

nova tecnologia, dificilmente dispõem de capacidade para transferir os "pacotes" tecnológicos para os agricultores.

Cabe, portanto, ao sistema de pesquisa agrícola participar de forma intensa neste trabalho de transferência de tecnologia. As estações experimentais devem se organizar com grupos interdisciplinares para

realizar pesquisa, e, uma vez testado um "pacote de práticas agrônômicas", difundir, com os agentes de extensão, seus resultados, por meio de campos de demonstração nas próprias fazendas dos agricultores, observando seu comportamento e procedimento e procurando os ajustes necessários, nestes "experimentos", para sua ampla difusão.

3. REFORMING THE BRAZILIAN AGRICULTURAL RESEARCH SYSTEM (*)

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Brazil is presently experimenting with a new model for organizing agricultural research activities the public corporation model. The primary objective of experiment is to increase the quantity and quality of scientific knowledge relevant to agricultural development. Its main characteristic is that the whole research system is more sensitive to the demand for technology. At the same time, the model is based on a type of organization which is extremely responsive to the change required by the agricultural production sector.

The main organizational agency of the new system is EMBRAPA - the Brazilian Public Corporation for Agricultural Research. This agency operates like any public enterprise, being open to all types of financial and human resources, and at the same time, ready to "sell" its service to all kinds of clients. The Corporation's principal product, of course, is agricultural technology and its primary client, the Government. Both federal and state governments establish their priorities in terms of products for export and domestic consumption. An increase in agricultural productivity is the basic need to be met by the research, extension and credit complex, with research being the responsibility of EMBRAPA. The initial task of EMBRAPA is to transform the general production goals of the government into research programs geared to increase the productivity of land and labor. Its second task is to organize and improve the human cadres who execute the research programs. EMBRAPA is not subject to civil service personnel hiring restrictions. In other words, it is free to hire whatever individuals are considered qualified for its programs at the national and international labor market prices. In order to maximize resources, EMBRAPA is directing its main research programs through national centers. This effort to concentrate financial and human resources in a few, but relevant products is just beginning. Three national centers have been installed to

date: wheat, rice and dairy.

This paper first offers a brief overview of the trends in Brazilian agricultural development. Second, it shows the role of research in agricultural development in Brazil by providing a more historical view. Third, the basic principles behind EMBRAPA are described and, finally, the main accomplishments to date are presented.

3.1. Trends in Brazilian Agricultural Development

The model of induced innovation (Hayami and Ruttan 1971) basically states that government and private research agencies tend to concentrate their effort in order to generate the type of technology which saves the scarce and hence expensive factors of production. In this sense, the main lines of scientific and research policies really reflect the relative prices of land and labor in the case of agriculture. Institutional reform, on the other hand, is made possible and stimulated by the new opportunities opened up by changes in the relative prices of land and labor and by the increase in the demand for food.

Land has been an abundant factor in Brazil since its discovery, while labor could have been a scarce factor if slavery had not been established early in Brazilian history. The occupation of space in Brazil has been directed in such way as to minimize investments in roads and other infrastructure items. As a consequence, agriculture developed along the coast, from the Northeast to the South. Penetration into the central plateau and the northern or Amazon region is an extremely recent phenomenon. The basic policy to increase agricultural production in Brazil has been, during many centuries, expansion of cultivated areas. Although pressures to expand the agricultural frontier and bring new land into cultivation continue to be present today, high quality land is becoming scarce.

The agricultural frontier, however, is not infinite even in a continental nation such as Brazil. In fact, in some regions growth through expansion was effected very early. This was the case of the Southern states, especially, São Paulo and Rio Grande do Sul and, to some extent, the eastern state of Minas Gerais.

(*) This paper was prepared for the Conference on Resource Allocation and Productivity in International Agricultural Research, organized by the ADC, Airlie House, Virginia, January 26 - 29, 1975.

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Indeed, São Paulo was the first state to organize a research network directed at increasing the productivity of both land and labor.

Ayer and Schuh (1972) found that São Paulo alone invested more in cotton research than the entire United States did in hybrid corn research. They estimated a rate of return of over 90% on this research, which is higher than the rates reported for hybrid corn (Griliches 1958), poultry (Peterson 1967), and the extension service (Evenson 1967) in the United States.

Pastore, Alves and Rizzieri (1974) have recently studied the trends of the Brazilian agriculture. Their work indicates that during the 1950/60 period, growth of agricultural production was due mainly to an expansion of cultivated area. Indeed, 70% of the increase in production was due to land expansion and only 30% could be explained by an increase in yields or land productivity. With respect to labor, the increase in the agricultural labor force explains 60% of the agricultural growth, while 40% seems to have been due to increases in labor productivity.

The data show some remarkable differences. In the state of São Paulo the increase of agricultural output was practically entirely due to the increase in land productivity which also influenced to a large extent the increase in labor productivity. In the southern region the phenomenon was essentially the same, although less pronounced. In the Northeast, on the other hand, output increase was almost entirely due to an expansion of the quantity of land and labor used.

In the last decade (1960/1970) the situation has changed. An increase in land productivity has been observed over the entire country, with exception of the Northeast. At the same time, the rate of labor absorption has declined significantly (it is negative in São Paulo). The importance of the land/ labor ratio becomes clear in its contribution to agricultural growth.

Comparing these findings with similar data for other countries, one finds that the increase of production per unit of labor is very similar in *developed*, *intermediate* and *less developed* countries. The Table summarizes this comparison and points out the fact that São Paulo shows a very dynamic growth pattern.

The change in trends of agricultural development that became clear in the last decade (1960-1970) was a consequence of many factors. Favorable conditions in the international market and growth of domestic demand suddenly started pressing for a large increase in agricultural production which exceeded the possibility of growth by expansion of the cultivated area. The availability of good and cheap land for agriculture diminished considerably. These new forces (international and domestic demand for food and fibers) produced a new dialogue between official authorities on the one hand, and the farmers, industrialists and, especially technicians on the other. The result was re-

TABLE

ANNUAL RATES OF GROWTH OF AGRICULTURAL PRODUCTIVITY

Group of countries (*)	Labor ** Y/N	Labor ** Y/A
Developed countries	4.7	2.1
Intermediate countries	4.4	2.0
Less developed countries	1.4	2.1
Brazil	4.0	2.0
Central-South	4.1	2.1
São Paulo	5.4	4.8
Northeast	3.8	0.6

(*) Data on three first types of countries are from Hayami and Ruttan (1971)

(**) Y/N = output per unit of labor and Y/A output per unit of land

direction of the basic agricultural policy. Growth through expansion was maintained. However, increases in land and labor productivity were explicitly introduced as a new, additional goal during the late 1960's and the beginning of the present decade.

Initially, the key move was the attempt to diffuse the existing technological knowledge from the research institutions to the farmers. The heavy emphasis on agricultural extension services during the 60's can be understood within this framework. This circumstance also explains the high priority allocated to development of especial lines of credit for purchase of modern inputs as well as the emphasis on minimum price policies to stimulate production and productivity.

An internal crisis for food in the domestic market became an additional and powerful factor for re-directing agricultural policies, especially in the middle 60's. The feeding of the large urban centers suddenly became a crucial economic and political goal. Government became aware that inflation plus food shortages were the ingredients for social convulsions and radical political changes which, obviously, were undesirable at that time.

In short, the increasing of agricultural production at lower production cost entered the picture of Brazilian development in a very explicit way in the beginning of the 70's.

This was crucial to meet the stated objectives as well as to combat inflation and to gain sizable slices of the international markets. These themes were discussed particularly at the federal level where, obviously, the link between agriculture and the general process of economic development was in focus. This is probably the reason why the initial step toward the modernization of the agricultural research system was taken at the federal level or, more explicitly, within the Ministry of Agriculture, which was under

increasing pressure to raise the productivity of the sector.

The economic forces that entered the picture in the last decade have created in the beginning of the 70's a favorable atmosphere for a profound change in the Brazilian research system. This system has undergone several changes, but none of them succeeded in providing Brazil with a research institution capable of facing up to agricultural problems. It is our contention that lack of incentives in the economic system have been responsible to a great extent for the failure of the reforms that have been tried. The next section will provide the reader with some historical perspective of the Brazilian agricultural research system.

3.2. Historical background

The great changes of XVIII and XIX centuries occurring in agrarian sciences in Europe had some manifestations in Brazil. Actually, the first Brazilian agricultural research units were created within the atmosphere of European liberalism which generated a *diffuse model* of research activity. The main feature of this type of model is that each research unit tries to diversify its activities, researching many different products and attempting to generate a wide array of technologies. The role of making the proper choice of technology as well as determining optimum system is left completely to the farmer.

The diffuse model represents an adequate system for organizing research in an environment with special characteristics. Among these characteristics are:

a) Abundant resources are available for research. The abundance of resources destined for research indicates that the society has already recognized the importance of research in the modernization of agriculture. Furthermore, mechanisms have been developed to provide agricultural research with sufficiently generous and flexible budgets to meet its needs.

b) Predominance of a liberal philosophy which accepts the behavior of the scientists as individuals and provides an atmosphere of liberty in the choice of research projects.

c) Existence of a critical mass of farmers sufficiently organized to interact with researchers and administrators and make the problems they face explicit. From this dialectic interaction, pressure develops that results in adequate resources being allocated to research and, at the same time, prevents the scientist from becoming alienated from reality and concerned only with problems of his particular preference.

The pressure from farmers, together with the individual orientation of the scientists, results in a research system which seeks to generate information of a diversified nature covering a vast gamut of subjects and large numbers of crop and animal enterprises. There will be many lines of research, some seeking to economize on land and/or labor. However, no attempt is made to direct the types of knowledge

generated by applying the criteria of relative change of prices.

The tendency is to develop, given the limitations of time and money, what is possible in a broad range of areas. The individual interests of the scientists are satisfied because they have a wide range of choice in their respective areas of research. At the same time, this system guarantees that the desires of the majority of farmers, particularly those in position to influence the research institutions, will be satisfied. When an individual farmer seeking information to improve the efficiency of his farm comes in contact with the universe of knowledge generated, it is highly likely that he will encounter the information he desires especially adopted to his financial situation and psychological nature.

It is natural that the dialectic process which develops between the farmer and researcher in an environment of abundant resources for research and researcher freedom will lead to the diffuse research model. In this sense, it is considered adequate and, additionally, given the diverse nature of knowledge generated, will permit the development of a large number of production systems which can be adjusted to widely varied conditions.

The freedom of choice of the researcher also guarantees that the research projects developed will not be concerned merely with short-run necessities. The gamut of research results generated will include some which have no immediate application, but which may be of great value if the socio-economic conditions change. This occurs because some researchers with great intuition anticipate change, and because of luck in other cases.

The diffuse model generates a large amount of information with a low probability of crystalizing into a new technology. For this reason the diffuse model is extremely expensive and possible only in rich societies which can invest large quantities of resources in research.

In the developing countries, two of the essential ingredients are lacking for the diffuse model to function. Resources destined for research are scarce, and further, the low cultural level of farmers, together with the difficulties of transportation and communication, make establishment of the dialectic mechanism difficult. On the other hand, researchers have cultivated the individualistic tradition inherited from the developed countries through training abroad and the scientific literature. Conditions exist that alienate research from the current agricultural situation and lead to a dispersion of research among many crop and animal enterprises. Since human and financial resources are limited, this dispersion of effort reduces the efficiency of research. In other words, the stock of knowledge being generated does not maximize the number of systems of production that could be developed. The farmer finds only limited and incomplete information available which does not permit the elaboration of a production system.

Presumably then, in an environment of scarce resources, the diffuse model of research has undesirable characteristics. It is necessary to modify it in such a way that the knowledge generated meets certain defined guidelines. Otherwise the knowledge generated does not allow for the efficient development of large numbers of production systems.

With the exception of São Paulo and Rio Grande do Sul, financial and human resources were extremely limited practically everywhere in the country. In addition, a critical mass of influential farmers does not exist to promote the necessary dialectic mechanism and to sensitize Brazilian authorities to the sector's needs. As a consequence, the imported diffuse model – which is in practice not only in Europe but also in the United States and, lately, in Japan – can not really have the same impact in Brazil.

The Brazilian agricultural research system little by little developed an extremely individualistic orientation; research topics and methodology were viewed as being the exclusive property of the investigators themselves even though research was completely financed by public money. Research priorities were viewed as "sacred" themes and the directing of science and technology toward solution of the entrepreneurs problems was considered "heretic" thinking.

Scarce resources tended to be allocated to a wide variety of research topics defined by the researchers who, not rarely, were more eager to duplicate an investigation recently published abroad than to solve the farmer's problem. The lack of pressures that accrue from scarcities in land and/or labor actually contributed to this exaggerated individualistic pattern. Researchers felt themselves unprotected and, at the same time, very independent and risk-averse. Their whole style of working was defined as the "one-man venture" type: research tended to be designed in such a way that research teams were completely dispensable. As a consequence, no emphasis was placed on training and preparation of new research generations. Few people went abroad for training and those who returned rapidly started defending the "uncommitted" type of research and reinforcing the diffuse model based on the individual pattern. The eventual long-run impact of research activity was used as the main argument for future investments in parallel projects. In fact, the government's research investments were mainly an "act of good faith" rather than a goal directed effort. This type of social background pervaded both the agriculture colleges as well as the more applied research units, namely, the agricultural experimental stations and institutes.

In short, the Brazilian agriculture research structure seems to have been negatively affected by two types of forces. On one hand, due to the relative abundance of land and labor, there was little pressure for research to develop technology which conomized on these factors. On the other hand, there was the prevalence of extremely individualistic research patterns imported from developed countries within

which positive benefits could be derived from the diffuse model of agricultural research. Changing forces entered the picture at the beginning of the 1970's in the form of pressure to enlarge agricultural production in order to meet the new economic forces; namely, the increase of domestic and international demand for food and fibers as well as the political need for feeding the urban population. These forces have created a new atmosphere for shifting from a diffuse and completely subsidiary model to one in which concentrated research efforts predominate. To these forces, one could probably add the emergence of concentrated model elsewhere, particularly the international research institutes which are concentrating massive financial and human resources on the researching of a very limited number of products.

The role of science and technology in increasing agricultural productivity became one of the central concerns of the Minister of Agriculture, Dr. Luis Fernando Cirne Lima, in late 1971. A decisive move was made by him in early 1972, when he called a meeting of all State Secretaries of Agriculture and Agricultural experiment station directors to present the clear desire of the central government to modernize the research system in order to accomplish the newly defined national goals. Simultaneously, the Minister nominated a special committee to present an appraisal and some lines of action to remove the main weakness of the Brazilian agriculture research sector.

The report of this committee pointed out the basic positive and negative aspects of the federal research units. The positive aspects can be summarized as follows:

- (1) a geographically dispersed network of research units was available to the federal government and covered practically the whole nation;
- (2) equipment and basic infrastructure were considered reasonably adequate for most of the units, with a total investment in land, building, laboratories and other facilities totaling about \$ 300 million;
- (3) sixteen technical journals were available for publishing the eventual results of agricultural research;
- (4) a small, but well qualified group of researchers could be better used by the units if their administrative load would be assumed by some other professionals;
- (5) a relatively well-defined consciousness of the need for an integrated research policy for the agricultural sector was present in most of those above mentioned researchers.

The negative aspects, unfortunately, were overwhelming:

- (1) the basic national needs of agriculture were unknown to most of the research personnel;
- (2) lack of a general policy and interaction between research personnel and farmers were dominant;

- (3) the existing administrative structure inhibited the recruitment, training, and promotion of well qualified personnel;
- (4) a complete lack of internal communication among units and individual researchers was evidenced by large numbers of parallel projects on unimportant products;
- (5) the lack of suitable programming and evaluation mechanisms permitted researchers, to undertake individual activities with doubtful research output and value;
- (6) of 1,902 individuals considered formal researchers, only 10% could be considered as professionals with some kind of graduate training in research;
- (7) a lack of salary policy which permitted competition in the professional labor market as well as quick admission and promotion of qualified personnel and demotion of the unqualified ones;
- (8) predominance of a personnel policy in which better salaries could be obtained only if an administrative position was held, thereby inducing a process of rapid shortening of the technical life of the better researchers;
- (9) inadequate mechanisms for obtaining and managing financial resources which were limited to the direct subsidiary budgets coming from federal government;
- (10) underutilization of all the existing facilities.

The committee also examined a variety of institutional arrangements that, according to Brazilian Law, could be chosen to implement research activities. A public corporation was considered the most adequate one. The Congress, in December 7, 1972, approved the creation of EMBRAPA as a public corporation to coordinate and to administer at the federal level research in the area of agriculture and animal husbandry. EMBRAPA started operating on the 26th of April, 1973. The basic principles of the model are presented in the next section.

3.3 The Basic Principles of the Present Brazilian Model

The years of 1971-1972 have marked the history of Brazilian agriculture as a period for the creation of a more flexible and sensitive mechanism for agriculture research. The basic tenant of this model is that the applied side of agricultural research, the one which is closer to technology and to the needs of the farmers, should be directed by the concrete needs of the national society. In other words, agriculture research institutions should be developed to meet the country's demand needs. Two demand components were visualized: the present demand and the potential demand. The present demand is visible through government policies and the concerns of industrialists, extension personnel, and farmers in general. The potential demand can be surmised by looking at longrun government

plans and the trends of particular scientific endeavors in Brazil and abroad and through researchers' intuition. In this respect, the execution of applied research directed toward present demand is visualized as a proper activity of the technological research institutes, whereas the more fundamental type of investigation should encounter its more appropriate habitat in the universities. This is not a rigid division of labor between the two types of research institutions; it is just the idea of using their comparative advantages for two types of research.

The components of the research system of the Ministry of Agriculture can be generally placed in the first category. Therefore, their main thrust should be directed toward the present demand for technology, which means generating the types of knowledge that can be readily incorporated into the production sector, thereby reducing costs and increasing product quality. Also, this general strategy implies that technologies should not be pursued separately. Rather, the development of the agricultural sector in other nations has shown the importance of working toward the creation of technological packages that achieve technical and economic efficiency.

In addition to these general principles, six other ideas have been used as guidelines in reforming the existing research apparatus. First, the transfer of foreign technology to the agricultural sector is considered as a valid means of improvement, but of limited importance in many instances. The transfer of materials and of certain packages (i.e., poultry technology) is looked upon as an opportunity to capitalize on some other country's investments. Among the types of technological transfer, training abroad and imports of personnel are defined as being most applicable to the Brazilian situation.

Second, given the scarcity of financial and human resources for research activities, the idea arose of concentrating efforts on regional projects. The main research programs reflect the basic national needs as well as regional demand. This principle should overcome the difficulties of transferring technology among different ecological and economic regions through the country. All programs and projects are designed with the closest possible involvement of the private sector, including financial participation in some cases.

Third, the private sector should operate as the originator and the controller of most of the research projects. At the same time, agricultural research should be closely articulated with the nation's overall science and technology system. Agricultural research, in short, should be closely related to the private sector, the university system, and the other science and technology units.

Fourth, the agricultural research system should be redirected in order to gain more administrative flexibility to include:

- (a) the possibility of obtaining additional resources through contracts and agreements;
- (b) the possibility

of paying wage of researchers on a market basis; (c) the possibility of developing an aggressive policy of human resource development, including basic training and graduate work.

Fifth, a closer relationship should be developed with the extension services and the agricultural input industries in order to speed knowledge dissemination throughout the country.

Sixth, knowledge from the international institutes and from other foreign research centers should be adapted and diffused in the country. The technological packages should be adapted by the research system to a great extent in order to decrease the farmer's risk. This means that an economic component should be systematically included in the agronomic investigations.

The concentrated model was chosen as the research model that requires investment of massive financial and human resources, but on a very limited number of products. The challenge that this model brings about is to define the criteria for orienting the generation of knowledge. One alternative would be to follow an orientation similar to an automobile company. First, two prototypes of production systems need to be defined. One, consists of modifications which improve the production systems already in use by farmers. This is what an automobile company does when it makes minor changes in a model well accepted by the public. The second prototype deals with production systems that one imagines will be appropriate for conditions some 5 to 10 or more years in the future. Its design depends largely on futurology. However, some orientation is provided by information existing in the factor and product markets, nationally and internationally.

Once the prototypes have been designed, researchers must select a group of research projects that will result in the systems of production designed. This provides the research system with a definite orientation from which the maximum number of production systems can be developed.

This type of orientation leads to a number of problems. Among the most important are:

- a) Problems of methodological nature occur, such as definition of the general lines of research and the specific projects to be undertaken.
- b) Since resources are scarce, it is necessary to limit the number of production system prototypes developed and the number of commodities researched. Hence priorities must be established.
- c) Selectivity with respect to enterprises to be studied implies some groups of farmers will not receive the benefits of research. National agricultural policy provides some orientation in this respect.
- d) For development of future production system prototypes, problems of foresight exist.

- e) There are problems of allocation of resources between research with immediate applicability and that with applicability in the longrun.
- f) For small farmers who combine various enterprises in their operations, the concentrated research model may have difficulty developing systems of production which are adequate for them.
- g) The concentration of effort requires an appropriate institutional system. It is unlikely that research institutes which work on a large number of commodities and are organized on the basis of disciplinary departments such as soils, plant improvement etc. will have a high degree of success in developing production systems. In this type of environment, given the individualistic tradition to which researchers are accustomed, pressures will develop that cause departure from the priorities and areas of concentration established. These pressures arise from the departments which seek to develop an area of specialization, as is common in the developed countries, and from researchers that have dedicated their lives to commodities not considered to be of national priority. It should be noted that the organization of research in institutes of this type is a consequence of the requirements of the diffuse model. In rejecting this model, it is also necessary to modify the institutional arrangements which made it possible.

3.4 Agricultural Research under EMBRAPA

The process of generating new knowledge seems to present two related levels of activity. The first one includes all research activity aimed at advancing sciences and experimental techniques, including hypothesis testing procedures and theory construction (Type I). The other level involves experimental work using existing scientific knowledge and is aimed at the generation of alternative technologies (Type II), which may improve the agricultural productivity. The gray area, obviously, is large.

On the basis of this distinction, one can organize the research agencies, recognizing their comparative advantage in one or the other of knowledge generation process. As a general rule of thumb, one can say that the first level of knowledge generation can be better performed by the universities or colleges of agriculture. The second type of research activity can be allocated to other research units. Depending on resources and time, the universities may allocate some of their personnel to the Type II research; conversely,

some people from technological institutes may devote some time to Type I research.

In addition to this type of specialization, Brazil, as a continental country, faces the problem of space specialization. In other words, EMBRAPA can be defined as an agency mainly concentrated on the Type II research for agricultural development and at the same time as an agency leading a system of state units dedicated to regionalized experiments. It has been recognized that it is not EMBRAPA's responsibility to perform all agricultural research in the 25 Brazilian states. As a consequence, two important roles have been defined for EMBRAPA. On one hand, it has the responsibility of creating and/or supporting the state research systems. On the other hand, it is responsible for creating and implementing commodity-oriented National Research Centers.

(1) Supporting the State Systems

Agricultural research at the state level is very heterogeneous in Brazil. The southern states, as it was pointed out, possess relatively mature research systems. EMBRAPA expects to continue supporting their activities. At the same time, it expects them to adopt more flexible administrative units (corporation type agencies) in order to facilitate the state-EMBRAPA articulation.

There are many other states, however, which have no research tradition whatsoever, although many of them have been receiving research funds from the central government. In these states, EMBRAPA is helping the state governments create their own capabilities. The main support up to now has been in terms of training massive groups of research personnel as well as aiding the state secretaries of agriculture in organizing their own state corporations.

(2) The National Centers

These centers are defined in terms of other basic national needs for the agricultural sector. The main strategy is to concentrate funds and talents in a few and relevant products and specific physiogeographic regions. Wheat, sugar cane, corn, cane, corn beans, soybeans, rice, coffee, rubber, livestock and dairy have been defined as the crucial agricultural products for the country. Among the key resource areas to be developed through national centers, EMBRAPA has included "cerrado", semi-arid agriculture, and humid-tropical agriculture.

State agencies can articulate themselves directly with the national research centers, particularly when they are located in a nearby state or in the state itself wherein a given center is located.

In this framework, there are two levels of research priorities guiding EMBRAPA's activities. The first one refers to those projects which can be performed by the state with EMBRAPA's support and guided by regional priorities. The second refers to those projects which will be per-

formed directly by EMBRAPA through the national centers and by integration with the state units when it is necessary. This combines national priorities with region specialization in order to assure transferability of research results. The most important results obtained in the 1973-

74 period are the following:

- (1) EMBRAPA replaced the National Department for Agricultural Research of the Ministry of Agriculture. The year of 1973 was a transitional year. The corporation indeed assumed the operation of research activities in 1974.
- (2) The realized budget of the old system in 1973 amounted to US\$ 14,000,000 (exchange rate of December, 1973). In 1974, EMBRAPA expended about US\$ 25,000,000 in research activities (exchange rate of December 1974). The Planned budget for 1975 was estimated at US\$ 65,000,000 (exchange rate of December 1974).
- (3) The old system was overcrowded with bureaucratic personnel. The Corporation was, by law, allowed to select the personnel best suited for its work. It selected 3422 (data of January 1975) out of 6705 employees of the old system.
- (4) The training of personnel is one of the most important part of this program. It is creating conditions for 1000 researchers to acquire M.S. and Ph.D. degrees in Brazilian and foreign universities. It is financed by Brazilian and foreign fund. In this respect, USAID, through a loan to Brazilian Government, is an important source of funds for a program with U. S. universities. At the present, 500 researchers are in universities obtaining M.S. or Ph.D. degrees. The aim of the program is to have at least 80% of EMBRAPA's researchers with Master's or Doctor's degrees. In the old system this percentage amounted to 10%.
- (5) National Centers for the most significant products of the Brazilian agriculture will be in operation by the end of this year. Nowadays, the National Centers for dairy cattle, rice and wheat are in operation. Three National Centers for the development of natural resources will be in operation this year. One in the area of the cerrado, another one for the semi-arid region of Northeast, and a third one in Center for Tropical Agriculture in the Amazonas region.
- (6) EMBRAPA is strengthening institutional linkages with Brazilian and foreign universities, with the International Research Centers, and with development banks to obtain technical and financial support for the program.
- (7) Three states have already reformulated their research systems according to the federal

model. Their research projects are supported to some extent by EMBRAPA funds. In other states an institutional arrangement has been established with the purpose of strengthening their research capability and creating conditions for the corporation model.

- (8) Brazil has accumulated a stock of knowledge that is useful to its agriculture. Farmers are drawing from this stock of knowledge to organize their production systems with the help of the Extension Service. The stock of knowledge is however insufficient to attend to Brazil's needs. It was generated according to the analytical tradition without paying attention to the idea of production systems. However, experience has demonstrated that it is possible to generate some technological packages out of this stock of knowledge. EMBRAPA organized several meetings for this purpose in 1974. The meetings covered the most important products and regions. Extension people, farmers and researchers met, on an informal basis, with the objective of organizing available knowledge into technological packages for different classes of farmers (classified according to size of land holding, type of land ownership, etc.) Each meeting covered just one product and generated technological packages for a region where the available knowledge is known to be applicable. EMBRAPA will expand the program in 1975. It will invest US\$ 1,300,000 in these activities compared with US\$ 360,00 that invested in 1974.
- (9) A system of planning has been worked out in detail. The priority criteria established will allow a detailed evaluation of the research projects of the Old System. Those projects that did not satisfy the priority criteria were either eliminated or reformulated.

The experimental stations are being reorganized. We seek to equip them in a more adequate fashion and to increase their sizes. For this reason some of

the experimental stations will be closed and others will go through a substantial enhancement of their research programs.

EMBRAPA has created conditions for young and competent researchers to assume leadership in their research areas. There were, consequently, profound changes in the power structure. These were deemed necessary for the implantation of the new research system.

BIBLIOGRAPHY

- 01 - AYER, H. W. & SCHUM, G. E. Social rates of return and aspects of agricultural research: the case of cotton research in São Paulo. *Am. J. Agric. Econ.* (54): 557-69, 1972.
- 02 - EVENSON, R. The contribution of agricultural research to production. *J. Farm. Econ.* (49): 1415-25, 1967.
- 03 - GRILICHES, Z. Research costs and social returns: hybrid corn and related innovations. *Journal of Political Economy.* (6): 419-31, 1958.
- 04 - . Sources of measured productivity growth: United States Agriculture 1940-60. *Journal of Political Economy.* (71): 331-46, 1963.
- 05 - HAYAMI, Y. & RUTTAN, V. W. *Agricultural development: an international perspective.* Baltimore, The John Hopkins Press. 1971.
- 06 - PASTORE, A. C.; ALVES, E. R.A. & RIZZIERI, J. B. Inovação induzida e os limites à modernização na agricultura brasileira. In: *ALTERNATIVAS de desenvolvimento para grupos de baixa renda na agricultura brasileira.* São Paulo, IPE, 1974.
- 07 - PETERSON, W. L. Return to poultry research in the United States. *J. Farm. Econ.* (49): 656-69, 1967.

4. NOVA ABORDAGEM PARA A PESQUISA AGRÍCOLA

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A literatura sobre os aspectos econômicos e institucionais da pesquisa agrícola apresentou uma grande expansão a partir de 1970, estimulada, em grande

parte, pelo trabalho de Hayami e Ruttan (Hayami e Ruttan: *Agricultural Development*, Baltimore 1971). A hipótese central daqueles autores é que a pesquisa agrícola é uma atividade induzida por forças econômicas e sociais; em particular, a pesquisa é induzida pelo preço relativo dos fatores de produção e por um processo dialético de pressão dos agricultores sobre os pesquisadores. Esse sistema de forças seria, assim, res-

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