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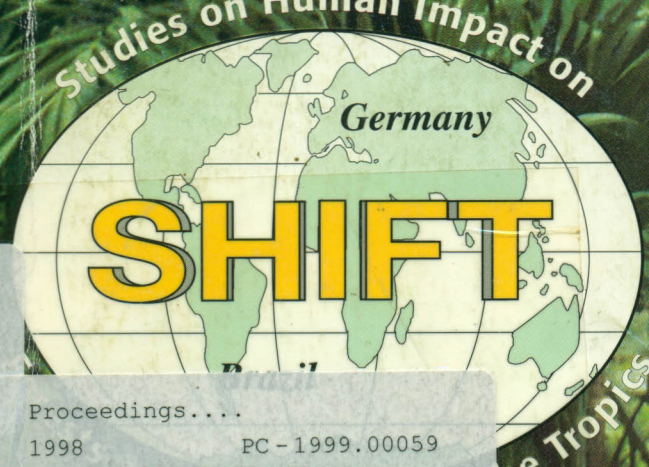

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Cost/benefit analysis of agroforestry systems: A case study

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ABSTRACT

This paper reports the results of a research on the macroeconomic dynamics of the Amazon region, in the eighties, that turned unfeasible the traditional agricultural extensive system, which remained so far, and started to demand constant increase in productivity, from the sector, as well as price reduction and better quality of products, without loss of preservation and conservation of the ecosystem. Based on this premise this study was directed to the analysis of the agroforestry production system experiments, carried out by a partnership research with the SHIFT - project, in areas of the EMPRAPA Amazônia Ocidental, Empresa Brasileira de Pesquisa Agropecuária, Manaus-Amazonas, with the objective of determining alternatives that could contribute to sustainable development for the Amazon region. The analysis of these systems, among others, indicated that results of the research may contribute to the sustainability of the region environment, mainly in comparison with the existent traditional systems. Their small profitability is inferior to the opportunity cost of the capital in the financial market; that structural and conjuncture changes occurred, resulting in increasing importance of sustainability, with concomitant loss of regional agricultural product competitiveness as a result of the economic openness and the Real Plan, not totally assimilated by the sector. As a consequence, they need to be better studied in order to minimize the negative effects; since the lack of market incentive for the sector's products is another limiting factor for the use of these systems. Moreover, there is a lack of policy that will help to insert the regional rural producer in the competitive regional, national, and international markets, which can be obtained with investment in human capital, making them to work more cooperatively and to use the compatible information means, with the need of the economic openness.

RESUMO

As mudanças na dinâmica macroeconômica da Região Amazônica, ocorridas nos anos oitenta, que se tornaram inviável o tradicional sistema de agricultura extensiva, por não mais atender a crescente exigência de aumento constante de produtividade, redução de preço e melhor qualidade dos produtos do setor, além de não preservar nem conservar o ecossistema. Com base nesta realidade dirigiu-se este estudo para a analise de sistemas de produção experimentais realizados através do do projeto SHIFT em áreas da EMBRAPA Amazônia Ocidental, Empresa Brasileira de Pesquisa Agropecuária em Manaus-Amazonas, com objetivo de determinar alternativas que possam contribuir para o desenvolvimento sustentável da Região. O resultado do estudo, entre outros, indicou significativa contribuição da pesquisa para o desenvolvimento sustentável da agropecuária regional, haja vista que a maioria dos sistemas produção analisados apresentaram

indicadores de rentabilidade econômica e financeira atrativos, superiores ao custo de oportunidade do capital, sendo que novos sistemas dispensam grande importância à preservação e conservação do meio ambiente.

ZUSAMMENFASSUNG

Untersuchungen werden vorgestellt zur makroökonomischen Dynamik in der Amazonasregion, die in den 80er Jahren einsetzte. Aufgrund der Notwendigkeit zu einer konstanten Produktivitätsteigerung, verbesserten Produktqualität und Preissenkungen wurde die traditionelle extensive Agrarwirtschaft zurückgedrängt. Dem verstärkten Nutzungsdruck steht die Erhaltung der Ökosysteme gegenüber. In diesem Zusammenhang wurden agroforstliche Produktionssysteme auf Flächen der EMBRAPA Amazônia Ocidental, Empresa Brasileira de Pesquisa Agropecuária, Manaus-AM, untersucht mit der Zielsetzung, Alternativen zu finden, die eine nachhaltige, schonende agrarwirtschaftliche Entwicklung ermöglichen. Die Analyse der Ergebnisse aus den untersuchten Produktionssystemen weist darauf hin, dass diese als Grundlage für eine nachhaltige Bewirtschaftung in der Amazonasregion geeignet sind. Besonders im Vergleich zu den in der Region üblichen Agrarsystemen mit geringer Profitabilität zeigt die Mehrzahl der Versuchssysteme eine höhere ökonomische Rentabilität bei gleichzeitig geringerem finanziellen Aufwand. Somit können diese Alternativen darstellen, die auf Grundlage der nachhaltigen Bewirtschaftung auch zur Belieferung des regionalen sowie des nationalen und internationalen Marktes geeignet sind und zur Erhaltung der natürlichen Ressourcen beitragen.

INTRODUCTION

The agriculture in the Amazon Area, until the end of the seventies, had its trajectory based in the extractive activity with prominence for rubber, brazil-nut and timber, complemented by subsistence. Ever since, only the extractive timber production continued economically important. In addition to timber production, a steadily growing missing activity started in the eighties, both being now the main propellers of the primary sector dynamics in the Amazon.

This change in the extractivism while the agriculture lags behind is a result, on the one hand, of the geographical isolation, the peculiar soil and climate, demographic the low density and the precarious infrastructure conditions, especially for primary processing, storage and transport of the production, and, on the other hand, in the readiness of income from extractivism.

The loss of economic relevance of the other plant extractive products, in spite of its social importance, it is attributed to the "irrationality of the exploration", that led to the fast exhaustion of the reserves in the areas of more intense exploration, as well as to the economic unfeasibility of this activity, denounced by the growing costs of extraction, processing and transport of the product to the consuming centers. With relation to the slash and burn agriculture, its relative loss is explained by the lack of competitiveness in price and, mainly, the low quality of the products.

This picture has been reshaped, in the recent years, by conditioning factors, such as: a) the need to conserve and to preserve the environment; b) lack of competitiveness of the regional agricultural products, which came out with the opening of the Brazilian economy; and c) larger dependence of the regional institutions of development, as the Superintendency of Development

of Amazônia (SUDAM) and Amazônia S.A.'S Bank (BASA), on the decisions in level of national macropolicy, elaborated by the Federal Government and implemented through controls of resources that, in particular, considerably limit, the area of performance of those institutions in the implementação of development alternatives for the Area.

The prevailing scenery environmentalist render unfeasible the process of expansion of the traditional agricultural border, which resulted in the deforestation of an area estimated in the end of the eighties in 43 million hectares (Teixeira and Leite, 1991).

In spite of the persistence of felling and burning of the primary forest in the region and of its serious consequences, as shown by of Fearnside (1982, 1984); Allen and Gould (1986); Martine (1987); and Hecht (1988), this issue has been tangentially approached not in depth as demanded by the complexity and interdependence of its components. In the agricultural borders, for example, due to the lack of basic infrastructure, tradition in the use of modern input, and to the insufficient research network and the environmental adversities, to adapt those systems, in order to turn them sustainable, represents challenge that consumes several years or several decades of research. These facts need to receive the society from the due attention, seeking to provide conditions so that the sustainable development of the region is promoted.

Results of agricultural research indicate that the diversification of cultivations through agroforestry systems can contribute to the farmer's economic and financial stability and, consequently, for the sustainability provide that the different crops are adjusted to the market opportunities and the environmental conditions. The mistake in the choice of the species to be cultivated may cause heavy burden to the system.

In Brazilian Amazon agroforestry systems are being developed without preset approaches. Smith et al. (1996), in a field research accomplished between 1988 and 1993, they verified that there were 108 configurations of production systems in 136 areas, involving 72 species of plants, including perennial crops thoroughly disseminated in States of Pará, Amazonas, Roraima and Acre, grown for fruits, timber and multipurpose uses.

The implementation of agroforestry can provide reduction or increment in the risk. They provide the diversification of income of the property and, as such they reduce the market risk, underlying to the handling of annual and perennial crops. However, there is a possibility of risk increment, a result as inadequate handling of the trees or supercompetition, that can reduce the associative growth of the crops, as well as lingering droughts, poverty of the planted material on increase in the investcoast - Such systems, in rule, demand larger investment than the traditional ones; and uncertainties with relationship to the market and the Government's policy.

Therefore, the confirmation of the favorable perspectives of those systems, imposes the need of better understanding of its dynamics, in order to define the conditions in which its implementation, in terms of Amazon Area, contribute, indeed, for the reach of this sustainable development.

Due to the assimilation of this fact by the agricultural research institutions of the Amazon for example, the Brazilian Enterprise of Agricultural Research (EMBRAPA), the research on mixed cropping began to be rated as highly priority since the beginning of the nineties. This resulted in the implementation of several station „on farm" experiments which need to be property monitored to present conclusive results.

The complexity of the subject denotes the relevance of environmental economic and socio-political issues to be integrated in the direction of possible solutions. That requests the wariness of the necessary compatibility among objectives that, in general, are contradictory and competitive, instead of complementary. Under these conditions, it is necessary the recognition and the integration of environmental problems, when formulating of agricultural policies, that, similarly to the environmental policies, should reflect the recognition of its potential impact on the product, the income and the agricultural prices (Sen, 1975; Schaus, 1987; Young, 1990; Scherr and Muller, 1991).

The implementation of policies with this scope requests the necessary technological support and as there is a large gap of suitable technology for the regional conditions, farmers do usually not have immediate available alternatives. This is a heavy constraint to the accomplishment of rural development programs. As a consequence, it urges that initiatives with this purpose be implemented.

The need to preserve and to conserve the natural resources of the region accurate financial and economic analysis of the agricultural practices used in the region, in order to define the alternatives which can contribute to sustainable rural development.

This study objective to make cost/benefit analysis of agroforestry systems indicated for the recovery of degraded areas in the Amazon. It is specifically, intended to identify economically sustainable solutions recover degraded areas in the Amazon, through the of exploitation of agroforestry systems being already implemented.

METHODS

For the evaluation of agricultural production system, two different approaches are available: the financial and the economic. Likeness exist among both, because they esteem the costs and benefits of those systems. In the financial evaluation, every analysis is made of the investor's point of view, that wants to know which is the return rate the can obtain from the capital invested in the agricultural activity. The economic evaluation seeks to study the possible effects that a new production system can to the process of regional or national economic development. Therefore, its effects include direct and indirectly raised costs and benefits. Indirect effects are costs and, or, benefits that would not exist in the absence of the system. Having side effects on the regional or national economy, they don't affect the investors' objective. For this reason, this effect type is not part of the financial evaluation, but it is essential that is included in the economic evaluation (Silva Neto, 1992).

Hoffmann et al. (1976), Squire and Van Der Tak (1975), Gregersen and Contreras (1980), Noronha (1987), Contador (1981), Buarque (1984) and Brent (1990), among other, describe several methods of investment analyses in the agricultural activity.

In this case study, the analysis of the experimental production systems, obeyed the following procedures: a) comparison of the new production systems with the traditional system, based on coefficients of internal return rate (IRR), present value (LVP) and benefit/cost ratio (B/C); b) explication of the effects of the new production systems on the sustainability c) sensibility analysis of those systems based on the more important variable ones more important; and d)

accomplishment of simulations to evaluate the risk and the underlying uncertainty to the referred systems.

LVP is defined by the formula

$$LPV = ILBt / (1 + i)^t$$

in that ILB = incremental liquid benefit; i = market interest rate (financial analysis) or it rates of discount (economic analysis); t = 1, 2,..., n years. In this selection approach the project is accepted if LVP is larger than zero.

IRR is a discount rate that turns into zero the value LPV. Therefore

$$IRR = ILBt / (1 + i)^t = 0$$

The selection approach that uses IRR consists in accepting the projects that have IRR superior to the effective interest rate in the market, if the analysis is financial, or superior to the social rate of discount, if the analysis is economic.

The ratio benefit/cost is obtained, by dividing the present value of the average benefit by the value of the average costs. Therefore

$$B/C = \frac{\sum_{t=0}^{n} B_t/(1+i)^t}{\sum_{t=0}^{n} C_t/(1+i)^t}$$

in that Bt = incremental benefit in the year t; Ct = incremental cost in the year t.

The selection approach is to accept the projects with a benefit/cost ratio larger than the unit. By definition, this decision should produce the same result with relationship to the acceptance or not of the project, that is to say, it is equivalent to the decision of doing the project or not.

As the future circumstances change and it is not possible to collect all the important information, to risk and the underlying uncertainty of the production systems, should be considered what will be made in, this research, through sensitivity analysis and probability analysis.

The applications of the sensitivity analysis involve the support to the investment decisions, being equally important in the administration for the reach of the objectives of the project. In this study, it is made by starting from variations in the prices of products, in the production factors, including the labor, and in the investment, in order to determine the effect of those changes on the coefficients of IRR, of LPV and of the B/C ratio.

It is assumed that the variables have normal, independent distributions of probability to each other and in each stipulated period (20 years). Inside of each one of the distributions, a value is chosen a for each one of the selected variables, which will substitute the original values, allowing to esteem a new variable.

That process is made simultaneously in all the simulated variables. It is stochastic process to determine, through multiple attempts, the nature of the distributions of probability, what would be difficult to do by the standard statistical procedures. It makes easier to represent the dynamics

- rubber, orange, „cupuaçu", coconut, „paricá", bean and cassava;
- „urucum" (*Bixa orellana*), Brazil nut, „cupuaçu", „peach palm", cassava and „puerária".

They are species cultivated with cash or potential market and, depending on the agronomic performance of the system, they have possibilities to contribute to the achievement of agricultural sustainability in particular in the level of small producer. In that sense, they act as important inducers of the implementation of these systems, besides the market incentives, the technical support, offered by the research, inherent to the referred systems, and the officials development of the policies region.

The cultures of those systems were planted in the period of February to June of 1993, in an original area of secondary forest, with approximately eight years of age, which was slashed and burned in the traditional way.

The analysis of the experimental agroforestry systems and to the traditional system was accomplished from its respective cash flows, in the Tables A1, A2, A3, A4 and A5.

The Table 1 presents the esteemed values of the profitability coefficients IRR, LPV and the B/C ratio of the systems of experimental production and of traditional agriculture in the periods of 10 and 20 years. For the experimental system (1), the values of LVP (-R $2,782.14 to the interest rate of 6%) and of the relationship B/C (0.57), in the 20 year-old horizon, they denote that, financially, this system is unfeasible. In consequence, it should not have continuity, even in experimental level, since it would be difficult to promote its diffusion, what turns still remote still the possibilities of its adoption by the producer.

Table 1: Internal Return Rates (IRR), Liquid Present Value (LPV) and benefit/cost ratio (B/C) corresponding to the cash flows of the traditional systems and of itinerant agriculture and of the experimental agroforestry systems. State of Amazonas, 1997

Parameters	Traditional Systems	Experimental Agroforestry System			
		1	2	3	4
IRR - 10 years	-1	(-)	16%	23%	35%
IIR - 20 years	1%	(-)	26%	28%	39%
LPV - 6% - 10 years	R$ 9,031.1	(R$ 2,933.04)	R$ 1,938.31	R$ 1,971.99	R$ 3,476.76
LPV - 6% - 20 years	R$ 13,675.8	(R$2,782.14)	R$ 11,416.85	R$ 6,196.29	R$ 8,109.56
Ratio B/C - 10 years	1.19	(-)	1.57	1.65	1.71
Ratio B/C - 20 years	0.98	0.57	2.55	2.49	2.32

Source: Shift research data.

The esteemed values, in the periods of 10 and 20 years, of the coefficients IRR (16% and 26%), LPV (R$ 1,938.31 and R$ 11,616.85 under on interest rate of 6% a year) and B/C ratio (1.57 and 2.55%) of the agroforestry experimental system No. 2 reveal a sound financial

performance of the referred system. It is noticed that the return rate of 26% a year, along 20 years, probably overcomes the cost of opportunity of the capital and it should motivate potential investors for the activity.

The comparative analysis of the experimental system No. 2, in relation to the system of traditional-itinerant agriculture, departed from its profitability indicators, constant of the Table 1, that shows a larger LPV for the system of traditional agriculture and a larger B/C ratio for the experimental system No. 2. As the system of traditional agriculture inflicts heavy losses to the environment, and computing its costs, its LPV becomes close to zero. Considering the appropriate use that the experimental system does of the soil, it can be inferred that this system constitute a considerable alternative for the recovery and sustainability of areas with degraded postures and crops found in the region.

The agroforestry experimental systems n^{os} 3 and 4 display esteemed values of the profitability coefficients IRR (28% and 39%), LPV (R$ 6,196.29 and R$ 8,109.56, under an interest of 6% a year) and B/C ratio (2.49 and 2.32) in the 20 year-old horizon (Table 1). Taking into account that these values are equal or superior to the presented by the agroforestry experimental system No. 2 and that these systems, also, make appropriate use of the soil, it is concluded that these systems are able to contribute to the sustainable development of agriculture in the region.

The high profitability of the experimental systems No. 2, 3 and 4 in relation to the of traditional system, with base on IRR and ratio B/C, among other reasons, can be explained in function of: a) considerable part of the yield produced by the small producer to be lost by infrastructure limitations, involving harvest and storage; b) the high price of the agricultural inputs, at gate and the precarious infrastructure of prevalent transport in the Area; and c) the small producers, a rule, don't give the crops the cultural treatments in its totality, according to as recommendations of the research institutions, in consequence, its productivity indexes are lower.

Table B1 display, among other, the distributions of accumulated probabilities of IRR, LPV and B/C ratio for the 20 year-old period, of the agroforestry experimental systems No. 1, 2, 3 and 4. The analysis of these data indicates, that for the system No. 1 there are 5% of probability of LPV to be lower or equal the R$ 2,786.00, and of 90% of the value of this parameter to be located among -R$ 2,786.00 and -R$ 2,626.00.

LPV of the agroforestry experimental systems No. 2, 3 and 4, present 5% of probability of being smaller or equal the R$ 11,895.00, R$ 6,442.00 and R$ 6,442.00, respectively. There is a 90% probability of these indicators being placed between R$ 11,895.00 and R$ 12,975.00 - system No. 2, R$ 6,442.00 and R$ 7,173.00 - system No. 3 and R$ 6,442.00 and R$ 7,173.00 - system No. 4. These results confirm the possibility of these systems to contribute to the sustainability of the regional agricultural activity.

SUMMARY AND CONCLUSIONS

The growing attention of the society to the environmental issues, the opening of the economy and the political actions implemented in the sense of inserting the national economy in the competitive global market turned unfeasible the extensive traditional systems of agriculture which prevailed so far in the Amazon and has put emphasis on the need of alternatives for the sector.

Based on these premises, this study aimed to analyze systems of agroforestry production, seeking to determine possible alternatives that may contribute to the sustainable development of areas with degraded cultures and pastures of the Amazon.

Among the results of the study, a substantial contribution come out of the agricultural research for the preservation and conservation of the ecosystems of the region. The new recommended implemented technologies take into account the physical aptitude of the soil and they generate positive effects for the environment, mainly when compared to the traditional systems. However, several problems remain, related to the sustainability of the agricultural activity, those inherent to the commercialization of the agroforestry products which are restricting the reach of this objectify.

The reach of this goal requests more biological research to fill the gaps of knowledge of the potential of the region, on one side; and socioeconomic research, that can offer subsidies for the consolidation of the alternatives of development of systems that provide larger economic and social benefit to the farmers. The accomplishment of investments in the improvement of the human resources, in order to enable them to use the compatible channels of information within the demands of the global market is also an acute requirement.

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Table A1: Cash flow, agroforestry experiment 1 - 1 hectare - Expressed values in R$ of January of 1997.

1) EXITS	ano 1	ano 2	ano 3	ano 4	ano 5	ano 6	ano 7	ano 8	ano 9	ano 10	ano 11	ano 12	ano 13	ano 14	ano 15	ano 16	ano 17	ano 18	ano 19	ano 20
Operational expenses																				
Seeds and dumb	520	-	50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fertilizers	166	111	96	80	80	80	80	80	96	96	96	96	96	96	96	96	96	96	96	96
Labor	388	104	172	172	172	172	172	172	192	192	192	192	192	192	192	192	192	192	192	192
Equipments and Utensils	356	-	-	-	-	-	-	20	-	-	-	-	-	-	-	-	-	-	-	-
Other Expenses	91	21	32	24	24	25	25	28	28	28	29	29	29	29	29	29	29	29	29	29
SUBTOTAL	1,521	236	350	276	276	277	277	300	316	316	317	317	317	317	317	317	317	317	317	317
2) ENTRANCES																				
Sales	-	-	-	-	-	-	-	-	300	330	345	355	355	355	355	355	355	355	355	355
Residual revenue	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other revenues	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SUBTOTAL	-	-	-	-	-	-	-	-	300	330	345	355	355	355	355	355	355	355	355	355
3)- Cash flow	(1,521)	(236)	(350)	(276)	(276)	(277)	(277)	(300)	(16)	14	28	38	38	38	38	38	38	38	38	38

	10 YEARS	20 YEARS
IRR		
LPV	(R$ 2,782.14)	(R$ 2,933.04)
Ratio B/C	0.57	

Table A2: Cash flow, agroforestry experiment 2 - 1 hectare - Expressed values in R$ of January of 1997.

1) EXITS	ano 1	ano 2	ano 3	ano 4	ano 5	ano 6	ano 7	ano 8	ano 9	ano 10	ano 11	ano 12	ano 13	ano 14	ano 15	ano 16	ano 17	ano 18	ano 19	ano 20
Operational expenses																				
Seeds and dumb	570	87	-	-	-	-	-	-	-	-	-	-			-	-	-	-	-	-
Fertilizers	202	217	217	238	238	262	262	262	276	276	276	276	276	276	276	276	276	276	276	276
Labor	620	264	264	264	276	276	276	276	276	276	276	276	276	276	276	276	276	276	276	276
Equipments and Utensils	356	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other Expenses		184	-	-	35	65	175	350	320	330	340	340	-	-	-	-	-	-	-	-
SUBTOTAL	1,748	752	481	502	549	603	713	888	872	882	892	892	552	552	552	552	552	552	552	552
2) ENTRANCES													-	-	-	-	-	-	-	-
Sales	-	924	-	-	346	650	1,748	2,943	2,943	2,943	2,943	2,943	2,943	2,943	2,943	2,943	2,943	2,943	2,943	2,943
Residual revenue	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other revenues	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SUBTOTAL	-	924	-	-	346	650	1,748	2,943	2,943	2,943	2,943	2,943	2,943	2,943	2,943	2,943	2,943	2,943	2,943	2,943
3) - Cash flow	(1,748)	172	(481)	(502)	(203)	47	1,035	2,055	2,071	2,061	2,051	2,051	2,391	2,391	2,391	2,391	2,391	2,391	2,391	2,391

	20 YEARS	10 YEARS
TIR	26%	16%
VLP	R$ 11,416.85	R$ 1,938.31
Ratio B/C	2.95	

Table A3: Cash flow, agroforestry experiment 3 - 1 hectare - Expressed values in R$ of January of 1997.

1) EXITS	ano 1	ano 2	ano 3	ano 4	ano 5	ano 6	ano 7	ano 8	ano 9	ano 10	ano 11	ano 12	ano 13	ano 14	ano 15	ano 16	ano 17	ano 18	ano 19	ano 20
Operational expenses																				
Seeds and dumb	685	66	-	-	-	-	-	-	-	-	-	-			-	-	-	-	-	-
Fertilizers	266	218	185	185	176	176	176	176	186	186	186	186	181	175	170	165	161	156	152	147
Labor	476	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
Equipments and Utensils	356	-	385	-	-	-	-	-	-	-	-	-		-		-	-	-	-	-
Other Expenses													-	-	-	-	-	-	-	-
SUBTOTAL	1,783	484	770	385	376	376	376	376	386	386	386	386	381	375	370	365	361	356	352	347
2) ENTRANCES													-	-	-	-	-	-	-	-
Sales	-	-	2,100	820	832	913	921	978	1,398	1,398	1,398	1,398	1,398	1,398	1,398	1,398	1,398	1,398	1,398	1,398
Residual revenue	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other revenues	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SUBTOTAL	-	-	2,100	820	832	913	921	978	1,398	1,398	1,398	1,398	1,398	1,398	1,398	1,398	1,398	1,398	1,398	1,398
3)- Cash flow	(1,783)	(484)	1,330	435	456	537	545	602	1,012	1,012	1,012	1,012	1,017	1,023	1,028	1,033	1,037	1,042	1,046	1,051

	20 YEARS	10 YEARS
IRR	28%	23%
LPV	R$ 6,196.29	R$ 1,971.99
Ratio B/C	2.49	

Table A4 Cash flow, agroforestry experiment 4 - 1 hectare - Expressed values in R$ of January of 1997.

1) EXITS	ano 1	ano 2	ano 3	ano 4	ano 5	ano 6	ano 7	ano 8	ano 9	ano 10	ano 11	ano 12	ano 13	ano 14	ano 15	ano 16	ano 17	ano 18	ano 19	ano 20
Operational expenses																				
Seeds and dumb	670	60	-	-	-	-	-	-	-	-	-	-			-	-	-	-	-	-
Fertilizers	147	119	123	123	130	130	136	136	136	142	142	142	145	148	152	155	158	162	166	169
Labor	632	344	344	344	364	364	364	364	392	392	392	392	392	392	392	392	392	392	392	392
Equipments and Utensils	356	-	-	-	-	-	-	356	-	-	-	-		356	-	-	-	-	-	356
Other Expenses													-	-	-	-	-	-	-	-
SUBTOTAL	1,805	523	467	467	494	494	500	856	528	534	534	534	537	896	544	547	550	554	558	917
2) ENTRANCES													-	-	-	-	-	-	-	-
Sales	-	924	1,176	1,176	1,176	1,337	1,501	1,667	1,737	1,737	1,737	1,737	1,737	1,737	1,737	1,737	1,737	1,737	1,737	1,737
Residual revenue	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other revenues	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SUBTOTAL	-	924	1,176	1,176	1,176	1,337	1,501	1,667	1,737	1,737	1,737	1,737	1,737	1,737	1,737	1,737	1,737	1,737	1,737	1,737
3)- Cash flow	(1,805)	401	709	709	682	843	1,001	811	1,209	1,203	1,203	1,203	1,200	841	1,193	1,190	1,187	1,183	1,179	820

	20 Years	10 Years
IRR	39%	35%
LPV	R$ 8,109.56	R$ 3,476.76
Ratio B/C	2.32	1.71

Table A5: Cash flow, system of traditional agriculture - 1 hectare - Expressed values in R$ of January of 1997.

1) EXITS	ano 1	ano2	ano3	ano4	ano5	ano6	ano7	ano8	ano9	ano10	ano11	ano12	ano13	ano14	ano15	ano16	ano17	ano18	ano19	ano20
Operational expenses																				
Seeds and dumb	42	42	22	42	42	22	42	42	22	42	42	22	42	42	22	42	42	22	42	42
Fertilizers	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Labor	1,650	1,250	1,250	1,700	1,236	1,236	1,751	1,273	1,273	1,803	1,311	1,311	1,857	1,350	1,350	1,913	1,390	1,390	1,970	1,423
Investments	163	-	-	82	-	-	164	82	-	-	164	-	-	82	-	-	160	-	-	82
Erosion cost	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other Expenses	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SUBTOTAL	1,860	1,297	1,277	1,829	1,283	1,263	1,962	1,402	1,300	1,850	1,522	1,338	1,904	1,479	1,377	1,960	1,597	1,417	2,017	1,552
2) ENTRANCES																				
Sales	3,120	3,120	1,872	3,120	3,120	1,872	3,120	3,120	1,872	3,120	3,120	1,872	3,120	3,120	1,872	3,120	3,120	1,872	3,120	3,120
Other revenues	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Residual revenue	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SUBTOTAL	3,120	3,120	1,872	3,120	3,120	1,872	3,120	3,120	1,872	3,120	3,120	1,872	3,120	3,120	1,872	3,120	3,120	1,872	3,120	3,120
3)- Cash flow	1,260	1,823	595	1,291	1,837	609	1,158	1,718	572	1,270	1,598	534	1,216	1,641	495	1,160	1,523	455	1,103	1,568

	20 YEARS	10 YEARS
IRR	-	-
LPV	R$ 13,675.8	R$ 9031.1
Ratio B/C	1.74	

Table B1: Distribution of accumulated probability of IRR, LPV and relationship B/C, of the experimental agroforestry systems no. (1), (2), (3), (4), in the 20 years-old horizon.

	Experimental Agroforestry Systems											
	1			2			3			4		
	IRR	LPV	Ratio B/C	IIR	LPV	Ratio B/C	IRR	LPV	Ratio B/C	IRR	LPV	Ratio B/C
Minimum =	-	(2,815)	0.57	26%	11,477	2.97	27%	6,142	2.47	27%	6,142	2.47
Maximum =	-	(2,594)	0.63	29%	13,501	3.26	33%	7,439	2.71	33%	7,439	2.71
Mean =	-	(2,699)	0.60	27%	12,405	3.10	30%	6,800	2.61	30%	6,800	2.61
Std Deviation =	-	46	0.01	1%	344	0.05	1%	222	0.04	1%	222	0.04
Mode =	-	(2,687)	0.60	27%	12,211	3.10	30%	6,593	2.59	30%	6,593	2.59
5% Perc =	-	(2,786)	0.58	26%	11,895	3.02	28%	6,442	2.54	28%	6,442	2.54
10% Perc =	-	(2,752)	0.58	27%	12,007	3.03	29%	6,544	2.55	29%	6,544	2.55
15% Perc =	-	(2,745)	0.58	27%	12,089	3.05	29%	6,575	2.57	29%	6,575	2.57
20% Perc =	-	(2,740)	0.59	27%	12,147	3.06	29%	6,619	2.58	29%	6,619	2.58
25% Perc =	-	(2,732)	0.59	27%	12,185	3.07	29%	6,641	2.58	29%	6,641	2.58
30% Perc =	-	(2,728)	0.59	27%	12,212	3.07	30%	6,683	2.59	30%	6,683	2.59
35% Perc =	-	(2,719)	0.59	27%	12,243	3.08	30%	6,707	2.59	30%	6,707	2.59
40% Perc =	-	(2,713)	0.59	27%	12,255	3.08	30%	6,737	2.59	30%	6,737	2.59
45% Perc =	-	(2,707)	0.60	27%	12,336	3.09	30%	6,755	2.60	30%	6,755	2.60
50% Perc =	-	(2,702)	0.60	27%	12,375	3.09	30%	6,783	2.61	30%	6,783	2.61
55% Perc =	-	(2,693)	0.60	27%	12,422	3.10	30%	6,796	2.61	30%	6,796	2.61
60% Perc =	-	(2,687)	0.60	27%	12,472	3.11	30%	6,844	2.61	30%	6,844	2.61
65% Perc =	-	(2,681)	0.60	27%	12,531	3.11	31%	6,892	2.62	31%	6,892	2.62
70% Perc =	-	(2,678)	0.60	27%	12,548	3.12	31%	6,921	2.63	31%	6,921	2.63
75% Perc =	-	(2,672)	0.61	28%	12,614	3.13	31%	6,943	2.64	31%	6,943	2.64
80% Perc =	-	(2,667)	0.61	28%	12,670	3.14	31%	6,971	2.65	31%	6,971	2.65
85% Perc =	-	(2,644)	0.61	28%	12,698	3.15	32%	7,005	2.66	32%	7,005	2.66
90% Perc =	-	(2,634)	0.62	28%	12,820	3.16	32%	7,083	2.67	32%	7,083	2.67
95% Perc =	-	(2,626)	0.62	28%	12,975	3.17	32%	7,173	2.69	32%	7,173	2.69

Source: Shift research data.