

Chapter 1

Scientific Computing in the Context of a Successful Agricultural Research Enterprise

Geraldo da Silva e Souza

Brazilian Agricultural Research Corporation - Secretariat for Strategic Planning, Brasília, Brazil

Eliseu Roberto de Andrade Alves

Brazilian Agricultural Research Corporation - Secretariat for Strategic Planning, Brasília, Brazil

ABSTRACT

Embrapa (Brazilian Agricultural Research Corporation), a governmental agricultural research institution from Brazil, is a case of successful organizational innovation that has as main characteristics: a public corporation model of organization; scale of operation at national level; spatial decentralization; specialized research units; enhanced training and remuneration of human resources and a vision of an agriculture based on science and technology. Moreover, from the beginning the organization has always been result oriented. Among the structural and political issues that led this enterprise to reach a well succeeded position, the authors argue that the strong application of scientific computing is the underlying reason that enabled high quality results achieved in research, development, and innovation. All of these reasons are presented in the next sections.

THE SUPPORT OF THE FEDERAL GOVERNMENT

This support has been critical to the survival of Embrapa. In the early years, it took the form of the federal government having understood the importance of technology for the development of agriculture. Once the results proved Embrapa could be profitable as an option for the government, the battle for budget support remained, but it takes

place in an environment where the corporation is one of the priorities of government, both in the sphere of executive and the National Congress.

In the first twelve years of its existence, Embrapa was a promise: of bold and modern design, but still a promise. During those twelve years, huge investments were made in the training of human resources and infrastructure - about six billion dollars in 2008 value. The federal government paid for this investment based on the promise that Embrapa could be for the modernization Brazilian agriculture. Without the support from

DOI: 10.4018/978-1-61692-871-1.ch001

the federal government, Embrapa would not have been possible.

But Embrapa's management has always been aware of the risk that the lack of achievements represented. For this, it led the research centers in a portfolio of research with short-term goals and to the conclusion of research already in progress. Moreover, it also gave special attention to the dissemination of existing results. And the media had a key role in creating the image Embrapa has. It is clear that the media not only operates on top of achievements, but also upon a consistent promise, provided it is not for long. In the early years of life of the corporation, the media bore the promise consistently, even in light of few existing results. This support was crucial to create a favorable image in society and in government. So, it has to be registered how important the development of competence to relate with the press, was for the success of the Embrapa. This relationship helped the government to justify the investment, over a period of lean achievements.

In a period of many macroeconomic imbalances and non-orthodox policies to deal with then, it is surprising that Embrapa's budget support did not falter, which only shows the decisive support the federal government gave to it. At the stage where Embrapa was only a promise, the expenditures of Embrapa evolved linearly until 1982. This was essential to consolidate its image. From 1982 onwards, the corporation was no longer a promise, and its success will explain the government's continued investments.

SCALE AND DECENTRALIZATION

Many wished that Embrapa would be small and only coordinated a research program run by the existing institutes and universities. This option was rejected because it was soon realized that, in a country of continental dimensions, the success of Embrapa depend on its size and an accumulated critical mass of researchers, diverse for talent,

and branched throughout the national territory. It was understood that Embrapa needed to have the scale as large as Brazil and that it needed to have its own research network, so it could be direct responsible for the results, allowing it to be well known and evaluated on its own merits. This model would also allow for it to seek cooperation with universities, research institutes, private sector and overseas in a position of equals. Being large, diverse and decentralized, Embrapa would have conditions to represent the federal government in an area as important as agriculture and receive priority, both in the allocation of resources and with regard to institutional development.

It was very important for Embrapa to have a presence throughout the national territory. This presence helped to attract sympathy of the state governments and the National Congress. Embrapa has a marked presence in the Federal District, where are located its Headquarters and: Embrapa Technological Information, Embrapa Cerrados, Embrapa Vegetables, Embrapa Genetic Resources & Biotechnology, Embrapa Agroenergy, Embrapa Technology Transfer. The units in the Federal District are an important window of Embrapa. Being in the proximity of power, they have had important role in helping establish and solidify the image of the corporation near the central power and the international market.

A CONCENTRATE ORGANIZATION MODEL FOR THE RESEARCH UNITS

Embrapa research units are distributed throughout the national territory and are specialized in products, natural resources or themes. For example, farmers know that the unit responsible for maize research is the Embrapa Maize & Sorghum, located in Sete Lagoas, Minas Gerais. Maize producers know where to go with demands for information and results, which will give them ownership in the center, providing help with the political leadership and the economic area of government. Similarly,

researchers have the exact notion of their responsibilities, and no ambiguities regarding goals and actions needed. Even more, there are strong ties of solidarity and spirit of corps, as if all employees are committed to having a winning team. Thus, Embrapa's model has aimed to facilitate and encourage interaction - researcher - farmer and researcher - society. It had an important role in preventing the dispersal of efforts, which is one of his pillars, and is an objective way of identifying priorities for research.

HUMAN RESOURCES

The human resources policy is one of the main reasons for Embrapa success. The policy aims to develop the human capital of the corporation and it is from this capital that Embrapa derives its success. To stimulate creativity and by creating an environment that encourages coexistence is another specific role of this policy. The policy is based on the following specific points:

1. The establishment of a career that stimulates the desire to study and progress. It has three levels (called positions), where the level I is for someone who holds only a bachelor degree, level II for those with master's and, finally, level III is for those who hold Ph.D. degree. Each level has several sublevels;
2. A level of salary that allows the researcher to have a dignified living with his family based on the salary Embrapa pays him;
3. A retirement plan, with voluntary membership, paid by Embrapa and the employee, to support old age. The plan aims to supplement the retirement of the public social security;
4. A health plan paid by Embrapa and the employees, with two purposes: support the researchers and his families for expenses in health care, and preserve the health of researchers, which is the most important capital of the corporation.
5. A series of activities to stimulate the researcher to accumulate knowledge and experience, allowing him or her to be productive and to love the Embrapa. There is a complex system of promotion on merit, based on individual, group and the research unity. The aphorism, ingrained in Embrapa, says that every year it has to deliver technologies to justify to society the investments made and produce better-trained researchers. Thus, there are two products that Embrapa has to deliver - researchers always more competent and technologies.
6. A training program at graduate and post-graduate levels, that meets both the interests of the corporation and researchers, and which seeks to train them at the same levels of the best centers of advanced countries;
7. The corporation recognizes that the technology generated incorporates the effort of all its employees. Thus, the training program is available for everyone, but graduate training focuses on researchers, but it is not exclusive of them;
8. Each research unit has a critical mass of researchers. It is organized around a specific target audience, a clear main problem to solve and the team's responsibility towards society. Each unit is in itself an instrument of concentrated effort in research and provides a work environment that encourages human development, creativity and sense of usefulness to society;
9. Embrapa seeks to stimulate the researcher to be an entrepreneur in his field, to seek resources, to interact with the outside world and ensure the dissemination of technology. Commands another aphorism: research results in the drawer of the researcher, means that; it did not result in anything or the researcher is not good enough, or both;
10. Embrapa's communication program aims to provide accountability for work, actions to disseminate research results, giving the

corporation visibility and transparency and valuing its employers. This communication program is organized around many ceremonies, some connected with the anniversary of the corporation and the research units, carried out in other seminars, symposiums in Brazil and abroad, and they all provide opportunities for learning and enhancing the employers. Thus, the communication program is also considered part of the human resource development policy, but with independent living;

11. Although the corporation is always looking for opportunities to improve its human capital, one has to plan for the future and the principle of orderly replacement has to prevail. In Embrapa's case the goal is to maintain an average age of 45 years old for the PhDs, imagining the following guideline: on the average a researcher should be finish his Ph.D. work around 30 years old, which would leave him with a horizon of around 30 years of productive work. Half of this is 15. So, 15 years should be added to 30, comprising 45 years. Thus, on average, a young doctor has 15 years of work alongside senior researchers. A complementary strategy is for the creation of conditions that would allow for competent and outstanding retiring researchers to continue to do some kind of work with Embrapa. There is much to be done in this regard.
12. In the beginning, an enormous effort was made to integrate the researchers to the spirit of Embrapa, in training courses, meetings and direct communication from the direction of the corporation. As the corporation was young, a world of opportunity was opened to those who joined the effort. The leadership did not have time to stratify on a separate level. For this and by having the support of society, there were no major difficulties to develop the spirit Embrapa. Today, the fame of Embrapa helps to develop the spirit

Embrapa, but we should not overlook this point.

In research, it is natural over time that seniority develops, that is how leadership solidifies, founded on knowledge and recognition. If these leaders do not have the ability to integrate with new researchers as part of their work, they will be disappointed to learn that they have no help to develop their careers. This disappointment can be transformed into rancor, leading quickly to an anti Embrapa attitude. This kind of problem cannot be solved by employing more democratic procedures. What should be done is to find mechanisms for promotion for those who can work in teams and spread their knowledge. Procedures have no place in making a competent researcher share more than what he has already reported in text or oral communication. However, a competent researcher has much more to offer.

SCIENTIFIC COMPUTING

Scientific computing is the field of study concerned with constructing mathematical models and quantitative analysis techniques and using computers to analyze and solve scientific problems.

Much of agricultural research is based on decision under uncertainty. Modeling in such a context depends heavily on quantitative methods and ultimately on scientific computing. Sciences like Statistics, Econometrics, Operational Research and Biometrics among others are of importance to scientific computing.

With the increasing availability of computer resources new techniques of analysis have been developed to analyze data in general from which agricultural research has much to benefit. Research data accumulated for years can now be assessed via data mining and experimentation optimized with the help of simulation.

Scientific computing allows complex modeling of world markets of commodities and the evalua-

tion of trends and demand and supply elasticities of ultimate importance for the implementation of public policies.

In Brazil of today we experiment a revolution in scientific computing. This goes from teaching in elementary schools to research in general. Agriculture is no exception. Indeed Agriculture has been a leading sector in the usage of scientific computing. As early as 1976, close to its very foundation, Embrapa – the leading state company responsible for applied agricultural research in Brazil, had already realized the importance of scientific computing in agricultural research, and created a quantitative methods department – DMQ, embracing four divisions: statistics, operations research and software analysis. The main objective of this administrative structure was to provide continuous support to experimental research, mimicking the operations of other successful institutions like Rothamstead in Great Britain. The new DMQ was filled with the best possible in human resources. The department was so successful that its development spilled over other research groups in Brazil. Indeed DMQ's research and support activities seeded the graduate programs of Statistics, Operations Research and Computer Science in the University of Brasília. In the 80's all research groups in the country engaged in agricultural research were associated with Embrapa in general and with DMQ in particular.

Today, DMQ, regrettably, no longer exists, but its inheritances are still present. From DMQ were originated Embrapa Agriculture Informatics, located inside the University of Campinas in São Paulo, a leading educational institution. This new

entity certainly has less statistics and operational research but is still competent in the development of support software to agricultural applications.

Although critical to the analysis and development of agricultural research, scientific computing and its roll of disciplines, remains a bit obscure to a big chunk of the population of agronomists, foresters, agricultural engineers, zootechnicians, veterinarians and administrators responsible for research in agriculture. This is a symptom felt at the market and at the universities as well. This is the truth for Brazil and elsewhere. Quantitative methods require proper education. In essence they are pure art, servicing science and society, but they require sensitivity and intelligence for proper understanding and recognition of their necessity. When Embrapa was founded these features were abundant in its administration. It is of crucial importance to maintain agricultural research quality at a high level.

OTHER IMPORTANT FACTORS

Without any further discussion we are going to nominate other factors that were important for Embrapa success. They are close integration to international research, ample exposure to the media and, at the first ten years, some research results that impressed Brazilian society such as the development of modern agriculture in the savannah region, nitrogen fixation in soybean to the point of 100% fixation of the plant needs and technologies that reduce the application of agro toxic and protect soils against erosion.