HUMAN RESOURCE DEVELOPMENT PROGRAM OF BRAZILIAN AGRICULTURAL RESEARCH CORPORATION (EMBRAPA)

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Introduction

This paper represents an attempt to describe investment made in human capital basically graduate and continuous training programs undertaken by Brazilian Agricultural Research Corporation (EMBRAPA). It points out the results and cost of graduate programs, especially in relation to doctoral level training. It tries to demonstrate the risks that the EMBRAPA system runs in view of the presence of factors which provoke the rapid deterioration of its human capital. A combination of measures is suggested which have been implemented to counteract this tendency. The paper indicated the objectives and principles of graduate programs based on an attempt to increase potential contribution of the research workers and his labor. Since it is assumed that the results of research are, to a great extent, a function of the knowledge accumulated by researchers.

To avoid the depreciation of human capital and to provide incentives for researchers to make continuous efforts aimed at obtaining additional knowledge, has been the constant concern of EMBRAPA; for its capacity to attain its objectives is more a function of the quality of the technical staff than of its number. For this reason continuous investments in human capital are imperative for the success of any research program.

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Initial Base of Human Resources

The high rates of economic growth, the opportunities which are now opening for agricultural products on the international market, Brazil's rapid urbanization and the diversification of its economy, as well as the better understanding of the role of science in modern society, have led to a growth in the demand for research and have affected the character of this demand so that now, more than ever, research work requires increasingly sophisticated skills. Brazil therefore requires skilled researchers capable of grasping innovations from abroad and adapting them to its circumstances. There are tremendous advantages in this policy in that a substantial part of the cost of the original research would not have to be born by Brazil. On the other hand, in view of the very diverse environmental conditions, which differ from those of the developed countries in many ways, generating appropriate knowledge which transcends mere adaptation is a component of prime importance in research programs of the agricultural sciences in each country.

In the past, the supply of researchers did not respond adequately to the dynamics of demand. This resulted in a shortage of researchers in qualitative as well as quantitative dimensions.

In 1971 there were 3,361 full time and part time researcher workers in agriculture in all of Brazil. Of these, 1,090 in Ministry of Agriculture and the remainder in state governments, private businesses and other Ministries.

Is was difficult to find a measure of these technicians' capabilities. One indication, however, would be the completion of graduate work at the master's and doctoral level. Within the network of the Ministry of Agriculture, of the 872 technicians employed in 1972, only three held PhDs and 93 had completed master's level graduate courses.

Creation of EMBRAPA

Since early nineteen seventies the expansion of agricultural productivity was the main objective of the Brazilian economic policy. The emphasis that till then has been largely on growth, has been shifted towards growth with equity.

In 1972, a Task Force was formed to study agricultural policy and propose institutional reforms. As a result of its recommendations, the Empresa Brasileira de Pesquisa Agropecuaria (EMBRAPA) was organized late that same year.

The statutes of EMBRAPA are contained in Law Nº 5.851 of December 7, 1972, which outlines the agency's main functions as follows: (a) direct, control and execute agricultural research activities for the purpose of producing new technology for the development of national agricultural production; (b) assist the federal executive branch, and its entities, in technical and administrative matters related to the agricultural sector; (c) stimulate and promote the descentralization of research activities to the benefit of state and local interests; (d) provide technical coordination of research projects, the execution of which involves the technical-administrative services of other federal agencies; (e) maintain close contact and coordination with the Brazilian Technical Assistance and Rural Extension Corporation (EMBRATER) to effectively execute diffusion of research results and technology, and (f) plan, program and budget research activities to reflect the guidelines and policies established by Government.

As already indicated, in 1973 when EMBRAPA was founded, the human resources devoted to research activities available within the network of the Ministry of Agriculture did not present a bright picture. This diagnosis led EMBRAPA to consider the implementation of an aggressive training program as its highest priorities. In order to guarantee the success of this program, a policy, based on the idea of promotion by merit which remunerates talent and work, in accordance with the standards of domestic and international markets was developed. An intensive recruitment campaign was undertaken with the objective of attracting to EMBRAPA young people and experienced technicians of talent, and thus a research staff capable of confronting the great challenge of the Brazilian agricultural development potential. At the same time, through international collaboration EMBRAPA has acquired the valuable assistance of technicians of other countries who come to combine their experience with that of Brazilian with the aim of solving the problems of Brazilian agriculture and advance knowledge in tropical and subtropical agriculture. Among these one could mention international Institutions like: World Bank (IBRD), Inter American Development Bank (IDB), Inter American Institute Cooperation in Agriculture (IICA), International Agricultural Research Institutes like: CIAT, CYMMIT, IRRI, IITA and CIP,

United National Development Program via FAO, International Agricultural Development Service (IADS), USAID till 1976, bilateral Programs with U.S.A., Canada, Japan, France, Federal Republic of Germany and others.

Over and above the 1168 technicians on the EMBRAPA staff in 1976 (Table 1), there were 47 technicians available through agreements with international agencies, the great majority of whom are trained through the doctoral level. By the end of 1981, this number nearly doubled.

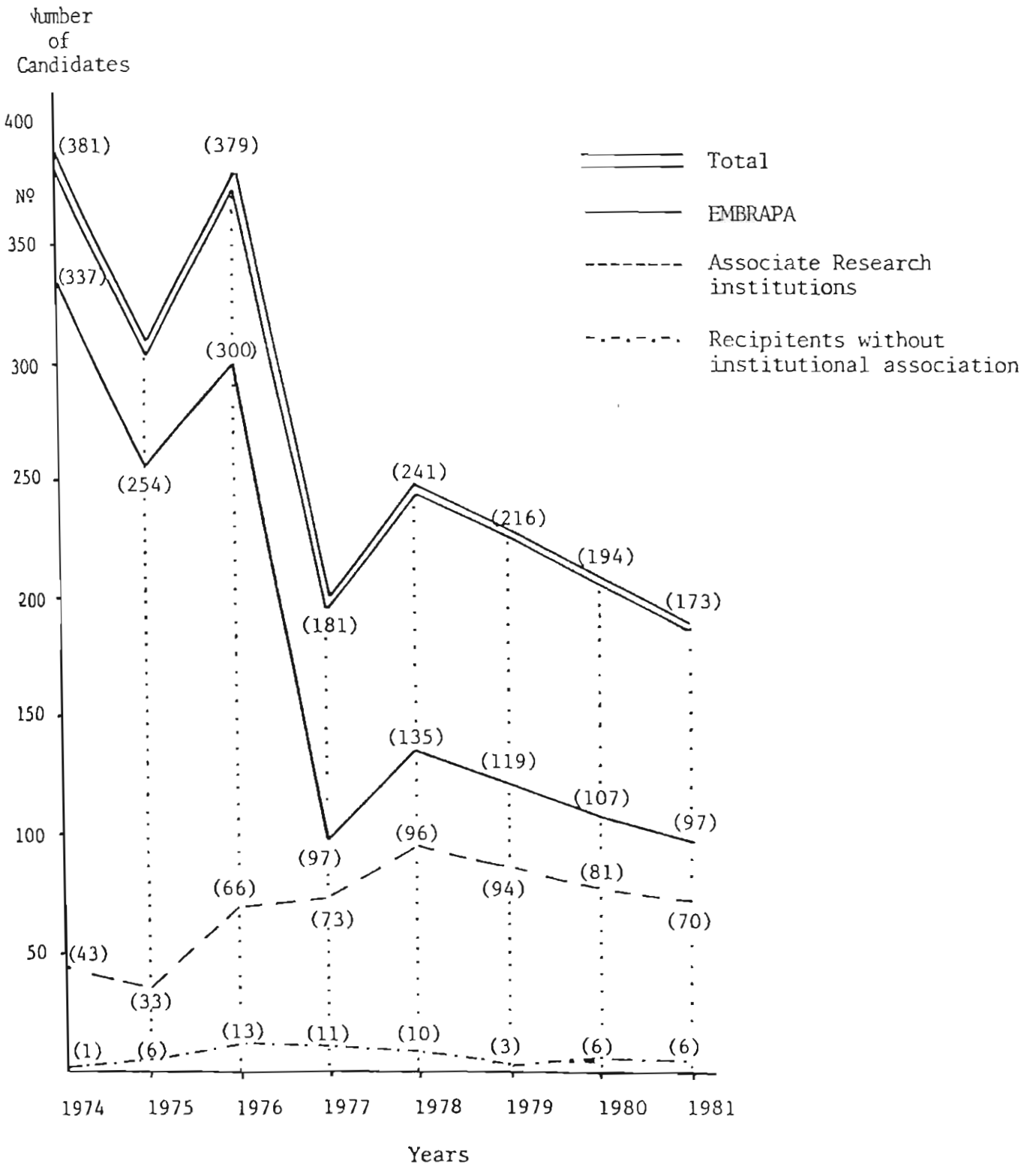
EMBRAPA began functioning on 4/26/73. From that date until the end of 1973 many tecnicians were sent to graduate school under the auspices of the organization. Chart 1 and table 1 shows the development of graduate training program in terms incorporation of new graduate degree candidates.

Table 1: Evolution of EMBRAPA's Research Staff as of the in the initial - 1973-76 Period

Educational level	On 12/31/73		On 3/10/76	
	No.	%	No.	%
Bachelor's degree	691	74.9	389	33.3
Master's or working on a master's degree	220	23.8	678	58.1
Doctorate or working on a doctorate	12	1.3	101	8.1
Total	923	100.0	1168	100.0

Source: Department of Human Resources (DRH) EMBRAPA

Chart 1 - Number of New Graduate Degree Candidates Incorporated in the Graduate Training Program - 1974-1982 period



Principles and Objectives of the Graduate Program

The following are the major objectives and principles used to develop and implement the graduate training program of EMBRAPA.

(1) To prepare researchers so that the goals and objectives of the EMBRAPA system may be attained. This means that the goals and objectives of the EMBRAPA system serve as a point of departure.

(2) This was undertaken in such a way as to:

(a) Help alleviate, in short period of time the shortage os researchers. In this case, not only EMBRAPA's needs, but also those of other institutions related to agricultural research, was considered.

(b) Prepare researchers, in terms of professional quality, who satisfy the needs of EMBRAPA and the National System of Agricultural Research.

(3) To adjust the program to the professional life cycle of the researcher. For some researchers this cycle begins at the university, when they first accept research fellowships. For the majority, however, the initial step is when they first join a research institution. The life cycle can have the following sequence for the person who is beginning a career as a researcher. There are three alternative situations: A, B and C, varying one from the other as to how they combine periods of training and of resarch work. The starting point is the university. Point O marks entry into the research institution. Point H, thirty or more years later, marks retirement.

Both situations B and C should be reserved for more promising candidates who have already shown a strong inclination for research.

Abreviation used below represent the following:

PI: University training on a fellowship

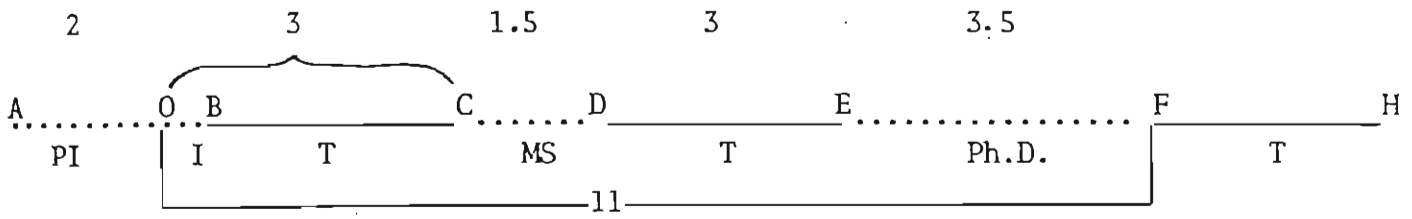
I : Initial training and orientation

MS: Master's level training

Ph.D.: Doctoral level training

T : Full Time work periods, as a researcher

SITUATION A



AO: 2 years on a university fellowship

OB: Beginning course in research, 2 months long (I)

BC: Work period, up to 3 years in length (T)

CD: 1-1/2 years (MS)

DE: Work period, minimum of 3 years in length (T)

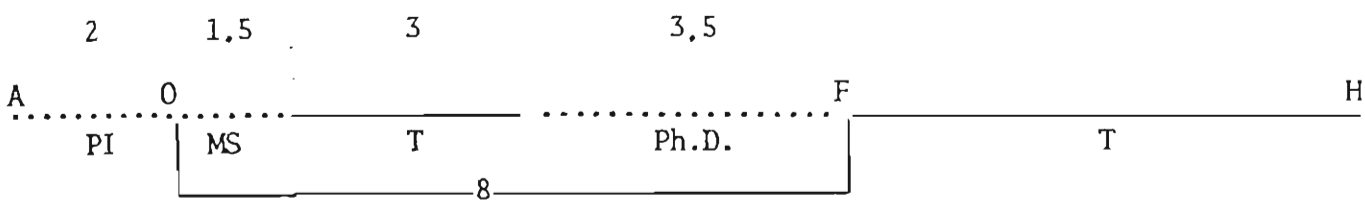
EF: 3-1/2 years (Ph.D.)

FH: Research including scientific trips, short courses, etc.

H : retirement

SITUATION B

In this case the researcher is contracted and directly enters a Master's program immediately:



SITUATION C

The researcher enters the research institution and afterwards works on his Master's and Ph.D.

Apart from these three situations, there are infinite possibilities tending to prolong the period necessary for the researcher to attain the top rung from the training point of view.

(4) To recognize that not every researcher will reach the doctoral level or its equivalent, lacking either the ability or the will to achieve this goal. Nevertheless, these researchers are useful for the many less complex tasks and they can thus save the time of better trained researchers.

(5) It is necessary to emphasize the training of research administrators and leaders. Without competent leaders and administrators the implementation of research tasks becomes extremely difficult, or even impossible.

(6) To recognize that the university is the fundamental base of all training, and needs to be stimulated and supported.

(7) To recognize that society is investing in the researcher and that the researcher himself reaps some of the benefits from this investment; it is therefore proper that adequate academic performance be required of him in graduate and other courses, as well as in the professional career which follows.

(8) To recognize that simultaneously with the acquisition of specialized knowledge, it is important to give the researcher a global vision of the Brazilian development model so that he will be able to choose his research projects within the context of this model.

Beyond this vision it is important to foster in the researcher a sense of the mission of research organization and the System, so that he will understand its intentions and objectives, its philosophy and manner of confronting problems and, in this way, feeling like an integral part, he will collaborate in an enthusiastic and decisive manner in the task shared by all.

(9) To recognize that long training periods provoke ruptures in relation to the work environment and that an effort should be made to reduce sacrifices involved in the adaptation process.

(10) To encourage creativity as a fundamental principle of training. To recognize that the researcher's most noble and most difficult task is to formulate relevant problems and that training emphasizing methodology and theory is of value in this respect to the degree to which it is heterodox and challenging, and is injurious when it is dogmatic, ritualistic, traditional, repetitive and based excessively on textbooks and formal classes.

(11) To recognize that graduate courses impose sacrifices on the researcher and his family who, therefore, require financial compensation of some kind.

(12) Given the high cost of graduate courses, EMBRAPA and the universities should strictly align themselves so that graduate programs and subjects of theses fit the interests of one institution as much as of the other; this joint effort will result in better trained researchers who are therefore more capable of solving agricultural problems.

(13) Given the complexity of the research task and the high cost of training, to establish a rigorous selection system which will facilitate the discovery of those with vocations and talents for research, while eliminating those not suited to this type of work.

The Results of Graduate Training Programs

Under normal conditions, graduate programs should follow a sequence that begins with the entry of the recent college graduate into EMBRAPA, work for a term of two or three years with the aim of demonstrating his potential, his capacity for adapting to the work, and his vocation for certain scientific areas. After this period, the technicians with potential are sent for a Master's course, being able, according to each case (in terms of institutional needs and the capability of the technician), continue directly for a doctorate or, instead, to return to work, acquire more experience, and be considered to enter a doctoral program later on.

Two factors interfered so that this sequence was not, in most cases, followed. In the first place, one could not count on having, on the Brazilian market, a sufficient number of technicians with graduate work to meet the needs of EMBRAPA and of other institutions of

Agricultural Research, such as state research corporations, universities, private businesses and research institutions linked to various ministries. In the second place, in its first two years of existence, EMBRAPA faced difficult problems related to the formulation of institutional models and the implementation of research, and, on the other hand, a series of actions of a normative and administrative character was elaborated and executed aiming to provide the young organization with the bulk of technical and financial resources, as well as capital, from the its predesessor DNPEA. While these efforts were underway, it was necessary to make an enormous effort to acquire resources with the aim of endowing EMBRAPA with sufficient resources to undertake its programs of agricultural research.

Therefore, a different strategy was selected which deviated from the norm in more established organizations. A fairly rigorous evaluation was made of the DNPEA technicians and those judged capable were designated for graduate programs in Brazil and abroad. An aggressive recruitment campaign was developed in the universities and the job market, aiming at attracting talented young people to EMBRAPA. The great majority of these was either sent directly into graduate programs or else underwent an "adaptation period" of one year in the Research Units and then entered graduate programs. The program that was implemented assured, for next three years, an average return of 250 technicians already at the master's level. The early program was weak at the doctoral level mainly because candidates were not available for a more advanced program. In the second phase of the graduate program, to be described below, the emphasis was put training at the doctoral level. The numbers in the Table 2 chart 2 below show how much has been accomplished up to the present.

Apart from the needs of state enterprises, it was estimated that in the period 1976-80 the staff of researchers should expand to 1600 technicians. This was achieved as indicated in the Table 2 & 3.

Doctoral Level Graduate Training

Education at the doctoral level is an expensive program that requires time: approximately 3-1/2 years beyond the master's program in good universities in Brazil and abroad. These technicians with an

TABLE 2

Evolution of Research Personnel em Terms of Post Graduate Training, 1976-82 Period

Year	1976		1977		1978		1979		1980		1981		1982 (1)	
Last Degree Held	nº	%	nº	%	nº	%	nº	%	nº	%	nº	%	nº	%
B.S.	823	62	811	61	548	41	548	37	509	33	439	28	234	15
M.S.	473	35	467	35	699	52	777	54	882	57	941	60	965	61
Ph.D.	52	3	53	4	89	7	123	9	162	10	196	12	379	24
TOTAL	1328		1311		1336		1448		1553		1576		1578	

Source: DRH - EMBRAPA

(1) Estimates

TABLE 3

Evolution of Number of Research Workers, Suport and Administrative Personnel, Brazilian Agricultural Research Corporation 1973-1982 Period

Year	Research Workers	Support Personnel	Administrative Personnel	Total
1973	12	07	47	66
1974	872	2.125	993	3.990
1975	1.037	2.356	1.416	4.809
1976	1.328	2.666	1.709	5.703
1977	1.311	2.678	1.696	5.685
1978	1.336	2.954	1.744	6.034
1979	1.448	3.191	1.935	6.574
1980	1.553	3.314	1.902	6.669
1981	1.576	3.340	1.948	6.864
1982	1.578	3.338	1.996	6.912

Source: DRH - EMBRAPA

advanced level of training have a fundamental role in the work of EMBRAPA. They are better qualified to grasp foreign technologies relevant to Brazilian problems and adapt them to local environment. They have at their disposal the best methodological tools--knowledge of experimental theories and techniques which gives them greater capacity for identifying problems and finding solutions. In the scientific exchange, wherein professional respect is the main component, it is they who are in a position to seek help where it can actually be found and, conversely, to offer help when necessary. The essence of scientific exchange is in the give and take. When one of these is absent, scientific exchange will not occur with the intensity desirable for Brazil. As a result of the knowledge they have, these technicians are bound to play an important role in the leadership, training and follow-up of the work of young researchers who constitute a large majority of EMBRAPA's scientific staff at the present time.

While the presence of highly trained researchers is essential to EMBRAPA, there were many difficulties in locating the human and financial resources needed to make this training possible.

The lowest ratio of Ph.D.'s to the total number of researchers forecast for 1983 is 1:4. This ratio implies that we need to have at least 380 Ph.D.'s actively engaged in research in 1983. This target was achieved by the end of 1982 as showen in table, 2 and Chart 2.

The selection of disciplines in which researchers on a doctoral level will be trained is of prime importance in terms of getting a broad outlook that is responsive to the principal interests of EMBRAPA. It is convenient to classify these into three groups:

Group 1: Ph.D.'s who will work only in the Central Office. Planning, business administration, mathematical programming, etc., are among the fields of specializations of this group.

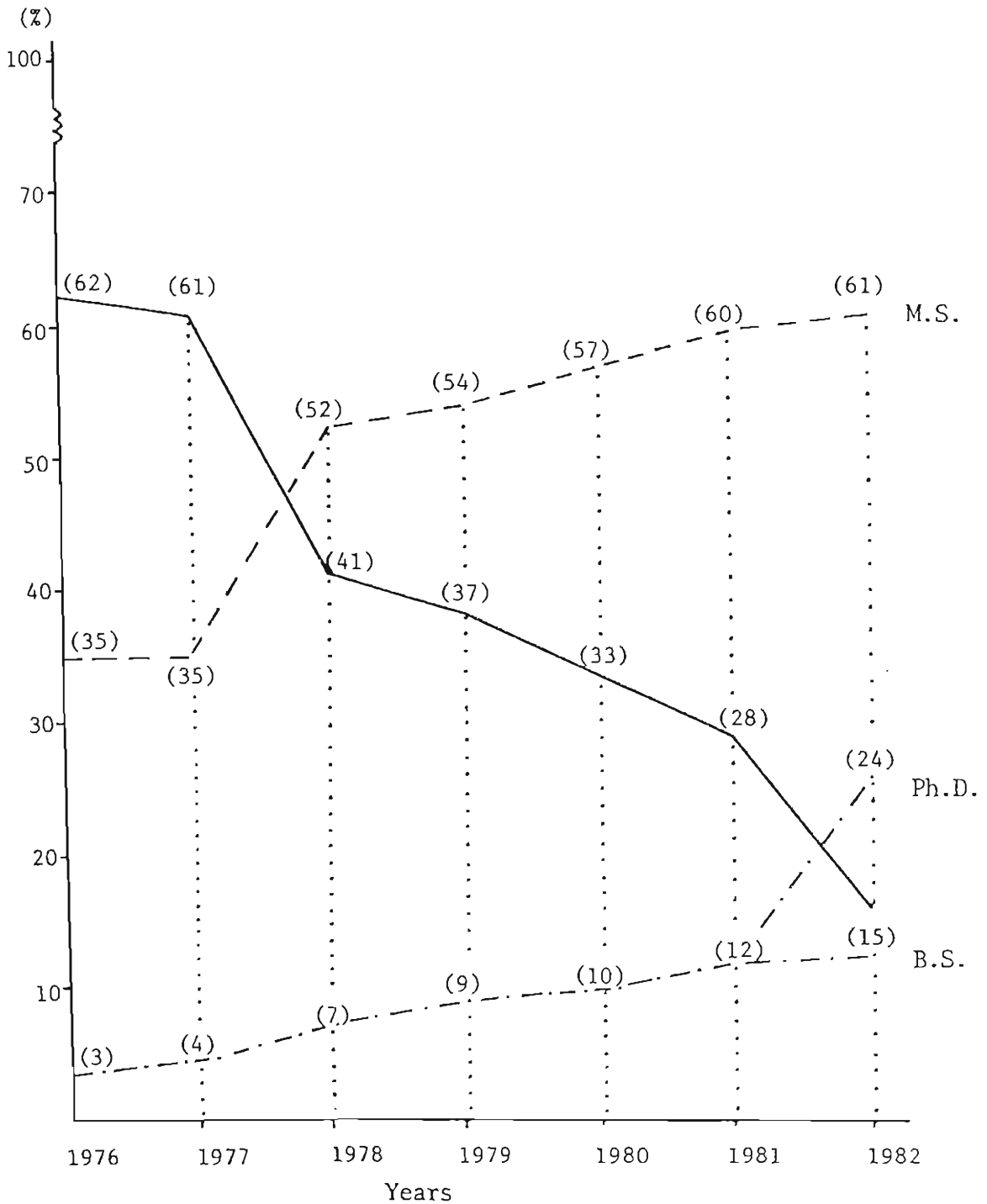
Group 2: Ph.D.'s who will work in the Central Office and in the National Centers. A huge range of specialized disciplines is included here, generally related to subjects that form various components of the agricultural sciences. Exemples of specialized training of this group are poltry diseases, genetic engineering, economic entimology etc.

Group 3: For Ph.D.'s who will be placed in the Central Office, National Centers, and other research units. These research workers will trained in a general approach to specialized field. In reality, the researcher in this category would be called "Production Researcher." Exemples of this group are: animal husbandary, poultry science, pasture improvement grain production etc.

Continuous Master Level Graduate Training

As far as he master's program is concerned, it may be considered as concluded. Nevertheless, it is necessary to continue with the program on a reduced scale in order to guarantee the replacements that normally occur through retirement, death, or departure from EMBRAPA. Maintaining 100 technicians studying on the master's level which corresponds to a departure rate of 50 per year, will fulfill EMBRAPA's needs, as this number guarantees a replacement rate on the order of 3.2%. which is satisfactory at this stage when the majority

Chart 2 - Percentage Distribution of Research Workers In Terms of Degree Heald



Potential Depreciation of Human Capital

Resources dedicated to Graduate training represent EMBRAPA's major investments in human capital. It must not be forgotten that human capital has potential depreciation the cost of which can be very high in an environment that does not stimulate the continuous search for knowledge, an environment which may affect health and create conflicts, thus producing internal divisions and alienating technicians from the principal objectives of the organization.

The Brazilian environment, moreover, has elements conducive to high rates of depreciation: the tendency to a leveling-off of salaries, the lack of competitiveness*, for there are few researchers with advanced training, bureaucratic shackles, the lack of competent assistants capable of turning out the work and, finally, the lack of tradition in the areas of research administration and leadership--these are some of the many factors that jeopardize the heavy investments EMBRAPA makes which are aimed at acquiring researchers with high productivity.

The effort to learn new things occurs as a result of the imbalance that the human being feels between what he knows and what he should know. Factors which make evident the perception of the imbalance and which, on the one hand, tend to keep the "state of imbalance" permanent, must be introduced into the EMBRAPA system as a means of motivating the researchers' desire to continually broaden their knowledge. The salary scale created, the graduate courses, the evaluation system based on the idea of recognizing merit and talent are measures which tend, to a certain extent, to perpetuate the "state of imbalance." The limited competitiveness which exists, principally among the more advanced level of researchers, the tendency to be intolerant with individuals who question procedures and technique the lack of graduate students who invariably stimulates the master in his constant search for knowledge, the difficulties of travelling in order to contract

* The lack of competitive spirit is in part due to the type of job market which employs technicians: in most cases, government agencies. The competition among these agencies is limited and as a result, the dynanism of the job market is reduced and one can therefore not count on this source of stimulus.

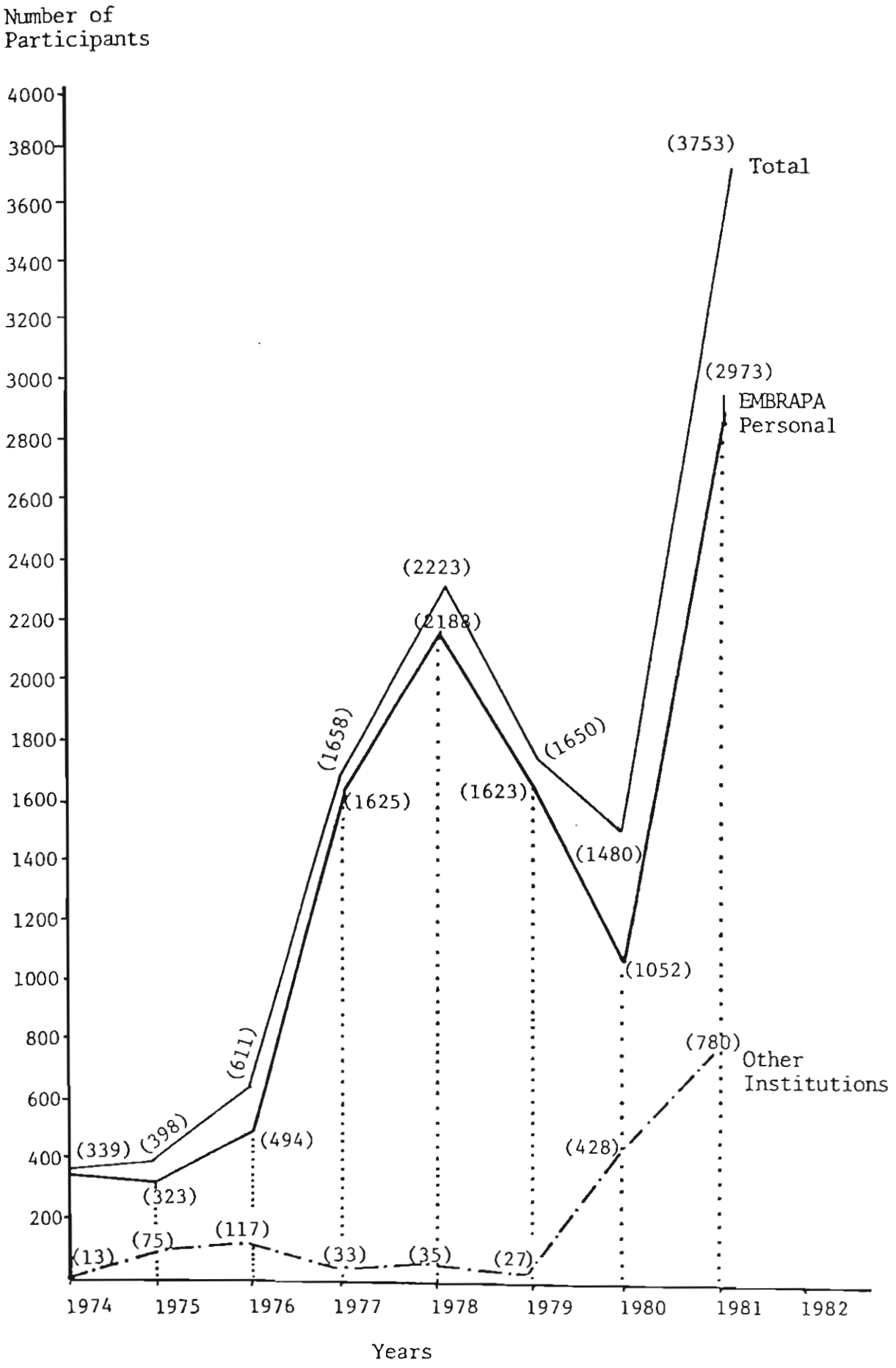
TABLE 4

PARTICIPANTS OF CONTINUOUS TRAINING: EMBRAPA AND ASSOCIATE INSTITUTION RESEARCH STAFF, 1974/1982

ORIGIN	LOCAL	1974	1975	1976	1977	1978	1979	1980	1981	1982	TOTAL
EMBRAPA	BRAZIL	321	238	421	1.550	2.085	1.472	967	2.748	1.160	10.000
	OVERSEAS	18	85	73	75	103	151	85	225	255	1.070
SUB-TOTAL		339	323	494	1.625	2.188	1.623	1.052	2.973	1.415	12.032
OTHER INSTITUTIONS	BRAZIL	13	69	111	33	34	2	402	709	482	1.855
	OVERSEAS	0	6	6	0	1	25	26	71	112	247
SUB-TOTAL		13	75	117	33	35	27	428	780	594	2.102
T O T A L		352	398	611	1.658	2.223	1.650	1.480	3.753	2.009	14.134

Source: DHR - EMBRAPA

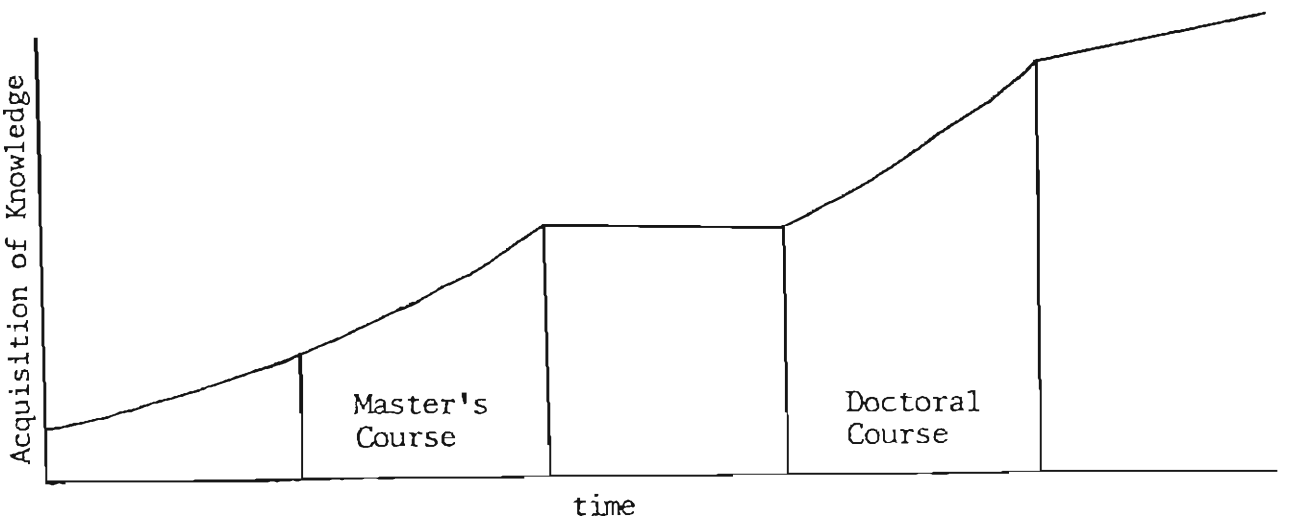
Chart 3 - Participants of Continuous Training Program 1974-1981 Period



researchers from other institutions and countries, and the absence of a better systematization of EMBRAPA's publications--all these are, on the other hand, factors which lead researchers to feel content with what they know, and thus have the effect of destroying the differential which must exist between what the researcher knows and what he ought to know.

It is necessary to point out that the depreciation of human capital has two dimensions: one absolute and the other relative. The absolute dimension relates to the loss of knowledge as a result of forgetting. The other dimension, without doubt the more important, is of a relative nature. It is the stagnation or slow progress made in relation to the scientific world which develops at an accentuated rate. Instead of the researcher curtailing the knowledge differential which exists between what he knows and the boundary of scientific knowledge, he allows this differential continually to increase.

Special care should be taken to avoid having the learning curve assume the shape depicted in the figure below. It shows that substantial knowledge is acquired only during the graduate school phase. Little is learned in the remainder of one's life, which means a relative depreciation of human capital to a high degree.



Among the measures that can be taken to stimulate high rates of learning outside of the graduate training, the following may be noted:

(1) Introducing the competitive spirit into EMBRAPA:

(a) Competition can occur between Research Centers, between the UEPAEs and UEPATs, between EMBRAPA Research Units and State Enterprises, the Universities and the private sector. This competition should be established on healthy terms and not as an unwholesome rivalry. Here the role of the administrator is fundamental, stimulating the interinstitutional environment when it is apathetic and lacking motivation, cooling things down when the temperature reaches dangerous levels which jeopardize interinstitutional relations.

(b) Competition among technicians. The system of evaluation, which restricts promotion to a small group of researchers only, will already fulfill this role. It is clear that there is a risk of discouraging those who are not promoted. It is therefore necessary to treat this matter carefully in order to avoid injustice and, on the other hand, to provide opoortunities for redress to those who think they have been unfairly treated. Self-evaluation needs to be encouraged. This technique has the advantage of focusing the technician's dissatisfaction on himself rather than on his fellow workers' revenues.

(2) Motivational Factors:

Spotlight the role that everyone plays in the building of a model institution which contributes significantly to the improvement of Brazilian agriculture. Demonstrate that higher authorities recognize the role scientists play in augmenting productivity. Seek the recognition of farmers and local breeders. Provide opportunity for contact, even among young technicians beginning their careers, with political leaders, governors, ministers, renowned scientists and, when possible, with the President of the Republic. Create a favorable image in the press and the media, including even seeking to promote technicians who are at the forefront of the action, citing their names and the work they are doing.

(3) Maintaining a salary scale that rewards work and talent:

Not permit a leveling-off of salaries. Recognize that technicians who question scientific norms and procedures may be very creative and their existence in EMBRAPA should, therefore, be guaranteed

and protected. Foster research projects which, judging by prevalent criteria, are not of obvious importance. It is clear that these projects should not surpass, as per EMBRAPA's conditions, approximately 10% of the estimated annual budget.

(4) Maintaining a dynamic evaluation system with all technicians participating not only in its development but also in its implementation:

Avoid patronage practices. Be rigorous with administrators who do not encourage creativity and who seek to maintain control, thereby discouraging talented technicians who threaten their position.

(5) Creating opportunities for researchers to publish their work in Brazilian and foreign scientific journals:

Encourage contacts with the Brazilian press. Encourage participation in congresses and contacts with renowned scientists. Organize meetings between researchers concerned with practical application and those dealing with standard and related areas. Meetings between plant breeders and geneticists, between social scientists and biologists; that is, maintain intensive interdisciplinary communication not only within Research Units but also among all units. These could be annual meetings, where scientists outside the EMBRAPA system should be invited to participate.

(6) Establishing a system of periodic evaluation of the work of the Research Units (not to be confused with evaluation of technicians):

Evaluation committees will be established which will necessarily include technicians from private enterprise, from universities, and from other countries.

(7) Promoting the training of executives in the field of research:

This training should be of a theoretical and practical nature. Permit an exchange of experience on a continuous basis between executives of the various Research Units and also among these executives and those of other institutions, public or private, within Brazil and abroad.

(8) Stimulating participation in technical assistance programs and frequent contact with farmers:

The greater the participation of farmers in our research institutions, the greater the likelihood that technicians will be

motivated to work and will not become alienated from the reality that they must transform.

(9) Creating a formal system of courses and seminars in the research units:

The objective is to simulate a microuniversity, thereby guaranteeing the students' attendance. Courses may be organized so as to prepare college-educated technicians for the master's, and master's level technicians for the doctorate. These may be conducted on Fridays. A credit system should be established.

(10) Equipping the libraries:

Facilitate bibliographic exchange. Create a physical environment with work rooms of an adequate size. Reduce bureaucracy to a minimum.

(11) Promoting training of auxiliary workers:

Greater productivity in this area means greater productivity on the part of technicians. Nonetheless, assure that scientists participate in field work, for contact between them and experimental materials, machines and equipment is important. If this were not done, an "office aristocracy" would be created who feel ashamed to carry out field work, deeming this incompatible with their doctoral title. Nothing more harmful than this can take place as this inhibits the development of the capacity for observation, a fundamental component of all research work.

(12) Stimulating familiarity with a more comprehensive view of reality:

That of the serious problems of Brazilian agriculture and the economy. This familiarity plays an important part in the development of the scientist and stimulates him to work on relevant problems.

(13) Special courses: Training periods in organizations such as international centers, universities and private businesses.

Investment in Human Resources

During 1974-1982 period EMBRAPA's payroll included 10.859 man years of Research personnel out of this total an equivalent of 3.842 or 35,4% years were spend on full-time and continuous part-time training.

TABLE 5

COST PER RESEARCH WORKERS OF EMBRAPA

1974 - 1982 PERIOD

Year	Number of Research Workers	Total Salaries Fringe Benefits and Other Expenses $US	Cost per Research Workers* $US
1974	872	6,782.860	7,778.51
1975	1.037	12,028.990	11,599.80
1976	1.328	23,561.650	17,742.21
1977	1.311	26,351.050	20,099.96
1978	1.336	33,243.530	24,882.88
1979	1.448	34,016.270	23,491.90
1980	1.573	45,043.210	28,653.23
1981	1.576	48,313.580	30,655.82
1982	1.578	58,344.000	36,973.38

* Salary amount to about 55% of the cost.

Source: DRH - EMBRAPA

TABLE 6

TOTAL BUDGET AND INVESTMENT IN HUMAN RESOURCES OF EMBRAPA

Year	Total Budget $US 000'	Investment in Human Resources*	
		Value $US 000'	% of Total Budget
1974	26,333	7,132	27.08
1975	56,040	13,631	24.32
1976	80,829	24,467	30.27
1977	98,065	26,754	27.28
1978	125,612	24,674	19.64
1979	154,122	23,354	15.15
1980	157,455	25,826	16.41
1981	182,954	32,331	17.67
1982	220,000	36,381	16.54
T O T A L	1,101.410	214,550	19.77

* Includes Salary indirect cost, substitution at a cost equal to salary and indirect cost plus direct education expenses like scholarship, fees and transportation.

Source: DRH - EMBRAPA

During the whole study period the research personnel had full salary, fringe benefit and education allowance and other expenses that amounted to 214,5 million dollars or 19,77% of Total EMBRAPA's budget of 1.1 billion dollars for the whole period (Table 6). This is estimate was calculated considering the theoretical cost of substitution of each research worker by another of similar level. In other words direct and indirect cost of research worker in training was multiplied by two. This assumption could be questioned, still one has to consider the opportunity cost of having a research worker with M.S. and some years of experience for four to five year outside research institution without directly contributing to research. One can argue that if thesis is related to on going research at the research institution of origin, this could contribute as much as his work at the research center. Table 5 shows the number and growing average cost of per research workers of EMBRAPA. Eventhough salary for the same scale of classification did not increase during the period in real terms, the increase of average indicates the sihift to higher scales based on graduate education and merit of individual research workers. Table 7 shows how average annual cost of graduate training has increased as a result of shifting from M.S. to Ph.D. level training and increasing educational level of research staff. These numbers give some idea of the cost or investment in human resources involved in a program of an institution such as EMBRAPA that decides to change its research staff from more than 90% B.S. level researchers to 61% M.S. and 24% B.S. level technicians in a relatively short period of time. One should mention that EMBRAPA in addition to its own staff in both graduate and continuous training program also included 738 candidates from other research institution, in graduate training and 2.102 participants in continuous training at a total cost of $US 14.8 million included in total human resource development training cost estimate, (Table 6).

Future Plants

Investment in human resources is supposed to be a continuous program in EMBRAPA. Eventhough there is no long term human resource development plan, loans with International Organizations include a well defined staffing and training component.

For exemple a World Bank Loan: IBRD II to be used during 1983-88 period covering mainly research in the North and North-East part

TABLE 7

COST PER RESEARCH WORKERS IN FULL TIME GRADUATE TRAINING AND COST OF CONTINUOUS TRAINING GIVEN THE REST OF RESEARCH WORKERS IN CURRENT $US - 1974-82

Years	Graduate Training		Continuous Training	
	No	Cost/Person	No	Cost/Person
1974	381	17,232	491	869
1975	474	26,562	563	1,109
1976	575	39,495	753	1,348
1977	457	49,407	854	3,657
1978	295	57,270	1,041	4,654
1979	324	55,494	1,124	3,166
1980	316	67,436	1,257	1,984
1981	320	70,065	1,256	5,854
1982	350	83,401	1,228	3,316

Source: DRH - EMBRAPA

of the country envisages an increase in professional staff by 122 senior scientists (Ph.D. & M.S.) and 102 junior scientists (B.S.). Administrative and research support staff would increased by 1,079 person.

The project includes a fellowship training program, totalling 205 fellowships for advance degree training, of which 87 would be for Ph.D. and 118 for M.Sc. training courses. An estimated total of 106 (52%) will attend Brazilian universities. These 205 fellowships would be filled by candidates mainly from within existing EMBRAPA staff, but previously selected staff and students at universities and from the private sector would not be excluded where candidates meet the specific requirements to fill specialized positions with EMBRAPA and agree to work for EMBRAPA upon completion of their training. During the selection process, special emphasis would be placed on obtaining agreement from such candidates to return from fellowship training and occupy long-term research positions at field experiment stations (not at EMBRAPA headquarters) within the national research system. Specific fellowship positions by disciplines would be identified annually and submitted for approval as part of the Annual Implemenation Plan. During the first year of the project, it is expected that some 46 candidates would commence post-graduate training (21 Ph.D. and 25 M.Sc.) in the fields of plant breeding, physiology, botany, crop protection, agricultural enginnering, economics, library science and documentation. To assist EMBRAPA in the management of the foreign fellowship program, EMBRAPA is expected to contact an agent or agencies, on terms and conditions satisfactory to the Bank, specialized in providing such placement and fellowship management services.

In addition, short-term fellowships varying in duration, nomally from one to three months, for non-degree study. Will financed these fellowships would be intended as a means of developing and improving human skills as well as introducing new technology and methodology into the EMBRAPA research system. It is expected that at least 340 candidates would benefit from this program. Since IBRD, as indicated, only covers North and North-East, an up coming Inter American Development Bank Loan is expected to cover the best of the country and more than double above given numbers.

Final Observations

Sagasti (1977) considers the countries with an endogenous scientific and technological resources as belonging to the developed world and those without endogenous capacity using exogenous scientific and technological resources as belonging developing world. In order to formulate a development strategy which will take the scientific and technological activities into consideration the development efforts should include indogenization of the scientific activities resulting in technological revolution in developing countries.

The development of North American agriculture during the last part of the nineteenth century and the beginning of this century can serve as a good example.

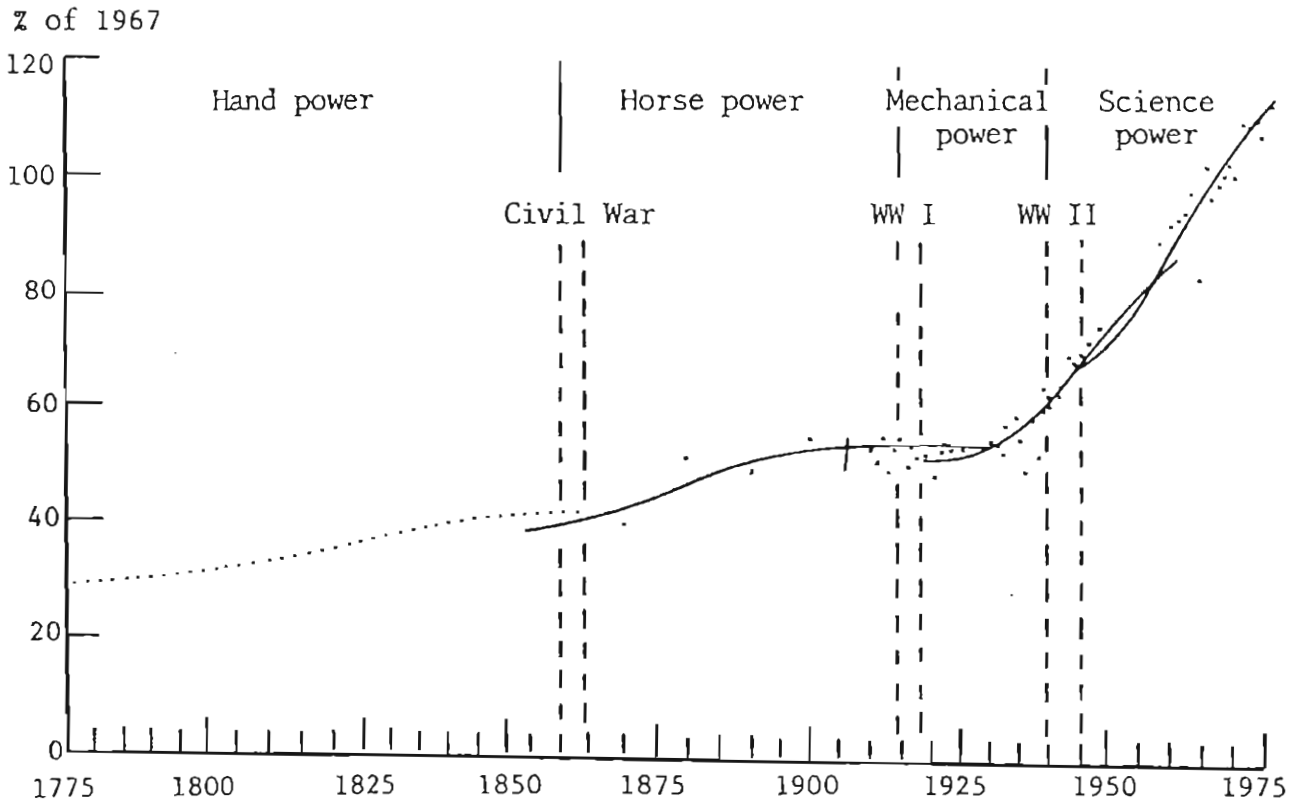
According to the USDA, Agricultural Economics Report No.435, historical changes in American agricultural productivity growth in the past 40 years can be attributed to "Science Power" (See Chart 4). In terms of Science Indicators of the National Science Foundation this power in 1977 was represented by 52.000 Ph.D. level research workers. Thus pure and applied science were the dominant productive forces in U.S. agriculture.

Science for our purpose could be considered as common good produced and available mainly in advanced societies, as a unique and universal body of knowledge of attitudes and methods for gaining knowledge.

Brazil sees the application of science and technology to agriculture as a major means of achieving economic and social progress. As a result, EMBRAPA's model is designed to change the focus of the relationship between advanced and developing countries from "technology transfer" to "science transfer". It is attempting, after appropriate selection and training of future scientists, to create challenging and rewarding career opportunities in agricultural and related research in Brazil. Only by retaining a large fraction of its best people can a developing country like Brazil build a stable and growing agricultural research system that will develop the appropriate technologies fundamental to the economic growth and stability of the agriculture sector.

Sometimes it is suggested that developing countries must concentrate on so called intermediate technologies leaving the fields of

Chart 4 - U.S. Agricultural Productivity Growth During the Past 200 Years



HISTORICAL CHANGES In American agricultural productivity (from USDA, Ag. Econ. Rpt. 435).

advanced science and technology to industrialized nations. Appropriate technologies do not have to be intermediate technologies as long as they are economically financially and ecologically adequate to serve the whole community.

This idea that developing nations must not have access to certain fields of knowledge in qualitative or quantitative terms is unacceptable. Since it results in perpetuating the actual international division of labour and resulting division of the world into reach-developed and poor-developing countries.

Ten year after EMBRAPA's foundation and reorganization of National Agricultural Research System in Brazil, agricultural science has become a powerful productive force in Brazilian society. Major research projects have been carried out and discoveries of world importance have been made over the past few years.

Still ten years for an institution of agricultural research is relatively short according to international standards to assess its whole economic impact. This means that investment costs made during this period also cover research units, program and projects which have not yet generated benefits. A study of rate of return on total investment and physical assets of EMBRAPA made in 1982 by da Cruz, Palma and Avila assumed that the annual net benefits estimated for the 1983/87 period would be maintened at the level of 33% of total potential benefits and at 50% for the 1988-92 period. This approach resulted in an internal rate of return equal to 42.8% for the whole period 1974/92. This rate is more than three times higher than the rate estimated by Langoni (1974) for various industries in Brazil.

At present agricultural science must work out strategy and tactics to provide new technologies for progress in agricultural production and for expansion of the entire agricultural-industrial complex.

As a result the scientists of the EMBRAPA Cooperative System are concentrating all their efforts toward successful solution of the problems confronting agricultural sector.

In 1962, the Brazilian Ministry of Agriculture was re-organized and rural universities became autonomous. As a result, agricultural education and research were no longer subordinate to a single administration. This situation still exists.

The tendency to dissociate the research from teaching and advisory services may have an indirect benefit of making the research program mission oriented and responsive to the needs of farmers and consumers rather than scientific interest of academic community.

Eventhough research could be made independent from universities the influence is through graduate work where a student is greatly influenced by the work and interest of his major professor. This prevails over his selection of a topic for thesis as well as his choice of a research project at the begining of his career with a research institution. Still, the academic community could be influenced to orient its interest and research work toward the solution of specific national problems as estabilished by official guidelines.

Just as during the initial period they will continue to count on a strong program of investment in human resources in the form of both graduate training and continuous training aimed at strengthening their research & problem solving abilities that constitute the major capability and asset of the institution. It will try to keep salary level competitive with other research organisms so as to avaid loosing its human resources to institutions outside agricultural research sistem or other countries.

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