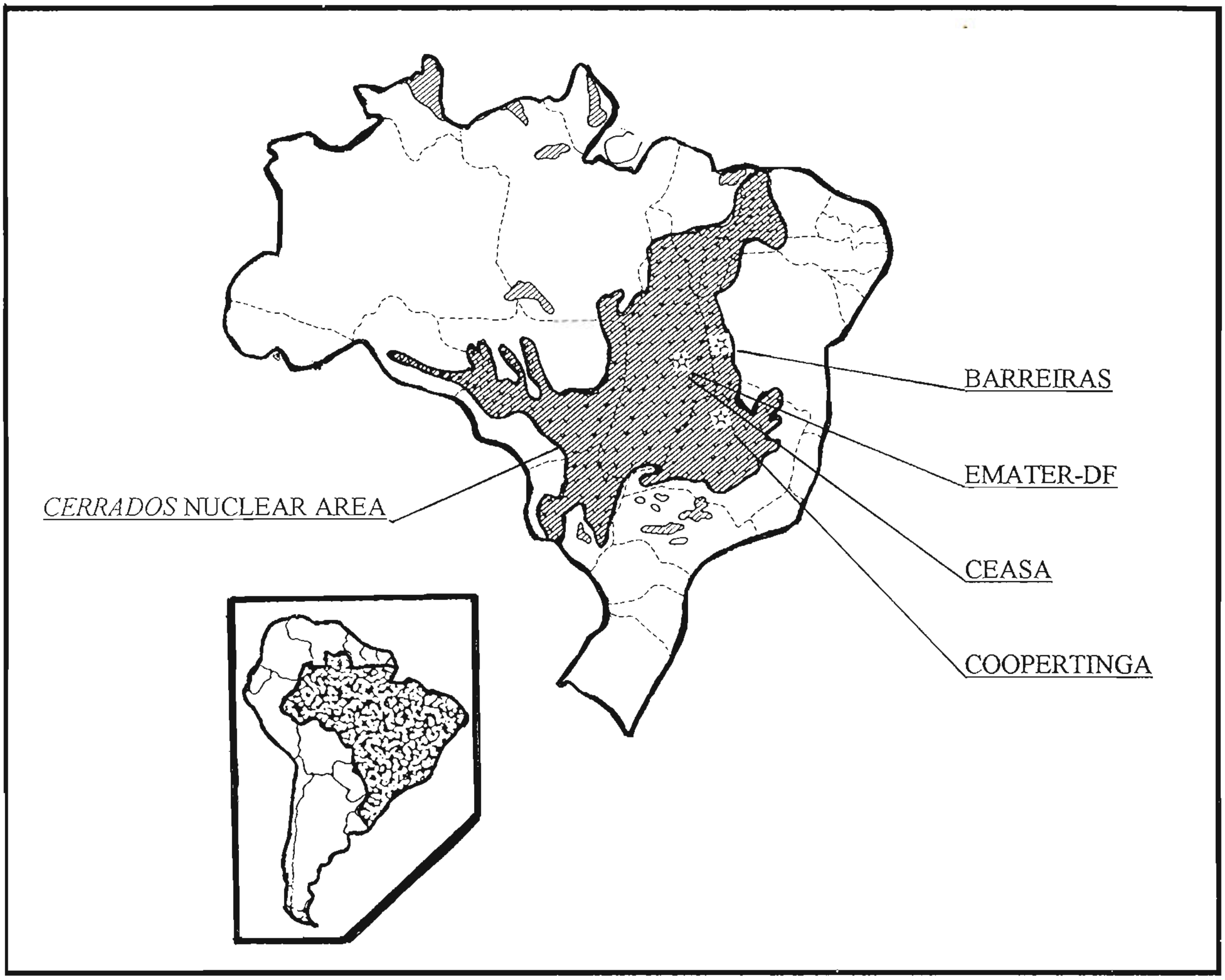

**LEGEND:**

CTI - Technical and Internal Committee
CCE - External Advisory Counsel
GPE - Group of Planning and Systems
CPD - Associate Director of Research and Development
CAT - Associate Director of Technical Support
CAD - Associate Director of Administration
SIN - Information Sector
SCE - Experimental Stations Sector
SMC - Marketing and Commercialisation Sector
SDL,- Laboratories Sector
SOF - Finance, Accountancy and Budget Sector
SRH - Human Resources Sector
SPM - Material and Patrimony Sector
SSA - Support Services Sector

Source: Based on EMBRAPA 1993c.

# APPENDIX 18

## The Data Collection Points and the *Cerrados* Region




**LEGEND:**

☆ **COOPERTINGA**: *Doko* Soya bean case study
☆ **CEASA**: *Brasília* carrot case study

☆ **EMATER- DF**: Additional information (*Brasília* carrot case study)
☆ **BARREIRAS**: Additional information (*Doko* Soya bean case study)

***CERRADOS*** **NUCLEAR AREA**

RO = State of Rondônia;
MS = State of Mato Grosso do Sul;
DF= Federal District;
BA= State of Bahia;
PI= State of Piaiuí;
CE= State of Ceará

MT= State of Mato Gross
GO= State of Goiás
TO= State of Tocantins
MA= State of Maranhão
MG= State of Minas Gerais

Source: Based on EMBRAPA 1979: 12 and JICA-EMBRAPA-CPAC n.d.