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CONTENIDO

THE CONTRIBUTION OF AGRICULTURAL RESEARCH TO THE ACHIEVEMENT OF DEVELOPMENT GOALS

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THE CONTRIBUTIONS OF AGRICULTURAL RESEARCH TO THE ACHIEVEMENT OF DEVELOPMENT GOALS

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I would like to start my comments with a brief characterization of the develop - ment model used by the United States (U.S.). I want to do this because it focuses on a number of points I want to make later.

The U.S. has until recently presistently followed a cheap-food policy. But contrary to many developing countries, it has not done this by direct manipulation of product prices. Rather, it has increased food output by investing in agricultural research and development, and -- at least in the post-World War II period -- has seen to it by means of trade policy that a larger share of the increased output was channeled to U.S. consumers than would have been the case under equilibrium exchange rates. Had an equilibrium exchange rate and relatively free trade prevailed, a larger share of the in - creased output resulting from technical change would have gone to foreign consumers.

The contribution that this particular policy mix made to the development of the general economy can be seen by noting a much neglected technical point that has recently been called to our attention by Art Okun. The macroeconomics of food supplies are such that under certain circumstances their social value is far greater than their market price. More specifically, he argues that in the conditions prevailing in the U.S. economy in late 1974 the social value of an additional $5 bushel of wheat is $25. With a price elasticity of demand of .2, the additional bushel would lower the food bill by $20. This reduction in the food bill would be available to purchase goods

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from the nonfarm sector, and with resources now unemployed, the presumption is that it would result in an additional GNP of $20. Hence, the social value of the bushel of wheat is $5 plus $20 or $25.

The importance of the inelastic demand for food in the aggregate has long been recognized by agricultural economists. Its importance, however, has been in the context of the income problem which technical change creates if it should shift the supply curve to the right faster than the demand curve. The U.S. experience of the last two years has been just the opposite, of course. Diminishing supplies and higher food prices in the domestic economy have siphoned purchasing power away from the nonfarm sector. With price rigidity in the nonfarm sector the stress caused can be rather severe.

The conditions under which the multiplier effect of increased food supplies will be this large are rather specific. But the example does show the importance of increasing supply relative to demand, and of the increased purchasing power this creates from the decline in the price of food and the extent to which the purchasing power is released to the nonfarm sector.

The combination of policies followed by the U.S. was either unusually fortuitous or extremely wise. Technical change, a cheap source of growth, was used as the basis of increasing agricultural output, a product for which the price elasticity of demand was relatively small. Then, rather than to capitalize on the comparative advantage in trade which this technical progress would have supported, the comparative advantage was stifled by means of an over-valued exchange rate. This in turn channeled some portion of the increased output to the domestic market, which meant that the domestic demand curve became the relevant demand constraint. Hence, the increased output resulted in more than a proportionate reduction in the food bill, with the increase so released available for the purchase of products of an expanding nonfarm sector.

The declining terms of trade which the overvalued dollar caused resulted in a relative decline in agricultural product prices. This decline, plus the rapid rate of technical change in agriculture, released resources -- both capital and labor -- for the expansion of the nonfarm sector. Hence, the particular policy mix chosen provided for the release of resources for the nonfarm sector, provided the incentives for their transfer, and provided the income through the multiplier effect so that there was adequate demand for the products of the nonfarm sector. What better growth policy could one want?.

It is worth noting that many developing countries have followed similar policies, but with an important ingredient missing. They did not invest in agricultural research. Hence, they did not get the output effect which is so essential.

Moreover, it should also be noted that the complex of policies followed by the U.S. is a particularly effective way of subsidizing industrialization, even though development efforts are not directed specifically to the industrial sector. The combination of cheap food and the exodus of labor from the agricultural sector which the policy encourages permits nominal wages to remain low, but there is a rise in real terms as a result of the decline in price of the wage good, food. 1/

The example of the U.S. is interesting because it emphasizes a couple of important points. In the first place, it is about as strong a case for investing in agricultural research as one can imagine. Because of the importance of food as a wage good, the benefits of technical change are diffused widely through the economy. Impetus to industrialization is given both because resources are freed up to the nonfarm sector and because income becomes available to purchase the goods and services of the nonfarm sector.

1/ It is somewhat ironic that if the developing countries do in fact give more attention to their agricultural sectors as a result of the current food crisis, they may well stimulate more industrialization than they did with their policies of forced-draft industrialization.

In addition, it shows the complementarity of economic and technological policy. Investment in research provided the sources of income. But economic policy provided the incentives for a more rapid rate of technological change, and also saw to it that the benefits of this technical change were broadly diffused in the economy.

In the remainder of my comments I would like to do four things:

1. Stress the importance of dealing as explictly and as operationally as possible with goals. We have to ask and answer the question of "research for what?".
2. Discuss possible goals that might be considered.
3. Stress the role social scientists and particularly economists make in identifying these goals.
4. Discuss briefly the complementarity of economic policy and technological change.

These will not be discussed item by item, but rather will hopefully come through the mosaic of a broader discussion.

A quote will perhaps help set the stage:

> "...The demand for new knowledge is derived from the contribution it is expected to make to the achievement of individual and collective goals as to the solution of private and public problems." 2/

This statement is a useful starting point for the analysis designed to determine to what activities research resources should be allocated. In accepting it, new technology is treated as an input in the development process, and not as an end in itself. Moreover, technology is seen to have an instrumental role attaining a lager set of

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2/ Donald R. Kaldor, "Social Returns to Research and the Objective of Public Research", in Walter L. Fishel (ed.), Resource Allocation in Agricultural Research, op. cit., p. 64

goals and objectives, and not something whose main goal is to entertain the researcher.[3/]

Once the notion that knowledge has this instrumental role in goal attainment is recognized, the specification of these goals becomes important. In the case of agricultural research, this would require a specification of the goals that society or the government would have with respect to the agricultural sector.

A perusal of the literature suggests that to date there are two lines of thought on this matter. On the one hand there are those who argue that the goals or objectives must be taken from the body policy, either through a democratic process, of by means of authoritarian decree of those in power, if that be the case. Kaldor,[4/] for example, makes a strong plea in the case of the U.S. for legislative attention to the problem of formulating a rigorous and operationally useful social objective function.

At the other extreme is the tendency to appeal to broad social goals or objectives, expressed as values that are thought to be widely held by members of society. In Iowa State University's attempt to establish research priorities the three fundamental criteria are growth, equity and security. [5/] In reviewing each new project submission the proposal is evaluated in terms of its contribution to these three goals.

3/ In this respect, one of the significant insights from the recent Hayami-Ruttan book is the instrumental role given to research in the aggregate in breaking down barriers to output expansion that arise from inelastic factor supply curves. At a somewhat different level they stress the instrumental role played by individual "technologies" in facilitating the substitutions of one input for another - new plant varities as a means of facilitating the substitutions of fertilizers for land, and mechanization as a means of substituting land for labor. See Yujiro Hayami and Vernon W. Ruttan, Agricultural Development: An International Perspective (Baltimore and London; The Johns Hopkins Press, 1971).

4/ Donald R. Kaldor, op. cit.

5/ See John P. Mahlstede, "Long-Range Planning at the Iowa Agricultural and Home Economics Experimental Station", in Walter L. Fishel (ed.), Resource Allocation in Agricultural Research, op. cit.

Both of these alternative approaches would seem to have serious deficiencies. The first alternative would preclude the contributions of economists and other scientists in identifying and specifying the objectives from the viewpoint of their particular disciplinary expertise. The second expresses the goals in such broad social terms that they have very little practical or operational value.

In order to obtain any degree of precision in research priorities, it seems important that these broad social goals be translated into a more operational, objective set of goals in terms of which individual research projects can be evaluated. If this can be done, more focus will be provided for the research program, a more efficient research effort will result, and there will be a more objective means of evaluating the research in an <u>ex post</u> sense. The problem is to arrive at this more operational set of objectives.

One way to proceed is to take the three fundamental goals specified for the Iowa State program and see what can be made of them. Most observers would agree that these are three widely held values or goals of society, and therefore constitute a solid basis for organizing an analysis. Perhaps the only restriction necessary for present purposes is to interpret security in an economic sense as the reduction of risks and uncertainty, and not in a political or freedom-from-aggression sense. In addition, I would like to add a fourth goal -- nutrition. So we have as possible goals: (1) Growth or development, (2) Equity, (3) Security, and (4) Nutrition.

The bulk of my comments will be focused on growth, since that was my assignment. However, some comments will be made on the others, since they are in a sense part of the larger development problem.6/

6/ For a more detailed discussion of growth and the other three goals, see G. Edward Schuh, "Some Economic Considerations for Establishing Priorities in Agricultural Research," presented at the Ford Foundation OLAC Seminar of Program Advisors in Agriculture, Mexico City, Nov. 6-10, 1972. The present paper is based in part on that earlier paper.

Growth

The concern with our ecological state of affairs aside, growth is still a widely held goal, even in advanced areas such as the U.S. and Western Europe. What does it mean in terms of establishing priorities for an agricultural research program? And can it be translated into a more meaningful set of operational goals?

In the first place growth usually refers to an increase in output, although many would want to define it as an increase in per capita incomes or in human well-being. In terms of the agricultural sector, then, the concern would be either with attaining an increase in agricultural output in the aggregate, or in attaining an increase in the per capita income of rural people. In a narrow sense the analysis could take these as the ultimate goals and proceed from there.

But that is an overly narrow view, and I believe that few would accept it as a satisfactory basis for deriving more operational goals. Rather, development is usually concerned with the development of the total economy, and an interest in agriculture arises for the most part in terms of its contribution to this larger goal. Development agencies such as the foundations, United States Agency for International Development, and the World Bank, which have specialized programs in agriculture, direct resources to this sector largely on this basis.[7/]

Given that this instrumental role for agriculture is accepted, there is a readily-available body of theory which can serve as a basis for arriving at a more operational specification of goals for the agricultural research program. This theory says that agriculture contributes (or can contribute) to the growth of the general economy in five ways.[8/]

7/ This point should not be over-done, however. People in the agricultural sector are an "end" of the development process just as are the people in the rest of the economy. And many policies are directed to them as an "end" and not just as a means.

8/ The classic articles on this point are Bruce F. Johnston and John W. Mellor, "The Role of Agriculture in Economic Development", American Economic Review 51 (September 1961): 566-93, and William H. Nicholls, "The Role of Agriculture in Economic Development", in Larry W. Witt and Carl Eicher (eds.), Agriculture and Economic Development.

1. By providing agricultural products to the non-farm sector at constant or declining real prices.
2. By supplying capital to the non-farm sector.
3. By supplying labor to the non-farm sector.
4. By providing a market for the products produced in the non-farm sector.
5. By earning exchange earnings necessary for the importation of goods and services needed for the development of the total economy.

A couple of comments on these contributions of the agricultural sector to the development of the total economy are in order. First, agriculture is viewed as making these contributions largely as a result of the natural transformation of an economy as it develops. The starting point of the development process is usually an economy that is primarily agricultural. The evolution towards development typically involves the transfer of more and more resources from the agricultural to the non-agricultural sector, so that the output of the non-farm sector can expand to produce the goods associated with a higher standard of living. Hence, somewhat paradoxically, development efforts directed to agriculture are usually designed to make it a smaller and smaller part of the economy in a relative sense.[9/]

Second, a summary way of describing these various contributions to the non-farm sector is in terms of an agricultural surplus -- which includes the extra product, the excess resources, the exchange earnings, etc.[10/] This has certain analytical advantages, but in a planning context it tends to be too aggregative.

9/ A point that is often overlooked is that the way to make agriculture a relatively smaller part of the economy is not to neglect it, but rather to make substantial investments in it.

10/ An excellent formal treatment is provided in William H. Nicholls, "An 'Agricultural Surplus' as a Factor in Economic Development", Journal of Political Economy 71 (February 1963): 1-29.

And third, an important means of generating this surplus is by raising aggregate resource productivity in the agricultural sector.

This framework provides a starting point for the establishment of priorities for the agricultural research program, and also provides a means of showing how economic analysis can make a contribution to establishing these priorities. The point is that in a given economy, and at a given point in time, the relative importance of these contributions will be defined by economic conditions. Or put differently, as a given economy evolves, the relative importance of these contributions will vary.

A couple of examples will illustrate the point. Consider an economy that is embarking on an import-substituting, industrialization drive. It has an export sector with considerable excess capacity and a monopoly position in the world market for use of its products which it exploits. Its agricultural sector is characterized by an abundant supply of labor and a large stock of land in ecological conditions about which very little is known. And there is sufficient slack in the agricultural sector that output can be expanded in the near future without an increase in the supply price of agricultural output.

Policy-makers want to make a great leap forward in their industrialization drive, and make the policy decision to import production technology for that sector from the advanced countries. This action will absorb very little labor. Moreover, they believe that one way to obtain this technology is to permit the inflow of foreign capital. This capital inflow, plus the economic rent which they realize on their monopoly position in the export market (and which is taxed away from that sector and diverted to industrialization purposes), is sufficient for their immediate industrialization needs. Hence, they turn to agriculture as a source of capital only in a marginal way.

The policy-makers are concerned about the employment problem, but decide to keep the labor in agriculture as long as possible as a low-cost means of providing employment. Hence, rather than to facilitate the transfer of labor from agriculture to the non-farm sector, they prefer to keep it there to the extent possible in order to minimize welfare costs.

The bulk of development resources are committed to industrialization, but a limited amount is provided for agriculture. On the assumption that these development resources for agriculture are dedicated to research, how could they best be used in attaining the overall development goals of the policy makers? It is very likely that they could best be used in an attempt to bring the additional land resources into the market economy. This addition of a stock of resources to the economy would in itself add to growth. At the same time it would create employment opportunities for the surplus and rapidly growing labor force. And under the right circumstances [11/] it would help supply agricultural products at a constant or declining price, and perhaps supply some additional capital.

Now, consider this same economy some ten years later. Import substitution possibilities have been exhausted, and an industrial sector is in place that is not realizing either its internal or external economies of size. The limited urban market is reasonably well-saturated with goods from this sector. The export sector is in trouble since its attempt to exploit its monopoly position has stimulated the production of that product in numerous other countries, with the result that its own share of the market is constantly declining. The research program was reasonably successful and large additional stocks of land have been incorporated into the economy, while at the same time major flows of labor have been siphoned from traditional agricultural areas and diverted to the new land. As a result labor is becoming increasingly scarce in the old areas. The supply price of agricultural products is rising because the source of supply has become further removed from the consumption centers, and there has been little technical improvement in traditional areas.

11/ An adequate transportation and communication infrastructure would be important, but investments in these would be consistent with the political goal of integrating the large land masses into the national economy.

As a result of this multiple set of events the economy enters a period of stagnation. A brake has been applied to the economy by a combination of circumstances. First, the import-substituting industrialization has caused the economy to turn inward, yet import-substituting possibilities have been exhausted, or else can be furthered only at a high resource cost. The lack of domestic market causes a demand recession in the industrial sector. Income has been siphoned from agriculture by means of an implicit tax that resulted from the chronic over-valuation of the exchange rate designed to facilitate the import of goods for the industrial sector. Hence, this large sector offers little or no market for goods from the industrial sector, even though agricultural output has about kept up with the increasing demand from the non-farm sector. Moreover, the failure to generate new production technology in the traditional sector means that there are no new income sources from that sector. And finally, matters are further complicated by an import constraint imposed by the erosion of the market for the primary export product.

In order to reactiviate growth the government changes completely its development strategy. It suddenly realizes that further expansion of the industrial sector will come about only if it exploits its internal market. This means the development of agriculture as a source of consumer demand, so it reallocates a major share of its development resources to that sector. At the same time it realizes that it has to shift from import substitution to export promotion, and belatedly realizes that the agricultural sector has considerable export potential, particularly if the exhange rate is brought into equilibrium, and the sector is made more competitive by means of an improvement in the level of technology.

One of its first policy decisions is to dismantle the price and trade policies that have discriminated heavily against the agricultural sector in the past. The result of these policy changes is a rather rapid and sizeable transfer of income back to the farm sector. If the product mix of the industrial sector has not been too

badly distorted this income transfer will provide a demand stimulus to the industrial sector and re-activiate industrial production. The adjustment of the exchange rate towards equilibrium makes some of the industrial products competitive in the world markets, thereby providing a further stimulus to the demand for industrial products. And the freeing up of prices in the agricultural sector provides a stimulus to output in that sector, and an incentive to adopt whatever production technology is available. Further stimulus to the agricultural sector is provided by expanding exports which result from the devaluation. This provides additional income both for the purchase of goods from the non-farm sector, and for modernization. 12/

In this changed situation a substantially larger amount of development resources is available for agriculture. The question now is, "How should that part that is ear-marked for research be allocated?". A first approximation would be that an important part should be allocated to improving the competitive position of products which have export potential, since export promotion is now the basis of development policy. Second, with improved price relatives and the desire to generate income in the agricultural sector, new technology in the form of improved varieties offer a great deal of potential. And finally, as the economy expands on a broad base it is likely that labor will become scarce and its price begin to rise, especially since agricultural output is being supplied from a much larger land base. In summary, a broad-based research program should be developed, concentrating first on the export products, expanding to products for the domestic market, and then attempting to economize on a scarce resource.

An initial reaction to these two cases might be that the first set of policies was a mistake and should never have been pursued in the first place. That could be so, but it would still be beside the point in terms of establishing research priorities. What is important is that by recognizing the contributions that agriculture can make to economic growth, and by identifying the policy model that the government is pursuing, it be-

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12/ It will be obvious to most observers of this Latin American scene that the country characterized is Brazil -- for most of the post-World War II period.

comes possible to specify objectives or goals for the research program that will help attain the larger development objetives.

In the first instance the policy-makers left little for agriculture to do, and as a result the small amount of research resources were perhaps best allocated to the longer-run objective of bringing additional resources into the economy. In the second situation a great deal was expected of agriculture, and in a sense it became the engine of development. Under these circumstances a broad-based research program should evolve, although with some priority to sequencing, and very likely a bias towards applied research in order to have a short-term pay-off and capitalize on the improved price relatives.

The skeptic will probably respond to this analysis by saying that research efforts cannot be turned off and on in this manner, and that in the first situation the researchers would have been better advised to generate the new production technology that would be adopted later. By pursuing that policy a stock of knowledge would be on hand for rapid diffusion when economic circumstances turned favorable.

There is some validity to this argument. The limited evidence we have on time lags suggests that it takes 5 or 6 years for a research program to produce a substantial output.[13/] But that still doesn't mean that resources should have been committed to the program all during the first stage. In most cases such policy mixes are pursued for periods of up to 10 to 15 years. It <u>would</u> be nice to be able to foresee the turning point and mount the necessary research program before it arrives. That is not likely to happen, however, and even if it could be done, it is not likely that resources for an expanded research program would become available until a full-blown crisis had arisen.

More importantly, with the price relatives that usually result from this particular policy mix, it is not likely that much new production technology would be adopted. Agriculture would tend to remain extensive and exploitative, with little intensification.

13/ Robert E. Evenson, "Economic Aspects of the Organization of Agricultural Research", in Walter L. Fishel (ed.), Resource Allocation in Agricultural Research, op. cit.

Under these circumstances the researchers will become discredited if they persist in trying to produce something that is not "saleable," and what little budget was allocated to them may very likely be taken away.

On the other hand, if the research program is successful in producing a new production technology that facilitates the incorporation of the new land into the economy, the researchers will have "produced" in the eyes of the policy-maker, and as a consequence may have earned additional budget support. At the same time they will have contributed to development by helping to add an additional stock of resources to the economy in the form of new land and in the creation of employment opportunities for labor that might otherwise have been unemployed or under-employed.

Three propositions seem to follow from the above discussion. First, the nature of the objectives for the research program will be determined in part by the stage of development of the economy. Second, the objectives of the research program should be related to the particular development model the government is implementing, and the specific economic policies it uses to implement this model. For example, it does not make sense to develop new varieties that are more responsive to fertilizer if price policy is such that use of fertilizer will not be profitable in any case. And third, with adequate understanding of the development process and the set of policies being pursued by the government, the goals and objectives of the research program can be specified at a quite operational level.

Each of these three propositions provide an important analytical role for the economist in determining research priorities. His contribution is in part in the light of the general policy matrix. If this is done at an operational level, there should be an increase in the efficiency with which research resources are used, since they will be focused more directly on policy objectives. In addition a sounder basis will be laid for evaluating research program in an <u>ex post</u> context.

<u>Equity</u>

The equity issue is one that has long been neglected by both economists and production scientists. Economists have neglected it because of the difficulty in stating categorically whether one distribution of income is better than another. Production scientists have neglected it because of a failure to recognize that much of their production technology was not uniformly adopted by different sized farms, nor that the benefits of production technology could redound uniquely to one or another category of resource owners.

Four aspects of the equity or income distribution issue are important. The first is the distribution of the benefits of technical change between the producer and the consumer. The second is the functional distribution of the benefits among the various resource-owners, given that some fraction of the benefits do redound to the producer (i.e. whether landowners or laborers benefit). Third is the distribution of the benefits among the various size groups of farms. And the fourth is the impact of the regional distribution of income within the country.

Unfortunately, we know all too little about the distributional effects of new production technology. But let me make a few comments on these four aspects of the problem.

On the distribution of benefits between the consumer and producer, two sets of considerations are important: (1) the relative conditions of demand and supply, and (2) economic policy. If agricultural researchers want to benefit producers, the presumption is that they should concentrate on products that have a high elasticity of demand. Examples of these are export products. If they want to benefit consumers, they should concentrate on products that have a low price elasticity of demand. Typically,these will be food staples or necessities like rice, edible beans, wheat, etc.

On the role of the economic policy, conditions in the U.S. during much of the post-World War II period were such that most of the benefits of technical change would have gone to the agricultural sector. Economic policy intervened, however, and a fairly large fraction of the benefits went to the consumer, although I think if fair to say that most agricultural researchers thought they were helping the producer.

On the distribution of benefits between the landowner and the laborers, the presumption is that in most cases the landowners will benefit and the laborers will have to pay the costs. This is not a straight-forward case, however, and much depends on the relative elasticity of the supply and demand for the factors, and the elasticity of substitution among the factors of production.

On the distribution of benefits among different size groups of farms, the issues have to do with the extent to which the new production technology is adapted to the resource endowments and other conditions of the various size groups, and the efficiency of the various economic institutions serving the different size groups. Many would argue that researchers themselves have tended to cater to the large producers. What is less often appreciated is that the failure of the small holders to adopt new production technology is often due as much to deficiencies in the factor markets serving these groups, especially the capital market.

On the regional implications, it should be noted that technical change in one region can impose enormous shocks on another region by virtue of the disadvantage given it. This problem is more serious as resources are more inmobile and as there are fewer production alternatives for the resources.

A final point about the equity or distribution of income issue is that it is very important in determining the allocation of public funds. The question of who receives the benefits is an important factor in determining whether support for the research will be forthcoming. In the case of Sao Paulo, for example, it appears that public support was provided for research on cotton and not on the food crops largely because the landowners controlled the political process. The conditions of demand and supply were such that they would benefit from the research on the export crop, cotton, while they would not have benefitted from investments in research on food crops.

Security

The third goal is security or risk. The main point that I would make here is that in my judgment we often take too narrow a view by assuring that farmers are only risk averters and want to minimize risk. It is a well-known fact that the same person often both purchases insurance and pays money to take a gamble, often at unfair odds. In the context of the small farmer in the Northeast of Brazil, the same man may plant his crops in consortium or association in order to minimize risks, while at the same time purchasing a ticket in the loteria esportiva.

Friedman and Savage have shown that there is nothing pathological about such behavior. The point is that the individual will pay to insure against certain kinds of losses, while at the same time paying for the chance to have rather large gains -- even if the odds are unfair. What this means in terms of a research program is that a farmer may opt for a variety that has a chance of giving a big pay-off, even though the variance associated with that payoff is quite large. We should not necessarily assume that they want only a minimum variance or a stable yield.

Nutrition

The fourth goal is nutrition. The point is that a country may decide that it wants to have a fully-nourished population as a policy goal. The agricultural research program can be related to this goal, with the emphasis, for example, being on increasing protein supplies, or on caloric intake, or on the quality of the protein.

Economists and other social scientists can make an important contribution in helping to focus the research effort on this goal. Per Andersen has done some very valuable work on this problem, and more recently James Ryan has proposed a very insightful price of the program of ICRISAT. By drawing together various studies on nutrition he is able to show that the nutrition problem in India is one of total caloric intake and not that of protein deficiency.

In addition recognizing that there is a trade-off between protein content of grains and yields, he is able to show that by concentrating on yield increase rather than protein content, it may well be possible to increase relatively more the total protein supply. This analysis raises some serious questions about the present emphasis of the research program of ICRISAT. I recommend Ryan's paper as an example of how some relatively simple economic analysis can help greatly to sharpen research priorities.

<u>Some Concluding Comments</u>

I would like to conclude by stressing three points. First, development needs are not the same for each country, or even for different regions within the same country. Moreover, these needs will generally change over time. It is for these reasons that the problem of analysis to determine what research priorities ought to be is almost neverending. For these reasons, it is difficult to generalize among countries. The analysis does have to be largely location-specific. Because of this there is an important need for strengthening national research priorities.

Second, research priorities need to be defined in terms of the particular development model that a country is using as a basis for policy and in terms of the particular measures used to implement it. To fail to do this is to run the risk of having economic policy negate the results of the research effort, and/or to forego a potential contribution that the research effort could have made.

And finally, goals may well be in conflict. For example, the attempt to attain a higher rate of growth in the aggregate may well aggravate the equity problem. Alternatively, a drive for export promotion may well reduce the amount of food available for the domestic economy and hence sacrifice a nutrition goal.

The controversy over the Green Revolution in India and Pakistan is instructive on a related issue. The conflict between the plant scientis and the social scientists came about in part because the two groups <u>weighted</u> the alternative goals rather differently. The plant scientists were growth minded and wanted to increase output. The social scientists, on the other hand, were much more sensitive to the equity problem,and were concerned that the new production technology might have deleterious equity consequences.

It is worth noting that had they worked more closely in the beginning to think about what the goals ought to have been. what weights to attach to them, and how the goals might have been attained, this counter-productive episode in our intellectual history might never have happened. Biological and social scientists <u>do</u> have a responsibility to attempt to understand each other, and to work towards the common goal of improving the well-being of that large fraction of the world's population that is disadvantaged.

STRENGTHENING NATIONAL AGRICULTURAL RESEARCH SYSTEMS

SOME CONCERNS OF THE INTERNATIONAL COMMUNITY

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The Rockefeller Foundation
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STRENGHTENING NATIONAL AGRICULTURAL RESEARCH SYSTEMS:

SOME CONCERNS OF THE INTERNATIONAL COMMUNITY

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The present requirements for increased food production are such that the agricultural research services of many of the developing nations must step up their performance. Fortunately there are a number of reasons to believe that these agencies can improve their effectiveness and do so rather rapidly. The environment for improvement is better than in the past. Some of their needs are more clearly evident than they have been previously, and steps can be identified whereby others may help them.

These statements outline the conclusions reached at the "Bellagio VI" conference. They were set forth briefly in the Notes prepared by the conference participants. I have been asked to elaborate these conclusions for you in terms of what they may mean to this workshop on methods used to allocate resources in applied agricultural research in Latin America.

I am not going to give a report on the conference, but rather I would like to examine the questions it raised from a general point of view, passing on to you thoughts on the current status of agricultural research in relation to world food problems. I would like also to reflect some of the attitudes about research expressed at the recent United Nations World Food Conference. (Special thanks are given to P. Oram, A.H. Moseman and S. Wortman for use of material they prepared for the World Food Conference and/or Bellagio VI.)

The Bellagio conferences are informal gatherings, and the Notes were the only report made by the group. However, it might be useful to review the series of Bellagio conferences for you, indicating how they have developed and what some of the outgrowths of the series have been.

The first Bellagio conference on international agricultural research took place in April, 1969 when The Rockefeller Foundation invited those officials who determine policies and programs of the major international, national, and private development agencies to a meeting at the Foundation's Bellagio Study and Conference Center in Italy. Participants were there on an informal basis to discuss and develop policy ideas. They were not there in an official capacity, but as individuals in positions of leadership, concerned about common world problems. They were to discuss needs, potentialities, and program priorities designed to sustain and extend the agricultural revolution which was seen to be taking place and which was strongly influenced by the new technology flowing from the International Rice Research Institute (IRRI) in the Philippines, and the International Maize and Wheat ImprovementeCenter (CIMMYT) in Mexico.

Bellagio I, as the first conference came to be called, focused promptly on the major importance of these new technologies in solving world food problems. The participants concluded that ways and means must be found to finance the existing centers and, after careful study, to establish and fund new ones. In spite of its emphasis on the international aspects of agricultural research, Bellagio I took distinct note of the need for strengthening regional centers and national agencies. In order to be of value, new technology must be adapted to local conditions and it must be put to use by farmers. Only the national agencies can adequately do this job.

This initial meeting was followed in 1970 by three successive meetings of either the top policy-making officials of the international agencies of their principal technical or agricultural officers. The techhical group made a more detailed assessment of research, training, and development opportunities. The upshot of these meetings, Bellagio II, III, and IV, was the formation of the Consultative Group on International Agricultural Research (CGIAR) and its Technical Advisory Committee. The meetings also provided some of the basic analyses that were necessary to plan and establish additional international centers. A unique international system of cooperation had been evolved.

Bellagio V, held in May, 1972, was primarily a critique of the system that had evolved so rapidly. Attention was given to the need to protect the unique character of the international centers, their flexibility, and their freedom from political constraints. Considerable discussion was devoted to the second-generation problems and to actions needed to modify and extend the new technology to small landholders and more disadvantaged groups. Linkages between the centers and national groups and gaps in the worldwide network were also subjects of concern.

Bellagio V recommended that a follow-up meeting be planned which would continue this dialogue. It was anticipated that linkages between agencies and gaps in the research effort would be the principal continuing concerns of the group.

In late 1973 when Bellagio VI was being programmed, a brief survey of the developing network showed that the Consultative Group system was becoming increasingly effective in dealing with research gaps and in marshalling support for agricultural research and development at the international level. The greatest need seemed to lie in the area of strengthening national agencies, and this was chosen as the focus of the conference.

Concern by the international community for the viability of the national research centers is, of course, not new. As a matter of fact, most, if not all, of the donor agencies responsible for the international centers were concerned with agricultural research in the national programs before the first of the centers was founded. Nor were the international centers ever viewed as substituted for national agencies. In fact, some of the earliest activities of IRRI were directed toward helping to strengthen national research agencies.

Bellagio VI brought together the principal agricultural officers of leading assistance agencies, supported by resource people from national agencies and from international and regional organizations. This conference provided a global look at agricultural research and development systems. Some details that were brought out seem distinctly more pertinent than others in the Latin American context - but the same would be true for any other region. But the common thread running through all the discussions was the need for vastly improved technologies, and these tend to be equally important for all regions. Three aspects of the current agricultural situation received particular attention: (a) world food supply; (b) interactions between international and national agricultural research organizations; and (c) the status of national agencies. I will not attempt to report on these discussions in any detail, but let me mention some of the points.

A. World Food Supply

The Conference viewed the world food situation as extremely critical and of concern to the entire international community; participants felt that for this very reason it is probable that major resources will be applied to meet the challenges.

The world is aware as never before of its precarious position with respect to the availability and costs of required food supplies. For the first time, the developed as well as the developing countries are feeling the pinch - of price if not of absolute availability.

Public or official perception regarding food needs has varied remarkably over the recent past and with it the willingness to support agricultural research. Even within the past decade opinion has fluctuated from concern over possible widespread famines to fear of surpluses and second-generation problems, and back to fear of famine. A brief review of the subject seems appropriate.

Serious concern about the capacity of the modern world to feed itself is of surprisingly recent origin. Thirty years would encompass most of the history of modern thought on this subject. A few specialists started to take note of the problem of chronic shortages in the middle 1940's, but even the problem was seen as limited in scope for the short run and of serious worldwide concern only on a time scale of many decades.

By the middle 1950's, recognition of world food needs was considerably more widespread. Rising incomes, as well as rising populations, made it obvious that the time scale to crisis was shorter than had been estimated. But a number of factors tended to blunt the sense of urgency which might otherwise have prevailed. On the one hand, significant actions were taken by individual governments of the less-developed countries. The most productive of these were in the area of developing unused land and water resources. India, for example, had an average annual growth in cereal grain production of about 6 per cent over the decade, largely due to the expansion of the area under cultivation.

While the developing countries were moving toward increasing their food production, the developed nations were finding that they could produce more food than had traditionally been presumed. An increasingly productive technology was evolving. Fertilizers became much cheaper than they had been, and higher-yielding varieties made it possible to achieve much better yields per acre than had previously been anticipated. The advanced nations had become largely self-sufficient in basic foodstuffs, and several significant commodities were chronically in surplus supply. This easing of the total world food situation made it relatively simple to cope with shortages in particular areas. Significant advances in output in some of the developing countries coupled with large surplus stocks, particularly in North America, conspired to obscure what was basically an increasingly unsatisfactory situation.

By the end of another decade, some of the underlying problems of world food production became more obvious. Improvements in output achieved through development of land and water resources had fallen behind increases in demand. Population had increased steadily, and yields per acre of most crops were essentially static. Two years of drought in the Asian sub-continent andthe mid-sixties were enough to tip the balance, causing prices to climb sharply and raising the spectre of widespread famine. Relief supplies of grain from the United States, plus emergency efforts to increase local production, were required to avert disaster.

The food crisis of the mid-sixties alerted the world, particularly the leaders of the affected nations to the need to give serious attention to food supplies. For the first time, agricultural questions were elevated to the first order of priority.

Top administrators were placed in charge of agricultural affairs, and widespread efforts were made by government planners to get production moving. Thanks to these efforts and to the emergence of the new high-yielding varieties of wheat and rice, some remarkable successes were achieved. Good weather prevailed at the same time, and grain shortages were rapidly alleviated.

The prompt turn-around in food supplies undoubtedly created some misconceptions in the thinking of national planners and of many international observers. Much attention was given to the dislocations caused by modest production surpluses in the developing countries. Grain prices fell back to more moderate levels, and iniquities in income distribution were aggravated in certain sectors. The so-called second-generation problems received more attention that did the question of sustaining the trends toward higher production. Given the predictable increases in demand caused by steadily rising populations, the future from the mid-sixties onwards could at best be expected to witness modest year-to-year surpluses, which would give way gradually to increasing labor shortfalls. Unless significant progress were made in reducing the world population growth rate, shortages of increasing severity would inevitably follow. This somber picture was evident to many in the mid-sixties, but the spirit of optimism resulting from the Green Revolution prevailed.

The next instance of world food shortage started in 1972 and the end is not in sight. This time, the developed as well as the developing countries are involved. Grain reserves are at an all-time low, even in the surplus-producing countries, and most of the available stocks are being absorbed by trading among the industrialized nations. Predictably, prices have soared.

Top attention has again focused on agriculture, and major efforts are being made to effect some more lasting solutions. For the first time, the general public is aware that food supplies are scarce and expensive on a global basis, and that the shortages are a major concern of all mankind.

The consensus at Bellagio VI was that the current food problem will cause new resources to be brought into use and that this time some more lasting gains can be expected in terms of continued support for the development and application of new technology. This time, unfortunately, some of the inputs which were formerly cheap and plentiful are now scarce and expensive. The turn-around will be slower, but it will in all probability be more soundly institutionalized.

Attitudes and reactions at the recent World Food Conference support the view that national leaders recognize increasingly that food production must receive top priority. In some countries it is taking precedence over all else. The attitude of a few short years ago that traditional agriculture would take care of itself and feed the nations is gone. Also it was obvious that the delegations recognized that only by increasing local production could the developing nations find a solution to their food needs. A world food security system could be envisioned as a means of handling deficits due to bad weather and other disasters, natural or otherwise. But the basic solution was seen to lie in improving agricultural production, even if it had to be done at the expense of plans for industrialization.

B. Interactions between International and National Research Organizations.

International cooperation in agriculture has reached a level that is spectacularly superior to anything attained in the past, in that a mechanism now exists for actual development of technology. Although several of the international agricultural research centers are very new, the network which they comprise represents one of the most comprehensive efforts ever undertaken to upgrade agricultural technology. In concept, it equals in scope and vigor anything undertaken in agricultural research in the past within the advanced nations. There has been nothing remotely comparable to it in the tropical environment. Further, a mechanism has evolved, although it has not yet been tested, to monitor programs and needs on a continuing basis and to make adjustments and additions where indicated.

While the international centers are a source of great satisfaction to their founders and sponsors and a basis of hope and reassurance for many others, several concerns have been expressed about them. These concerns are chiefly related to the interactions between the centers and the national agencies with which they work. They are put forth by individuals and agencies who are vitally interested in making the network as effective as possible. They are concerned with finding solutions.

There is some feeling that the resources of the centers are being spread too thin. They are being asked to take on too many responsibilities or projects where their particular organizational advantages do not come into play. Some of the outreach activities have become so broad in scope that they tend to resemble the bilateral assistance programs in which ad hoc teams of technicians have been employed to undertake development projects, some of which have, of course, been quite valuable. There is no reason to believe that the international centers could not be proficient in undertaking this kind of work, but there is serious concern that it would interfere with the achievement of the centers' basic job of developing technology for a particular commodity or set of commodities.

The sharp focus of a multidisplinary team on a clearly defined range of problems is recognized as one of the reasons for the centers' success. Institution-building projects, whether they are carried out as outreach or cooperative efforts, must be selected with care so that they will not lead the center away from this sharp focus.

With respect to the core program, similar expressions of concern have been registered about the "systems" projects which have been developed by several of the centers. It is feared that these undertakings may also become too general and hence dull the comparative advantage of the international centers. There is, in addition, a feeling that the very nature of this work and its close association with the farmer dictate that national programs be basically responsible for much of it. Systems projects should be reviewed regularly to assure that they contribute fully to the centers' main objectives.

Still another problem may be the overlapping of several centers' outreach programs. For example, some of the small technical groups in Southeast Asian countries have received enthusiastic overtures from international center representatives interested in deep-water rice, corn, cassava, potatoes, and vegetables. The proposals have been accepted with appreciation, but also with some perplexity. These small countries, often with complex agricultural patterns, are precisely the ones that must rely most heavily on the centers for much of their new technology. But they may need help in putting together a mix of technical assistance which meets their needs and is within the reach of their resources. Also, they may urgently need help with cotton or jute or some other crop that has no advocate from an international center.

What about the status of the international centers in the eyes of the developing countries themselves? The best answer I can give is one derived by inference at the World Food Conference. This conference attempted to articulate its views primarily through a set of resolutions which were drafted by the organizing Secretariat or submitted by national groups. Before being passed, each resolution was read and debated almost word-by-word by a group that included representatives from some 130 countries and from numerous international agencies. The resolution on research and training contained one very distinct proposal recommending in specific terms that increasing funds be made available to the CGIAR so that the international centers could amplify their work. More than 50 national delegations expressed their views on this resolution. Not one questioned that particular clause. You might also be interested to know that the opening speeches by Secretary-General Waldheim of the United Nations and by Secretary of State Kissinger of the United States both specifically urged strengthening the CGIAR system.

Let me emphasize that similar recommendations were made for support to national agencies. Recommending and implementing are two different matters, but there is nothing here that is beyond the capacity of the individual countries and international organizations to handle over time. It seems clear that the centers will be funded generously so long as they produce results. And the national research agencies are not merely going to be funded more adequately; they are going to be required by their countries to make unprecedented contributions in the years ahead.

C. Status of National Agricultural Research and Development Institutions.

Considerable progress has been made over the past three decades by some of the less-developed nations in improving their agricultural research and development capability. Success has been spotty, and critical shortages exist in various components of a complete program, but trained manpower, funding, administrative capability, and organizational arrangements have all improved, particularly over the past 15 or 20 years. Prospects for the future are good, provided there is a sustained effort and upgrading of the whole activity in terms of national priorities.

The status of programs in individual countries is as varied as the countries themselves. It is not possible to generalize as to needs except in the broadest terms.

Trained scientific manpower still is short in most countries. Even those which have unemployed scientists are not overstaffed so much as they are underfinanced. However, the shortage of staff to man line research positions is less acute than it was even a decade ago. In most research areas, key posts can be filled by nationals of the country concerned. Some research fields have been neglected (plant physiology is an example) and outsiders are needed for research posts while local staff is being trained. Some countries have failed to keep salaries and working conditions in agriculture competitive, and in these, manpower shortages tend to become chronic in spite of active training programs. Also - and this is important for the near and medium term - none of the developing countries can be said to have a program of sufficient size to do the job ahead. As the organizations expand, the shallowness of the manpower supply becomes evident. Brazil, for example, is presently directly employing agricultural scientists from the world market. As they expand their agricultural technology sector, training of their own personnel is falling behind needs, even though that, too, is being strongly accelerated.

Crop and animal production specialists who can do the integrated type of research needed to get production up are in short supply in essentially all the developing countries. This is a type of training that most graduate programs do not emphasize and that many organizational charts fail even to identify. Help in this kind of activity, both to do specific jobs and to train local staff to do them, is widely needed.

Intermediate and top-level management personnel to analyze problems and to plan and implement programs are badly needed in all developing countries. This type of expertise is necessary to assist in the analysis of problems at the national level for agriculture as a whole and for specific sectors. It is also needed at the farm level and for specific research, teaching, and extension programs.

Funding of national programs is obviously well below the optimum, so far below that attempting to estimate what the optimum might be is something of an academic exercise. The real question is not how much should be spent by the developing countries under optimal conditions, but rather what rate of increased expenditures can be efficiently utilized, given the manpower restrictions and other constraints of a particular situation. It might be observed, incidentally, that it is very difficult to obtain realistic figures on research expenditures in many developing countries. Funds are frequently appropriated under one heading but expended under another. Most official figures probably overestimate what is actually going into research.

In view of the current world food situation and the probability that stresses will exist in this area so long as populations continue to rise, it is highly appropriate that each country examine its agricultural research services and make the indicated adjustments. Parenthetically we might add that the surplus producers among the so-called developed nations are not immune from this need. They, too, may find that they should reorder some of their priorities and procedures in the light of the current world situation.

The developing country that wishes to upgrade its research system must be prepared at the top level to make a long-term, sustained commitment to the job. Government leaders must appreciate that it takes years to train men and decades to build institutions. Those in charge of research must, in turn, make a special effort to acquaint government leaders with the kinds of research and research-related activities and services most critical to national development. They must make known the types of organizations, manpower, and facilities necessary to achieve the desired results.

In making some of these determinations, national agencies may wish to call on assistance from outside their borders. Technical and financial assistance from multinational and bilateral sources should be utilized when required. Indications are that funds for such purposes will be increasingly available over the coming years. The World Food Conference was essentially unanimous in calling for a several-fold increase in expenditures for national research services over the next decade, much of it to be financed from outside resources.

Careful planning will be necessary to make effective use of current budgets and of new funds which probably will become available. Such planning might include the following steps, among others:

(a) A review of existing facilities and staff resources and an evaluation of their adequacy to meet national goals. Frequently, the reorientation and integration of resources which are presently fragmented will in effect give a near-term increase in capacity through greater efficiency. Rethinking the goals and priorities will be a natural part of this step.

(b) The planning of a national research system of manageable proportions, designed to serve the different farming regions of the country. Outside expertise, including experienced personnel from other developing countries, may be particularly helpful in this process.

(c) The development of a long-term schedule for facility and man-power development, with meaningful commitments of financial support. Training opportunities should not be left to chance and the possible availability of grant funds. Local and regional training centers should be used to the extent possible, and they should be strengthened along with the research services.

The Challenge

The job facing a national program of agricultural research is much larger and more complex than one facing an international agricultural research center. The centers gain a great deal of leverage by focusing on a few major crops, but the individual nations must consider the allocation of resources for every crop or commodity that the nation produces. This is not to say that everything must receive attention at once - quite the contrary. But priorities must be set and resources allocated accordingly.

The international centers can further delineate their areas of activity and deal largely with the biological components of agricultural systems. While the centers are increasingly aware of the need to broaden their scope in this regard, they also recognize that many socioeconomic aspects of agricultural development can be handled only by national agencies. The national agencies have no such freedom of choice. They must deal with the whole range of social, economic, and political problems facing agriculture in their particular situation. While the two kinds of research agencies may work together, the major burden falls on the national organization.

Food production and not research for its own sake must be seen as the aim of the national agricultural agencies of the developing countries. Frequently this is overlooked. Too often the researchers have tended to be out of touch with the farmer and even out of touch with researchers in related fields. The individual scientists and the research structure as a whole must see their responsibility as a broad one. They must accept their part in working toward the specific national goals of increased farm production and improved standards of living.

It is increasingly clear that the research structure must deal with more than the various disciplines and individual commodities. It must deal with integrated farming systems. The developing countries are faced not merely with achieving production in-

increases on a nationwide basis, but of achieving increased incomes for large numbers of small farmers. Further, these objectives must be achieved at price levels for agricultural products that are acceptable to urban consumers and that do not fluctuate excessively from year to year.

Considerable progress has been made in recent years in the establishment and implementation of national production efforts. It has been a slow and painful process. One of the first and hardest lessons to be learned was that a truly effective production system, suited to the location where it is to be used, must be available. Adequate adaptive research must be done before the program is introduced to farmers. Many of the national production drives and many of the foreign assistance efforts of the 1950's were doomed by the lack of an adequate technology.

Given an adequate technology, the job of instructing large numbers of small farmers in its use is a massive one, so much so that past tendency has been to focus production drives on larger farms and on more favored areas. While this may be the quickest way to achieve production goals per se, it is no longer an acceptable route, except possibly to meet critical short-term needs. Appropriate extension procedures to reach the small farmer are required. Some interesting innovations in this regard have been developed in the Puebla Project in Mexico, the "Masagana 99" program in the Philippines, and India's "minikit" program, which focuses applied research directly on the small farmer.

Farmers can't use the new technology without the necessary inputs and the necessary credit. Fertilizers, seeds, pesticides, and other vital inputs must be available when and where they are needed, and the farmer must have the means to buy them. He must also have reasonable market facilities and prices that offer a reasonable return on his investment in new technology. All of these things will require decisions and actions by a number of agencies both public and private. The research and development agencies of individual nations must see this area as one in which they have major responsibilities.

This is the challenge that faces national agricultural production agencies. At present there are distinct indications that increasing numbers of national leaders will be willing to take the steps necessary to form truly effective programs. They will, in fact, in many cases demand that their research units take up the challenge and provide the technology and know-how to do the job. The whole world hopes that this will be the case, for it is only by this route that recurrent food crises can be alleviated. International and bilateral assistance agencies will be increasingly willing to participate in these activities. They, too, are more knowledgeable than they were a few years ago. I believe you will find them anxious to learn from your experiences and to try to adjust their policies to more nearly match your needs.

PROCESO DE LA TOMA DE DECISIONES PARA ASIGNACION DE RECURSOS DE INVESTIGACION EN UN INSTITUTO NACIONAL EL CASO DEL ICA EN COLOMBIA *

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* Trabajo presentado en el Seminario sobre "Métodos para asignar recursos en la Investigación Agrícola Aplicada en América Latina". CIAT, Cali, Colombia
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C O N T E N I D O

1. ANTECEDENTES 1/

Si bien la experimentación agrícola es casi tan antigua como las formas más primitivas de agricultura, los primeros ensayos sistemáticos de aplicación del conocimiento científico al mejoramiento de la agricultura, fueron realizados a mediados del siglo XVIII. Tul, en 1731, realizó experimentos en Europa sobre siembras en hileras y labranza del suelo e inventó una sembradora mecánica. Hoy día, la mayor parte de los países, en todos los continentes, disponen de recursos y sistemas de investigación agropecuaria que han brindado excelentes resultados en muchos campos.

En Colombia, la investigación agropecuaria se remonta a 1928, año en el cual el Gobierno Colombiano, con base en la Ley 41 de 1926 y la Resolución No. 29 del 16 de Mayo del Ministerio de Industrias, fundó una entidad encargada de fomentar el desarrollo de la agricultura colombiana; esta entidad creó en el Valle del Cauca, con un aporte inicial de 100.000 pesos, una granja modelo hoy llamada Estación Experimental de Palmira. Esta granja inició trabajos agronómicos el 23 de Diciembre del mismo año, en los cultivos de algodón, caña de azúcar, arroz, tabaco, plátano, yuca, maíz, fríjol, soya y nuevas especies de plantas forrajeras, algunas de ellas, para corte. Dichos trabajos estuvieron bajo el control departamental hasta el 1º de Julio de 1938, cuando la granja pasó a formar parte del Ministerio de Agricultura.

En el año 1943, se inició una profunda reorganización en la investigación agropecuaria, la cual culminó en 1950 con el establecimiento de la Oficina de Investigaciones Especiales (OIE), mediante un convenio de cooperación entre el Ministerio de Agricultura y la Fundación Rockefeller.

En 1955, por medio del Decreto 062 del mismo año, se creó la División de Investigaciones Agropecuarias (DIA), la cual estableció los programas nacionales de investigación. En 1959, se dió el primer paso importante en la divulgación de resultados de la

1/ Los conceptos que se incluyen en este documento no reflejan necesariamente el pensamiento de la entidad a la cual están vinculados los autores.

de la investigación, mediante un convenio entre el DIA y la Caja Agraria, para que el Departamento Agrícola de esta entidad se encargara de multiplicar y distribuír las semillas mejoradas que obtenía el DIA.

En 1962, por medio del Decreto 1562 de Junio 15 del mismo año, se creó el Instituto Colombiano Agropecuario, ICA, incorporando al DIA. La nueva institución se reestructuró en 1968, mediante el decreto 2420. Si bien antes de 1957 se realizaban trabajos agronómicos importantes (principalmente, colecciones de semillas y de plantas vivas), la investigación propiamente dicha comenzó en este año. En la actualidad, el ICA ha producido más de 300 materiales mejorados * y ha generado múltiples recomendaciones para el cultivo y manejo de especies, tanto vegetables como animales.

El ICA, si bien primordialmente se ha ocupado básicamente en funciones de investigación, también cumple actividades de diferente índole como son el desarrollo rural, la asistencia técnica, control de insumos y de calides y la educación agrícola superior. Para tener una mejor comprensión acerca de la asignación de recursos que percibe el Instituto, se ha hecho una clasificación de actividades la cual se presenta en el cuadro 1, en el cual el rubro de Investigación figura con labores experimentales en agronomía, ciencias animales, socioeconómía, ingeniería agrícola y actividades de apoyo, estas últimas agrupando la dirección de la institución, la administración de los centros y estaciones experimentales, así como una Oficina de Estadística y Sistemas.

Con respecto a la investigación en sí, es necesario definir su papel en los países en desarrollo. En términos generales, se puede decir que la actividad agrícola debe aportar al país divisas a través de la exportación, proveer mano de obra a la industria, suministrar materias primas a la industria, mejorar los niveles nutricionales y proveer los alimentos necesarios para una población que tiene, en los países en desarrollo, una tasa de crecimiento de alrededor del 3 por ciento. Sin embargo,

* En particular, en los cultivos de ajonjolí, alverja, arroz, avena, cacao, caña, cebada, fríjol, frutales, habichuela, hortalizas, maíz, papa, pastos, sorgo, soya, trigo y yuca.

Cuadro 1. Clasificación de actividades que lleva a cabo el ICA.

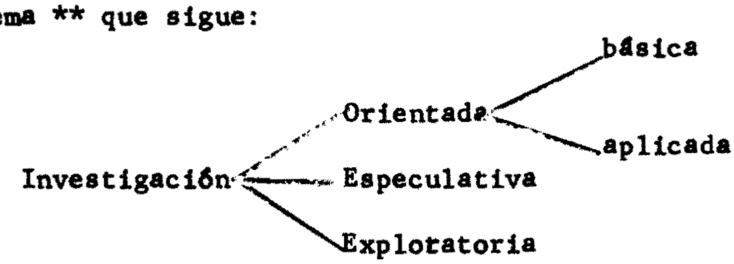
Actividades	Subactividades
1. Investigación	Agrícola, pecuaria, socioeconómica, ingeniería agrícola y labores de apoyo.**
2. Adopción de tecnología	Desarrollo Rural, Pruebas demostrativas, Divulgación, Producción y Certificación de Semillas, Sanidad vegetal y animal y Control y supervisión de insumos agropecuarios.*
3. Educación	
4. Convenios Internacionales	
5. Funcionamiento	Administración y Servicio de la Deuda.

* Incluye Asistencia Técnica

** Centros y Estaciones Experimentales, Dirección y Estadística.

la agricultura en estos países es, en su mayor parte, de tipo tradicional* por lo cual no puede, prácticamente, producir más en razón a que los factores de producción se usan tan eficientemente como es posible. Por lo anterior, el crecimiento económico no se puede lograr simplemente aumentando los factores de producción sino que es necesario mejorar la calidad de los alimentos y producir nuevos insumos como variedades mejoradas, fertilizantes, herbicidas y plaguicidas lo cual, obviamente, sólo se puede lograr mediante una <u>investigación organizada</u>, que responda a las verdaderas necesidades del país.

En realidad, en el ICA se have investigación dentro de las diferentes especialidades con que trabaja la institución y dentro de distintas categorías o tipos fundamentales de acuerdo con el esquema ** que sigue:



La investigación orientada tiene como meta contribuír a la solución de problemas prácticos y en términos generales, se lleva a cabo a través de investigación básica y aplicada.*** Realmente, esta investigación orientada constituye el mayor esfuerzo del ICA y está representada principalmente por los proyectos de mejoramiento genético y estudios de prácticas de cultivo y pruebas regionales, así como trabajos sobre nutrición y manejo de especies animales. La investigación especulativa, la cual se caracteriza porque, en la etapa de planeación, no es posible apreciar inferencias previsibles

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* Algunos trabajos indican que, en Colombia, algo más del 60 por ciento de los alimentos es producido en parcelas familiares y subfamiliares.

** Adaptado de: I. ARNON. Organización y administración de la investigación agrícola. 341 p.

*** La investigación básica generalmente se refiere al estudio de las leyes de la naturaleza con o sin aplicación práctica inmediate y es precedente a la investigación aplicada, la cual busca el descubrimiento de nuevos conocimientos científicos con objetivos específicos.

de uso práctico, representa el menor esfuerzo del Instituto, expresando principalmente en algunos trabajos especiales sobre Fisiología y Endocrinología. Finalmente, la investigación exploratoria, que se refiere a ideas o métodos que a priori pueden tener aplicación práctica pero que requiren un período exploratorio antes de afirmar si se tendrá éxito o nó, tiene sus ejemplos más ilustrativos en el estudio de hipótesis de trabajo sobre causas originarias de enfermedades limitantes, como son, entre otras, la muerte sorpresiva de la palma africana, la moniliasis del cacao ó el anaranjamiento del arroz, en los Llanos Orientales.

En Colombia, como en muchos otros países, se ha tratado de dar un mayor status a la investigación básica que a la aplicada; lo cierto es que cuando se trata de re - solver un problema específico, se soluciona casi siempre recurriendo a investigaciones tanto básicas (principios generales de aplicación universal) como aplicadas, estas últimas casi por lo general, con utlización regional. Lo cierto es que, aunque muchos principios básicos pueden ser importados con el consecuente ahorro de esfuerzos, existen casos en los cuales Colombia debe realizar la investigación básica por ser el problema a solucionar completamente nuevo y sin antecedentes aplicables de otros países, como lo son, entre otros, los estudios básicos de suelos, ecología de insectos nocivos, enfermedades limitantes y fisiología animal.

Otro aspecto importante para la investigación en Colombia es el hecho de que, en esta actividad, se presenta la ley de los rendimientos decrecientes. Siendo el vacío tecnológico relativamente grande, en muchos cultivos, los primeros esfuerzos tecnológicos generalmente tienen resultados espectaculares. Por tal razón los recursos asignados a investigación agropecuaria generalmente están produciendo resultados cuya utilidad marginal es muy superior a los resultados obtenidos en otras actividades.

A pesar de lo anterior, parece que el procedimiento en cuanto a asignación de recursos para investigación agropecuaria en Colombia no es muy satisfactorio. Si se toma como referencia los recursos que otros países asignan para investigación agropecuaria, generalmente, entre el 0,005 y el 0,015 por ciento del PIB*, se llega a la conclusión

* Aunque, en los países desarrollados, puede llegar hasta el 0,05 por ciento.

(Ver Cuadro 2) de que, en Colombia, los recursos asignados para investigación agropecuaria y adopción de tecnología son alrededor del 0,0025 por ciento, es decir, más o menos la mitad del límite inferior que otros países asignan. Si al ICA se le asignara el 0,005 por ciento del PIB, el presupuesto para 1972 hubiera sido de 925 millones en lugar de 474 millones.

A lo anterior se debe agregar el hecho de que, a pesar de que la participación del sector agropecuario en el PIB (Producto Interno Bruto) haya disminuído*, los recursos dedicados a investigación agropecuaria han aumentado en muchos países. Por ejemplo, Estados Unidos aumentó de 32,2 a 106,6 millones de dólares los recursos para investigación durante el período de 1937-1951**.

Es importante, además de lo anterior, ilustrar el lugar que la investigación colombiana ocupa en el Presupuesto Nacional. En el Cuadro 3 se pueden observar las cifras que, insistentemente, demuestran en primer lugar un descenso del sector agropecuario dentro de la participación en el presupuesto nacional, llegando a su cifra más baja en 1973 (19 por ciento). Igual cosa occure con el presupuesto del ICA, que ha llegado a la cifra más baja en 1973 en relación con el total del Presupuesto Nacional (1,17 por ciento)*** Lo anterior obviamente está demostrando que el sector agropecuario y por ende el ICA, han venido perdiendo importancia dentro del orden de prioridades asignado por el Gobierno a sus inversiones, al menos, en el período 1969-1973.

Aunque, en términos teóricos, los fondos para investigación se deberían asignar teniendo en cuenta unos rendimientos marginales (económicos) cuando menos iguales a los costos marginales esperados, lo cierto es que la mayor parte de las veces se hace en una forma subjectiva, simplemente usando criterios individuales o de grupos, derivados

* Para Colombia, el sector agropecuario contribuía al PIB con un 38 por ciento en 1950, disminuyendo a un 26.7 por ciento en 1972.

** SCHULTZ, T. 1965. La Organización Económica de la agricultura. 2a. edición. Fondo de Cultura Económica, México, D.F. p. 138

***La pérdida de participación del ICA en el Presupuesto Nacional ha sido dos veces más rápida que la del sector agropecuario, ya que en los 5 años ha perdido un 31,2 por ciento sobre el Presupuesto Nacional, contra un 15,5 por ciento del sector agropecuario.

Cuadro 2. COLOMBIA, PIB y Recursos Totales asignados para Investigación y Adopción Tecnológica en el período 1969 - 1972 (Cifras representan millones).

AÑOS	PIB*	ICA, Recursos Totales apropiados**	% Presupuesto ICA sobre PIB
1969	110.953	281	0,0025
1970	130.590	304	0,0023
1971	153.765	450	0,0029
1972	185.092	474	0,0025

* Cuentas Nacionales (PIB a precios corrientes de mercado)

** Fuente: Participación del ICA en el Desarrollo Agropecuario Colombiano,p.39

Cuadro 3. Ubicación de la Investigación en el presupuesto Nacional de Colombia, en el período 1969-1973 (cifras representan millones).

Años	Presupuesto Nacional*	Presupuesto del Sector Agropecuario.	% del Sector sobre el Presupuesto Nacional.	Presupuesto ICA**	% ICA sobre presupuesto Nacional
1969	17.109	3.855	22,5	281	1,6
1970	22.171	5.580	25,1	304	1,3
1971	26.170	5.449	20,8	450	1,7
1972	34.914	7.321	20,9	474	1,3
1973	43.903	8.344	19,0	491	1,1

* Fuente: Boletín de la Dirección General de Presupuesto No. 64, Diciembre 1973.

**Fuente: Participación del ICA en el Desarrollo Agropecuario Colombiano, p.39

de la experiencia y familiaridad con los problemas de investigación, más un elemento intuitivo; obviamente, el error en la asignación de recursos por este método subjetivo se minimiza si participan personas con diferentes antecedentes de caracter científico, económico y técnico.

Quién hace en Colombia la investigación agropecuaria y con cuáles fuentes se financia? En este país la investigación agropecuaria ha sido hecha tradicionalmente por el Estado, a través del ICA, y sus recursos corresponden en cerca del 90 por ciento al Presupuesto Nacional, incluyendo los recursos que el ICA recibe por concepto de la venta de subproductos de la investigación.

Como es sabido, esta investigación agropecuaria es hecha por el Estado, por varias razones; en primer lugar, algunos de los beneficios de la investigación no pueden ser apropiados privadamente, a no ser que estén cubiertos por el sistema legal de patentes; por ejemplo, la semilla de una variedad o una recomendación sobre prácticas de cultivo o manejo pueden ser usadas por cualquier persona, mientras que un híbrido o un pesticida ó herbicida podría ser controlado mediante patentes, en cuyo caso representa un interés para el sector privado, ya que puede usufructuar de sus beneficios. En igual forma, las inversiones hechas en investigación muchas veces sólo producen sus efectos a largo plazo lo cual implica un riesgo que generalmente el capital privado no asume. Finalmente, esta investigación requiere de grandes inversiones físicas en terrenos, laboratorio y equipo de campo, así como pago de personal altamente especializado, que el sector privado no está interesado en financiar. Por otro lado, la entidad que realiza la investigación no percibe directamente los beneficios pues la mayor parte de sus realizaciones se considera que es patrimonio nacional y como tal, son usadas ampliamente por los agricultores. Esta circunstancia incide en el hecho de que es generalmente el Gobierno el que lleva a cabo dicho tipo de actividades, sin excluír, en algunos casos, la cooperación con la empresa privada.

En investigación, el ICA realiza actividades en los siguientes campos:

a) Agronomía

Algodónero, arroz, cacao, caña (azúcar, panela), avena,cebada, trigo, hortalizas, frutales, leguminosas de grano comestible, oleaginosas anuales, maíz, sorgo, palma africana, cocotero, plátano y banano, papa, yuca, tabaco, entomología, fisiología vegetal, fitopatología y suelos.

b) Ciencias Animales

Ganado de carne y de leche, porcinos, ovinos, avicultura, fisiología animal, nutrición, pastos y forrajes, especies menores (conejo, cuy) epidemiología, microbiología, parasitología, patología y toxicología.

c) Ingeniería Agrícola

Desarrollo de recursos (agua y tierra) procesos agrícolas, maquinaria agrícola y fuerza motriz y estructuras rurales.

d) Economía Agrícola y Sociología Rural

Estudios económicos regionales y sectoriales y de apoyo a la investigación biofísica del ICA, estudios sobre medios de comunicación de masas, sociología rural y educación en desarrollo.

Para lo anterior, el ICA cuenta solamente, en investigación, con 517 profesionales de los cuales 40 tienen nivel de Ph.D. y 80 de M.S. Además, físicamente cuenta (Ver Cuadros 4 y 5) con 26 Centros y Estaciones Experimentales para llevar a cabo sus actividades.

Cuadro 4. Ubicación de los Centros y Estaciones Experimentales operadas por el ICA en Colombia.

No.	Nombre	Localización Municipio	Localización Departamento	Area (Hectáreas)
1	Tibaitatá	Mosquera	Cundinamarca	550
2	Surbatá	Duitama	Boyacá	69
3	San Jorge	Soacha	Cundinamarca	801
4	Turipaná	Cereté	Córdoba	1.472
5	Santa Lucía	Santa Lucía	Atlántico	25
6	El Carmen	El Carmen	Bolívar	72
7	Motilonia	Codazzi	Cesar	646
8	Caribia	Sevilla	Magdalena	444
9	Tulenapa	Chigorodó	Antioquia	306
10	El Nus	Maceo	Antioquia	1.800
11	La Selva	Rionegro	Antioquia	44
12	Tulio Ospina	Medellín	Antioquia	163
13	Palmira	Palmira	Valle	432
14	San Juan	Tumaco	Nariño	160
15	El Mira	Tumaco	Nariño	670
16	Obonuco	Pasto	Nariño	556
17	Balboa	Buga	Valle	102
18	Macagual	Florencia	Caquetá	364
19	Yamboró	Pitalito	Huila	525
20	Nataima	Espinal	Tolima	304
21	Tinagá	Cerrito	Santander	101
22	La Libertad	Villavicencio	Meta	1.350
23	Carimagua	Orocué	Meta	20.090
24	El Paraíso	Acacías	Meta	23
25	Iracá	San Martín	Meta	480

Cuadro 5. Area de influencia de los Centros y Estaciones Experimentales del ICA dentro del territorio Colombiano.

Formación Ecológica	No. de Centros y Estaciones	Area de influencia (ha)
Bosque muy húmedo tropical	3	8.243.055
Bosque húmedo tropical	3	31.057.870
Bosque seco tropical	9	20.057.870
Bosque húmedo subtropical	2	3.351.551
Bosque muy húmedo subtrópical	1	4.158.021
Bosque seco montano bajo	4	1.078.496
Bosque húmedo montano bajo	2	1.016.867
Transición y bosque muy húmedo y húmedo tropical	1	26.778.742
Subtotal influenciado		95.742.472
% del Total		84%
Area marginal a actividades agropecuarias		5.897.463
% del total		5%
Area total		113.834.000

2. PROCESO ACTUAL DE ASIGNACION DE RECURSOS PARA INVESTIGACION AGROPECUARIA EN COLOMBIA

2.1 El Sistema Nacional de Asignación de Recursos

El sistema a través del cual se asignan recursos para investigación agropecuaria en Colombia se ubica dentro de un proceso nacional de planeación, cuya línea de autoridad comprende el Consejo Nacional de Política Económica y Social, el Departamento Nacional de Planeación, la Oficina de Planeamiento del Sector Agropecuario y el ICA. La planeación en Colombia, si bien tuvo antecedentes que se remontan a los trabajos de la Misión Currie y del Padre Lebret, realmente, se institucionalizó en 1963 mediante los Decretos Leyes 3242 y 3243 del mismo año, que reorganizaron el Consejo Nacional de Planeación y el Departamento Nacional de Planeación (DNP). Los procesos y mecanismos de la Planeación sólo fueron implantados a partir de 1967.*

Este proceso de planeación implica realmente un sistema de asignación de recursos escasos, entre fines competitivos; se puede apreciar mejor en la Figura 1. Comienza con la obtención de resultados de la actividad socioeconómica. Obtenidos los resultados se hace un diagnóstico, del cual se deducen los criterios necesarios para el diseño de los planes. Después, hubo una etapa de coordinación y promoción la cual se refleja en el hecho de que los criterios básicos para la asignación de recursos sean mantenidos en las numerosas decisiones que se toman diariamente. Después, el Gobierno, a través de la planeación directa, cristaliza sus medidas a través de un sistema de planeación, de ejecución obligatoria, en las áreas en las cuales realiza el gasto (ICA en el caso de investigación agropecuaria). En el sector privado, la Planeación es de tipo indicativo, en cuyo caso los recursos pertenecen a la persona que ejecuta el gasto (la cual tiene la oportunidad de dar otros usos a tales recursos). El organismo ejecutor del gasto público no tiene más alternativa que usar los recursos en los fines ya decretados.

El mecanismo de planeación en el sector público utiliza como instrumento las fuentes de financiación del gasto público, el cual, mediante criterios que reflejan la

* La Planeación en Colombia. 1969. Documento DNP-331-5.6. 18 pp.

política del estado, se expresa en los planes de inversión que se ejecutan a través de los presupuestos anuales de las diferentes entidades. Después de las anteriores etapas, se vuelve de nuevo a la medición de resultados. En Colombia este proceso de planeación es un resumen de aproximaciones sucesivas hacia los objetivos básicos perseguidos.

2.2 La estructura actual de Asignación de Recursos

Como se mención en la sección 2.1, en Colombia la asignación de recursos para investigación ocurre dentro de un proceso de Planeación Nacional, el cual se expresa en los planes cuatrienales de Inversión Pública y anualmente, en los proyectos de Presupuesto. Para efectos del Plan de Inversiones, el Departamento Nacional de Planeación trabaja con 20 programas, a saber:

- Servicio de la Deuda
- Gastos de funcionamiento
- Administración superior
- Defensa y Seguridad
- Planeación e Información
- Educación y Cultura
- Salud
- Bienestar y Organización Social
- Vivienda
- Transporte
- Ingeniería Sanitaria
- Energía y Combustibles
- Comunicaciones
- Recursos hídricos
- Agricultura
- Ganadería
- Silvicultura, Caza y Pesca
- Minería y Extracción
- Industria
- Fomento comercial y Turismo

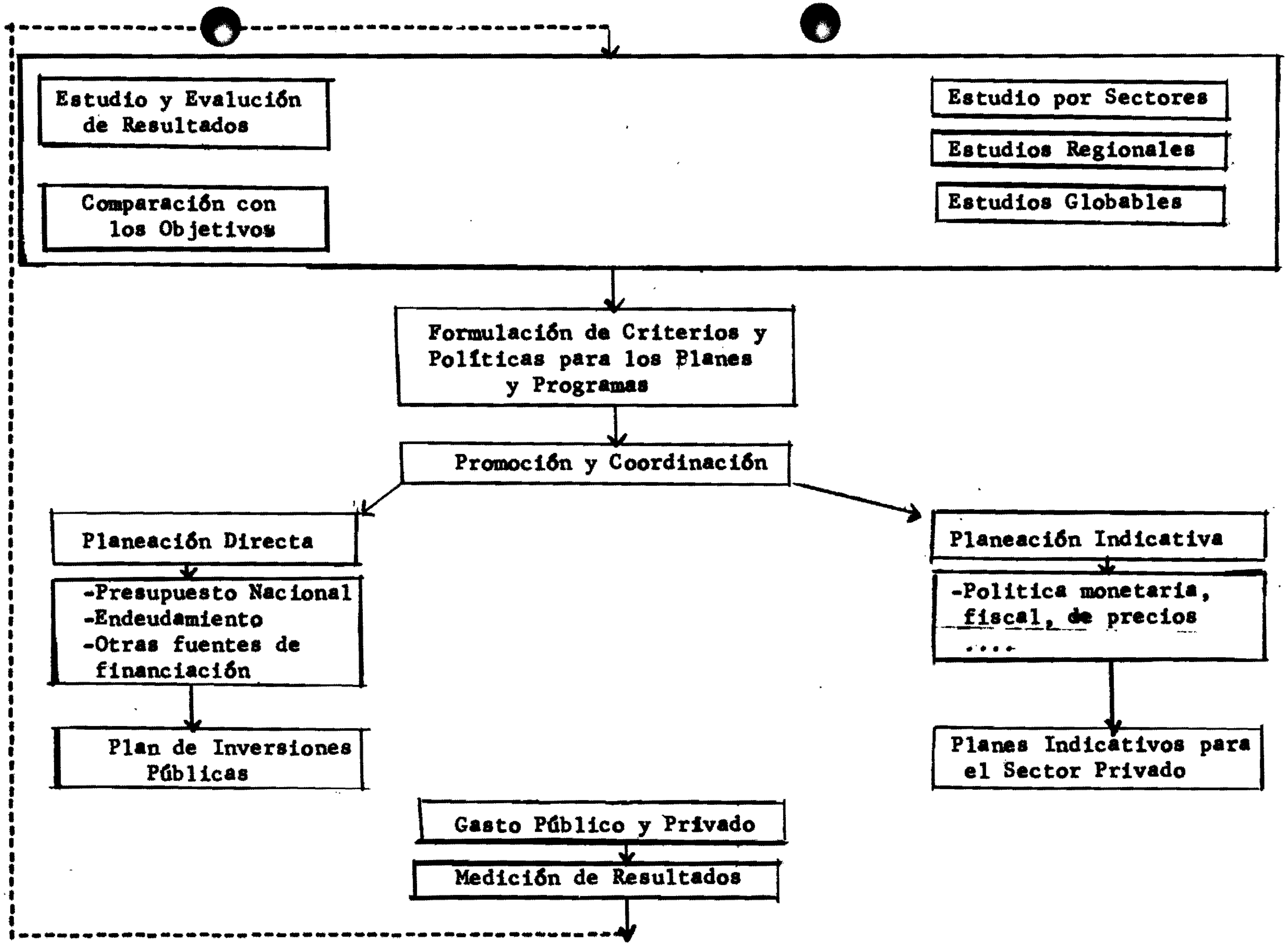

Figura 1. El Proceso Nacional de Planeación

A su vez, cada entidad ejecutora puede participar en varios de los anteriores programas según las funciones y actividades que realice. En el caso del ICA, la investigación está ubicada en los programas de agricultura y de ganadería; pero, como además el Instituto lleva a cabo actividades en Desarrollo Rural, participa en el Programa de Bienestar y Organización Social, aparte de los gastos administrativos que se ubican en el programa de Gastos de funcionamiento y el Servicio de la Deuda, correspondiente a un criterio externo para refuerzo de inversiones físicas, principalmente en maquinaria y laboratorios.

La anterior clasificación por programas se puede presentar, a su vez, por sectores, a fin de ubicar inversiones afines con la estructura administrativa que rige en Colombia. Con base en lo anterior, se enumera a continuación la lista de los sectores:

- Fomento Económico
- Fomento Agropecuario
- Transporte y Comunicaciones
- Salud y Previsión Social
- Educación y Cultura
- Bienestar Social
- Servicios Especializados
- Comercio Exterior
- Fondo Rotatorio
- Establecimientos Financieros

Las entidades ejecutoras, agrupadas en cada sector, están adscritas al Ministerio respectivo. Así, el ICA está adscrito al Ministerio de Agricultura, el cual agrupa al sector agropecuario; concretamente, bajo este sector, se encuentran los siguientes organismos:

- Instituto de Mercadeo Agropecuario, IDEMA
- Instituto Colombiano Agropecuario, ICA
- Instituto de Recursos Naturales, INDERENA
- Instituto Colombiano de Reforma Agraria, INCORA
- Servicio Colombiano de Meteorología e Hidrología, SCMH
- Corporaciones Regionales de Desarrollo Agropecuario
- Otras (VECOL é INAGRARIO)

La competencia por la asignación de los recursos económicos se manifiesta en un comienzo a nivel intersectorial y sectorial, según se ha expresado en los párrafos anteriores. Sin embargo, a nivel de entidad, como en el caso del ICA, los recursos para investigación compiten con recursos para los otros programas que ejecuta como son adopción de tecnología y educación, aparte de los gastos de funcionamiento.

Tan sólo Investigación,
Tomando sólo Investigación, los recursos compiten en los diferentes proyectos (arroz, ganado de carne, etc.) y dentro de éstos, en las diferentes actividades como mejoramiento genético, prácticas de cultivo, etc. Este proceso competitivo de los recursos para investigación se presenta en la Figura 2.

De lo anterior se puede inferir que los recursos para investigación deben pasar por todo un proceso que implica necesariamente varios niveles de asignación de recursos, así como varios niveles de decisión en dicha asignación. En el cuadro 6 se pueden apreciar estos aspectos. Cabe destacar que en los niveles de decisión existe un paso más, aparte del representado por los Directores Nacionales de Proyectos y consiste en las decisiones que éste debe tomar sobre asignación de recursos, por actividades, entre varias regiones.

Cuadro 6. Niveles de asignación de recursos y niveles de decisión en el Instituto Colombiano Agropecuario.

Niveles de asignación	Niveles de decisión
1. Intersectorial	1. Consejo Nacional de Política
2. Sectorial	2. DNP y Mihacienda
3. De programas a nivel entidad	3. Planeación, Ministerio de Agricultura, OPSA
4. De Proyectos	4. ICA. Planeación/Comité Gerencia
5. De actividades	5. Directores Nacionales de Proyectos.

Los niveles de decisión se refieren a las entidades, oficinas o personas que toman decisiones sobre asignación de recursos, a un solo nivel de asignación o a varios niveles. Por ejemplo, el DNP toma decisiones sobre asignación de recursos desde el nivel intersectorial hasta el nivel sectorial hasta el nivel de proyectos, mientras que los Directores Nacionales de Proyectos sólo toman decisiones a nivel de actividades. En el Cuadro 7 se puede apreciar el cruce actual entre niveles de asignación y de decisión.

Cuadro 7. Niveles de asignación y de decisión en la programación de recursos para Investigación, en el Instituto Colombiano Agropecuario.

Niveles de asignación / Niveles de decisión	Intersectorial	Sectorial	Programas	Proyectos	Actividades
CONPES	X	X	X		
DNP/Hacienda	X	X	X	X	
ICA/Planeación/Comité			X	X	
Directores de Proyectos					X

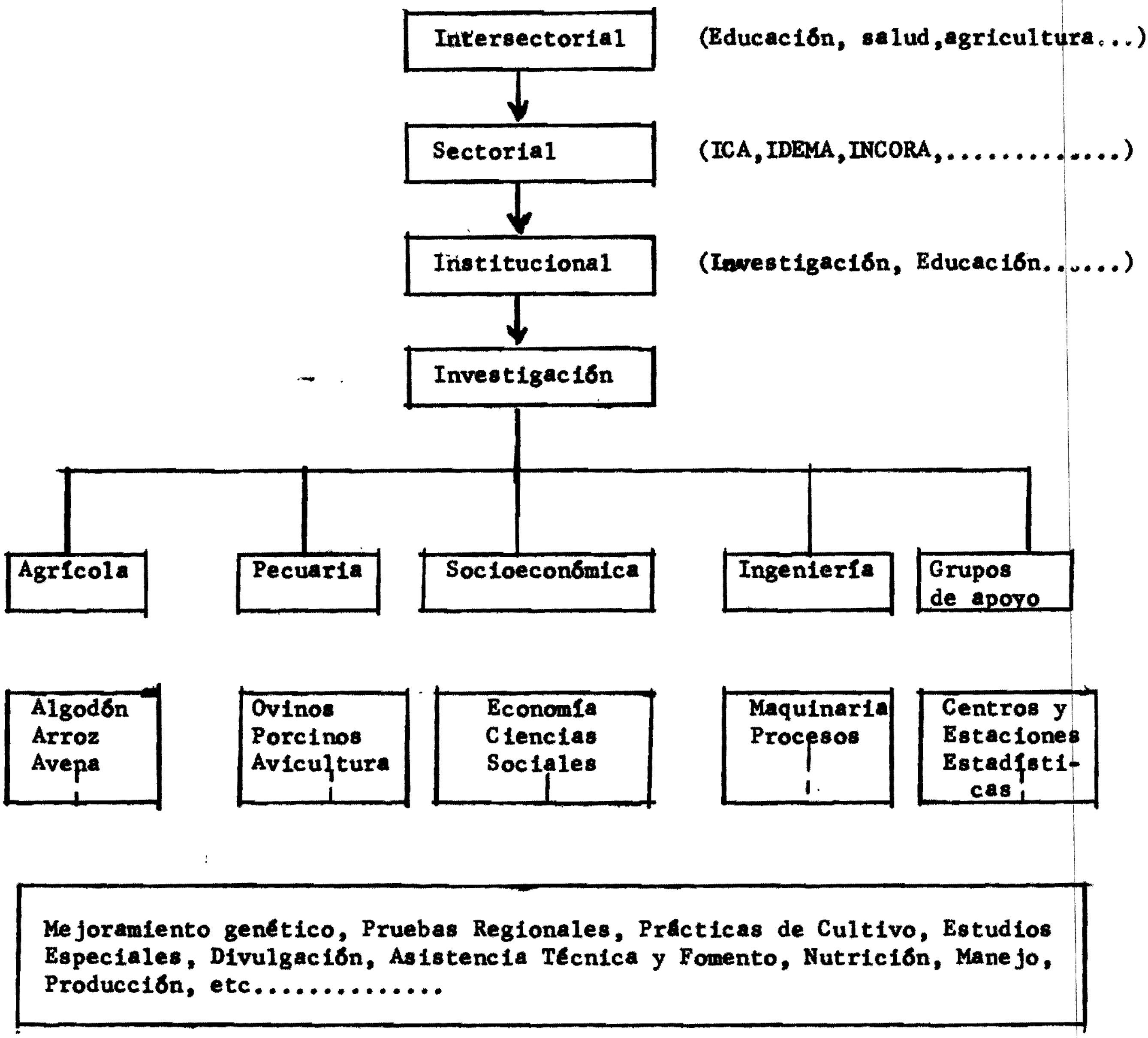

Figura 2. Competencia en la Asignación de Recursos para Investigación.

Por ahora, sólo se ha identificado a cuál nivel asignan los recursos y quién toma las decisiones sobre dicha asignación. A continuación, se describe en detalle el proceso actual de asignación de recursos, con el fin de aclarar un poco los pasos siguientes, como son las clases de decisiones y los criterios y prioridades para tomar esas decisiones.

2.3 Descripción del proceso actual de Asignación de Recursos

La asignación de recursos para investigación en el ICA tiene dos etapas bien definidas. En la primera, llamada programación global, se asignan recursos a nivel de programa (Investigación, Educación...) y a nivel de Proyecto (algodón, arroz,...) y en la segunda, llamada Programación Detallada, se asignan recursos a nivel de actividades (mejoramiento, multiplicación de semilla,...) y a nivel regional.

La etapa de programación global comprende la revisión anual del Plan Cuatrienal de Inversiones y la elaboración (paralela al Plan de Inversiones) de la solicitud presupuestal para el año inmediatamente posterior. Así, en 1974 se elabora el Plan para el período 1974-1977 y se solicita el presupuesto para 1975; el año siguiente se revisará el Plan para el período 1975-1978 y se solicitará el presupuesto para 1976 y así sucesivamente.

Todos los pasos que se siguen en esta etapa global se ilustran en la Figura 3. En primer lugar, DGP y UIP* hacen un cálculo inicial de los ingresos del Gobierno, con base en lo cual la UIP con los jefes de las otras unidades hace la distribución inicial de cuotas por sectores y prepara las instrucciones para elaborar el Plan de Inversiones y la solicitud anual de presupuesto. Hecho lo anterior, la Unidad Agropecuaria del Departamento Nacional de Planeación prepara las cuotas a nivel de entidades y programas del Sector Agropecuario; después de lo anterior, UIP prepara un informe al Consejo Nacional de Política Económica y Social (CONPES) sobre el proyecto de cuotas.

* Dirección General del Presupuesto del Ministerio de Hacienda y Unidad de Inversiones Públicas del Departamento Nacional de Planeación DNP, respectivamente.

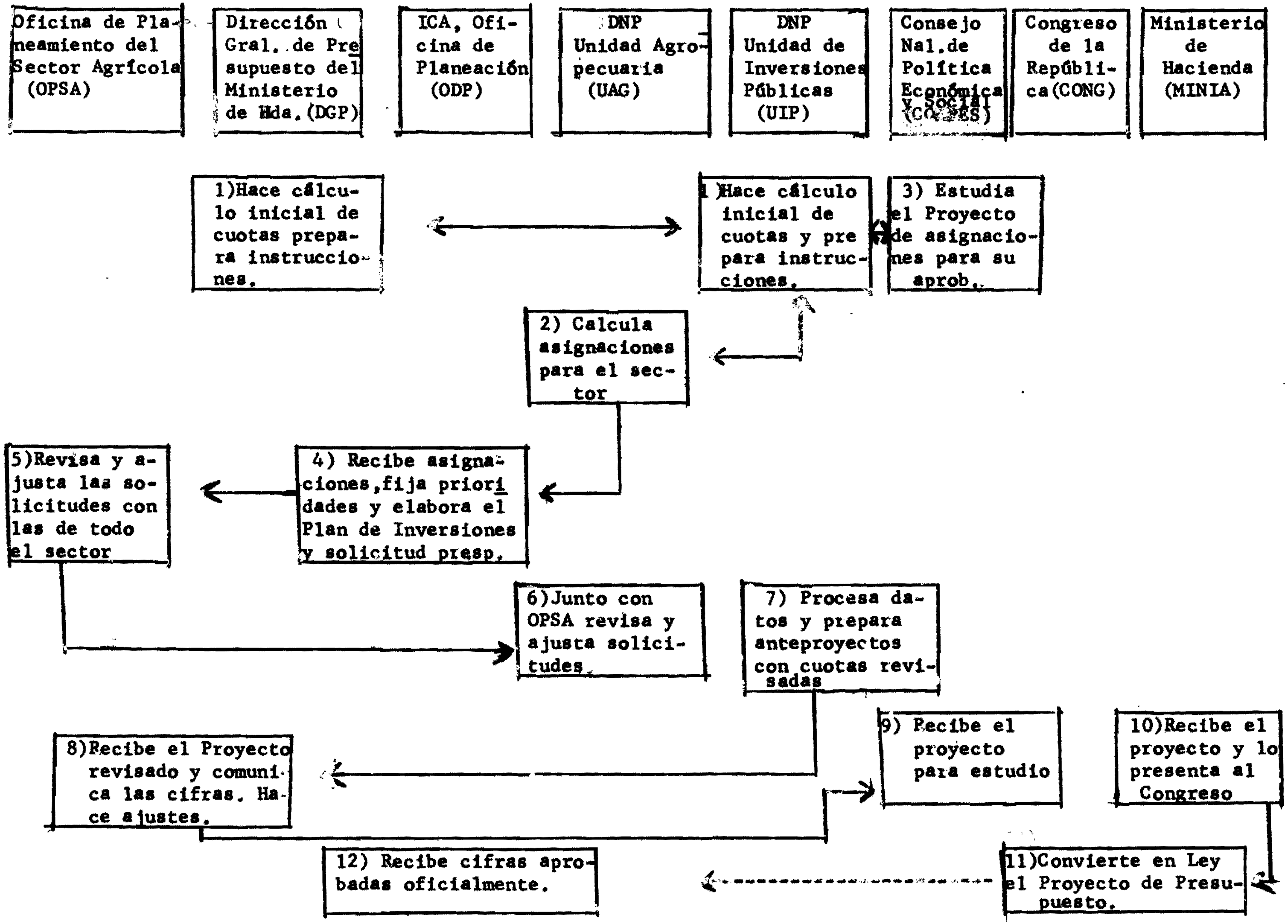

Figura 3. Etapa de Programación Global en la Asignación de Recursos

Aprobado el proyecto de cuotas por el CONPES, la UAG informa a la Oficina de Planeación del ICA las cuotas (generalmente globales), con base en lo cual y de acuerdo a cierto orden de prioridades, ésta elabora el Plan de Inversiones y la solicitud de presupuesto a fin de que sea estudiado por el Comité de Gerencia del Instituto.

Aprobado por el ICA el plan de Inversiones, OPSA y UAG revisan y ajustan las solicitudes (generalmente, con información adicional solicitada al ICA). Después de lo anterior, UIP procesa los datos y prepara un Anteproyecto de Ley con las cuotas ya revisadas; si han hecho adiciones en los ingresos por medidas posteriores, UIP realiza los ajustes del caso y envía el anteproyecto a DGP para revisión y ajuste. Finalmente, se envía el Proyecto al CONPES y al Ministerio de Hacienda, el cual lo presenta oficialmente al Congreso Nacional para su aprobación y promulgación por Ley de la República. Todo este proceso se lleva a cabo, generalmente, entre los meses de Mayo y Agosto.*

La etapa de programación que se ha descrito y que se ilustra en la Figura 4, llevada a cabo en los meses de Octubre a Diciembre, se inicia con el recibo de las cuotas definitivas aprobadas en el Proyecto de Ley, a nivel de Programa y de Proyecto. Una vez recibidas las cuotas correspondientes a los recursos del Presupuesto Nacional, Planeación del ICA redistribuye los otros recursos disponibles (ingresos por venta de subproductos de investigación, donaciones, etc...) de acuerdo a ciertas prioridades y con la colaboración de la División de Presupuesto y Finanzas, prepara un proyecto de asignación a nivel de Proyectos, para la consideración del Comité Asesor de Gerencia.

Aprobadas las cifras globales, se inicia el proceso de distribución de las partidas asignadas a cada Proyecto, a nivel de actividad y por regiones; al final del proceso, la Oficina de Planeación y la División de Presupuesto y Finanzas, consolidan todas las cifras, realizan los ajustes del caso y someten el presupuesto definitivo al Comité de Gerencia, para iniciar su vigencia en el mes de Enero del año próximo.

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* Esta descripción corresponde al sistema empleado durante los años 1969-1973.

Se debe anotar que en esta etapa los gastos para cada Proyecto se programan en tres niveles: por regiones, por objeto del gasto* y por actividades**. Cuando los técnicos de cada Proyecto conocen la cifra aprobada ya han elaborado (desde hace varios meses) una serie de proyectos de investigación con su respectiva justificación y con sus costos respectivos, además de prioridades asignadas. Estos proyectos (generados en las diferentes regiones de trabajo) ya han sido aprobados por el Director Nacional (del cultivo o especie animal en cuestión), por un Comité Especial de Revisión de Proyectos (interdisciplinario), además del Director de Investigación. Al conocer la cifra, se toman los proyectos prioritarios que tengan un costo igual al presupuesto lo cual, automáticamente, genera las actividades para el año siguiente y su costo correspondiente.***

Después de cumplida la etapa de programación viene la ejecución que implica, por un lado, una solicitud de fondos al Gobierno y por otro, una aprobación interna de gastos a los diferentes programas. Estos dos niveles de ejecución se pueden observar en las Figuras 5 y 6. Además, es importante anotar que la generación mensual de recursos generalmente no guarda mucha relación con la programación de gastos, en razón a que las fuentes de financiamiento tienen diversos períodos de gestación. Lo anterior, obviamente, introduce algunas modificaciones con respecto a la programación inicial.

* Por objeto del gasto se entiende: sueldos, prestaciones, materiales y suministros, etc.

** La programación por actividades indica cuánto se va a gastar en mejoramiento, prácticas de cultivo, etc... y es el único dato que no se lleva a nivel de ejecución, pues el ICA no posee sistemas de contabilidad de costos, aunque existe un proyecto a corto plazo para institucionalizar este sistema.

***Se debe anotar que, posiblemente para 1975, esta etapa de programación detallada cambie, en el sentido de asignar cuotas no a nivel de proyecto sino a nivel de programa regional, por ejemplo: Investigación en cada Regional por cifra, para después programar en cada Regional a nivel de Proyecto y actividades afines.

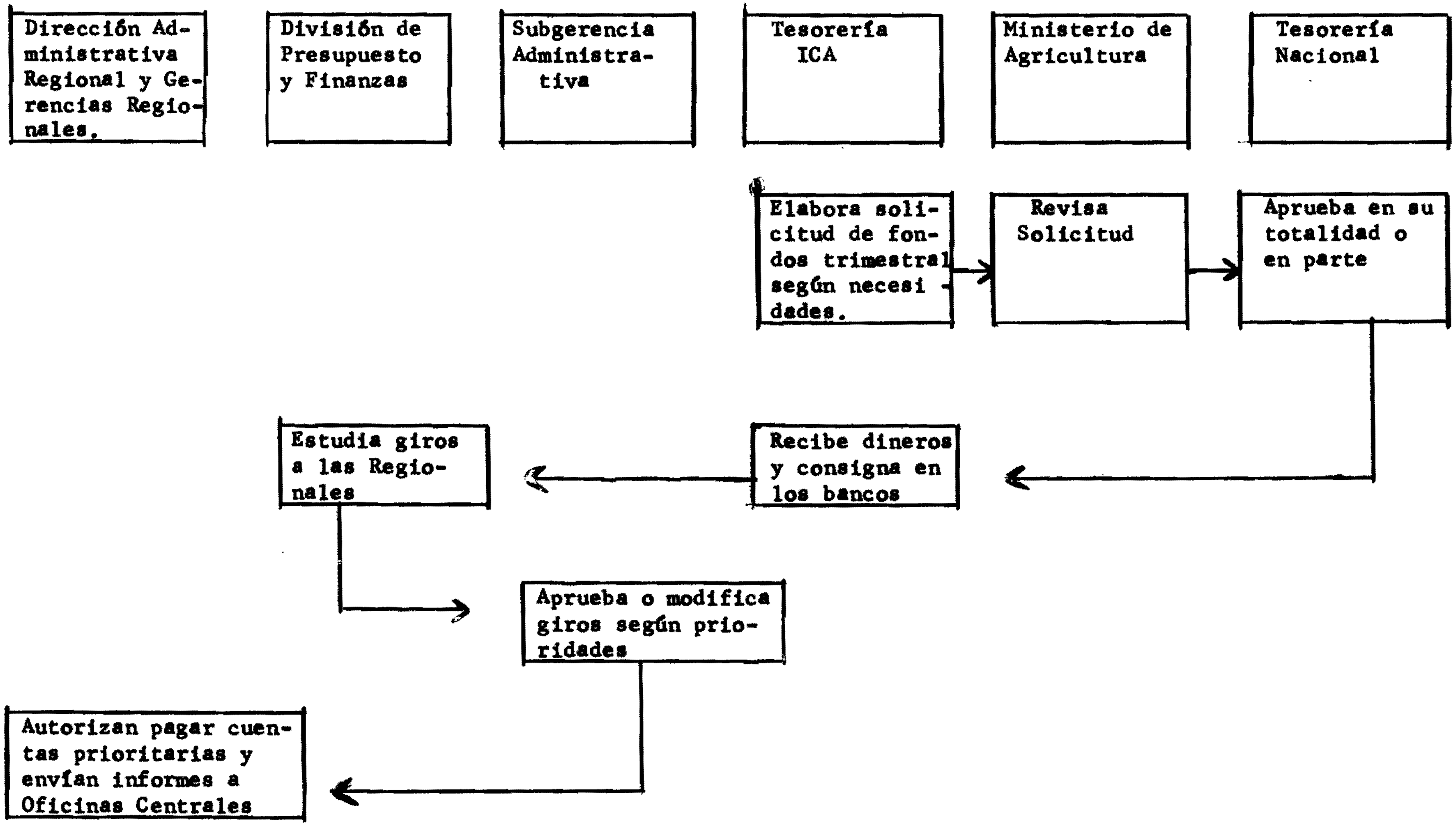

Figura 5. Proceso para la Ejecución de Ingresos en el ICA.

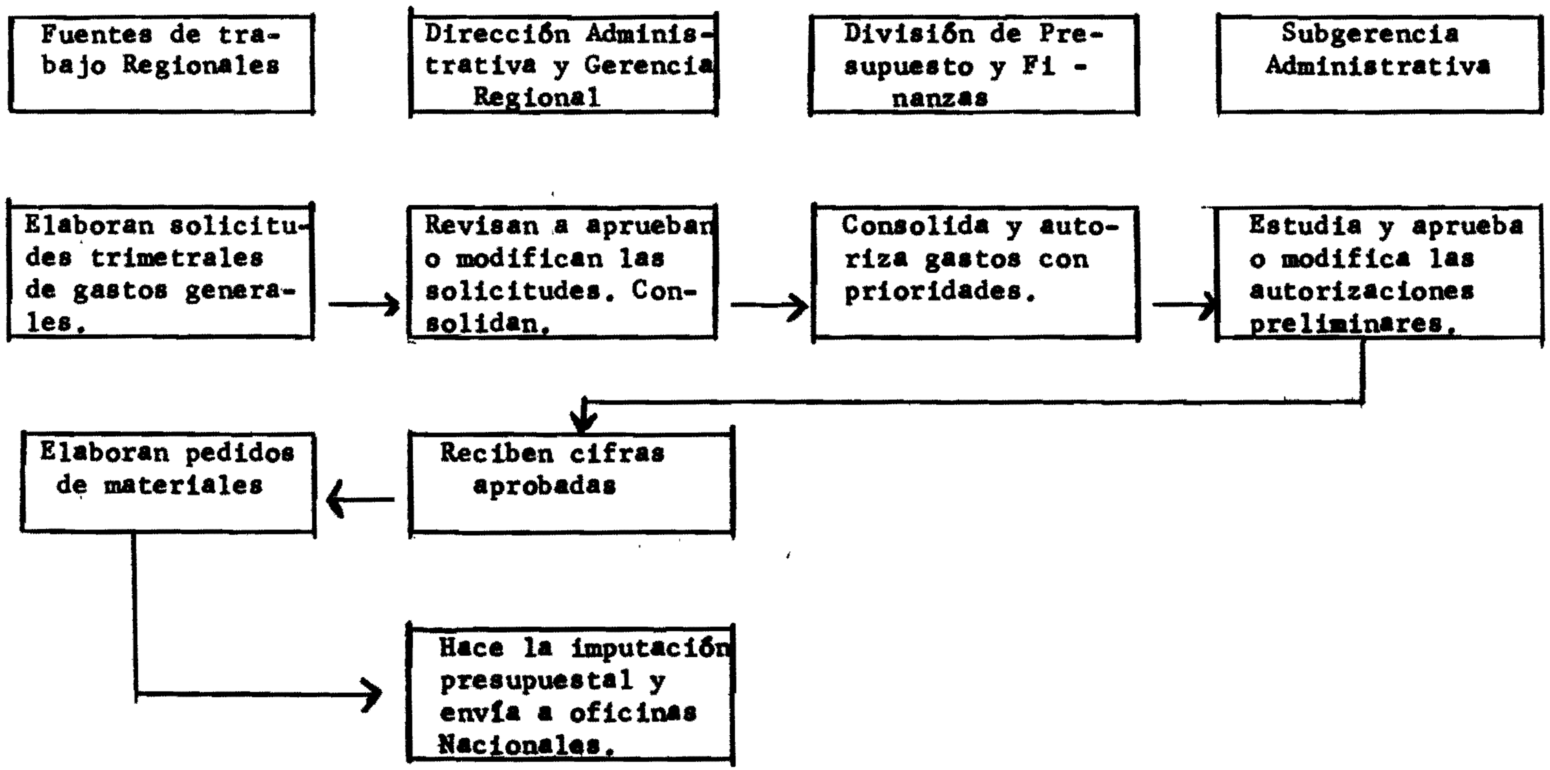

Figura 6. Proceso Para la Ejecución de Gastos en el ICA.

3. NIVELES Y CLASES DE DECISION

En términos generales, después de analizar el proceso seguido en la asignación de recursos, se pueden identificar seis clases de decisión y seis niveles decisorios (Ver Cuadro 8). Los niveles en los cuales se toman decisiones corresponden, en el plano nacional a CONPES, DNP, DGP* y OPSA en un plano institucional, a los Comités de Gerencia y Subgerencia de Investigación y a los Directores Nacionales de Proyectos (algodón, arroz,....). Las decisiones en sí son también de seis clases: en primer lugar, decisiones sobre cuanto asignar, del Presupuesto Nacional a Agricultura en relación con otros sectores; después, dentro del sector, cuánto asignar a las diferentes entidades ejecutoras de políticas**; tomadas las anteriores decisiones, se debe determinar para cada entidad, cuánto asignar a los diferentes programas (Investigación, Adopción de Tecnología, Educación, etc...) y dentro de cada programa, cuánto a cada Proyecto (por ejemplo: en Investigación, cuánto a algodón, arroz,...) para decidir finalmente cuáles actividades desarrollar y en qué regiones del país (para cada Proyecto).

A nivel de actividad, el ICA ha trabajado con una clasificación funcional la cual agrupa tareas genéricas que se llevan a cabo en cada Proyecto. Esta blasificación funcional, para especies animales y vegetales, aproximadamente es como sigue:

<u>Especies Vegetales</u>
- Mejoramiento genético
- Pruebas regionales
- Prácticas de cultivo
- Pruebas de calidad
- Estudios especiales
- Capacitación
- Divulgación
- Fomento y Asistencia Técnica

<u>Especies Animales</u>
- Mejoramiento genético
- Estudios sobre nutrición
- Estudios sobre manejo
- Fisiología y Endocrinología
- Producción animal

* Dirección General de Presupuesto, dependencia del Ministerio de Hacienda.

** INCORA (Reforma Agraria); IDEMA (Mercadeo); ICA (Investigación, Tecnología, Desarrollo Rural y Educación Agrácola Superior, etc.).

Cuadro 8. Instituto Colombiano Agropecuario. Niveles y clases de decisión en el proceso de asignación de recursos.

Nivel de decisión / Clase de decisión	Intersectorial	Sectorial	Programas del ICA	Proyectos	Actividades	Regiones
a) Nacional						
1. CONPES	X	X	X			
2. DNP/DGP *	X	X	X	X		
3 OPSA		X	X	X		
b) Institucional						
1. Comité Gerencia			X	X		
2. Comité Subgerencia				X	X	
3. Directores Proyectos					X	X

* DGP es la abreviatura de la Dirección General de Presupuesto, perteneciente al Ministerio de Hacienda.

Con las anteriores explicaciones suponemos que ya es claro para el lector cómo el proceso de toma de decisiones, a nivel de actividades y región, es bastante complejo, en razón a que se den manejar muchas variables.

Esta clasificación funcional de las actividades de Investigación es, en realidad, complementaria a la presentada por Andersen*, según la cual las decisiones, a nivel de actividad, se refieren a: 1) productos para los cuales el riesgo debería ser reducido y tipos de riesgo a reducir; 2) productos e insumos para los cuales de be aumentar la productividad; 3) productos para los cuales algunas características se deberían cambiar y 4) en cuáles productos se debe cambiar su composición.

Por ejemplo, en un proyecto sobre mejoramiento genético en arroz para variedades enanas, se está produrando la reducción del riesgo por volcamiento, mientras que en una práctica de cultivo referente a distancias de siembra o fertilización se están buscando aumentos en productividad. Igualmente, un proyecto de investigación sobre maíz opaco está cambiando la composición del producto, o bien, una investigación sobre variedades de algodón de maduración no uniforme está trabajando sobre características del producto.

Además, de lo anterior es necesario aclarar que no necesariamente (en Colombia) a cada nivel de decisión corresponde una clase de decisión. Por el contrario, un nivel decisorio como DNP/DGP tiene un rango de decisión muy amplio que comprende desde asignaciones a nivel intersectorial en los grandes rubros de la actividad gubernamental (defensa, salud, educación, agricultura) hasta el nivel de proyectos (arroz,...) mientras que los directores de Proyecto sólo deciden entre actividades y regiones (ver Cuadro 8).

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* ANDERSEN Per-Pinstrup, 1974. Toward a workable management tool for resource allocation in applied agricultural research in developing countries. CIAT. Cali, Colombia, 31 p.

4. CRITERIOS QUE SE UTILIZAN EN LA TOMA DE DECISIONES

Para facilitar la presentación de criterios se han agrupado las decisiones en tres clases, a saber:

a. Decisiones a nivel intersectorial y sectorial

b. Decisiones a nivel de programa y proyecto

c. Decisiones a nivel de actividades y regiones.

Estos grupos de decisiones, a su vez, son tomados por varios niveles de oficinas o instituciones (CONPES, DNP, DGP, etc.). Como realmente no existen diferencias de criterios en las clases de decisiones que toman varias oficinas, la discusión sobre estos criterios se hará sin considerar específicamente una oficina o institución sino el Grupo. Por ejemplo, las decisiones a nivel intersectorial y sectorial, son tomadas por CONPES, DNP/DGP y OPSA pero éstos, a su vez, tienen una unidad de criterios para asignar recursos a este nivel; igualmente, la asignación a nivel de programa y proyectos es hecha por CONPES, DNP/DGP, OPSA y respectivos Comités pero éstos, a su vez, usan aproximadamente los mismos criterios. Lo anterior es cierto en razón a que, generalmente, las programaciones sobre asignación de recursos son discutidas por todos los niveles de decisión.

4.1 <u>Criterios usados para asignar recursos a nivel intersectorial y sectorial</u>.

En términos generales, se puede decir que los criterios en estos niveles de asignación están asociados con:

a) Rendimiento relativo de las inversiones, por sectores, en términos económicos y sociales

b) Disponibilidad de recursos

c) Asignaciones hechas en años anteriores

d) Objetivos y metas del gobierno expresados en los planes de desarrollo en los cuales se asigna mayor importancia a unos sectores sobre otros.

4.2 Criterios usados para asignar recursos a nivel de programas y proyectos.

En este nivel, el principal criterio lo constituyen las políticas y metas sectoriales del Gobierno Nacional. Para Colombia, estas políticas generales se refieren principalmente a:

- Aumento en el empleo productivo y en los ingresos
- Distribución equitativa de los recursos productivos y el ingreso
- Mejoramiento de la productividad y aumento de la producción de bienes agropecuarios.
- Mejoramiento de la comercialización
- Aumento y diversificación de las exportaciones
- Capacitación de los campesinos y promoción de su organización
- Aprovechamiento adecuado y conservación de los recursos naturales renovables.

Como se puede observar, estos son criterios que, principalmente, definen prioridades a nivel de programa.* Para apoyar lo anterior, el Ministerio de Agricultura determina más específicamente los criterios en cuanto a programas determinados, como investigación, dentro de los planes sectoriales de desarrollo. Por ello, en algunas oportunidades, se han diseñado planes específicos por productos, para sustitución de importaciones, promoción de exportaciones o aumento en la producción de productos de consumo popular, indicando claramente la participación de la investigación. Además de estos planes a mediano plazo, el Ministerio de Agricultura suministra orientaciones anuales para investigación a nivel de proyecto a través de los programas agrícolas y pecuarios que se ejecutan anualmente, indicando algunas veces los problemas específicos a atacar** (mejores variedades, control de plagas, etc...).

* Estos programas, a su vez, son ejecutados por diferentes entidades.

**Estos programas agrícolas se hacen con la participación de las entidades ejecutoras, representantes de los productores y se tienen en cuenta el estado del cultivo o industria animal, proyecciones de producción y consumo, problemas de comercialización, producción, crédito, asistencia técnica, comercio exterior e investigación, fijando en algunos casos metas muy específicas para investigación.

Además de estos criterios emanados de las políticas sectoriales del Gobierno, generalmente, se tienen en cuenta otros criterios como:

- Asignaciones hechas en años anteriores
- Resultados obtenidos
- Compromisos internacionales que condicionan contrapartidas locales.(Este criterio es usado únicamente por el Departamento Nacional de Planeación).

Finalmente, es posible que el criterio personal de quien decida sobre estos asuntos tenga alguna influencia en la asignación de recursos.

4.3 Criterios usados para asignar recursos a nivel de actividades y regiones

En este nivel, los criterios que generalmente se han tenido en cuenta para decidir en cuanto al énfasis por actividades de investigación han sido principalmente de carácter técnico, en el sentido de que no necesariamente se han hecho estudios sobre las metas socioeconómicas del Gobierno; en general, los criterios generales han sido:

- Urgencia de investigación
- Tiempo necesario para realizar la investigación
- Costo de la investigación
- Posibilidades y costos de su adopción
- Factibilidad técnica de realizar la investigación (personal, equipo, métodos,etc)
- Número de personas, de explotaciones y área que beneficia la investigación.
- Incidencia de los resultados en la producción (posibles beneficios).

La"lista de problemas" de investigación no es solamente producto del criterio del investigador sino también de sus relaciones con los productores y con todas las entidades oficiales y privadas que tienen relación con el cultivo. Como se dijo anteriormente, este proceso de comunicación muchas veces tiene lugar en el mismo campo en donde se establecen los cultivos y otras veces, en reuniones llevadas a cabo anualmente en el Ministerio de Agricultura para producir los programas agrícolas y pecuarios.

En cuanto a la ubicación de las actividades, en las diferentes regiones, existen varios criterios dentro de los que figuran, además de las facilidades físicas y económicas, requisitos de orden técnico-económico que determinan - para cada cultivo o especie animal - exactamente en dónde se deben llevar a cabo las actividades. Más claramente, el Instituto opera tres clases de centros: en el primero de ellos, llamado centro piloto, se llevan a cabo principalmente estudios de mejoramiento genético* y poseen el personal mejor calificado en razón a que son las instituciones en las cuales se produce la mayor parte de la tecnología; existe otra clase de institución llamada Centro satélite, en el cual, en términos generales, se hace la primera comprobación de los mejores resultados obtenidos en los centros pilotos, incluyendo la especie local o el tratamiento testigo; aquí también se produce alguna tecnología, aunque a una escala menor; finalmente, existen los centros demostrativos en los cuales, en explotaciones comerciales o semicomerciales, se aplica la tecnología comprobada en los centros satélites. Por ejemplo, en trigo, la Estación Experimental de Tibaitatá es piloto. Obonuco, Satélite y Surbatá, demostrativo, mientras que en ganado de carne los centros de Turipaná, El Nus y Carimagua son piloto. La Libertad y Tibaitatá, satélite y Palmira, demostrativo.

4.4 Peso relativo de los criterios y métodos empleados

Hasta el momento nos hemos limitado a hacer una "lista" de criterios, pero no se ha determinado la importancia relativa de cada uno de ellos ni el método usado para aplicar estos criterios ya ponderados, en la asignación de recursos. Sin embargo, se podría decir en términos generales que a nivel de programa y de proyecto, los criterios más importantes han sido las asignaciones hechas en años anteriores, mientras que, a nivel de actividades y de regiones, los más importantes han sido la urgencia de la i-

* Parte de estos requisitos se basan en el hecho de que, en Colombia, el mejoramiento racial de plantas y animales no se debe hacer para nichos ecológicos específicos sino para zonas extensas, en razón a que los principios estudiados, en unos pocos centros, pueden aplicarse a sectores más extensos haciendo los ajustes necesarios para responder a exigencias locales.

investigación, su costo y la factibilidad técnica de realizarla.

En cuanto al método, éste realmente es subjetivo en el sentido de que no usa modelos sistemáticos sino criterios individuales o de grupos, derivados de la experiencia y familiaridad con los problemas, más algo de intuición.

5. PRIORIDADES DE INVESTIGACION EN EL ICA

5.1 Prioridades actuales

Suponiendo que existe una alta correlación entre prioridades de investigación y recursos asignados, se presenta a continuación una serie de cifras que pueden dar alguna base al respecto.*

A nivel intersectorial, las cifras que muestran una disminución de importancia al sector agropecuario, hasta el año de 1973, se pueden observar en el Cuadro 3. Igualmente, la participación del ICA dentro del presupuesto nacional ha venido descendiendo.

A nivel de programas dentro del ICA y partiendo del hecho de que los gastos de funcionamiento son aproximadamente fijos, se ha tomado como base los programas de Investigación, adopción de tecnología y educación (Ver Cuadro 9).

En conclusión, sería posible afirmar que el Instituto ha venido otorgando una mayor prioridad a los programas de Adopción de Tecnología que, en 1974, representan cerca del 53 por ciento del presupuesto del ICA.

Por el contrario, el Programa de Investigación ha perdido importancia relativa (-11.4 por ciento aunque, en términos monetarios, haya aumentado su valor absoluto en 135,6 millones a 153,1 durante el mismo período. Igualmente, el Programa de Educación Agrícola Superior ha disminuído su participación.

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* Este supuesto de correlación no es estrictamente cierto ya que existen proyectos de investigación que son mucho más costos que otros, y que requieren, por ejemplo, una superficie grande al igual que inversiones en equipo (por ejemplo, arroz vs. palma africana).

Cuadro 9. Composición porcentual del presupuesto por programas en el período 1970-1974. Instituto Colombiano Agropecuario.

Programas		1970	1974	±
1.	Investigación	57,4	46,0	- 11,4
2.	Adopción de tecnología	36,5	52,8	+ 16,3
3.	Educación	6,1	1,2	- 4,9

Fuente: ICA, Resoluciones Iniciales de Presupuesto. 1974.

A nivel de proyectos, tomando como base la asignación para los años 1970-73, se puede decir que el ICA ha tenido las siguientes prioridades en lo que respecta a Investigación:

Prioridad A: plantas tuberosas, Maíz y Sorgo, Leguminosas de grano comestible y Oleaginosas anuales, Hortalizas y Frutales, Cacao, Oleaginosas perennes, Ganado de Carne, Ganadeo de leche.

Prioridad B: Algodón, Arroz, Trigo, Pastos y Forrajes, Porcinos, Ovinos, Avicultura.

Prioridad C: Avena, Caña de azúcar, Cebada, Plátano y Banano, Tabaco.

Esta clasificación se ha hecho teniendo en cuenta que los productos incluídos en cada grupo han tenido, durante 1970-73, una asignación que está dentro de los siguientes rangos, a precios reales (1958:100)

A $>$ 3,5 millones

1,5 $<$ B $<$ 3,5 millones

C $<$ 1,5 millones

Además de lo anterior, se debe considerar que no se han incluído las disciplinas de apoyo* en razón a que éstas, casi siempre, reparten sus actividades entre los diferentes cultivos y especies animales.

Un comentario adicional se relaciona con los movimientos que han tenido las asignaciones por proyectos, dentro del período 1970-73, que - en términos generales - han otorgado cada año una mayor importancia a los proyectos de investigación pecuaria (incluyendo las disciplinas), como una respuesta a la importancia que el Gobierno Nacional les ha atribuído en los últimos años. Complementando lo anterior, se puede decir también que, en general, la investigación pecuaria es más reciente que la agrícola y

* Entomología Fisiología Vegetal y Animal, Fitopatología, Suelos, Toxicología, Microbiología, Nutrición, Parasitología y Patología Animal.

require, al comienzo, inversiones grandes sobre todo en laboratorios.

A nivel de actividades, las prioridades varían según el cultivo o la especie animal. Por ejemplo, en Pastos y Forrajes la prioridad corresponde a Manejo de pastos con animales, prácticas culturales y pruebas regionales. En cambio, Mejoramiento ocupa la menor prioridad en razón a que Colombia es un país que cuenta con suficientes variedades de pastos, lo cual otorga mayor importancia a estudios de manejo. En avicultura, por ejemplo, no se hace mejoramiento; todo el esfuerzo se concentra en estudios de nutrición y de manejo.

5.2 Hacia un intento de sistema de asignación de recursos para investigación

El sistema descrito de asignación de recursos implica la distribución presupuestal de acuerdo con las prioridades establecidas por el gobierno colombiano. Sin embargo, esta asignación por prioridades no se hace en forma sistemática. La asignación se hace en forma subjetiva, aunque teniendo en cuenta las prioridades establecidas.

Se intenta, en esta parte del presente documento, diseñar un patrón de medida que permita establecer si las asignaciones presupuestales se hacen de acuerdo a las prioridades establecidas o nó. El principal obstáculo de este intento es establecer el patrón de medida. Este patrón debe ser sistemático, es decir, tener una lógica interna y no susceptible de ser modificado caprichosamente.

El patrón de medida presupuesto se debe adaptar a los criterios supuestamente sugeridos para asignar las actuales partidas presupuestales, es decir, las prioridades establecidas por el Gobierno Nacional de Colombia. Se dispone, entonces, de los criterios que se deben aplicar para la asignación de recursos. El problema consiste en ensamblarlos en una forma sistemática y lógica, de modo que puedan ser utilizados como un patrón de medida.

Como se expresó en párrafos anteriores, existen varios niveles de decisión en la asignación de recursos. La evaluación que se intenta aquí se refiere a la asignación por proyectos. El problema de decisión se reduce a distribuír óptimamente, o de acuerdo con ciertos criterios, una suma previamente asignada entre varios cultivos.

Para la determinación del patrón se consideraron variables que reflejan las prioridades establecidas por el Gobierno Colombiano. Se tomaron variables sobre: a) nutrición, b) empleo, c) distribución de ingreso, d) balanza de pagos, e) ventaja comparativa, f) importancia del cultivo en la economía, g) demanda por el producto y h) necesidades de investigación.

Las observaciones, criterios y forma de medida de estas variables son las siguientes:

a) Nutrición. El Instituto Nacional de Nutrición ha hecho varios estudios en los cuales muestra que las mayores deficiencias nutricionales del pueblo colombiano corresponden a calorías y a proteínas; por lo tanto, para efectos de medir esta variables, se tomaron: el número de calorías y los gramos de proteínas contenidos en cada 100 gramos de producto comestible de cada cultivo.

b) Empleo. Para tal efecto se hizo un estimativo de la ocupación directa generada por los cultivos en 1973. Estos datos no se encontraron para la lenteja, por ser un cultivo de muy poca producción, y además, porque la mano de obra generada por el mismo es, en su mayoría, de tipo familiar. Se debe incluír el empleo indirecto generado en futuras investigaciones.

c) Efectos en la distribución del ingreso. Con base en el Censo Agropecuario de 1970, se calcularon los siguientes datos:

i) El número total de productores cuya principal explotación fue el cultivo en referencia.

ii) Con base en los estudios realizados por el Ministerio de Agricultura se estableció un porcentaje que indica la proporción de la producción obtenida de agricultura tradicional (esta agricultura, generalmente, está calculada en las explotaciones de 0-5 hectáreas) y la producción obtenida en explotaciones mayores de 5 hectáreas. Esta agrupación es más o menos válida dependiendo del cultivo.

d) Importancia en la Balanza de Pagos. Se sumaron los cultivos de exportación (con signo positivo), de importaciones (con signo negativo) y cero para los cultivos en los cuales no hubo intercambio internacional.

e) Ventaja comparativa. Para el cálculo de la ventaja comparativa se establecieron diferencias entre los precios internacionales y los nacionales (P_i-P_n). Esta diferencia muestra la ventaja comparativa a nivel de la tecnología corriente. Aquellos precios con signo negativo disminuyen el valor total del índice del cultivo.

Los precios internacionales fueron obtenidos, en lo posible, para el mes de Junio de 1973. En el caso de la papa se estimó un promedio anual de US$100/ton. En el caso del fríjol, se estimó un promedio de los precios de las exportaciones hechas en Agosto de 1973. Los precios internacionales anotados son todos precios FOB.

f) Importancia del cultivo en la economía. Para medir esta variable se tomó el valor de la producción en 1973.

g) Demanda por el producto. La demanda calculada para 1974 es estimada para los Programas Agrícolas del Ministerio de Agricultura. En el caso de la lenteja (importada) no se pudo obtener esta estimación porque se está tratando de sustituír el producto importado por la lenteja real, de producción nacional.

h) Necesidad urgente de Investigación. Se solicitó a varios investigadores que distribuyeran un determinado puntaje (25 puntos) entre los 12 cultivos de la lista, teniendo en cuenta las necesidades de investigación, los problemas a resolver y la tradición en lo que respecta a la investigación.

Cultivos seleccionados

Se tomó una muestra de los cultivos más importantes, de modo que representaran los criterios de selección y varios niveles de investigación tomados dentro del ICA. Los cultivos seleccionados fueron: maíz, trigo, leguminosas de grano (fríjol, soya, lenteja), papa, algodón, arroz, cacao, caña de azúcar, cebada y tabaco.

En el Cuadro 10 se incluyen las cifras que se calcularon para cada una de las variables y cultivos seleccionados. Estos valores se utilizaron para construír los índices de cada cultivo, como se indicará más adelante.

Indice Ordinal de Asignación Presupuestal (I_a)

Se tomaron las asignaciones presupuestales promedias del período 1970-1974 (Cuadro 11) para los cultivos seleccionados y se ordenaron de mayor a menor, de acuerdo con la asignación presupuestal. También se hizo la misma ordenación para las asignaciones presupuestales del año 1973 al cual se refieren la mayor parte de las estadísticas básicas. Esta ordenación constituye el "Indice Ordinal de Asignación Presupuestal" el cual será comparado con el "Indice Ordinal de Prioridades".

Indice Ordinal de Prioridades (I_p)

Teóricamente, el "Indice de Prioridades" expresa el peso relativo de las variedades que se deben tener en cuenta en la asignación de recursos. Operacionalmente, a un cultivo con un índice de prioridad alto le debe corresponder una mayor asignación presupuestal. Simbólicamente, el índice se puede representar como:

$$I_{pj} = P_1/V_1 \cdot v_{1j} + \dots + P_n/V_n \cdot v_{nj} \qquad (1)$$

En donde:

I_{pj} Es el índice de prioridad a calcular para el cultivo j

V_i Es el valor total de la característica i considerada como factor de determinación de prioridades.

P_i Es el peso relativo de la característica i dentro del conjunto n de características y donde $P = \sum_{i=1}^{n} P_i = 100$

v_{ij} Es el valor de la característica i en el cultivo j.

La expresión anterior no es una función continua sino una expresión discreta aditiva, en la cual las distintas variables o criterios contribuyen a la magnitud final de Indice. Es decir,

$$I_{pj} = \sum_{i=1}^{n} P_i/V_i \cdot v_{ij} \qquad (2)$$

Cuadro 10. Información Básica para el Cálculo del Indice Ordinal de Prioridad

Factores estudiados	Maíz	Trigo	Fríjol	Soya	Lenteja
Nutrición					
# Calorías/100 gr. Producto comestible	326.4	314	298	366	315
G proteína en 100 g de producto comestible	8.12	10.8	20.7	3.0	23.5
Empleo					
Jornales directos generados en 1973	16.376	2.600	4.100	1.522	-
Distribución del Ingreso					
Total de Productores*	311.398	19.991	14.858	2.021	16
Producción obtenida en agricultura tradicional	65%	70%	75%	0	100%
Producción obtenida en agricultura comercial	35%	30%	25%	100%	0
Balanza de pagos					
Valor Importaciones y Exportaciones US$**, en miles	-12.430	-35.993	1.863.9	-4.728	-1.500
Ventaja Comparativa					
Precio nacional US$/ton	98.4	131.200	246.0	164.0	736.44
Precio internacional US$/ton	110	121.6	338.9	333.0	500.0
Importancia en la Economía					
Volumen de producción,mls/ton	739	76.4	56.9	97.2	0.75
Valor de la producción,en millones	1.773.6	244.48	569.0	388.8	14.37
Demanda por producto mls/ton	806	520	69.3	133.5	4.0
Necesidad de Investigación					

* Con base en el Censo Agropecuario de 1970

** El signo negativo corresponde al valor de las importaciones

Continuación del Cuadro 10...

Factores estudiados	Papa	Algodón	Arroz	Cacao	Caña de Azúcar	Cebada	Tabaco
Nutrición							
# calorías/100 g. producto comestible	84	(aceite) 884	359	531	384	311	0
g.proteína en 100 g. de producto comestible	1.9	0.0	7.8	12.4	0.0	10.2	0
Empleo							
Jornales directos generados en 1973	9.000	21.800	9.318	8.550	8.800	2.020	7.515
Distribución del Ingreso							
Total de productores*	70.860	3.137	26.942	16.468	78.581	9.841	11.084
Producción obtenida en agricultura tradicional	25%	0	13.4%	52%	0	90%	98%
Producción obtenida en agricultura comercial	75%	100%	86.6%	48%	100%	10%	2%
Balanza de pagos							
Valor Importaciones y Exportaciones US$** en miles	0	40.888	1.500	-7.000	32.600	-429	38.644.3
Ventaja Comparativa							
Precio Nacional US$/ton	83.93	676.1	102.5	800.51	114.8	116.85	625.1
Precio Internacional US$/ton	100	957.58	120.0	1.500.0	186.0	143.0	2.525.7
Importancia en la Economía							
Volumen de Producción miles/ton	983.5	332.3	748.2	22.0	(azúcar) 800.0	81.4	38.7
Valor de la Producción en millones	2.013.33	2.926.91	1870.5	429.5	2.148.0	231.9	590.0
Demanda del Producto miles/ton	1.020.2	427.5	1072.6	36.0	825.0	144.0	64.7
NECESIDAD DE INVESTIGACION							

* Con base en el Censo Agropecuario de 1970

**El signo negativo corresponde al valor de las importaciones

Cuadro 11. Asignaciones Presupuestales para Cultivos Seleccionados Para el Período 1970-1974.

Cultivo	1970 (ooo) Ejecutado	1971 (ooo) Ejecutado	1972 (ooo) Ejecutado	1973 (ooo) Ejecutado	1974 (ooo) Apropiación
Maíz	3.958	3.990	3.930	4.605	5.461
Trigo	1.867	1.321	1.501	1.931	1.891
Leguminosas de grano	2.892	3.797	2.823	3.152	4.328
Papa	3.025	4.253	4.049	4.196	4.085
Algodón	2.420	3.383	2.438	2.260	2.360
Arroz	2.615	2.573	2.824	2.970	3.349
Cacao	1.695	1.853	2.764	3.620	3.746
Caña de Azúcar	464	1.227	1.099	1.268	1.422
Cebada	956	520	1.000	-	-
Tabaco	1.217	1.683	1.058	1.099	1.300

Peso relativo de las características

Quizás el elemento más subjetivo y cuestionable de toda la construcción del patrón de medida radica en la asignación de pesos relativos a las variables. En el presente caso, los valores se asignaron teniendo en cuenta la mayor importancia que se estimó que el Gobierno Nacional asigna a cada característica. Es evidente que, en el futuro, se requiere diseñar un sistema menos vulnerable para determinar estos pesos relativos. Ante la carencia de un mejor sistema, a cada característica se le asignó un puntaje, de tal forma que el total de las variables fuera 100. El asignar mayor valor a una característica dada, es subjetivo, pero así mismo es subjetivo suponer que todas las variables tienen el mismo peso relativo. Los valores asignados a las variables se pueden observar en el Cuadro 12.

Para la construcción del índice, el puntaje asignado a cada variable se distribuye entre el valor numérico total de la característica para los cultivos considerados. Esta distribución mostrará entonces cuántas unidades (k) de la característica i son equivalentes a 1 punto del peso de la característica. Bastará, entonces, multiplicar el factor k_i por el valor numérico de la característica i del cultivo j para asignarle el valor correspondiente. Simbólicamente,

$$k_i = \frac{P_i}{\sum_{i=1}^{n} v_i} = \frac{P_i}{V_i} \quad \text{para los n cultivos} \qquad (3)$$

$$I_{ij} = v_{ij} \cdot k_i \quad \text{para el cultivo j} \qquad (4)$$

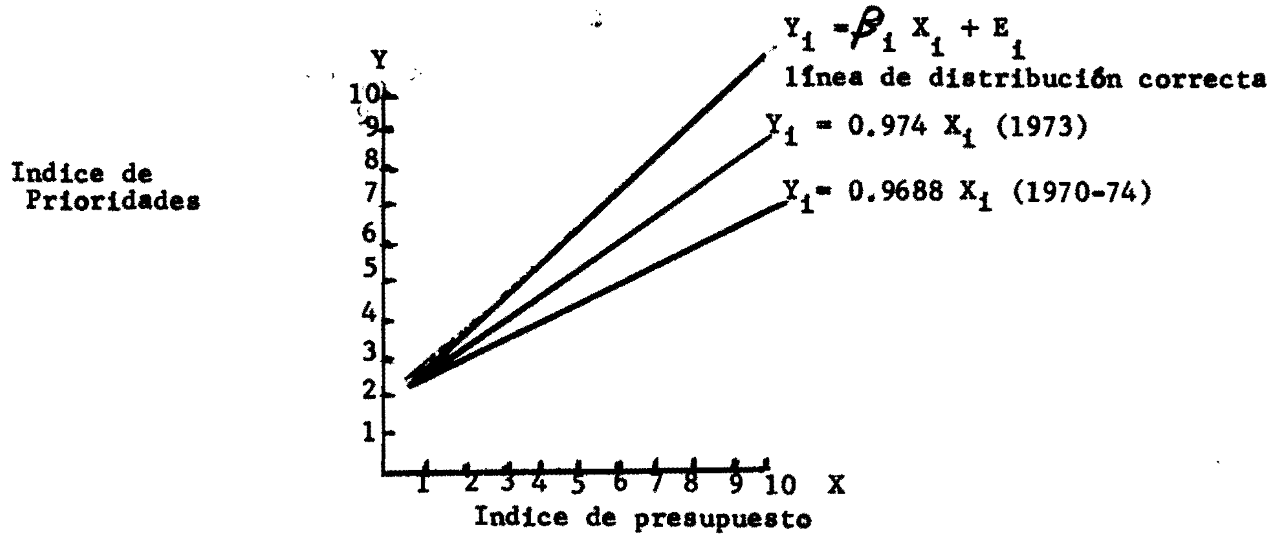
$$I_{pj} = \sum_{i=1}^{n} I_{ij} \quad \text{para el cultivo j} \qquad (5)$$

Los índices I_{pj} se ordenan descendetemente para compararlos con la asignación ordinal descendente de los gastos presupuestales en cada cultivo. Si las escalas de índices coinciden, indican que los presupuestos asignados corresponden a una ordenación sistemática de prioridades.

Es necesario llamar la atención sobre las limitaciones del patrón construído. Dado que los factores de ponderación p no fueron establecidos sistemáticamente, el peso de cada variable y por ende, el valor del índice para un cultivo variarán si se asignan pesos diferentes. En este sentido se tiene un patrón de medida elástico, lo cual es contrario al concepto de patrón de medida. Sin embargo, mientras no se modifique la ponderación de los criterios, el patrón sirve a los propósitos de comparación.

Resultados

Si las asignaciones de presupuesto han sido hechas de acuerdo a los criterios reflejados por el patrón de medida, los puntos de cada índice deben coincidir en una línea recta de 45 grados de pendiente si en las ordenadas se colocan los índices ordinales de Presupuesto y de Prioridades.



Correlacionando los dos índices para la asignación presupuestal de 1973 se obtuvieron las siguientes relación lineal:

$$Y_i = 0.974\ X_i$$

Cuadro 12. Peso relativo de las características consideradas como factores para determinación de prioridades.

Factores estudiados		Puntos
1. Nutrición: Por calorías		4
Por proteína		6
2. Empleo: jornales directos generados en cultivo	i	10
3. Distribución del Ingreso		20
a. Número total de agricultores en el cultivo	10 i	
b. Porcentaje de producción obtenida en (-5 ha)	5	
c. Porcentaje de producción obtenida en (+5 ha)	5	
4. Importancia de la balanza de pagos		10
5. Ventaja comparativa $(P_i - P_n)$		5
6. Importancia del cultivo en la Economía Nacional		5
7. Demanda por el producto		15
8. Necesidad de la investigación		25
Total..........................		100

Cuadro 13. Valores calculados del Indice de Prioridades

Factores estudiados	Valor	Maíz	Trigo	Leguminosas: Fríjol	Leguminosas: Soya	Leguminosas: Lenteja	Papa
Nutrición							
Calorías	4	.31	.30	.29	.35	.30	.08
Proteínas	6	.50	.66	1.26	.18	1.43	.12
Empleo							
Jornales directos generados en 1973	10	.15	.02	.05	.02	0	.11
Distribución del Ingreso							
Total de productores	10	5.51	.35	.26	.04	0	1.25
Producción obtenida en agricultura tradicional (%)	5	.55	.59	.64	0	.85	.21
Producción obtenida en agricultura comercial	5	.25	.21	.18	.70	0	.53
Balanza de pagos							
Valor de las Importaciones y Exportaciones	10	.70	2.03	.10	.27	.08	0
Ventaja Comparativa							
Precio Internacional menos el Precio Nacional	5	.02	-.02	.18	.33	-.47	.03
Importancia del Cultivo en la Economía Nacional							
Valor de la Producción	5	.67	.09	.22	.15	.01	.76
Demanda del Producto	15	2.67	1.72	.22	.44	.01	3.38
Necesidad de Investigación	25	3.0	2.0	2.0	3.5	.50	3.5
Total	100	14.33	7.95	5.40*	5.99*	2.26*	9.97

* Los valores de los cultivos (5.4 + 5.98 + 2.26 = 13.64) se suman, pues los presupuestos asignados están asignados en forma global para los tres cultivos bajo el rubro "Leguminosas de grano comestible".

Continuación del Cuadro 13....

Factores estudiados	Valor	Algodón	Arroz	Cacao	Caña Azúcar	Cebada	Tabaco
Nutrición							
Calorías	4	.85	.34	.51	.37	.30	0
Proteínas	6	0	.48	.76	. 0	.62	0
Empleo							
Jornales directos generados en 1973	10	.23	.10	.10	.10	.02	.08
Distribución del Ingreso							
Total de productores	10	.06	.48	.29	1.39	.17	.19
Producción obtenida en agricultura tradicional (%)	5	0	.11	.44	0	.76	.83
Producción obtenida en agricultura comercial (%)	5	.70	.60	.34	.70	.07	.01
Balanza de pagos							
Valor de las Importaciones y Exportaciones	10	2.30	.08	.39	1.84	.02	2.18
Venta Comparativa							
Precio Internacional menos Precio Nacional	5	.56	.03	1.38	.14	.05	1.78
Importancia del Cultivo en la Economía							
Valor de la Producción	5	1.11	.71	.16	.81	.09	.22
Demanda del Producto	15	1.41	3.55	.11	2.73	.47	.21
Necesidad de Investigación	25	3.50	2.50	9.00	0.50	0.50	0.50
Total	100	10.72	8.98	12.04	8.58	3.07	6.00

El valor calculado de t para 1973 es 0.34, es decir, no hay diferencia significativa entre Y_i y X_i .

Se hicieron los mismos cálculos para el período 1970-74 con la siguiente estimación de beta:

$Y_i = 0.9688\ X_i$ $\qquad$ $tc = 0.38$

Los resultados anteriores indican, de acuerdo con el patrón utilizado, que la asignación presupuestal para los cultivos seleccionados se hizo de acuerdo a las prioridades establecidas por el gobierno nacional.

Es interesante, sin embargo, estudiar más de cerca aquellos cultivos en los cuales no coinciden los índices y enfocar la atención en las variables que pueden estar incidiendo en la discordancia. Tomemos el índice presupuestal de 1973. El caso menos extremo de discordancia (Cuadro 14) está dado por la caña de azúcar. Para este cultivo, el índide de prioridad es 7. La asignación presupuestal dentro del ICA es 8 pues las empresas agro-industriales hacen su propia investigación.

Otro cultivo con discrepancia es papa. El índice de prioridad es 5 (baja prioridad) y el índice presupuesta es 2 (alta asignación). El efecto de las características de nutrición, empleo, balanza de pagos y ventaja comparativa son relativamente bajos comparada con los otros cultivos, mientras que en el presupuesto figura como plantas tuberosas, en las cuales existen otros cultivos presupuestales, además de la papa. Este es un error de los datos básicos.

Otra discrepancia está constituída por "leguminosas de grano comestible". La revisión de los índices indica que existiría un error de asignación presupuestal, es decir, que a este tipo de cultivos se debería dar mayor importancia dentro del presupuesto de investigación. Las características más importantes, en el índice de prioridades, son: nutrición, distribución del ingreso, balanza de pagos y necesidad de investigación.

Otras consideraciones son posibles con la comparación de los dos índices. Los resultados demuestran que un índice de prioridades como el construído puede ser útil en la toma de decisiones para asginar más eficientemente los recursos de Investigación. Es necesario, sin embargo, constuír el índice con más variables y examinar más aofondo

Cuadro 14. Clasificación ordinal* de los índices de presupuesto asignado y de índice de prioridades.

Cultivo	Orden según Promedio Presupuestal 1970-74	Orden según Asignación Presupuestal 1973.	Orden según Indice de Prioridades
Maíz	1	1	1
Papa	2	2	5
Fríjol, Lenteja, Soya	3	4	2
Arroz	4	5	6
Cacao	5	3	3
Algodón	6	6	4
Trigo	7	7	8
Caña de Azúcar	8	8	7
Tabaco	9	9	9
Cebada	10	10	10

* Orden descendente en importancia dentro de las prioridades presupuestarias asignadas.

las cifras básicas.

Se debe "sistemarizar" la determinación de los valores p de ponderación y finalmente, ordenar las "actividades" de investigación de acuerdo con la mayor o menor importancia de los criterios tenidos en cuenta.

6. CONCLUSIONES

6.1 Acerca del sistema actual

El sistema actual de asignación de recursos para investigación, que ha estado en funcionamiento por varios años, si bien ha producido en algunos cultivos como arroz, soya y algodón elevadas tasas de rentabilidad social*, no posee las herramientas suficientes para predecir el efecto de la tecnología, en variables socioeconómicas involucradas en las metas de desarrollo del gobierno, diferentes al aumento en producción y productividad.

En términos generales, se puede decir que el criterio(para asignar recursos entre proyectos) basado en las asignaciones de años anteriores, no es del todo racional -como punto de partida - pues a veces no se justifica mantener ciertas relaciones entre asignaciones para diferentes proyectos. Además, con este sistema se favorecen los proyectos ya implantados, cuyas necesidades de investigación no necesariamente son iguales a las de proyectos nuevos o menos desarrollados.

Es preciso conceder mayor división de trabajo, en el proceso de toma de decisiones y asignación de recursos. Por lo anterior, se sugiere que el nivel decisorio nacional correspondiente a CONPES, DNP y DGP sólo opere en la asignación de recursos hasta el nivel de programa, dajando la decisión de asignación de recursos entre Proyectos al ICA**

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* En términos de su contribución económica, medida como una relación entre costos de investigación, y el aumento en el valor de la producción debido solamente al uso de variedades y prácticas de cultivo mejoradas.

**Sin deterioro de Información suplementaria, a nivel de proyectos y aún de actividades.

6.2 <u>Es necesario establecer un nuevo sistema</u>?

La condición general de que un nuevo sistema no sea muy costoso ni difícil de operar, sumado al hecho de que realmente bride resultados sinificativamente superiores al sistema existente, justificaría su implantación. Más aún, habría justificación si ese sistema habría de brindar criterios claros para asignar un recurso que sea cada vez más escaso. A continuación, se describen algunas ideas sobre condiciones que debería tener el nuevo método.

En primer lugar, el hecho de establecer criterios y prioridades, a nivel de proyecto, no garantiza que las actividades investigativas contribuyan al logro de las metas de Desarrollo del Gobierno.

Lo anterior es cierto si el nuevo sistema usa como ponderaciones algunos criterios a nivel de proyecto que correspondan a metas socioeconómicas, sin llegar con éstos al nivel de actividad. Si, por ejemplo, una de las metas del gobierno es crear empleo productivo y el cultivo X es el que mayor empleo genera y por consiguiente, se le asigna mayores disponibilidades financieras, es posible que:

a) Tenga un nivel tecnológico suficientemente avanzado como para no ser prioritario en Investigación.

b) Es posible que la tecnología que se produzca sea trabajo-ahorrativa*, en cuyo caso aún dándole dinero por ser prioritaria frente a otros proyectos, no contribuya a la meta social de empleo.

Por lo anterior se considera que la asignación de recursos a nivel de proyecto debe constatar si las actividades de investigación contribuirán al logro de aquellas metas que hicieron al proyecto prioritario. Sin embargo antes de esto debe elegirse un criterio o grupo de criterios que permita determinar si el proyecto en cuestión tiene un <u>vació tecnológico</u> que "justifique" la asignación de recursos para su investigación. Obviamente la guía básica serán las metas y objetivos de desarrollo del Gobierno. Por ello se cree que el sistema nuevo de asignación de recursos debe estar en capacidad de responder preguntas como las siguientes:

a) Qué productos o especies animales tienen problemas que el ICA pueda resolver mediante su investigación?

b) Qué problemas* son los más limitantes, cuánto vale su solución y en qué plazo de tiempo?

c) Cuál es el impacto esperado sobre las metas del gobierno (teniendo en cuenta su grado y costo de adopción por los agricultores)?

Un producto puede tener problemas de mercadeo para disponibilidad de crédito, baja adopción tecnológica y otros, pero, en realidad, la variable que decide la asignación de recursos para Investigación debe ser la Tecnología que sea aplicable.

El nuevo sistema debe ofercer la capacidad de distinguir entre prioridades a largo, mediano y corto plazo, ya que, por ejemplo, un cultivo como el algodón actualmente en Colombia requiere el empleo de variedades de maduración no uniforme, a fin de contribuír al empleo bien distribuído de mano de obra pero, si las tendencias de oferta de mano de obra a largo plazo, hacen prever una escasez de ésta, el proyecto debe incluír, dentro de sus objetivos a largo plazo, la obtención de variedades de maduración uniforme. Además, la asignación anual debe considerar la inversión necesaria para mantener un nivel tecnológico en un cultivo, expresado en términos de creación de variedades de reemplazo.

Un punto bastante arduo, en el nuevo sistema que se diseña, es el de la predicción acerca del efecto de las actividades investigativas en las metas socioeconómicas de desarrollo pues este efecto dependerá, en su mayor parte, del grado de adopción de la tecnología producida. Este factor estará, principalmente, en función del rendimiento esperado de la nueva tecnología y del costo de su aplicación. Básicamente, el productor sustituirá, dentro de su función de producción, aquél que más se ha encarecido en relación con los otros. Pero, cómo predecir el grado de adopción?

Dentro de este concepto, quizás, el nuevo sistema debiera tener en cuenta que las tecnologías que se producen son de diferentes tipos y características y que, igualmente,

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* Estos problemas, en general, se refieren a riesgo en la producción, productividad de insumos, o productos y características, y composición de los productos.

afectan en forma diferente al capital, tierra, trabajo y rendimientos. Las clases de tecnologías son, en general de índole biológica (semillas mejoradas, razas de ganado), mecánicas (utilización de cosechadoras, sembradoras...) químicas (aplicación de pesticidas, fertilizantes y plaguicidas) y agronómicas y zootécnicas (prácticas de cultivo y de manejo).

Las tecnologías de índole biológica requieren la inversión de poco capital, son ahorradoras de tierra y dependen del producto obtenido por lo cual pueden tener un efecto negativo o positivo sobre el trabajo; así mismo, aumentan significativamente los rendimientos cuando se aplican dentro de un paquete tecnológico integral. Las tecnologías mecánicas son intensivas en capital y sustitutivas de mano de obra; son casi neutrales en uso de la tierra y en la mayoría de los casos, no aumentan significativamente los rendimientos. Las tecnologías químicas son intensivas en capital y mano de obra y ahorradoras en uso de la tierra, aumentando también los rendimientos. Finalmente, las tecnologías agronómicas y zootécnicas no requiren casi capital, son ahorradoras del recurso tierra, intensivas en trabajo y aumentan significativamente los rendimientos.

Bajo la situación de una nueva tecnología, la productividad marginal de uno o de varios insumos (si se mantienen constantes las cantidades aplicadas de los mismos) puede aumentar, disminuír o mantenerse en el mismo nivel. Si un productor maximiza beneficios, cuando la cantidad de cada insumo asegura que el valor de su producto marginal es igual a su costo marginal, la nueva tecnología puede resultar en un mayor, igual o menor uso de cada factor y por consiguiente, en un mayor o menor cumplimiento de las Metas de Desarrollo.*

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* En cada zona o región existen, a su vez, diferentes condiciones de oferta y demanda de insumos. Esto significa que un cambio tecnológico tiene, a su vez, efectos regionales diferenciales.

EL PROCESO DE DECISION APLICADO A LA ASIGNACION DE RECURSOS EN UNA INSTITUCION INTERNACIONAL DE INVESTIGACION AGRICOLA : EL CASO DEL CIAT*

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En 1961, cuando las fundaciones Ford y Rockefeller decidieron unir sus esfuerzos para el establecimiento de un centro internacional de investigaciones y de adiestramiento, que se dedicaría al desarrollo de tecnologías que permitieran incrementar la productividad y la producción de alimentos en el Sudeste de Asia; se apoyaron en las recomendaciones de un grupo de notables científicos para decir acerca de los objetivo, las prioridades y los recursos que permitirían la operación eficiente de una institución internacional cuya acción principal estaría orientada al cultivo del arroz. Así, en 1961, nació El Instituto Internacional de Arroz (IRRI), estableciéndose un mecanismo para decibir sobre las prioridades y el apoyo económico a las investigaciones, el cual se puede considerar como un antecedente histórico para la nueva modalidad de la investigación agrícola internacional, destinada a contribuír al mejoramiento de las condiciones de vida de los habitantes del mundo, particularmente de las regiones de menor desarrollo económico.

Posteriormente, en el año 1963, se establece el Centro Internacional para el Mejoramiento de Maíz y Trigo (CIMMYT), un centro de investigación agrícola internacional enfocado al desarrollo de metodologías más eficientes destinadas a elevar la productividad y la producción del maíz y el trigo. La decisión de las fundaciones Ford y Rockefeller para apoyar este nuevo esfuerzo, posiblemente, se fundamentó en la gran importancia mundial de estos cereales, de su amplia aceptación para la producción y el consumo y en la diversidad de los problemas limitantes de la productividad de estos cultivos, cuyo resultado era una baja producción mundial de los mismos. Además, en el caso del CIMMYT, se contaba con la base inicial de un equipo de científicos especializados y con materiales prometedores, resultantes de las actividades del programa cooperativo de investigaciones agrícolas entre el gobierno de Mexíco y la Fundación Rockefeller.

Casi simultáneamente, en el año 1966, se plantea la necesidad de crear dos centros internacionales en los trópicos del mundo para el desarrollo de investigaciones que permitieran acelerar la utilización de vastas áreas de América, Africa y Asia en la producción de alimentos, para tratar de hacerle frente al especto del hambre que amenazaba, y es ya una terrible realidad, a un amplio sector de las poblaciones de estas regiones.

Los Doctores Roberts y Hardin, a fines de 1966, esbozaron en un documento básico una propuesta para la creación del CIAT, en la cual se sugería la iniciación simultánea de dos áreas de actividades de investigación, una en cultivo y otra en ganadería de carne. Esta fué la primera ocasión en la cual se incluyó a una especie animal dentro de los programas de investigación y adiestramiento de un centro internacional.

En el documento de Roberts y Hardin se proponía que las actividades del centro se concentraran en el mejoramiento de unos pocos y bien seleccionados cultivos, en lugar de diluír los esfuerzos trabajando con un grupo grande de especies. Se estableció la premisa de que los cultivos que finalmente se seleccionaran tuvieran un potencial de amplia utilización en las regiones bajas y húmedas de los trópicos del mundo y que fueran especialmente importantes en la nutrición humana.

Los criterios mencionados sirvieron de base a Roberts y Hardin para sugerir las áreas de investigación que deberían ser consideradas, prioritariamente, en la nueva institución. Este primer documento propone actividades de investigación en las siguientes especies y disciplinas:

<u>Especies</u>:

Leguminosas de Grano: soya; fríjol; caupí; guandul

Plantas forrajeras tropicales: leguminosas y gramíneas

Maíz

Arroz

Ganado de Carne

<u>Disciplinas</u>:

Suelos

Fisiología Vegetal

Protección Fitosanitaria

Control de Malezas

Salud Animal

Nutrición

Fisiología, Genética y Reproducción Animal

Economía Agrícola

Ingeniería Agrícola

Biblioteca y Documentación

Servicios de Información

Roberts y Hardin resaltaron la necesidad de que, a su debido tiempo, en el nuevo centro de investigaciones para el trópico, se diera atención a otras especies de cultivos importantes dentro de los sistemas agrícolas de los trópicos y mencionaron dentro de esta categoría a cultivos como la yuca, la batata, el ñame, las hortalizas y las frutas tropicales.

Tanto para los trabajos de investigación en las especies vegetales como en las especies animales, se sugiere con firmeza que el esfuerzo deberá ser fruto de la interacción de científicos de diferentes disciplinas, es decir, mediante la integración de equipos científicos multidisciplinarios.

No fué sino hasta fines de 1967 cuando el CIAT comenzó a delinear su formación jurídica, al firmarse un Memorandum de Entendimiento y un Acuerdo entre el Gobierno de Colombia y la Fundación Rockefeller, para el establecimiento del Centro en Colombia. A la firma de estos documentos siguió el acto de reconocer al CIAT la personaría jurídica necesaria para operar en Colombia. A principios de 1968 se firmó el decreto que define los principios y prerrogativas para el CIAT y para su personal técnico y científico internacional.

Durante la etapa formativa del CIAT se continuó prestando atención al mecanismo de decisión sobre el programa del CIAT y su contenido, y para complementar el texto del documento presentado por Roberts y Hardin, se contrataron varios destacados científicos a quienes se les asignó la tarea de efectuar estudios de factibilidad sobre algunas de las áreas de actividad sugeridas en el documento de Roberts y Hardin. Estos estudios fueron desarrollados individualmente o por equipos, durante el año 1968, habiéndose cubierto los siguientes aspectos:

A.	Leguminosas de Grano	W. J. Zaumeyer
B.	Programa de Forrajeras para Ganado. Investigación y Adiestramiento.	L. V. Crowder y R. E. Blaser
C.	Programa de Ganadería del CIAT. Investigación y Adiestramiento.	J.J. Gallis, L.J. Lambourne, J.T. Gallo, H.H. Stonaker y K. L. Turk
D.	Necesidades de Investigación y Desarrollo hortícola en Colombia	W. Reuther
E.	Programa de Yuca	David Rogers
F.	Programa de Adiestramiento y Comunicación	T. White, L. A. Doyle y Hal Alford

Estos estudios y la base original plantead para CIAT por Roberts y Hardin sirvieron de base a la Junta de Directores del CIAT para definir la composición inicial de los programas de la institución. Al comenzar formalmente sus actividades en 1969, el CIAT tenía ya el mandato de su Junta Directiva para iniciar las actividades de identificación y empleo de científicos para activar los siguientes programas en las siguientes fechas del año mencionado:

División de Ciencias Pecuarias: Mayo

Ganado Vacuno: Mayo

División de Ciencias Agrícolas: Mayo

Raíces Tropicales (yuca; ñame; batata): Mayo

Leguminosas Comestibles: Fríjol; Soya; Caupí; Guandul

Maíz y Sorgo: En colaboración con CIMMYT, para enlace y coordinación de actividades en la Zona Andina.

Arroz: En colaboración con el IRRI, para el desarrollo de tecnología aplicada a las zonas tropicales del Continente Americano.

Pastos y Leguminosas Forrajeras

Sistemas Agrícolas

Adiestramiento: En Producción de Cultivos y en Disciplinas

La Fundación Rockefeller ofreció apoyar unilateralmente al Programa de Porcinos, dentro de la División de Ciencias Pecuarias, lo cual fué aceptado por la Junta Directiva. Posteriormente, el apoyo fué también otorgado por la Fundación Ford, con lo cual se consolidó este programa integralmente dentro de las actividades básicas de la División de Ciencias Pecuarias.

Con el fin de lograr una adecuada integración multidisciplinaria en las actividades del Programa de Ganado de Carne se decidió incluír, en ese equipo, al especialista en pastos y leguminosas forrajeras.

En vista de la magnitud de la tarea que debía realizar el Programa de Maíz, las investigaciones sobre sorgo fueron discontinuadas totalmente, a partir de 1972, por recomendación de la Junta Directiva. Igualmente, se hizo una serie de ajustes entre los equipos y dentro de cada equipo multidisciplinario, en respuesta a necesidades expresadas por lo equipos, los líderos de los programas, los científicos individualmente o por la propia Junta Directiva.

Todo lo expresado anteriormente relata, a grandes rasgos, el desarrollo de la organización y la estructura de los programas de investigación del CIAT. Ahora desearía hacer una breve revisión del proceso de desarrollo de dos de nuestros programas prioritarios, el de Yuca y el de Fríjol (Phaseolus),con la intención de describir los mecanismos que se han utilizado, en ambos casos, para definir: 1) los objetivos generales de cada programa; 2) el contenido y los objetivos de trabajo de cada disciplina dentro de cada uno de estos programas; 3) la asignación de recursos a cada proyecto de investigación y 4) los adjustes que ha sido necesario hacer dentro de cada disciplina, en estos programas, para alcanzar el objetivo establecido para cada uno.

Para ambos programas, el objetivo principal ha sido el incremento de la productividad y de la producción, como un camino para lograr el aumento de la disponibilidad de alimentos para los habitantes del trópico bajo y húmedo. Este objetivo cae dentro de lo que el Dr. Per Pinstrup-Andersen ha catalogado como "Objetivos de Crecimiento" y ha sido determinante dentro del proceso de decisión sobre prioridades de investigación y de asignación de recursos, como se discutirá más adelante.

Describiré primero el programa de Sistemas de Producción de yuca del CIAT.

Desde la iniciación de actividades de los que originalmente se denominó Programa de Raíces Tropicales del CIAT, el énfasis se orientó fundamentalmente hacia la colección de la diversidad genética existente en el cultivo de la yuca (M. esculenta Crantz). Las exploraciones se iniciaron en 1969, se intensificaron en 1970 y culminaron en 1971. Además de la yuca, se colectaron algunos cultivares de batata (Ipomea batatas), taro (Xanthosoma sp.) y ñame (Dioscorea sp.) pero, la mayor colección de germoplasma, correspondió a cultivares de yuca y a algunas especies silvestres de Manihot.

Durante la reunión de la Junta Directiva, en Agosto de 1971, se tomó la determinación de concentrar los esfuerzos de investigación exclusivamente en la yuca y de acelerar la expansión del programa de investigaciones. Esto coincidió con la decisión de la Canadian International Development Agency (CIDA) de apoyar, a través del International Development Research Centre (IDRC), las investigaciones de yuca del CIAT.

Como consecuencia de lo anterior, se activó la contratación de personal científico, se seleccionó el coordinador del programa y se organizó una conferencia, bajo los auspicios del CIAT y del IDRC, para revisar el Programa de Yuca del CIAT. Esta conferencia se efectuó del 10 al 12 de Enero de 1972 y a ella se invitó un grupo de 25 sobresalientes científicos y técnicos interesados en la yuca, procedentes de Inglaterra, Canadá, Estados Unidos de América, Escocia, Holanda, Brasil, India, México, Nigeria, Sierra Leona, Madagascar, Trinidad y Colombia.

Los objetivos de la conferencia fueron: 1) Revisar el Programa de Yuca del CIAT y sus proyecciones futuras; 2) Delinear una distribución óptima de prioridades de investigación y 3) Identificar áreas potenciales para desarrollar esfuerzos colaborativos.

Los científicos invitados prepararon presentaciones breves para: 1) expresar sus ideas sobre la situación de la producción de la yuca en sus respectivas áreas; 2) revisar los principales factores limitantes de la producción y de la utilización de la yuca; 3) sugerir las investigaciones necesarias para eliminar los factores limitantes; 4) describir el status de las investigaciones en la yuca en sus respectivas instituciones. Además, se dió oportunidad de hacer un comentario sobre sus posibilidades e intereses en participar, en un esfuerzo de investigación cooperativa sobre distintos aspectos del cultivo de yuca.

Además de los objetivos expresados, esta primera conferencia sobre yuca, ofreció la mágnífica oportunidad de conocer la participación y contribución de los científicos asistentes, con el objeto de seleccionar a los más destacados para invitarlos posteriormente a ser miembros de un Comité Asesor del Programa de Yuca del CIAT.

El Comité Asesor fué creado de común acuerdo entre el CIAT y el IDRC, como un mecanismo para evaluar críticamente el avance de las investigaciones, el valor de las contribuciones científicas, revisar los objetivos específicos de los proyectos de investigación, dentro de cada disciplina, y para sugerir los ajustes que se deberían hacer en el énfasis de cada disciplina y consecuentemente, en la distribución de las asignaciones de personal y de financiamiento, no sólo para las actividades de investigación a ser desarrolladas en el CIAT, sino también para los trabajos de apoyo que serían adelantados en instituciones canadienses académicas y de investigación.

Se considera que la primera conferencia de evaluación del Programa de Yuca del CIAT, tuvo la virtud de ofrecer al equipo científico que se estaba gestando y a los administradores del CIAT, criterios sólidos para definir las prioridades del programa de yuca lo cual permitió, además, efectuar los ajustes necesarios dentro de cada disciplina para tratar de lograr un desarrollo del programa de investigaciones más en concordancia con las necesidades reales, definidas éstas por las apreciaciones y criterios, no sólo de los científicos del CIAT sino también de los miembros del Comité Asesor.

El Comité Asesor del Programa de Yuca, inicialmente, celebraba dos sesiones anuales, una en el CIAT y la otra en Canadá pero, el avance del programa, la madurez alcanzada en los proyectos y en el equipo de investigadores, ha permitido ampliar el período entre revisiones a un año. Precisamente en el mes de Enero próximo se reune el Comité Asesor para evaluar las actividades del Programa de Yuca, tanto en el CIAT como en instituciones canadienses. Con este motivo, se efectuará una reunión de dos días en Ottawa y otra de dos días en el CIAT.

El Comité Asesor del Programa de Yuca es un mecanismo de evaluación continua, el cual ofrece amplias bases de juicio para tomar las decisiones necesarias sobre los cambios de énfasis en las prioridades de investigación establecidas. Con este mecanismo se ha logrado imprimir gran dinamismo al programa de investigaciones de yuca.

La acción del Comité Asesor ha tenido, además, la virtud de propiciar la interacción entre los miembros del equipo de investigadores de yuca, tanto del CIAT como de las instituciones canadienses, creándose un verdadero equipo multidisciplinario con buena coordinación y con enfoque claro, cuyos resultados han sido extraordinarios y están a la vista de todos.

Veamos ahora el desarrollo del programa de Sistema de Producción de Fríjol del CIAT.

Como ya se indicó anteriormente, el programa de actividades indicado inicialmente para el CIAT, en el documento de Roberts y Hardin, señalaba que los trabajos de investigación se deberían enfocar al mejoramiento de las siguientes leguminosas de grano: soya, fríjol, caupí y guandul, las cuales se consideraron de mayor importancia para el trópico bajo y húmedo. De hecho, esta recomendación sirvió de base para el mandato inicial de la Junta Directiva al Director del CIAT mediante el cual se autorizaba la iniciación de trabajo de investigaciones en las leguminosas de grano, sugeridas por Roberts y Hardin.

El programa de Leguminosas de Grano del CIAT se inició formalmente en 1970, con un plan de actividades exploratorias y con la participación, inicialmente, de un estudiante graduado quien, a la vez que desarrollaba algunas investigaciones en soya, las cuales posteriormente le sirvieron de base para su disertación doctoral, inició la introducción y evaluación de germoplasma de fríjol y de caupí.

A fines de 1970, Roberts presentó un trabajo al Grupo Consultivo sobre Investigaciones Agrícolas Internacionales, sobre "Leguminosas Comestibles: Recomendaciones para expandir y acelerar las investigaciones tendientes a incrementar la producción de algunos de estos cultivos de alto contenido proteínico". Este es un documento valioso y en el se recomienda dar atención prioritaria a seis especies de leguminosas comestibles y se sugiere que el CIAT debiera ser responsabilizado de la tarea de mejorar y promover sistemas eficientes de producción de fríjol, actuando en colaboración con otros programas similares en el mundo.

El año 1971 es marco para dos hechos significativos. En primer lugar, el Banco Interamericano de Desarrollo (BIC) integra un Comité Asesor Especial compuesto por reconocidos científicos agrícolas latinoamericanos, a quienes se les dá la misión de recomendar prioridades para la investigación agricola en América Latina. Este comité coloca el fríjol en un puesto destacado entre los renglones de producción de mayor importancia para América Latina y recomienda se apoye el desarrollo acelerado de investigaciones en fríjol. El otro hecho destacado es que la Junta Directiva del CIAT, en sesión extraordinaria convocada para definir aspectos de prioridades de investigación, decide que sea el Fríjol (Phaseolus vulgaris) la única especie dentro del grupo de Leguminosas de Grano comestible, que recibiría atención prioritaria en aspectos de investigación para el desarrollo de sistemas más eficiente en producción. Cabe mencionar que esta decisión la tomó la Junta Directiva del CIAT, después de ponder los proyectos sobre Frijol y sobre Frijol y Soya que se le presentaron.

A partir de esta decisión de la Junta Directiva del CIAT, se acelera la expansión del Programa de Frijol y se contrata el personal adicional necesario para las actividades correspondientes de investigación.

En 1972, casi simultáneamente, se celebran dos trascendentales reuniones internacionales, una la del Grupo Asesor de Proteínas de la Organización Mundial de la Salud/UNICEF/FAO, celebrada en Roma, en la cual se recomendó la aceleración de las investigaciones genéticas y agronómicas para elevar la producción y mejorar el valor nutritivo del fríjol. Por otro lado, la Reunión Regional de la FAO para América Latina, se celebró en Cali, Colombia, en la cual se reconoció el fríjol como un renglón importante de producción y se recomendó que la FAO diera atención prioritaria a su mejoramiento.

Los antecedentes anteriores se han mencionado para resaltar la gran preocupación e interés manifestados en diferentes sectores y entidades por apoyar y promover el mejoramiento del fríjol. A estas acciones podemos agregar la recomendación ofrecida, a comienzos de 1973, por la Comisión Especial del Comité Técnico Asesor (TAC) sobre la necesidad de organizar un programa cooperativo regional en América Latina, para el mejoramiento del fríjol.

Dado el interés expresado en forma tan amplia y por tan diversas entidades sobre la necesidad de acelerar las investigaciones tendientes a mejorar la producción y el valor nutritivo del fríjol, el CIAT organizó un Seminario sobre "El Potencial del Fríjol y de Otras Leguminosas Comestibles en América Latina y el Caribe". Este seminario, al cual asisterion 150 investigadores procedentes de 20 países, se celebró en Cali del 26 de Febrero al 1º de Marzo de 1973 y tuvo como objetivos los siguientes:

a) Considerar el status de la investigación y de la producción de leguminosas de grano comestible en América Latina y el Caribe.

b) Conocer cuál es el papel de las instituciones nacionales en el mejoramiento de la producción, el mercadeo y la aceptación de las leguminosas comestibles en la región y los mejores caminos para coordinar las actividades de investigación, desarrollo y adiestramiento.

c) Identificar las prioridades en las actividades de investigación, adiestramiento, producción y distribución.

d) Definir las oportunidades específicas para la participación y la contribución de las organizaciones internacionales a los esfuerzos de las instituciones nacionales.

e) Estudiar el funcionamiento y el apoyo a los proyectos específicos.

f) Tratar de establecer una cadena efectiva de colaboración institucional e individual para el desarrollo de investigaciones cooperativas y para el intercambio fluído de las ideas y de los materiales.

Se puede considerar que este seminario brindó pautas de organización y definición de prioridades al programa de fríjol del CIAT, las cuales permitieron aglutinar al equipo de investigadores y afinar los objetivos del programa, en general, y de los proyectos, en especial.

Como resultado del Seminario de Enero/Febrero de 1973 se estableción un grupo de trabajo ad hoc, el cual formuló una propuesta para el establecimiento de un programa cooperativo de investigación de frijol (Phaseolus vulgaris) para la América Latina y el Caribe, para ser presentada al TAC con una solicitud de apoyo económico para su funcionamiento. El CIAT no consideró que esta primera propuesta conduciría a un programa eficiente de cooperación, dado que sugería disociar las actividades de investigación de la de coordinación. Por esta razón, el equipo de investigadores de frijol del CIAT preparó una contrapropuesta, la cual fué finalmente aceptada por el TAC y la responsabilidad global del mejoramiento del fríjol fué asignada al CIAT. También, se obtuvo el apoyo economíco del BID para acelerar las actividades de investigación y de adiestramiento en aspectos de frijol en América Latina.

Un punto de coincidencia entre las propuestas presentadas al TAC, la del Comité ad hoc y la del CIAT, es el establecimiento de un Comité Asesor del programa de frijol, cuya función sería la de evaluar las actividades de investigación y adiestramiento y delinear la asignación de prioridades de investigación y promover la coordinación general de actividades.

Con el fin de evaluar el avance de los trabajos de investigación de frijol que había desarrollado el CIAT hasta Octubre de 1974, se organizó una conferencia de evaluación a la cual asistieron 19 científicos procedentes de 12 países. Esta conferencia también sirvió de base para definir la composición del Comité Asesor de Programa de Frijol, el cual quedó integrado por cuatro miembros de países latinoamericanos, uno de los Estados Unidos, uno de la región de Europa/Africa y un miembro del CIAT. Se espera que este comité actué con absoluta libertad, con amplitud de criterio, para establecer los mecanismos que servirán de base para el proceso de definición de prioridades y la correspondiente asignación de financiamiento a las disciplinas que integran el programa general de mejoramiento de frijol y los proyectos de actividad específica, dentro de cada disciplina.

De la información anterior se desprende un hecho común. Las decisiones sobre la asignación de los recursos disponibles para la investigación en el CIAT han sido hechas por diversos componentes del sistema y se han basado en muy diversos elementos de juicio. La Junta Directiva, los administradores de programas, los líderes de los equipos científicos, los mismos equipos científicos, así como los científicos individuales, han participado en una forma o en otra, en este complejo pero interesante y valioso proceso.

Es igualmente evidente que diversas entidades externas a nuestra institución también han sido determinantes en el proceso de decisión de prioridades y de asignación de recursos. Las instituciones donantes, el Grupo Consultivo, el TAC, los Comités Asesores específicos, los Comités Especiales de Estudio, los científicos destacados que nos visitan periódicamente, las opiones y demandas de las instituciones nacionales, etc., son tan solo unos pocos ejemplos de las entidades que, en una forma u otra, han influído y contribuído a dar la estructura actual a los programas del CIAT.

Obviamente, los caminos utilizados por el CIAT para tomar las decisiones sobre las prioridades de nuestras actividades de investigación, como una base para la asignación de los recursos necesarios para realizarlas, no son los más eficientes para este propósito.

Tampoco se pretende que deban ser ejemplos únicos a seguir en el futuro por nosotros mismos o por otras entidades de investigación sean ellas nacionales o internacionales. Consideramos muy necesario el mejoramiento de la eficiencia en la obtención de la información pertienente y necesaria, que deberá servir de base para el desarrollo de las metodologías que se deberán aplicar en los procesos de decisión de prioridades y de asignación de recursos en la investigación agropecuaria. A este respecto, quiero hacer referencia al trabajo que presentará el Dr. Per Pinstrup-Andersen, en el cual se propone un modelo que ha sido desarrollado por el Dr. Andersen con la colaboración de un grupo de sus colegas del Programa de Economía Agrícola del CIAT, modelo que se espera permitirá mejorar la base de información para la asignación de recursos. Seguramente que la metodología sugerida por el Dr. Andersen y sus colaboradores contribuirá a lograr la eficiencia en este campo que todos buscamos y deseamos.

PROCESO DE TOMA DE DECISION PARA ASIGNACION DE RECURSOS DE INVESTIGACION, EN UNA INSTITUCION NACIONAL: EL CASO DE INIAP, ECUADOR

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y

Kamal Dow *

Trabajo presentado en el Seminario sobre Métodos para Asignar Recursos en la Investigación Agrícola Aplicada en América Latina, CIAT, Cali,Colombia

Noviembre 26-29, 1974

* Instituto Nacional de Investigaciones Agropecuarias (INIAP) Quito, Ecuador

I. ESTRUCTURA Y ANTECEDENTES 1/ Enrique Ampuero *

Descripción General

El Instituto Nacional de Investigaciones Agropecuarias, INIAP, es una institución autónoma, adscrita al Ministerio de Agricultura, con representación jurídica y patrimonio propio. El presupuesto de INIAP se asigna anualmente o bianualmente en el presupuesto del Estado.

La máxima autoridad administrativa del INIAL es el Consejo de Administración, compuesto por el Ministro de Agricultura y Ganadería (quien lo preside), un Presidente Alterno, un representante de los agricultores y vocales que son representantes del Ministro de Finanzas, del Presidente de la Junta Nacional de Planificación y Coordinación Económica, del Banco Nacional de Fomento y de la Corporación Financiera Nacional.

El Consejo de Administración traza la política de investigación del INIAP, aprueba la marcha técnica y administrativa del Instituto, orienta las inversiones y ratifica la creación de nuevos programas dentro del contexto del Plan Nacional de Desarrollo del Ecuador.

PROCEDIMIENTO PARA LA TOMA DE DECISIONES DE ASIGNACION DE RECURSOS

Las prioridades que han guidado la Asignación de Recursos

El INIAP se creó en el año 1962, adquiriendo la responsabilidad de organizar, poner en marcha y desarrollar la investigación agropecuaria nacional. Antes de la creación del Instituto, las labores de investigación estaban repartidas entre varias entidades públicas, cada una enfocando su trabajo en áreas de propio interés y llevando a cabo la investigación, como actividad subordinada a sus responsabilidades pr-

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1/ El autor desea expresar su agradecimiento al Dr. Michael Schwartz, miembro de la Misión de Asistencia Técnica de la Universidad de Florida, por sus valiosas sugerencias.

primarias. Bajo este sistema, las entidades funcionaban aisladamente, con personal e instalaciones cuya orientación principal no era la investigación.

Cuando el INIAP inició sus actividades, los directores asignaron, como su primera función, la creación de una institución especializada en labores de investigación, con suficiente competencia para afrontar las necesidades del sector agropecuario y mantener un alto nivel de capacidad técnica, a largo plazo. Para realizar este trabajo el INIAP señaló tres objetivos prioritarios, en su etapa inicial:

- La selección, capacitación y estructuración del personal técnico
- El desarrollo de la infraestructura para llevar a cabo los programas de investigación
- La creación de un ambiente de estabilidad institucional y de estímulo para sus técnicos.

Estos tres objetivos continuaron siendo el propósito fundamental de los directores de INIAP, durante los primeros diez años de funcionamiento del Instituto. Para lograr los dos primeros objetivos, la institución buscó la ayuda y asesoría de aquellas entidades internacionales con mayor experiencia y hubieran alcanzado mayor éxito en actividades similares. El tercer objetivo se ha logrado con la cooperación del Gobierno Nacional el cual ha sabido apreciar, no solamente la importancia que tiene un instituto de investigación en el progreso económico y social de un país, sino también el hecho de que su efectividad depende, en gran parte, de su autonomía filosófica y administrativa, ajena por completo a los vaivenes transitorios de la política, a los cuales el sector público se expone con alguna frecuencia en América Latina.

El mecanismo de Toma de Decisiones

La Dirección General del INIAP mantiene una política flexible en lo referente a asignación de recursos especiales a proyectos y programas. Tal asignación se hace con base en la mayor efectividad que muestran tales programas, ya sea valorada por la calidad del personal técnico responsable, por las contribuciones y resultados obten-

obtenidos en los proyectos en marcha, o bien, por nuevas necesidades surgidas durante el período de duración de los proyectos.

Por medio de reuniones anuales de revisión de programas y discusiones quinquenales de evaluación de objetivos de los programas; evaluaciones periódicas del estado de preparación del personal y realizaciones obtenidas, se logra formar criterio, por parte de las autoridades del Instituto, para estimar las necesidades de un programa y en consecuencia, ajustar las asignaciones de recursos humanos y físicos.

A estas reuniones periódicas de evaluación se invita a agricultores, líderes del sector agropecuario y directivos de instituciones agropecuarias vinculadas con cada programa, incluyendo a los directivos de las diversas dependencias del Ministerio de Agricultura.

La oficina del Director General del INIAP elabora la proforma presupuestaria para el año siguiente, recogiendo e integrando las necesidades físicas y de personal de los diversos departamentos de las Estaciones Experimentales. Los Jefes de Programa y de Departamento, en cada una de las Estaciones Experimentales, preparan sus respectivas proformas, las cuales son remitidas posteriormente a la Dirección General.

El Consejo de Administración revisa y aprueba la proforma presupuestaria siendo luego enviada a consideración de la Dirección Nacional de Presupuesto y de la Junta Nacional de Planificación Económica.

Los Jefes de Programa y de Departamentos deben someter a consideración de la Dirección General y Consejo de Administración a más tardar en el mes de Diciembre los proyectos de investigación que intentan realizar en el siguiente año. Esta programación debe guardar relación con la proforma presupuestaria del INIAP. Ajunta a la proforma presupuestaria, la Dirección General debe presentar a las autoridades nacionales un justificativo de objetivos de cada programa, proyectos y posibles realizaciones.

En el mes de Enero, de cada año, el Gobierno Nacional publica en el Registro Oficial la Ley de Presupuesto que contiene la asignación que se ha otorgado a cada institución. Con base en la suma asignada el Comité Técnico del INIAP, compuesto por los Directores de Estaciones Experimentales, Subdirectores y Director Administrativo, se reúnen para hacer los reajustes necesarios, de acuerdo con las prioridades establecidas en la Programación Nacional de Investigación. En esa reunión se revisan las necesidades físicas de desarrollo de las Estaciones Experimentales y las creaciones de nuevos cargos. Antes de delebrar esta reunión, cada Director de Estación ha tenido una discusión con los Jefe de Programa para establecer las prioridades de cada programa.

Por lo menos una vez cada año, se lleva a cabo una reforma del presupuesto para aumentar las disponibilidades de las partidas que están agotadas y de ser necesario, hacer transferencias de recursos de partidas sobrantes. El Comité Técnico del INIAP participa en estas decisiones; el Consejo de Administración de INIAP aprueba finalmente la reforma y ésta es remitida inmediatamente a la Dirección de Presupuesto para su aprobación final.

La Administración Central transfiere, quincenalmente, un fondo rotativo a cada Estación para los gastos generales con base en sus respectivos presupuestos. Internamente, en cada Estación, el Director asgina los recursos a los programas de acuerdo a las necesidades y proyectos en marcha. Estraordinariamente, se giran fondos de la Administración Central a las Estaciones, para atender necesidades urgentes.

<u>Grupos especiales que expresan demanda por investigación</u>

La Junta Nacional de Planificación y Coordinación Económica, y el Ministerio de Agricultura y Ganadería, solicitan al INIAP que se lleven a cabo algunos programas específicos de investigación que se considere son necesarios para el país, dentro del contexto del Plan Nacional de Desarrollo.

Los agricultores, a través de las Cámaras de Agricultura, Centros Agrícolas y Convenciones Nacionales, solicitan al INIAP la iniciación de programas de investigación que consideren prioritarios o el establecimiento de estaciones experimentales.

Además, las instituciones de desarrollo regional, como la Comisión de Estudios para el Desarrollo de la Cuenca del Río Guayas (CEDEGE), el Centro de Reconversión de Manabí (CRM), del Austro (CREA), y otros proyectos regionales, presentan al INIAP solicitudes para hacer investigación sobre el comportamiento de las nuevas variedades, prácticas de cultivo y desarrollo de sistemas de producción apropiados para su zona en particular.

La presión que recibe INIAP de los agricultores e instituciones de Gobierno para instalar nuevas estaciones experimentales y crear nuevos programas de investigación es considerable y continua; sin embargo, el INIAP ha sido cauteloso en no multiplicar el número de actividades ántes de terminar el desarrollo de las Estaciones actuales y llegar a niveles aceptables de productividad en los programas existentes. Una vez que esto se ha logrado, se podrán añadir nuevas dimensiones al Instituto, con base en criterios socioeconómicos de prioridades para el desarrollo.

La experiencia del INIAP en cuanto a la asignación de recursos y de prioridades para la investigación agropecuaria, ha sido satisfactoria. Los programas de investigación actualmente en marcha están relacionados con prioridades establecidas por el Gobierno Ecuatoriano en cuanto a producción de alimentos y materia prima para la industria. El desarrollo de los recursos humanos y de infraestructura ya permite la consideración de nuevas actividades y centros de investigación en áreas y zonas prioritarias. El establecimiento de una institución especializada en la investigación agropecuaria ya ha sido lograda; en adelante, el énfasis se pondrá en la selección de los campos de investigación que exijan, en mayor grado, la atención del INIAP.

II. CRITERIOS Y PERSPECTIVAS 1/ Kamal Dow *

La primera parte de este trabajo (Capítulo I), puso en claro dos hechos muy importantes con respecto a la asignación de recursos; en primer lugar, se dió prioridad a la creación de la infraestructura institucional, hecho muy lógico dado el poco tiempo que tenía la institución de haberse establecido; en segundo lugar, en la asignación de recursos a diferentes actividades, el criteri que rigió fué el rendimiento relativo de cada actividad medido por los resultados o contribuciones al sector y de una manera esencialmente subjetiva.[1]

El personal del INIAP está consciente de que este criterio único que ha servido sus propósitos no puede regir la asignación de recursos a largo plazo. En primer lugar, los resultados o contribuciones están probablemente determinados, en gran parte, por las asignaciones anteriores de recursos, las cuales - en muchos casos - obedecen a factores externos o no relacionados con los criterios que deben guiar la determinación de prioridades.

Entre los factores externos, es fácil identificar dos que han influenciado la asignación de recursos en el pasado:

1. La disponibilidad de fondos de ayuda externa que, en la mayoría de los casos, implican la obligación de ser usados exclusivamente en determinados productos agropecuarios o programas.
2. La escasez de personal profesional calificado; esta limitación impide hacer una adecuada distribución de recursos humanos en la forma como pareciera más deseable.

1/ En programas de investigación incipientes una medición objetiva de los resultados, en términos de contribución al sector, es muy difícil de lograr, si no es del todo imposible.

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Con el objeto de cofregir la influencia de estos factores y para poder tener elementos de juicio que permitan una asignación óptima de recursos <u>ex ante</u>, hemos tratado de incluír una serie de criterios económicos y sociales que deseamos presentar, como tema de discusión, en este seminario. El primer esfuerzo de inclusión de estos criterios para determinar prioridades en INIAP fué un trabajo realizado hace aproximadamente dos años[2/] y en el cual se usó el siguiente modelo:

$$PTi = \sum_{j=1}^{n} \alpha j \; Wij \qquad i = 1, \ldots, m \;\; ; \quad j=1, \ldots, n$$

en donde:

PTi = Puntaje total correspondiente a la actividad i

α_j = Peso relativo asignado al criterio j

Wij = Peso relativo asignado a la actividad i dentro del criterio j

n = Número de criterios considerados

Este modelo permitió comparar m actividades y ordenarlas de acuerdo al puntaje obtenido. Obviamente, este modelo es bastante crudo y simple; para ser usado en el proceso de toma de decisiones a largo plazo, habría que perfeccionarlo. Como el propósito de este seminario es exactamente el de estudiar la forma como se puede mejorar el proceso de toma de decisiones, creo que vale la pena exponer y discutir los criterios usados y sus problemas.

<u>Número de Explotaciones</u>

Parece obvio que un criterio importante para determinar su prioridad sea el número de agricultores que se beneficien de un programa de investigación. En los datos de censos agropecuarios se encuentran cifras de número de agricultores por cultivo. Sin embargo, como estos censos se realizan por lo general con intervalos de aproximadamente diez años, los datos en muchos casos no son corrientes y hay que acudir, como en nuestro caso, a una encuesta agropecuaria con sus siguientes defi-

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2/ KAMAL DOW, 1973. Determinación de Prioridades en la Investigación Agropecuaria. INIAP. Publicación Miscelánea No.4. Quito, Ecuador.

deficiencias. En el caso de Equador fué también difícil identificar los agricultores beneficiarios ya que los datos disponibles no diferenciaban entre productores comerciales y marginales; por ejemplo, entre las explotaciones de 50 a 100 hectáreas sembradas con maíz está incluída la explotación que tiene 80 hectáreas de maíz comercial, lo mismo que la finca de 80 hectáreas de trigo en la que el propietario tiene una hectárea de maíz para consumo de su familia y trabajadores.

Incidencia en la Balanza de Pagos

En la mayoría de los paísese latinoamericanos, la disponibilidad de divisas es factor importante en el desarrollo; en igual forma, la mayoría depende del sector agropecuario para la obtención de esas divisas. También, en muchos casos, hay una gran dependencia en exportaciones del extranjero para el abastecimientos de ciertos productos (trigo, por ejemplo, en países tropicales). Por estas razones, parece lógico dar prioridad a los productos importantes en la exportación o en la sustitución de importaciones. En el caso particular del Ecuador, hay que tener en cuenta que si se fuera a realizar este estudio de nuevo, tal criterio merecería menos importancia ya que el petróleo ha aliviado bastante la situación de Balanza de Pagos. Este criterio es el más fácil de medir de todos, puesto que el Banco Central lleva estadísticas al día del comercio internacional.

Crecimiento Futuro de la Demanda

Este criterio se consideró importante desde el punto de vista de protección y satisfacción de las necesidades futuras del consumidor el cual tendría que pagar, con menor consumo o precios más altos, el fracaso del sistema productivo de aumentar la oferta a la par con la demanda. La medición de este criterio es menos confiable que los anteriores ya que se basa en proyecciones de demanda afectadas no sólo por la incertidumbre inherente al futuro sino por la deficiencia de estudios de demanda y de conocimiento de elasticidades para los diferentes productos.

Valor de la Producción

Este criterio es importante ya que refleja los pagos hechos y por lo tanto, los ingresos de los diferentes factores que contribuyen al proceso de producción agropecuaria. La dificultad principal de medición en este criterio reside en la ausencia de datos de precios a nivel de finca; por tal razón, debemos conformarnos con precios al por mayor, los cuales incluyen los márgenes de comercialización que varían de producto a producto.

Empleo de Mano de Obra

Una de las metas principales del Plan de Desarrollo es la reducción del desempleo y subempleo los cuales afectan al agro Ecuatoriano; por esta razón se consideró importante este criterio. Su medición se hizo a través del empleo de mano de obra en número total de jornales por año, para cada actividad. En un modelo más refinado habría que pensar en la posibilidad de más de un subcriterio; por ejemplo, los productos que requieren más etapas de procesamiento antes de llegar al consumidor final contribuyen a generar empleo y a redistribuír el ingreso; una medida de este factor podría ser una relación precio final-precio de finca; el uso de esta relación, sin embargo, implicaría un buen conocimiento del proceso de comercialización y sus posibles imperfecciones para que la comparación no sea distorsionada. Igualmente, la intensidad de uso de mano de obra, medida en jornales por unidad de superficie en producción, sería importante para identificar las actividades que contribuirán más a la creación de nuevas fuentes de empleo.

Impacto Social

A pesar de su gran importancia, este criterio es el más difícil de cuantificar dadas sus condiciones de subjetividad. En el caso del INIAP, se usaron medidas tales como número de pequeños agricultores en los que se reflejaría la actividad, impacto de la actividad en el nivel nutricional de la población, etc.

Para la asignación de los pesos relativos a las distintas alternativas dentro de cada criterio fué necesario tener en cuenta las limitaciones en la disponibilidad de información; por tal razón fué difícil hacer una clasificación estrictamente ordinal. En la mayoría de los casos, hubo que conformarse con agrupar las alternativas en tres grupos que fueron llamados de alta, normal y baja prioridad. Esto es particularmente cierto en aquellos criterios que son más subjetivos, así como en los que implican proyecciones. Por ejemplo, podemos diferencias fácilmente entre un producto cuya demanda se proyecta que aumentará en un 100 por ciento y uno que aumentará en un 30 por ciento; sin embargo, si las cifras son 30 y 40 por ciento, al diferenciarlos, no se puede tener la misma confianza en la clasificación final.

Para la asignación de los pesos relativos a los diferentes criterios se ha de tener en cuenta, principalmente, su importancia relativa dentro de los planos nacionales de desarrollo. En el caso del INIAP, también se consideró la objetividad y la confiabilidad de la información usada para la medición, dando más peso a aquellos criterios con mejor información estadística y cuya cuantificación era más confiable.

De la misma manera que el modelo utilizado en el INIAP no pretender ser final, los criterios utilizados no pretenden ser exhaustivos y la metodología, en todos sus aspectos, está sujeta a ser discutida y mejorada; por tal razón, creemos que la discusión del proceso de toma de decisión en el INIAP, a la luz de los demás que se expongan en este seminario, harán que los beneficios que obtengamos será mayor que nuestra contribución. Indudablemente, es poca la experiencia que tenemos de esta materia debido a lo nuevo del tópico: sin embargo, deseamos hacer la sugerencia de que, a lo largo de estas reuniones, se discutan - entre otros - los puntos siguientes:

1. Estudiar la necesidad de desarrollar un modelo refinado para comparar alternativas y determinar prioridades en la asignación de recursos para la investigación.

2. Determinar la adaptabilidad de este modelo general, para casos que difieren en lo que se refiere a disponibilidad de información, es decir, que no sea un modelo rígido.

rígido.

3. Explorar nuevos criterios que puedan utilizar para determinar prioridades.

4. Explorar criterios alternos a los mencionados, que aunque están orientados a satisfacer las mismas metas, tengan mejores características de objetividad o mesurabilidad.

5. Desarrolar criterios que permitan una mejor asignación de pesos relativos para las diferentes alternativas dentro de cada criterio, así como para cada criterio.

6. Discutir posibles maneras de cuantificar la importancia dentro de los criterios de los diferentes "programas de apoyo" que juegan papel tan importante en la investigación agropecuaria. Por motivos obvios, es más difícil incluír estos programas como alternativas medibles para ser comparados con programas de producción. Por esta razón, en muchas ocasiones, se consideran como que su prioridad está condicionada a las prioridades que tengan los programas que lo utilizan en distintas proporciones. Por esta razón, la determinación de prioridades para programas de apoyo es posterior a la de programas de producción.

7. Hacer hincapié en la necesidad de investigar mejores maneras de medir el producto de la investigación, de tal manera que, en el futuro, se puedan usar con más frecuencia criterios de costo-beneficio para evaluar diferentes alternativas. Sería conveniente ir desarrollando herramientas que ayuden a determinar la función de producción de la investigación en diferentes casos específicos.

MODELO PROPUESTO PARA MEJORAR LA BASE DE INFORMACION PARA LA ASIGNACION DE RECURSOS EN INVESTIGACION*

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* Trabajo presentado en el Seminario sobre "Métodos para asignar recursos en la Investigación Agrícola Aplicada en América Latina," CIAT, Cali, Colombia. 26-29 de Noviembre, 1974

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Con el fin de establecer prioridades de investigación con alta relevancia se necesita tener disponibilidad de información sobre las utilidades esperadas, los costos y el tiempo requerido para cada una de las líneas de investigación consideradas. Lo ideal sería que el administrador de investigación* tuviera un conocimiento perfecto de los resultados de la investigación y de su posible contribución al logro de metas establecidas, así como de los costos y del tiempo requerido para cada línea de investigación. Si este fuera el caso, asumiendo que existe una meta bien definidad, sea singular o agregada, los recursos de investigación disponibles se podrían asignar de tal manera que maximizaran la contribución para lograr esta meta y no se necesitase un juicio subjetivo en el proceso de toma de decisiones.

Sin embargo, a cuasa de la naturaleza misma de la investigación, las decisiones sobre prioridades de investigación estarán siempre sujetas a la incertidumbre. Esta incertidumbre inherente de los resultados de la investigación, con frecuencia va acompañada de la falta de información sobre aspectos importantes para las decisiones que pueden, de hecho, estimarse con cierto grado de certeza. Estos factores incluyen la ganancia potencial en producción y productividad proveniente de resultados alternativos de investigación, su impacto sobre el empleo, nutrición e ingresos agrícolas. Los autores del presente trabajo sugieren que la información adicional sobre estos y otros puntos relacionados puede ser de gran utilidad para el administrador de investigación al establecer las prioridades de la misma.

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* El término "administrador de investigaciones" se emplea para designar a la persona o al grupo de personas que toman las decisiones sobre prioridades de investigación. Dependiendo de la organización de la investigación y del nivel de investigación para el cual se necesita establecer prioridades, el "administrador de investigación" puede ser el mismo científico o un grupo de ellos, un director de investigaciones o cualquier otra persona o grupo dentro del sistema investigativo.

Un modelo general para suministrar esta clase de información se sugiere en otros trabajos.** El presente documento se limita a presentar una metodología para 1) describir el proceso de producción, 2) identificar los factores limitantes de la producción y de la productividad, 3) estimar la importancia relativa de cada uno de estos factores, y 4) obtener indicaciones sobre las características de la tecnología preferida por el agricultor.

Además de los requisitos de información descritos en el presente trabajo, otra información importante para la toma de decisiones sobre asignación de los recursos en investigación incluye la demanda futura esperada de los productos, la oferta futura y disponibilidad de recursos y las preferencias de los consumidores.

El presente trabajo se divide en dos partes. Primero, se sugiere una metodología sencilla para obtener del sector agrícola la información mencionada anteriormente y luego, se describe la experiencia obtenida al probar empíricamente la metodología y se incluyen algunas ilustraciones de la clase información obtenida. El trabajo enfoca los aspectos prácticos de la recolección y análisis de los datos.

METODOLOGIA SUGERIDA

Con frecuencia, las prioridades en la investigación agrícola aplicada se establecen con base en información muy limitada sobre los problemas existentes y su relativa

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**PINSTRUP-ANDERSEN, PER. 1973 Asignación de Recursos en Investigación Agrícola Aplicada en América Latina; Enfoque preliminar. Trabajo presentado en el Seminario Regional de Aspectos Socioeconómicos de Investigación Agrícola organizado por el IICA. Maracay, Venezuela. Abril 10-13, 1973.

PINSTRUP-ANDERSEN, PER. 1974. Toward a Workable Management Tool for Resource Allocation in Applied Agricultural Research in Developing Countries. Versión revisada del trabajo presentado en la Reunión de la Fundación Ford para Consejeros de Programa en Agricultura. Ibada, Nigeria. Abril 29-Mayo 4, 1974.

PINSTRUP-ANDERSEN, PER y DAVID FRANKLIN. 1975. A Systems Approach to Agricultural Research Resource Allocation in Developing Countries. Trabajo preparado para la Conferencia sobre Asignación de Recursos y Productividad en Investigación Agrícola Aplicada. Airlie House, Virginia. Enero 26-29, 1975.

importancia económica en el proceso de producción. A menudo, la comunicación entre el sector agrícola y los centros de investigación es deficiente y el administrador de investigación no conoce bien las demandas de investigación a nivel de la finca. Con excepción, tal vez, de los agricultores comerciales y de los miembros de asociaciones de productores efecientes, los agricultores de la mayoría de los países en desarrollo tienen severas dificultades para comunicar sus necesidades de investigación a los institutos de investigación, a causa de barreras institucionales y sociales. Esta situación hace que algunas de las investigaciones posiblemente no se relacionen con los problemas reales de la finca y que los resultados de la investigación no sean adoptados.

Con frecuencia, se asume que el bajo nivel de adopción de la nueva tecnología es el resultado de un servicio de extensión poco efectivo. Aunque es posible que el servicio de extensión, en ciertos casos, no tenga la capacidad necesaria para asegurarse de la adopción de nueva tecnología, una de las razones primordiales de la baja tasa de adopción puede ser el que la nueva tecnología disponible no satisface las necesidades más urgentes de la finca ni las preferencias del agricultor. Para asegurar el que la nueva tecnología se ajuste a las necesidades y preferencias de los agricultores y, por lo tanto, acelere la adopción y aumente la utilidad de la investigación, se debería establecer un flujo continuo de información hacia el administrador de investigación sobre las ganancias potenciales de producción, productividad y riesgo de actividades investigativas, tales como: 1) desarrollo de resistencia a los insectos y enfermedades prevalentes; 2) cambio de prácticas culturales; 3) cambio de tipo de planta; 4) cambio de respuesta de la planta a los nutrimentos, etc., así como información sobre las preferencias de los agricultores en relación con la nueva tecnología.

Este flujo informativo puede consistir en un suministro continuo de información dada por el agricultor a las instituciones de investigación por medio del servicio de extensión. Otro medio efectivo de información sería el contacto directo entre investigadores y agricultores a través de reuniones, visitas a la finca, etc. Se sugiere en este trabajo un tercer método para complementar los dos anteriores. Este consiste en una combinación de encuestas agroeconómicas y de experimentos agrobiológicos, los cuales se describen a continuación.

Encuestas agroeconómicas

La encuesta agroeconómica trata de transmitir al administrador de investigación la demanda de investigación agrícola aplicada a nivel de la finca, mediante una relación directa establecida entre la finca y el centro de investigación. Además de satisfacer las necesidades de los administradores de investigación, se espera que la información generada por las encuestas agroeconómicas sea útil para establecer o revisar la política gubernamental en tópicos tales como extensión agrícola, crédito y precios. Finalmente, la información puede ser útil para las asociaciones de productores y los agricultores (Figura 1). Sin embargo, el propósito primordial de las encuestas es el de suministrar información para establecer prioridades de investigación.

La Figura 2 muestra el marco de referencia sobre el cual se basa la selección de datos que se van a recolectar. Se intenta describir ciertos aspectos claves de la estructura, conducta y desempeño del proceso de producción, de los objetivos del agricultor y de la interacción de estos factores. Se ha dado énfasis a la identificación de los principales factores limitantes de la producción y de la productividad y a la estimación de las implicaciones que se presentarían al eliminar estos factores.

Estructura del proceso. La estructura del proceso de producción se refiere a características determinadas por factores externos al proceso mismo. La estructura representa las limitaciones dentro de las cuales funciona el proceso. Algunas de ellas pueden ser modificadas o eliminadas por el agricultor, mientras que otras están fuera de su control. La Figura 3 muestra los factores estructurales descritos por las encuestas agroeconómicas. Dado el propósito de la encuesta, se da mayor énfasis a los factores agrobiológicos y ecológicos.

La mayoría de los datos relacionados con los factores agrobiológicos se obtiene mediante observación directa en los campos de los agricultores. Se notan la presencia y severidad de ataques de las enfermedades y por insectos, las deficiencias de minerales y la aparición de malezas. Además, se describen la altura, la calidad del suelo (mediante muestras de suelo), la disponibilidad de agua, el tipo de planta y el desarrollo general de la misma. La percepción de los problemas agrobiológicos, por parte del agricultor, se compara con las observaciones de campo. Además, se obtienen datos de los agricultores sobre precios de insumos y productos y sus fluctuaciones; disponibilidad de insumos comerciales, crédito y asistencia técnica; tenencia de la tierra, tamaño de la finca, capital y ciertas características del agricultor y su familia.

Conducta del proceso. La conducta describe la acción resultante de las decisiones del agricultor en relación con el proceso de producción. En la encuesta se obtienen datos sobre: 1) el uso de la tierra controlada por el agricultor; 2) los cultivos encontrados en el proceso de producción estudiado; 3) las prácticas culturales de siembra y de cosecha; 4) el uso de insumos tales como fertilizantes e insecticidas así como crédito y asistencia técnica y 5) la utilización de los productos obtenidos mediante el proceso estudiado (Figura 4). Se da énfasis al análisis de la relación existente entre la estructura y los objetivos, por una parte, y de la conducta, por otra, para determinar los principales factores limitantes de la producción.

Desempeño del proceso. El proceso mide los resultados del proceso de producción en términos de metas establecidas. Mediante la encuesta, se obtienen datos sobre rendimiento, producción, costos, absorción de mano de obra, consumo casero, variación de rendimientos (riesgo) e ingresos brutos y netos (Figura 5).

Objetivos de los agricultores. Se intenta describir las metas del agricultor y la importancia relativa de los ingresos, riesgo y disponibilidad de productos para consumo casero dentro de la función objetiva para ayudar a identificar tecnología, con un alto índice esperado de adopción. Este trabajo incluye recolección de datos sobre la razón por la cual ciertos tipos de tecnología han sido o no adoptados y los factores que determinan la selección de sistemas de cultivo.

Mecanismo para la recolección de datos. Un pequeño grupo especializado de agrónomos y economistas obtiene los datos primarios en un panel de fincas que se espera sean representativas de las fincas para las cuales se intenta hacer investigación agrobiológica. El grupo hace visitas periódicas (normalmente, 3-4 visitas) a cada finca durante el ciclo completo de cultivo. Aproximadamente, la mitad del tiempo en la finca se gasta en la recolección de datos de campo sobre tópicos agrobiológicos (mediante observación directa) y el resto del tiempo se emplea en entrevistar al agricultor.

Antes de comenzar la recolección de datos, el grupo de campo recibe adiestramiento sobre el diagnóstico de problemas de producción a nivel de la finca. El adiestramiento del grupo de campo es uno de los puntos más importantes para asegurarse de la obtención de datos de alta calidad de la encuesta agroeconómica. Se requieren una habilidad y experiencia considerables para hacer el diagnóstico en el campo; por ejemplo, cuando se trata de distinguir entre los diversos síntomas de ciertas enfermedades, daños causados por insectos, deficiencias de minerales, etc. De aquí que la participación directa de un grupo de investigación multidisciplinario y altamente calificado en adiestramiento y labores de campo sea esencial para el éxito de la encuesta. Los grupos de campo que trabajan en las encuestas agronómicas que se realizan actualmente en el CIAT reciben de 3 a 4 meses de adiestramiento antes de iniciar la encuesta, durante los cuales están en contacto directo con los científicos de las disciplinas correspondientes.

Experimentos agrobiológicos

La encuesta agroeconómica suministra un estimativo del área afectada por cada uno de los problemas identificados. Además, indica el impacto sobre el rendimiento. Sin embargo, es difícil estimar con precisión el impacto sobre el rendimiento basándose sólo en los datos obtenidos en la encuesta. Por consiguiente, se realizan experimentos controlados con el fin de poder cuantificar el impacto de los problemas en el rendimiento.

<u>Análisis de datos</u>

Los datos obtenidos en la encuesta agroeconómica y los experimentos relacionados se analizan con el fin de: 1) describir la estructura, conducta y desempeño del proceso de producción bajo estudio y 2) estimar el impacto del cambio de la estructura del proceso y la conducta en el desempeño. Además de sumar los datos para poder presentar una descripción del proceso, se da énfasis a la estimación de la pérdida económica causada por cada uno de los factores agrobiológicos y ecológicos, tales como enfermedades, insectos, malezas, deficiencias del suelo, condiciones adversas de precipitación fluvial y las implicaciones que se presentarían al cambiar estos factores. Además, se estiman: 1) los costos de producción y absorción de mano de obra de cada actividad de producción; 2) los retornos netos al proceso en cada uno de los principales sistemas de cultivo; 3) la contribución de cada uno de los principales recursos a los retornos netos y 4) los factores que influyen en la toma de decisiones por parte del agricultor, en relación con la adopción de nueva tecnología y selección de sistemas de cultivo.

ILUSTRACION DE RESULTADOS EMPIRICOS

Actualmente, se realizan proyectos en Colombia para probar en el campo la metodología descrita anteriormente, en cultivos de maíz, yuca y fríjol. Aunque se espera que la información obtenida de estos estudios empíricos sea útil para la instituciones colombianas y para el CIAT, el propósito principal de este trabajo es desarrollar y probar una metodología sencilla para utilizarla en las instituciones nacionales de investigación en América Latina y en otras áreas del mundo. Este capítulo tiene por objeto presentar unos pocos resultados preliminares sobre este trabajo con el fin de dar una ilustración sobre la clase información suministrada por la encuesta agroeconómica. A medida que se encuentren disponibles los respectivos informes de proyectos, se podrá obtener información más completa.

La Figura 6 muestra los sistemas de cultivo encontrados en las fincas incluídas en un análisis agroeconómico del maíz en Colombia. Aproximadamente, la mitad de los agricultores visitados cultiva maíz mezclado con otros cultivos, principalmente fríjol. En un estudio sobre yuca se identificaron 14 sistemas diferentes de cultivo. La Figura 7 muestra la presencia de problemas agrobiológicos y ecológicos en las fincas visitadas. El daño causado por insectos parece ser más frecuente en las regiones de poca altura y las enfermedades, menos importantes en las mayores alturas.

El porcentaje de fincas de maíz visitadas y el del área total de estas fincas afectadas por cada una de las enfermedades y los insectos más importantes aparecen en las Figuras 8 y 9. Se encontró que Helminthosporium, Phyllacora maydis y Puccinia sorghi son las enfermedades más comunes en las fincas maiceras. Spodoptera es el insecto más comunmente encontrado (45 por ciento de las fincas y 20 por ciento del área sembrada de maíz). Sin embargo, aunque se encontró Diatraea en una menor proporción de findas (37 por ciento) el área afectada es mayor (22 por ciento).

Actualmente, se encuentran disponibles los datos sobre el ataque de las enfermedades y sobre los daños causados por insectos en yuca, recolectados durante las primeras visitas hechas a 300 productores de yuca (Figuras 11 y 11). La primera visita se hizo cuando el cultivo tenía menos de cuatro meses de edad; por consiguiente, los datos que aparecen en las Figuras 10 y 11 se refieren solamente a cultivos de esa edad.

El uso de insumos es otro de los aspectos tratados en la encuesta agrobiológica. La Figura 12 muestra el porcentaje de agricultores de la muestra que emplea semilla mejorada, fertilizantes e insecticidas. El uso de semilla mejorada no era común en ninguno de los tres departamentos incluídos en la encuesta. El porcentaje de agricultores que aplica fertilizantes y/o insecticidas al maíz, varió considerablemente entre los departamentos.*

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* División territorial utilizada en Colombia.

Como última ilustración de la clase de datos obtenidos, la Figura 13 muestra los rendimientos de maíz por departamento, altura y sistema de cultivo. Se encontró una diferencia considerable en el rendimiento entre los diferentes departamentos. La relación entre rendimiento y altura no fué pronunciada aunque hay indicaciones que los rendimientos son mayores en fincas que se encuentran ubicadas a poca altura. Es interesante anotar que la presencia de otros cultivos en el campo de maíz parece no haber tenido ningún impacto en los rendimientos de ese cultivo. Deseamos repetir que la información presentada previamente es sólo de naturaleza ilustrativa. Tan pronto como sea posible, después de completar los proyectos que están en marcha, se dispondrá de informes completos de los estudios anteriormente descritos.

Beneficios del adiestramiento

Además de la utilidad esperada de la información disponible resultante de los análisis agroeconómicos, el trabajo suministra una valiosa oportunidad de adiestramiento para agrónomos y economistas jóvenes interesados en producción. El extenso adiestramiento inicial y la experiencia obtenida durante la conducción de encuestas produce profesionales conocedores de las limitaciones de producción a nivel de la finca y de las posibles medidas para eliminar estas limitaciones en el cultivo o cultivos, sobre el cual o los cuales, se hizo la encuesta. Se espera que estos profesionales en sus actividades futuras complementen los resultados empíricos de la encuesta creando estrechos lazos entre la investigación y los problemas a nivel de la finca.

Comentarios finales

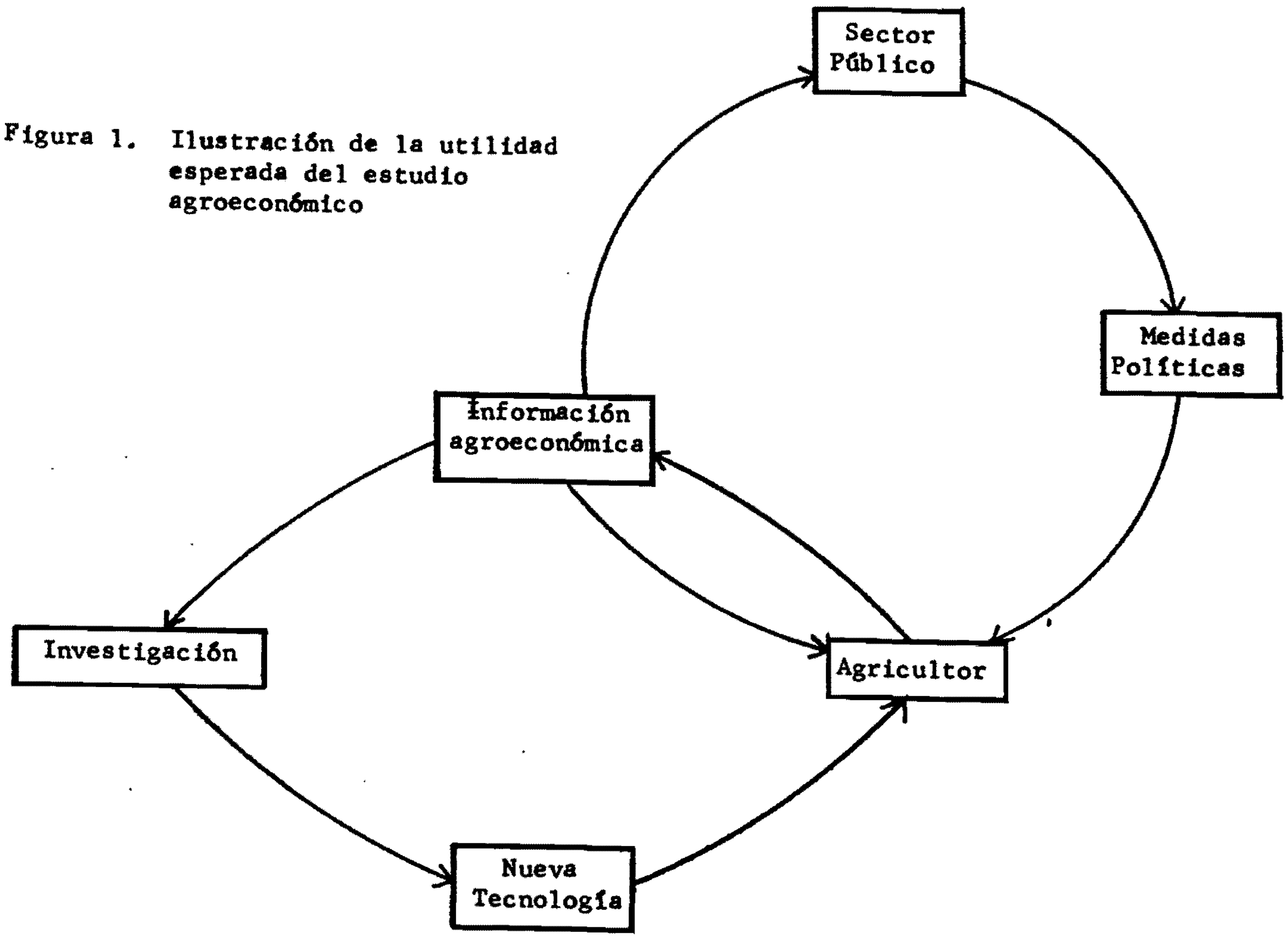
No se trata de afirmar en el presente documento que la encuesta agroeconómica es una nueva invención pues, en épocas anteriores, se han realizado muchas encuenstas entre agricultores. Sin embargo, ciertos aspectos del trabajo descrito anteriormente tienden a distinguirlo de las encuestas agronómicas tradicionales y a hacerlo más útil para establecer prioridades en la investigación agrícola aplicada. Estos aspectos son:

1. Una considerable proporción de los datos se obtiene en observaciones directas de campo hechas por agrónomos que han recibido adiestramiento previo en este aspecto;
2. Cada finca es visitada periódicamente durante un ciclo completo del cultivo.
3. El trabajo es de caracter multidisciplinario e involucra la participación directa de profesionales de todas las disciplinas pertinentes.
4. El trabajo se enfoca especialmente en el suministro de información necesaria para establecer prioridades investigativas. Aunque la información puede ser útil para otro propósito, esto último se considera secundario.

El trabajo previamente descrito se encuentra en una fase preliminar y aún no se puede identificar una contribución significante a la asignación de recursos para investigación. Sin embargo, se puede esperar que la participación directa de los científicos biológicos del CIAT en la planificación de proyectos y en el adiestramiento de agrónomos para trabajo en el campo, así como la interacción con estos agrónomos cada vez que regresen a la estación experimental y la distribución de los resultados preliminares, en relación con los proyectos, pueden haber sido de algún valor para los científicos al planear futuras investigaciones. Sin embargo, se necesita más tiempo para terminar la primera etapa de recolección y análisis de datos antes de poder establecer el valor real de estos esfuerzos para asignación de recursos en investigación.

La metodología y experiencia obtenidas con este trabajo estarán a disposición de las instituciones nacionales de investigación interesadas, que las soliciten. Además, el CIAT tomará en consideración posibles solicitudes de asistencia técnica y adiestramiento para proyectos de esta naturaleza. Actualmente, se está planeando un proyecto cooperativo con el INIAP, en Ecuador, en el cultivo de yuca. También, se está considerando la posibilidad de realizar proyectos con este cultivo en Brasil y Tailandia y se han obtenido fondos para suministrar asistencia técnica a dos proyectos en fríjol en América Latina.

Figura 1. Ilustración de la utilidad esperada del estudio agroeconómico



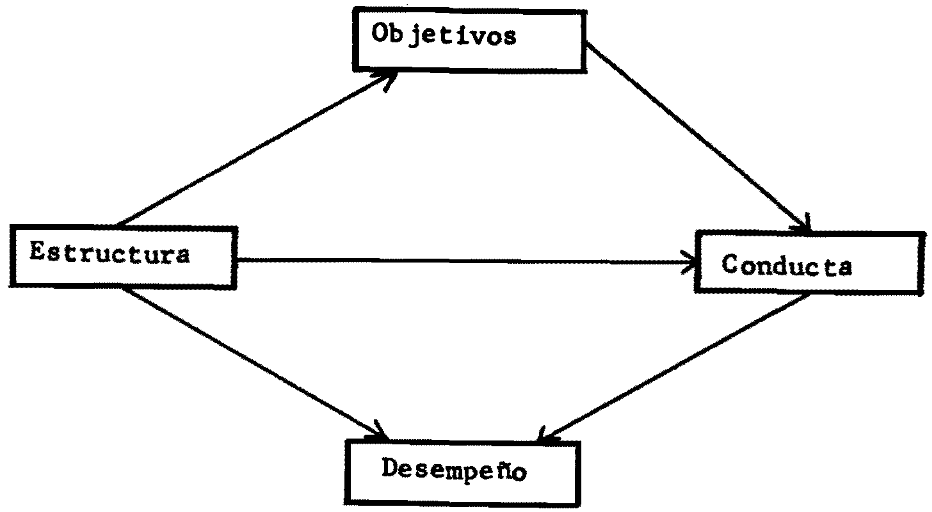


Figura 2. Modelo básico usado para determinar la selección de datos a recolectar.

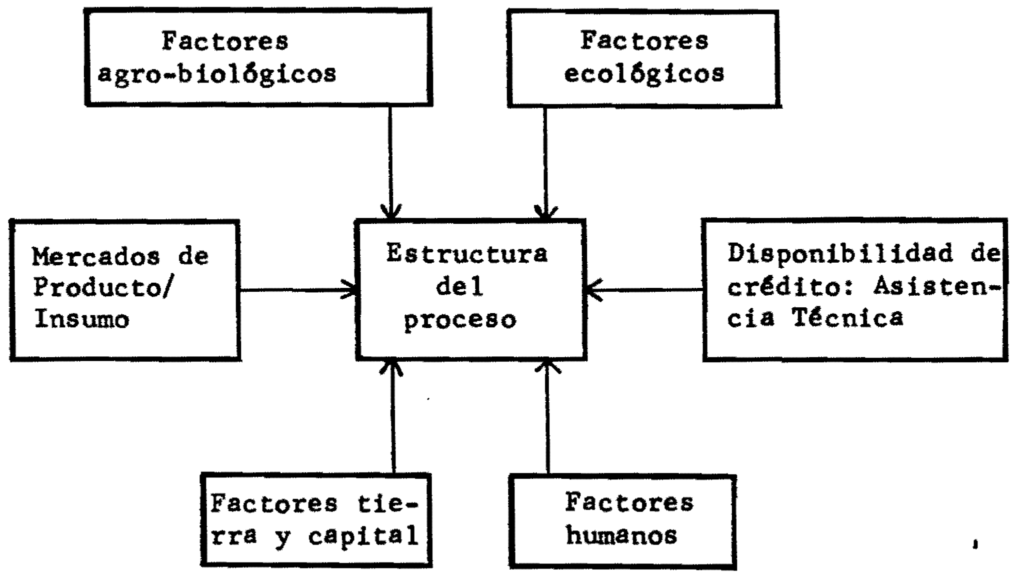


Figura 3. Factores que determinan la estructura del proceso de producción.

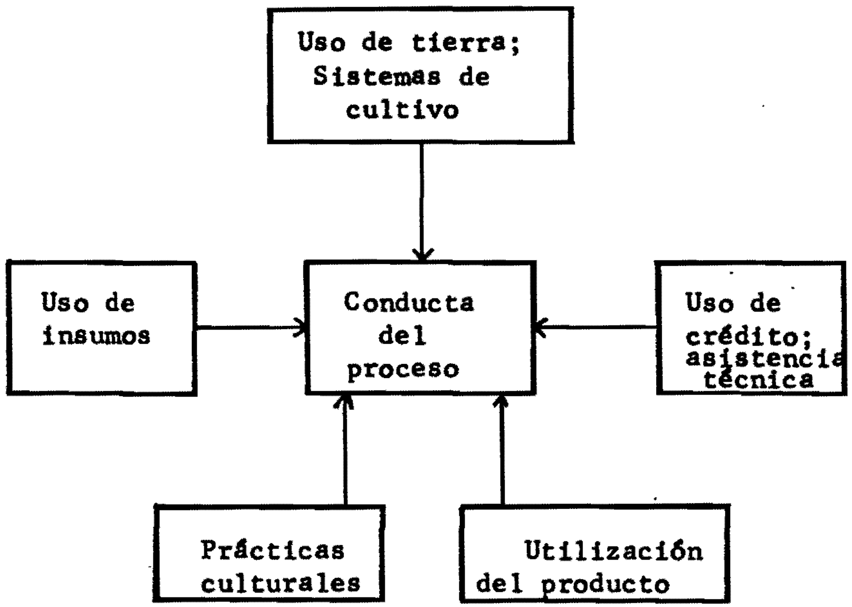


Figura 4. Factores que expresan la conducta del proceso de producción.

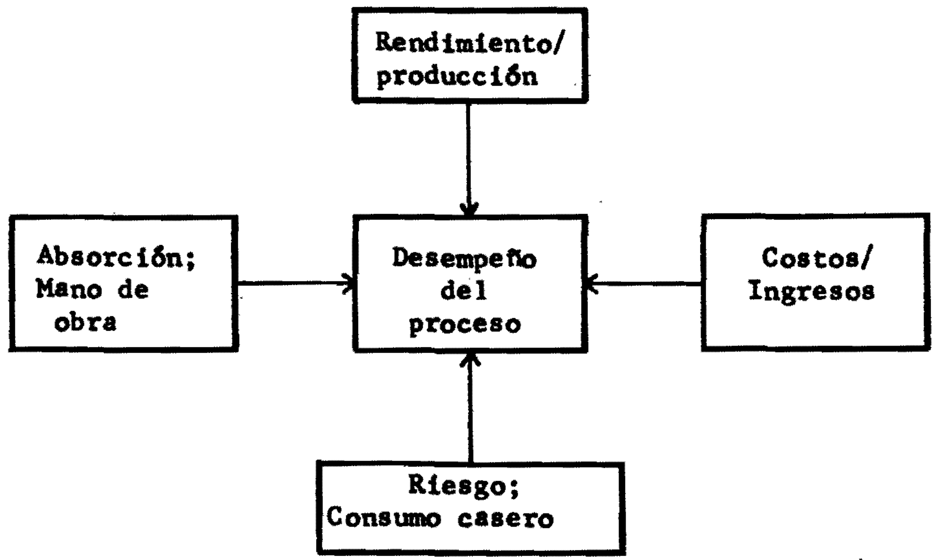


Figura 5. Factores que expresan el desempeño del proceso de producción.

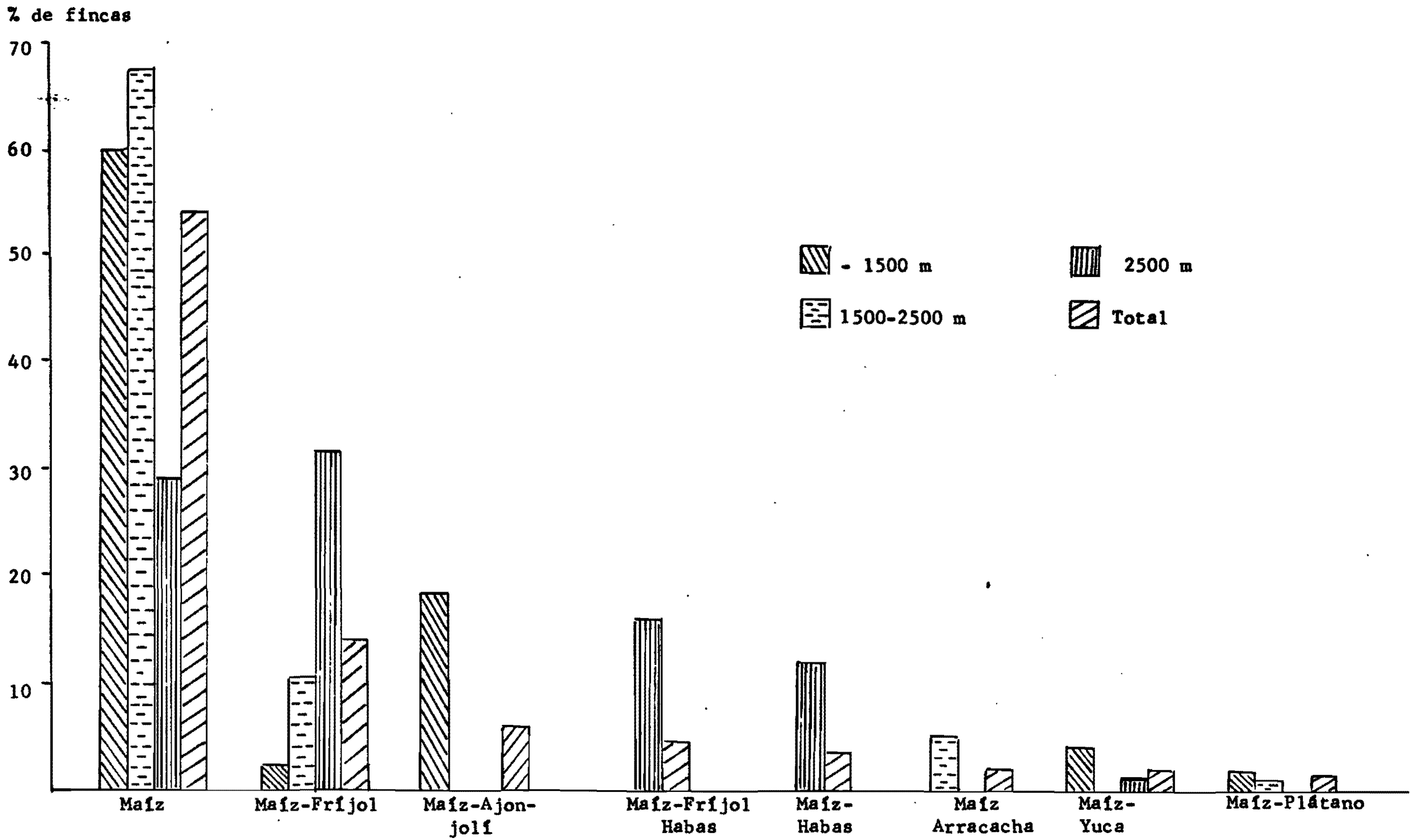


Figura 6. Sistemas de cultivo de 372 fincas de maíz en Colombia, por altura (metros sobre el nivel del mar)

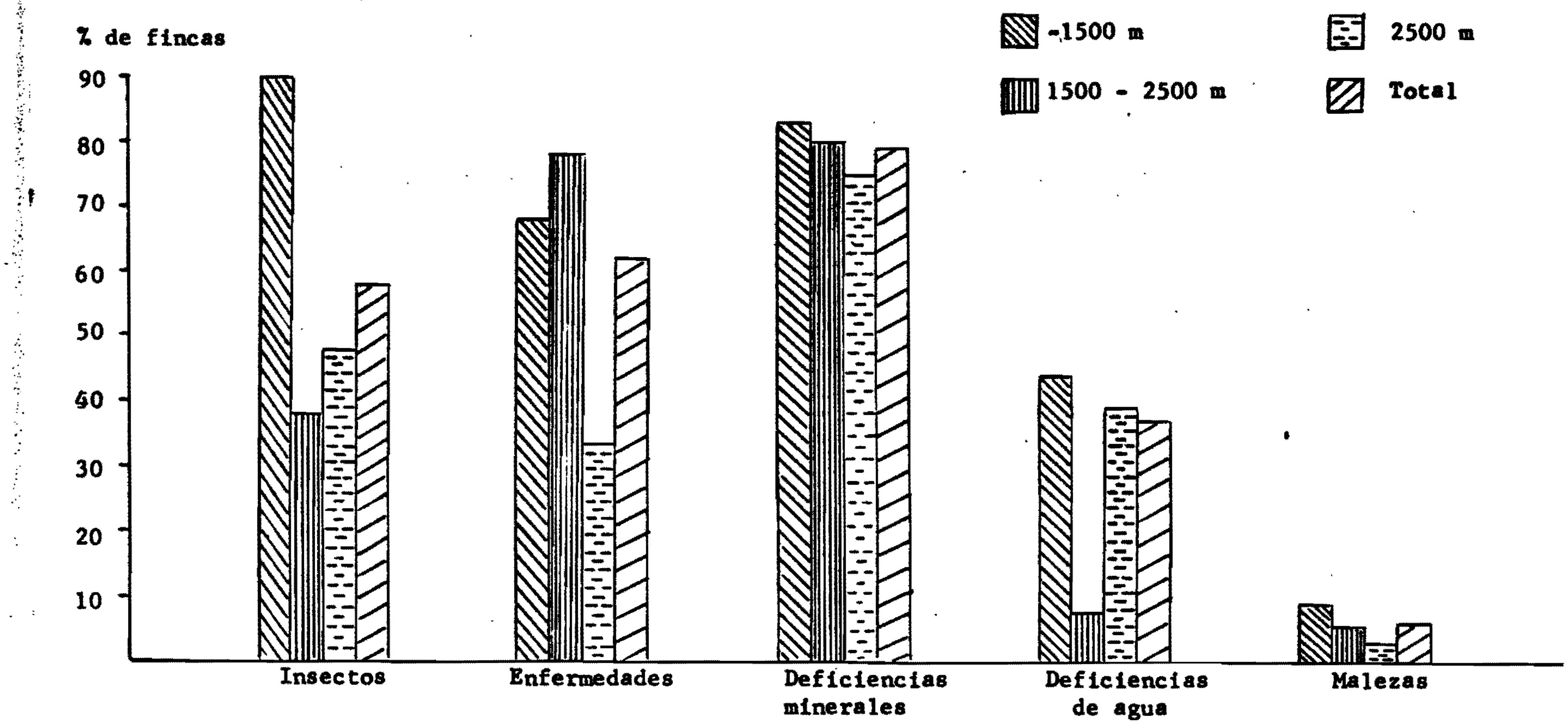


Figura 7. Presencia de problemas agro-biológicos y económicos en las fincas maiceras de la muestra, por altura sobre el nivel del mar, en metros.

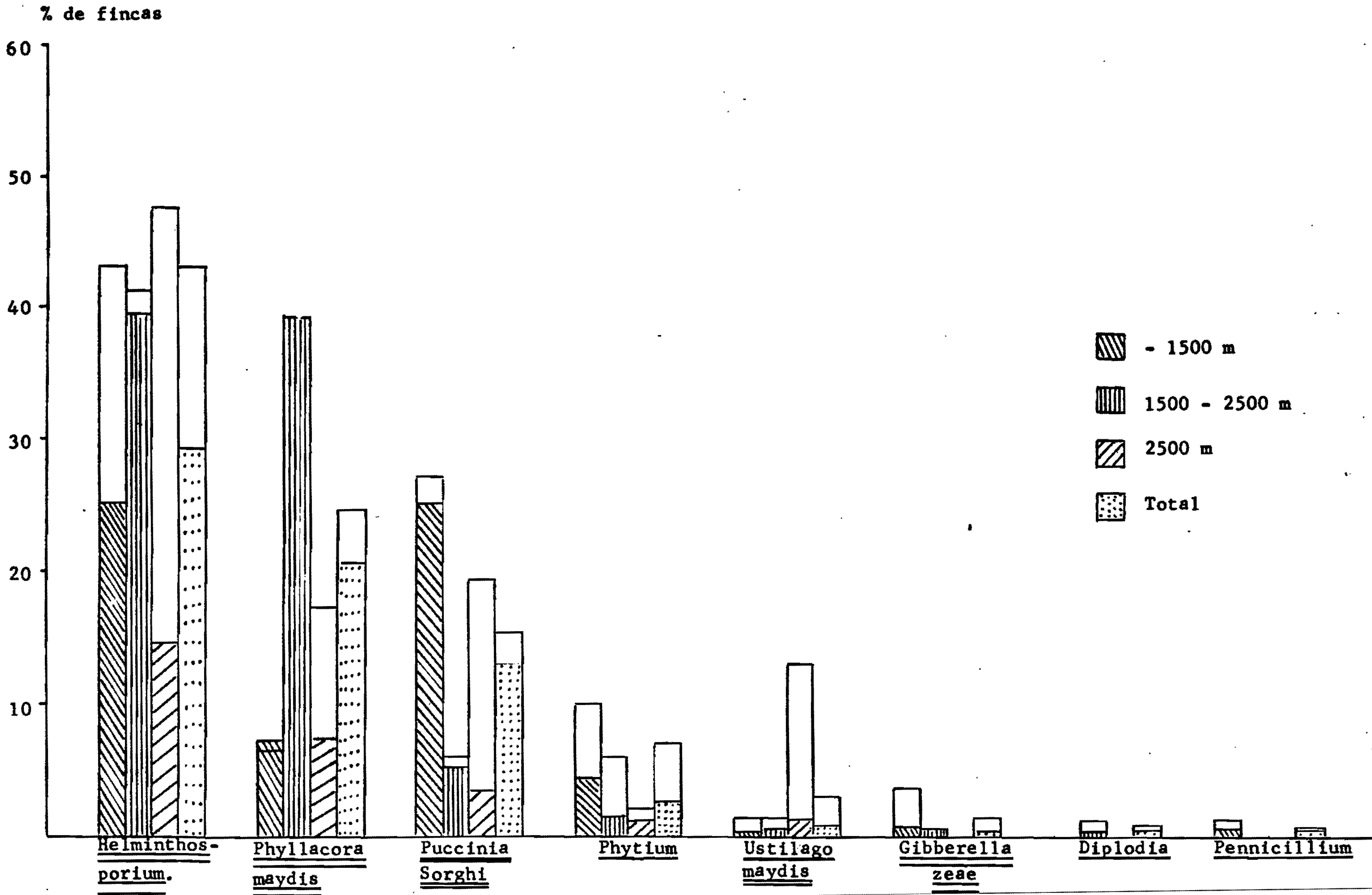


Figura 8. Presencia de enfermedades en maíz en las fincas visitadas, por altura en metros sobre el nivel del mar.

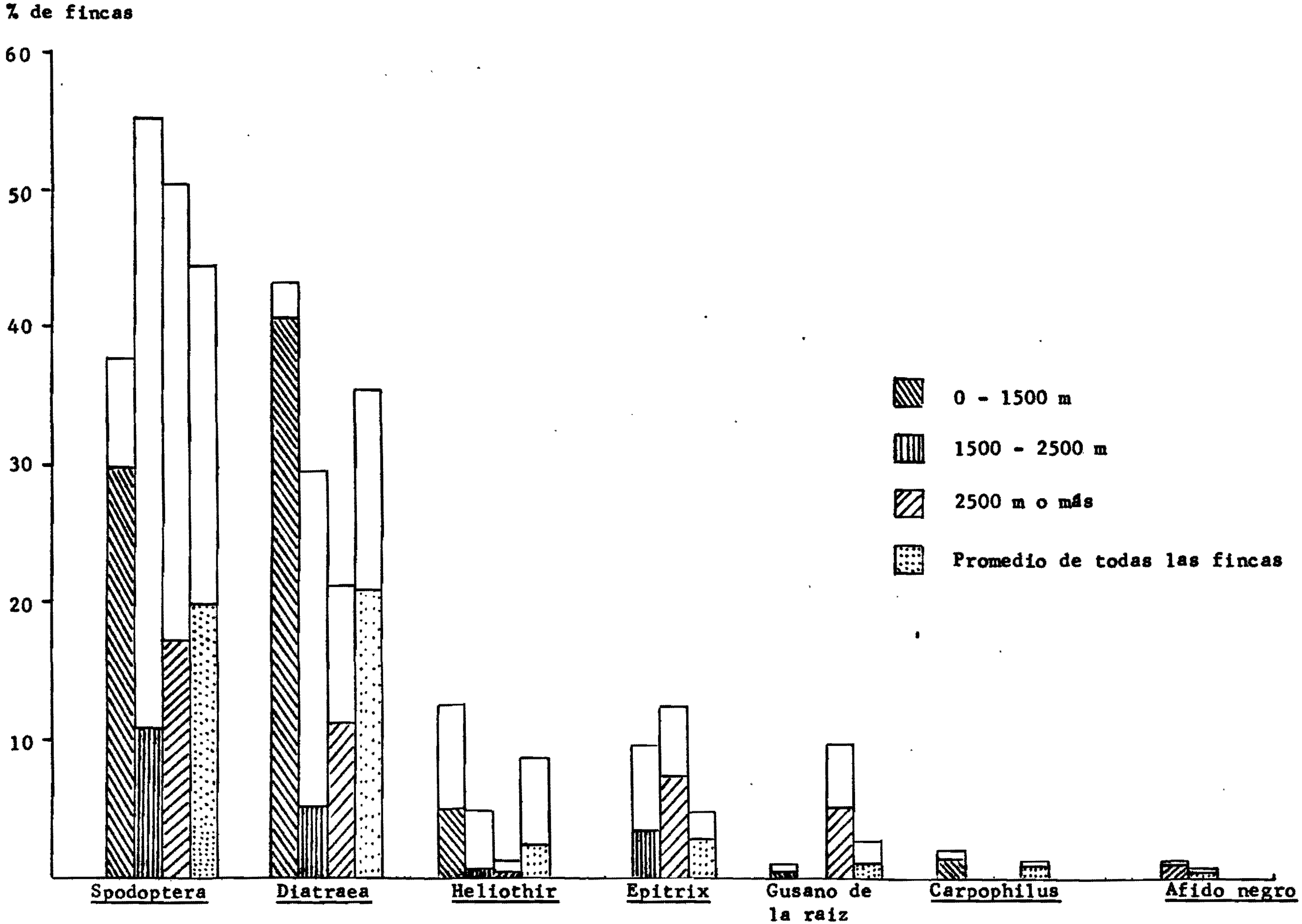


Figura 9. Presencia de daño de insectos en maíz en las fincas visitadas.

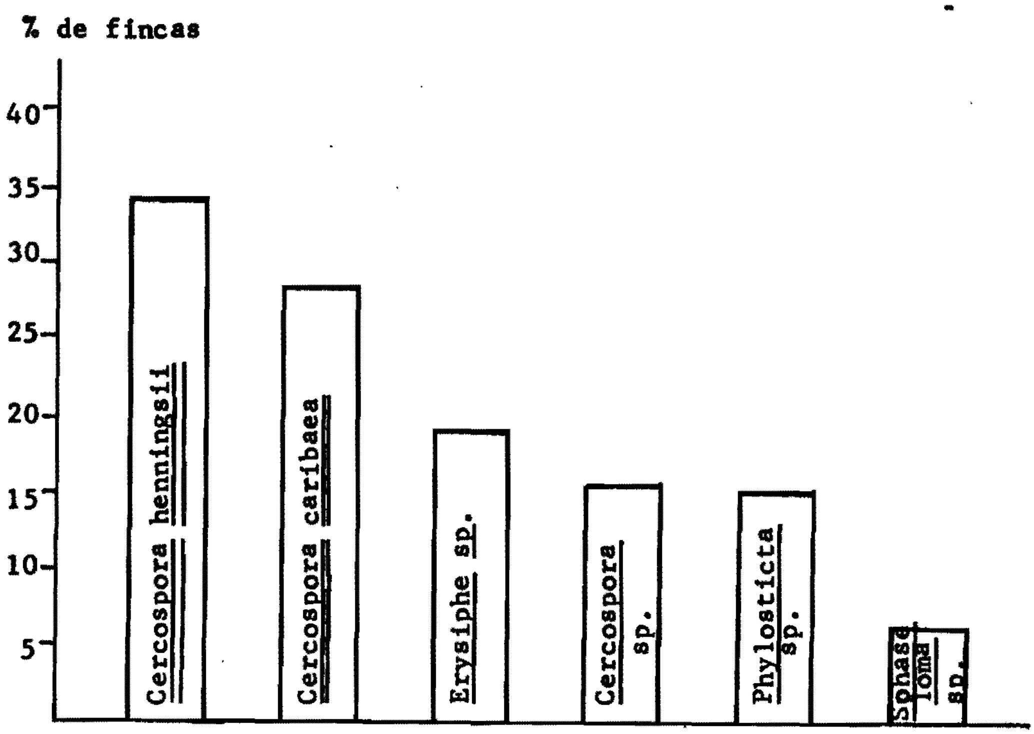


Figura 10. Presencia de enfermedades en yuca en las fincas visitadas (0 - 4 meses).

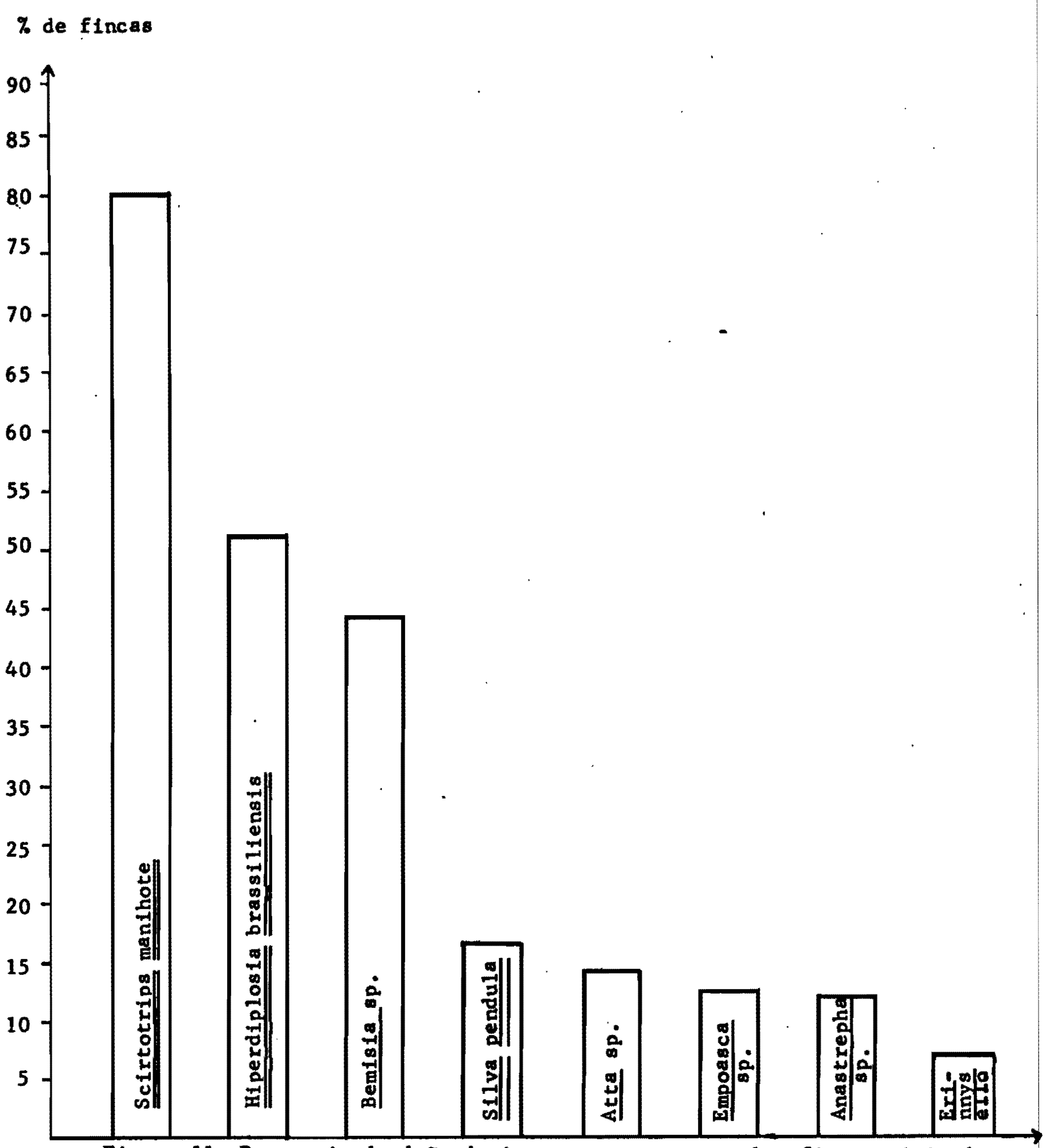


Figura 11. Presencia de daño de insectos en yuca en las fincas visitadas (0 - 4 meses)

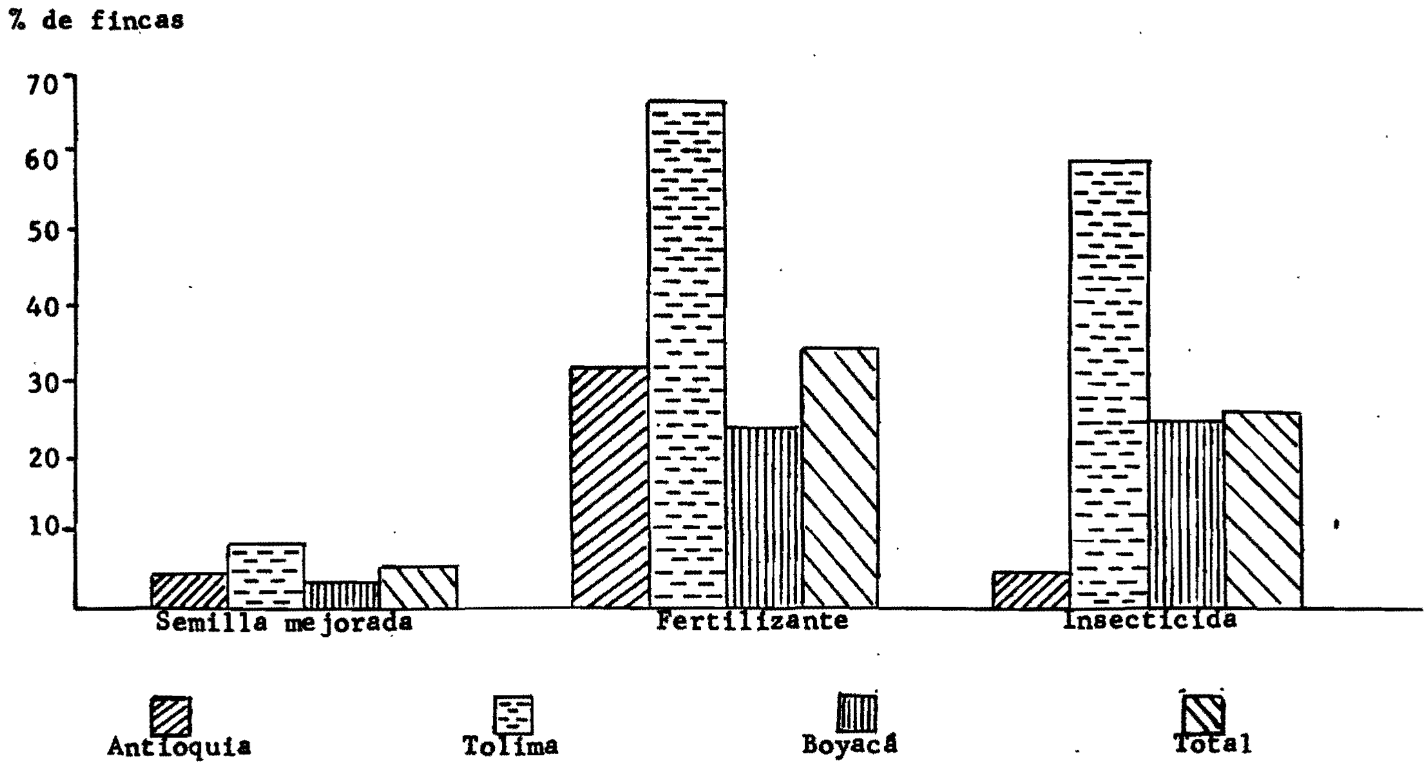


Figura 12. Uso de abono, insecticida y semilla mejorada por los productores de maíz visitados, por Departamento. (Se incluyen tres departamentos de Colombia).

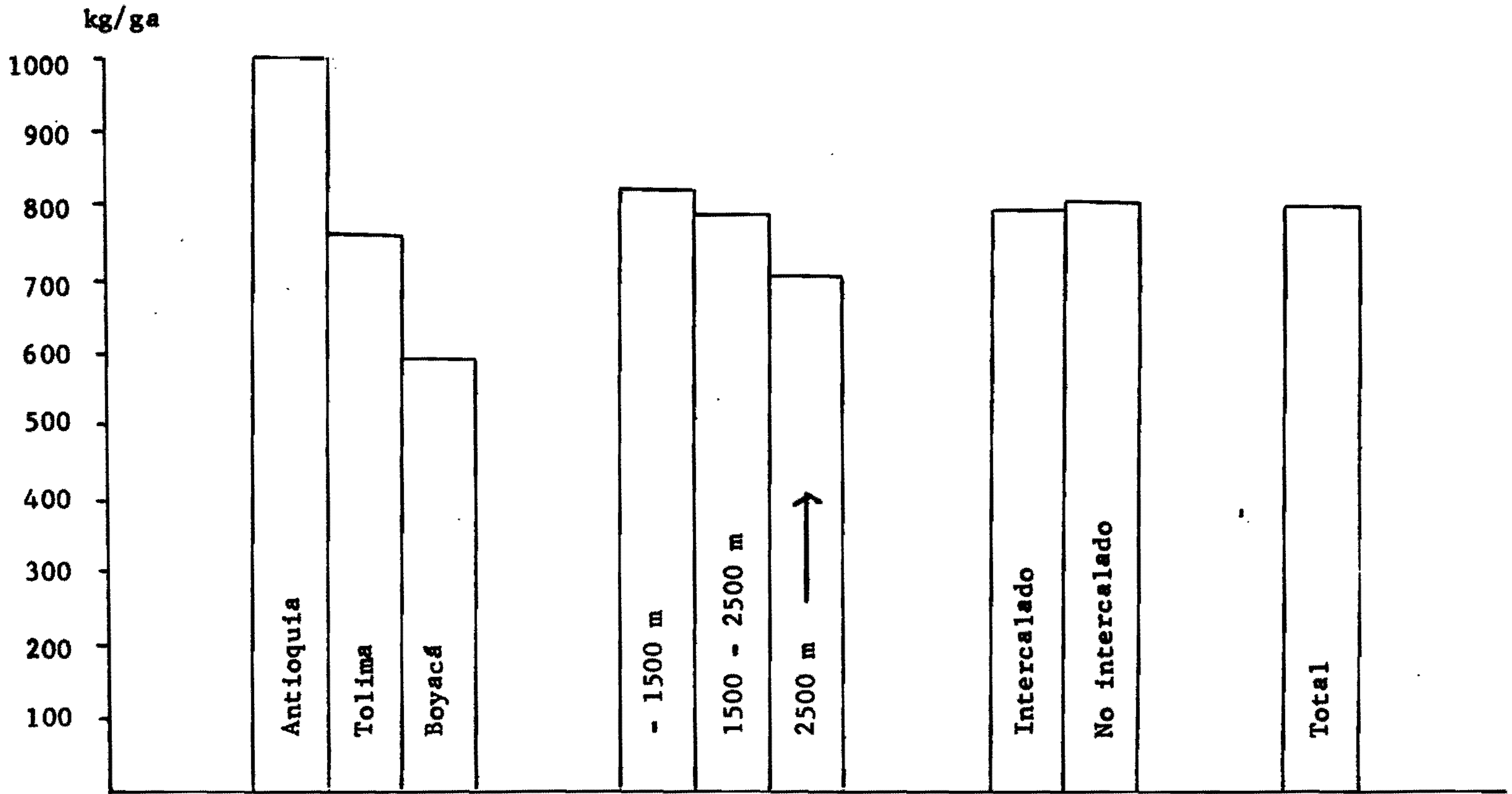


Figura 13. Rendimiento de maíz en las fincas visitadas por Departamento, altura (m.s.n.m) y sistema de cultivo.

EMPRESA BRASILEIRA DE PESQUISAS AGROPECUARIAS - EMBRAPA

MECANISMOS UTILIZADOS EN LA ASIGNACION DE RECURSOS PARA LA INVESTIGACION AGROPECUARIA Y LA ACTUACION DE EMBRAPA

por

Augusto Simões Lopes Neto

MECANISMOS UTILIZADOS NA DESTINAÇÃO DE RECURSOS À PESQUISA AGROPECUÁRIA E A ATUAÇÃO DA EMBRAPA

por

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SUMARIO

1. INTRODUCAO

A destinacão de recursos para a execução da Pesquisa Agropecuária no Brasil, tem sido objeto de real preocupação dos Setores Governamentais, a quem cabe a tomada de decisões no mais alto nível.

Os reflexos das políticas e diretrizes traçadas no Plano Nacional de Desenvolvimento Econômico e Social, PND, e no Plano Básico de Desenvolvimento Científico e Tecnológico, executados pelos órgãos da Administração Direta e Indireta, incidem de forma significativa nos grupos que expressam a demanda pelos resultados da pesquisa. Por sua vez, a quantidade e qualidade destes resultados estão em razão direta da efectividade que possuem os seus executores.

A Empresa Brasileira de Pesquisa Agropecuária, EMBRAPA, é o principal instrumento promotor, do Ministério da Agricultura, que a partir de 1972, foi institucionalizada, com o objetivo de coordenar a pesquisa no País.

Considera-se que o momento atual é, verdadeiramente, histórico em decorrência da coragem dos atuais dirigentes face a introdução de profundas e amplas reformulações no setor. Além disso, pelo dinamismo e entusiasmo já exteriorizados pelos pesquisadores brasileiros, a quem de direito cabe o mérito dos êxitos alcançados.

Se por um lado, é forçoso reconhecer que a EMBRAPA atravessa, no momento, o período crítico de implantação das novas idéias, que poucos dados fornece para uma análise mais profunda, por outro, deve-se reconhecer a presença de um incipiente e progressivo marco de referência que permite vislumbrar uma perspectiva otimista para a Pesquisa Agropecuária no Brasil.

Aproveita-se a oportunidade para agradecer as colaborações recebidas dos companheiros da Empresa, que contribuiram para a elaboração deste documento que expressa opiniões de responsabilidade de própio autor.

2. O SISTEMA BRASILEIRO DE PESQUISA AGROPECUÁRIA

Antes de abordar os objetivos específicos do Seminario considera-se de vital importância fazer uma retrospectiva histórica sobre a pesquisa agropecuária brasileira.

Para tanto, sintetizou-se a evolução histórica e as transformações institucionais havidas, que culminaram com a recente criação da Emprêsa Brasileira de Pesquisa Agropecuária - EMBRAPA.

2.1. EVOLUÇÃO HISTÓRICA

Desde a época do Império até a década dos anos quarenta, quando a industrialização do País passou a ser a meta fundamental da política econômica a expansão da fronteira agrícola foi o instrumento predominante utilizado para aumentar a oferta de produtos de subsistência e da agroindústria.

A abundante disponibilidade de terra e mão de obra relegavam para segundo plano os esforços de modernização da agricultura para aumentar a produtividade dos fatores terra e trabalho. Característica principal deste primeiro período.

O segundo período histórico compreende a década de 50 até início da década de 60, quando a expansão da fronteira agrícola passou a ser nitidamente insuficiente para atender a demanda de alimentos.

O terceiro período teve início no bienio 1963/1964, estendendo-se até os dias de hoje.

De acôrdo com J.I. Cabral (3), nesta fase o aumento da produtividade dos fatores terra e trabalho e a expansão da fronteira agrícola passaram a ser os dois objetivos capitais.

Considera também, que a estratégia da política agrícola, dispõe de dois elementos essenciais: o primeiro, a curto prazo, trata de criar os instrumentos e desenvolver um conjunto de ações capazes de difundir entre os agricultores o estoque de conhecimentos acumulados no país e no exterior, e neste último caso, quando adaptado às condições ecológicas brasileiras. O segundo elemento diz respeito aos instrumentos aptos a aumentar o estoque de conhecimentos e, desta forma, criar condições para assegurar-se um crescimento auto-sustentado da produtividade agropecuária.

2.2. TRANSFORMAÇÃO INSTITUCIONAL E OPERATIVA DO SISTEMA

A evolução da pesquisa agropecuária, a nível federal, pode ser subdividida em três períodos delimitados por eventos marcantes na evolução institucional.

O primeiro período considerado como precurssor caracterizou-se pelo reflexos das transformações na Europa, em fins do século XVIII e século XIX, que resultaram, principalmente, na formação de Escolas de Agronomia, 1800/1908.

A criação das primeiras instituições pertencentes ao Governo Federal, com a finalidade específica de realizar pesquisa agrícola, e a idéia de um orgão com jurisdição a nível nacional para coordenar as atividades de pesquisa caracterizaram o segundo período considerado como de implantação 1909/1937.

O terceiro período, de consolidação teve início com a criação do Centro Nacional de Ensino e Pesquisas Agronômicas, CNEPA, em 1938, instituição que tinha a seu cargo a execução e coordenação da pesquisa agropecuária e do ensino agronômico, 1938/1974.

Durante esta evolução nos anos de 1859 e 1869, realizaram-se os primeiros esforços de organização da agricultura brasileira, quando, por Decreto do Imperador, foram criados vários institutos de agricultura, destacando-se o Instituto Baiano que deu origem a Imperial Escola Agrícola da Bahia em 1875. Infelizmente não houve continuidade na evolução da pesquisa que, somente a partir de 1918 com a criação do Instituto de Quimica e, em 1920 através do Instituto Biológico de Defesa Vegetal, passou a desempenhar papel mais significativo. Desta época até 1937 não se verificaram outros eventos de importancia no setor.

O Centro Nacional de Ensino e Pesquisas Agronômicas, CNEPA, marco de referência do terceiro período, evoluiu e passou a constituir-se no Departamento Nacional de Pesquisa e Experimentação Agropecuária, DNPEA, extinto quando, for força da Lei N° 5.831, de 7 de dezembro de 1972, o Poder Executivo ficou autorizado a criar a Empresa Brasileira de Pesquisa Agropecuária - EMBRAPA.

O panorama da pesquisa agropecuária ao final do terceiro período levou o Governo a criar um Grupo de Trabalho, com o objetivo de estudar e propor uma reforma institucional que dinamizasse o setor.

Além de outros problemas menores os seguintes obstáculos eram observados:

Indefinição da política científica e tecnológica;

Dificultade de coordenação do setor pela pluralidade dos órgãos e duplicidade de projetos;

Inexistência de um plano integrado de pesquisa agropecuária;

Recursos Humanos insuficientes (pesquisador) e com pouco preparo para liderar e administrar a pesquisa;

Desestímulo ao aperfeiçoamento profissional decorrente da política salarial.

2.3. JUSTIFICATIVA PARA A CRIAÇÃO DA EMPRESA

Conforme visto anteriormente, a partir do dia 7 de dezembro de 1972, com fundamento na Lei N°5.851, foi criada a empresa pública sob a denominação de Empresa Brasileira de Pesquisa Agropecuária, EMBRAPA, vinculada ao Ministério da Agricultura, instituida pelo Decreto N° 72.020, de 28 de março de 1973.

Esta emprêsa possui personalidade jurídica de direito privado, patrimônio e autonomia administrativa e financeira, com sede e foro na Capital Federal sendo integrante da Administração Federal Indireta.

Estatutariamente, as finalidades da EMBRAPA são definidas como segue:

Promover, estimular, coordenar e executar atividades de pesquisa, com o objetivo de produzir conhecimentos e tecnologia para o desenvolvimento agrícola do País.

Dar apoio técnico e administrativo a órgãos do Poder Executivo, com atribuições de formulação, orientação e coordenação das políticas de ciência e tecnologia no setor agrícola;

Para tanto é facultado a Empresa desempenhar suas atividades mediante convênios ou contratos com entidades públicas ou privadas, nacionais estrangeiras ou internacionais.

Da Exposição de Motivos (3) dos então ministros Luiz Fernando Cirne Lima, da Agricultura, e João Paulo dos Reis Veloso do Planejamento e Coordenação Geral, propondo ao Senhor Presidente da República Federativa do Brasil, na época, o General Emilio Garrastazu Médici, a criação da EMBRAPA, destaca-se os seguintes aspectos:

O reconhecimento, a despeito do enorme esforço do Governo, da agricultura em muitas regiões e áreas do País continuar organizada em forma tradicional e sua eficiência apresentar, ainda, grandes distorçoes. Nessas zonas o seu crescimento ocorre, principalmente, em virtude da expansão da fronteira agrícola e dos incentivos financeiros que lhe concede o Governo, não se observando de maneira significativa um aumento de produtividade com emprego de novas técnicas;

A evidência de ser a pesquisa agrícola e tecnológica de fundamental importância no processo de desenvolvimento nacional;

Ainda que dos índices de aumento, principalmente da produtividade agrícola e dos novos processos de tecnologia de produtos agropecuários dependerá, em grande medida, o incremento da oferta de alimentos, da expansão das exportações e a melhoria da renda dos produtores;

A identificação dos principais obstáculos à execução das atividades de pesquisa agropecuária, especialmente no âmbito do Ministério da Agricultura, concluindo pela profunda reformulação institucional e operativa do sistema formado pelo extinto Departamento Nacional de Pesquisa Agropecuária, DNPEA.

Finalmente, salienta-se que na Exposição de Motivos conjunta, enviada à Presidência da República em 21 de setembro de 1972, a alternativa escolhida foi baseada "na idéia de que esse tipo de instituição por seus própios fundamentos legais - órgãos de administração indireta - conta com condições intrinsecas para dar flexibilidade e eficiência aqueles aspectos relacionados com captação e manejo de recursos financeiros e humanos".

3. A IMPLANTAÇÃO DA NOVA EMPRESA

Espera-se que no menor prazo possível, em que pese a enorme complexidade da tarefa, o Governo Brasileiro venha a dispôr, através da EMBRAPA, de um eficiente e eficaz instrumento para acelerar o processo de desenvovimento nacional.

A pesquisa agropecuária, considerada como fundamental para o aludido processo, ao institucionalizar-se sob a forma de Empresa tem, estatutariamente os seguintes objetivos:

I. Promover, estimular, coordenar e executar atividades de pesquisa, com o objetivo de produzir conhecimentos e tecnologias a serem empregados no desenvolvimento agrícola nacional;

II. Dar apoio técnico e administrativo a órgãos do Poder Executivo com atribuições de formulação, orientação e coordenação da política de ciência e tecnologia no setor agrícola. As pesquisas serão de natureza agropecuaria, tecnológica e sócio-econômica no setor agrícola podendo, ainda, em cooperação com entidades própias, abranger assuntos florestais, de pesca de metodologia e outros compreendidos nas áreas de atuação do Ministério da Agricultura.

Oficialmente, a data de 26 de abril de 1973 marca o início da instalação da EMBRAPA. Consequentemente, o ano de 1973 ficou reduzido a oito meses, nos quais a preocupação maior foi a de assegurar a continuidade das atividades de pesquisa que se vinham desenvolvendo através do Ministério da Agricultura.

Destaca-se neste período como realizações das mais significativas, entre outras, a definição do Modêlo Institucional da Empresa e do Sistema de Planejamento da Pesquisa Agropecuária.

3.1. MODELO INSTITUCIONAL DA EMPRESA

Neste ítem é apresentado, de forma resumida, o Modêlo Institucional de Execução da Pesquisa Agropecuária (7) definido pela EMBRAPA. Os dados aqui expostos foram extraídos da Deliberação N° 067, ato oficial da Diretoria Executiva que implantou o referido modelo.

O Ministério da Agricultura, no atual período governamental, definiu três grandes linhas de atuação;

Sistema de Planejamento e Controle;

Sistema de Produção;

Sistema de Abastecimento.

A pesquisa agropecuária, e via de consequência, a EMBRAPA como seu principal instrumento promotor, inserida no Sistema de Produção, deverá manter como preocupação permanente o melhor aproveitamento dos recursos institucionais disponíveis no País, mobilizando-os com o objetivo de produzir melhor e procurando influir nas adaptações que se fizerem necessárias ao atendimento dessa finalidade.

Por conseguinte, a par da introdução de novos enfoques na condução da pesquisa agropecuária paralelamente houve a definição e consequente criação de instrumentos de execução diversos dos existentes que integram o modêlo institucional de execução da pesquisa agropecuária. Este modêlo é constituido por um Sistema Nacional que compreende duas linhas fundamentais de atuação:

Ação direta, através de unidades de execução de âmbito nacional (Centros Nacionais) e de unidades de execução de âmbito estadual (Empresas Estaduais ou Representações Estaduais);

Ação coordenadora (programática, normativa, de acompanhamento e de avaliação), com execução a cargo de Empresas Estaduais de pesquisa agropecuária.

Centros Nacionais

Às unidades de execução de âmbito nacional (Centros Nacionais), compete a condução direta de trabalhos da geração de tecnologia mediante concentração interdisciplinar em relação a um número limitado de produtos de interesse nacional.

Além dos Centros para produtos integram essa linha de ação direta os Centros de pesquisa de recursos com a mesma concentração interdisciplinar e objetivos de caráter nacional, ou regional, em relação a fatores essenciais ao processo produtivo e outros. Estes Centros estudarão a relação planta/solo/meio ambiente e/ou animal/solo/meio ambiente em regiões ecológicas nos quais o recurso "terra" esteja subaproveitado.

Os objetivos específicos das atividades desenvolvidas nos Centros Nacionais são os seguintes:

Geração de tecnologia para produtos de interesse nacional;

Coordenação técnica especializada em relação a produtos de interesse nacional;

Geração de tecnologia para desenvolvimento de recursos naturais e de processamento de produtos agropecuários.

A atuação dos Centros será sempre caracterizada por estreita articulação com os Sistemas Estaduais levando-lhes o produto da pesquisa gerado para as devidas adaptações a nível estadual e deles recebendo subsidios, tanto para a elaboração quanto para a condução de projetos.

<u>Sistemas Estaduais</u>

A nível da Unidade da Federação poderão ocorrer as seguintes figuras:

Empresa Estadual de Pesquisa Agropecuária;

Representação Estadual, quando não houver Empresa;

Unidade de Execução da Pesquisa de Âmbito Estadual.

Estas figuras constituem o Sistema Estadual, que é o instrumento básico para o desenvolvimento de Programas Integrados de Pesquisa Agropecuária, envolvendo sempre que possível, os governos estaduais, universidades e demais organismos que atuam em pesquisa na área, inclusive a iniciativa privada passivel de mobilização.

Nos Estados onde existe a Empresa Estadual, criáda em articulação com a EMBRAPA, caberá à mesma a coordenação do Programa Integrado. Inexistindo a Empresa Estadual, a coordenação do sistema será convertida à própia EMBRAPA, através das Representações Estaduais.

Corresponde ao Sistema Estadual, através das Unidades de Execução de Pesquisa de Âmbito Estadual, UEPAE que podem ser da EMBRAPA, dos Governos Estaduais, Universidades, entidades privadas e outras, as funções de promover, planejar, estimular, supervisonar, coordenar e executar atividades de pesquisa e experimentação agropecuária, objetivando:

A adaptação a nível estadual, da tecnologia gerada pelos Centros Nacionais;

A geração de tecnologia para produtos de interesse local;

Colaborar com as unidades de âmbito nacional sempre que as condições ecológicas o permitam, na geração de tecnologia em relação a produtos de interesse nacional sem prejuízo, da sua função principal, de adaptação dessa mèsma tecnologia a nível local, para sua posterior transferência ao produtor rural.

Una vez constituida a Empresa as responsabilidades e objetivos são os mesmos da UEPAE.

Os Sistemas Estaduais, conforme dito inicialmente, atuarão, sempre que possível, sob a forma de Programa Integrado de Pesquisa Agropecuária, que consiste na conjugação de esforços, a nível estadual que objetiva o aproveitamento racional e unificado de recursos humanos, materiais e financeiros disponíveis no Estado.

Mecanismos Regionais

O Modelo Institucional de Execução da Pesquisa Agropecuaria prevê a utilização de mecanismos de caráter regional, tendo em vista, sobretudo a necessidade de articulação com os organismos de desenvolvimento regional (SUDENE, SUDAM, SUDESUL, SUDECO, etc...).

Tais mecanismos terão ação preponderante nos aspectos que dizem respeito à captação e à alocação de recursos específicos, bem como ao desenvolvimento de políticas a nível regional e à coleta de informações para a programação de pesquisa.

3.2. O SISTEMA DE PLANEJAMENTO DA EMBRAPA

Esta sintese foi extraida do Sistema de Planejamento de Pesquisa Agropecuária (8) aprovado pela Diretoria Executiva da EMBRAPA, através da Deliberação N°068. Este Sistema é um dos instrumentos mais importantes da Empresa para alcançar o produto final e, principalmente, para efetivar a pesquisa como instrumento fundamental para o processo de desenvolvimento.

Propiciando a participação de todos os pesquisadores e o envolvimento dos usuários dos resultados, o planejamento da pesquisa, como processo e instrumento, exige um esforço permanente de revisão - consolidação - revisão. Este esforço, expressa o principio básico do Sistema de Planejamento.

Da conjugação de fatores biológicos, fisicos, tecnológicos, econômicos e sociais resulta a atividade agropecuária e a EMBRAPA está empenhada sempre que possivel, em abordar o processo produtivo em forma integral. Para tanto, o enfoque de sistema de produção como elemento básico, é o adotado para a identificação das ações, que devam ser realizadas pela Empresa ou com o seu apoio.

A experiencia nacional acumulada induz a Empresa a operar através de uma estrutura na qual se concentre, a nível nacional, o estabelecimento de diretrizes, a seleção de prioridades, a fixação de normas de programação e o controle e a avaliação de resultados.

O Sistema propicia uma das principais funções da Empresa que é a de Execução de projetos de pesquisa, pelos Centros Nacionais, Unidades de Execução de Pesquisa de Âmbito Estadual e demais instituições que atuam nas diferentes áreas geográficas do País.

Função do Sistema

O Sistema de Planejamento tem por função básica definir e aplicar uma metodologia que permita:

Definir objetivos e metas;

Seleccionar ações mais adequadas para atingir os objetivos e metas estabelecidas;

Decidir sobre instrumentos e meios a serem utilizados para executar ações selecionadas;

Avaliar resultados e propor ajustes, em função de condições dinâmicas que trata de afetar.

Nivels de Planejamento

A elaboração de Planos Indicativos, Projetos e Programas Operativos pode ocorrer nos seguintes níveis:

Nacional

Regional

Estadual

Institucional ou local

Destes quatro níveis, o nacional, o estadual e o local, conforman a estrutura minima necessária para elaborar e executar o Programa Nacional de Pesquisa Agropecuária, PRONAPA.

O nível regional embora importante, pode ser dispensado quando houverem razões para tal.

Figuras Programáticas

A operacionalidade do Sistema de Planejamento decorre de três figuras programáticas básicas:

Planos indicativos

Projetos

Programas

Estas figuras, no entretando, podem conter outras, como planos operativos, linhas de pesquisa, subprojetos, atividades e experimentos.

Etapas Programáticas

Envolvendo fases coordenadas e orientada pelos diversos níveis da EMBRAPA (diagnóstico, programação e avaliação) bem como a execução que demanda uma participação direta e permanente dos setores técnicos, especializados na realização da pesquisa agropecuária, o Sistema de Planejamento identifica as seguintes etapas programáticas:

Diagnóstico	Realizado através de consultas a documentos, instituições, organismos e pessoas que de alguma forma, tem relações com os objetivos da Empresa;
Programação	Que é o processo de elaboração e organização de diretrizes, políticas, prioridades, objetivos, metas, atividades, prazos e recursos para a ação da Empresa, nos diversos níveis. A execução e a avaliação também são esboçadas nesta etapa;
Execução	Através da qual é realizada a atividade fim da Empresa e para a qual o Sistema de Planejamento é um meio, desenvolve-se de forma direta através das pesquisas propriamente ditas; pelo assessoramento à sua realização e, ainda, pelo acompanhamento, como instrumento de controle e auxiliar na avaliação.
Avaliação	Como divisão do trabalho de programação, tem a responsabilidade de analisar os projetos que constituirão os programas de pesquisa, no que diz respeito aos seus principais objetivos. A avaliação será realizada também antes de implantação durante e ao final da execução dos projetos.

Órgãos Participantes

O Planejamento de Pesquisa, objeto do Sistema implantado pela Empresa, considerado como um processo participativo, envolve todos os órgãos que atuam no Sistema de Pesquisa.

Os principais órgãos envolvidos no processo são:

Comissão Nacional de Pesquisa Agropecuária e de Assistencia Técnica e Extensão Rural;

Diretoria Executiva

Departamento de Diretrizes e Métodos de Planejamento;

Departamento Técnico Científico;

Departamento de Difusão de Tecnologia;

Centros Nacionais;

Órgãos Centrais dos Sistemas Estaduais;

Unidade de Execução de Pesquisa de Âmbito Estadual;

Comissões Locais.

As atribuicões destes órgãos envolvidos no processo são definidas no item 5.2.critérios utilizados na tomada de decisões.

Instrumentos Básicos

O processo de planejamento da pesquisa formaliza-se de uma série de instrumentos, cuja interrelação e sequência na elaboração permitem manter a necessária unidade e coerência dos processos normativo - executivo (para a própria Empresa), e indicativo - executivo (para os órgãos não pertencentes a EMBRAPA).

Estes instrumentos são os seguintes:

Plano Nacional de Desenvolvimento Econômico e Social;

Orçamento Plurinacional de Investimentos;

Plano Básico de Desenvolvimento Científico e Tecnológico;

Plano Indicativo para a Pesquisa Agropecuária;

Programa Nacional de Pesquisa Agropecuária;

Orçamento - Programa;

Subprojeto.

No item 4.1-Instrumentos básicos para a tomada de decisões, está especificada a participação de cada um destes instrumentos bem como, informações adicionais especificas sôbre os responsáveis pela elaboração dos mesmos. Além destes instrumentos também é caracterizada a participação da Comissão Nacional Agropecuária e de Assistência Técnica e Extensão Rural - COMPATER.

4. QUEM TOMA AS DECISÕES

Cabe a EMBRAPA coordenar todas as atividades de pesquisa agropecuária no território nacional e, também, executar pesquisas com seus recursos própios.

Não obstante o Governo Federal venha dispensando um total e irrestrito apoio à Empresa, o reconhecimento de que as dimensões do País e as consequentes disparidades regionais e ecológicas exigem mecanismos diferentes de atuação, a Empresa definiu um Modêlo Operativo compatível à realidade nacional.

Através deste Modêlo consubstanciado no Modêlo Institucional e no Sistema de Planejamento define-se quem toma as decisões na Empresa no sentido de viabilizar e tornar efetivas as diretrizes emanadas do Governo e as aspirações e necessidades dos grupos que demandam resultados de pesquisa.

4.1. PRINCIPAIS INSTRUMENTOS PARA A TOMADA DE DECISÕES

Plano Nacional de Desenvolvimento Econômico e Social

O processo decisório tem inicio a partir do momento em que o Excelentíssimo Senhor Presidente da Republica, General Ernesto Geisel, encaminha ao Congresso Nacional, para apreciação e emendas o Plano de Desenvolvimento Econômico e Social - II PND, em o Governo consubstância as metas tentativas a alcançar no quinquênio.

O II PND (9), com vigência para o período de 1975/1979, foi elaborado através de uma ação integrada de todos os Ministérios sob a coordenação da Secretaria de Planejamento da Presidência da República - SEPLAN, e se constitui no documento básico norteador de toda a ação governamental.

Os principais indicadores de perspectivas do II PND são:

Renda per capita, em 1979, superior a mil dólares;*

PIB superior a US$100 bilhões em 1977;

* 1 dólar = Cr$ 7,35

Criação de novos empregos, no quinquênio, com perspectiva de expansão e taxas superiores a 3,5% ao ano;

Nível de comércio exterior acima de U$ 40 bilhões em 1979.

Aumento do produto agrícola de Cr$ 93 bilhões para Cr$ 130 bilhões em 1979.

Foram consideradas como prioridades, no II PND, os seguintes setores:

Agricultura

Educação

Saúde

Ciência e Tecnologia

A expressão financeira dos Planos Nacionais de Desenvolvimento Econômico e Social são os Orçamentos Plurianuais de Investimentos - OPI. Sob a égide do II PND foi então elaborado o OPI para o triênio 1975/1977, onde são apresentados os programas detalhados a nível de projetos e de atividade, dos órgãos e entidades que recebem recursos do Tesouro, considerando-se, no global, também outras fontes de recursos (recursos própios, financiamentos internos e externos).

Ao Ministério da Agricultura foram destinados 1.767 milhões de cruzeiros em 1975, o que representa um aumento em relação a 1974 de 105,2% e 3,53% da Despesa do Tesouro.

Para o triênio, está previsto no OPI para o Ministério 12.902, 7 milhões de cruzeiros, que representarão 5,17% da Despesa do Tesouro.

Plano Básico de Desenvolvimento Científico e Tecnológico

Além do Plano Nacional de Desenvolvimento Econômico e Social-PND e do respectivo Orçamento Plurianual de Investimentos integra o processo decisório, a nível federal, o Plano Básico de Desenvolvimento Científico e Tecnológico - PBDCT.

A responsabilidade de elaboração do PBDCT cabe ao Conselho Nacional de Desenvolvimento Científico e Tecnológico (transformação do atual Conselho Nacional de Pesquisas) que, dotado de flexibilidade administrativa, financeira e estrutura institucional, sob a forma de Fundação atual vinculado à Secretaria de Planejamento da Presidência da República, e também, em estreita colaboração com os diferentes Ministérios.

Assim sendo, o novo Conselho passa a ser na coordenação da política de ciência e tecnologia o principal instrumento auxiliar do Governo.

O I PBDCT, aprovado pelo Decreto N° 72.527, foi elaborado para o bienio 1973/1974, que assegurou, através do programa prioritário de Tecnologia Agrícola, 476 milhões de cruzeiros para a Agropecuária, Recursos Florestais, Pesca e Meteorologia.

O II PBDCT consubstanciará os programas e projetos prioritários do sistema nacional de ciência e tecnologia, nas áreas dos diferentes Ministérios, contando para sua execução, além dos recursos normais dos Ministérios, de reforço substancial através de um sistema de fundos, por exemplo: Fundo Nacional de Desenvolvimento Científico e Tecnológico - FNDCT.

Para o quinquênio, 1975/1979, há uma estimativa da ordem de 22 bilhões de cruzeiros.

A ação integrada das agencias e fundos especiais que suplementam os recursos do PBDCT destinados a consecução dos objetivos do Plano configuram dois subsistemas de ação principais:

O primeiro opera mediante a colaboração financeira a programas e projetos específicos de responsabilidade de entidades publicas e privadas brasileiras, com suporte no mecanismo financeiro integrado pelo Conselho Nacional de Pesquisas - CNP, a Coordenação do Aperfeiçoamento do Pessoal de Nível Superior - CAPES, do MEC, Fundo Nacional de Desenvolvimento Científico e Tecnológico - FNDCT cujos recursos são geridos pela Financiadora de Estudos e Projetos - FINEP, empresa publica vinculada a Secretária de Planejamento da Presidência da República - SEPLAN, e, do Fundo do Desenvolvimento Técnico-Cientifico - FUNTEC, criado no Banco Nacional de Desenvolvimento Econômico.

O segundo subsistema opera mediante a mobilização de órgãos nacionais, internacionais e estrangeiros de cooperação técnica e financeira, através de operações de empréstimos, protocolos de cooperação técnica bilateral ou acordos de assistência técnica sob a jurisdição da Secretária de Cooperação Internacional - SUBIN da SEPLAN, e da Divisão de Cooperação Técnica, do Ministério de Relações Exteriores.

Comissão Nacional de Pesquisa Agropecuária e de Assistência Técnica e Extensão Rural

Com os objetivos de caráter programático, normativo e de coordenação em relação as atividades de pesquisas agropecuárias, assistência técnica e extensão rural desenvolvidas no Brasil, foi criada a Comissão Nacional de Pesquisa Agropecuária e de Assistência Técnica e Extensão Rural - COMPATER (Decreto N°74.154, de 6 de junho de 1974).

Esta Comissão é integrada pelos seguintes membros:

Representante do Ministério da Agricultura - presidente;

Presidente da EMBRAPA;

Presidente da EMBRATER;

Representante do Banco Central do Brasil;

Membro escolhido pelo Ministério da Agricultura em lista tríplice elaborada pela Confederação Nacional de Agricultura;

Membro escolhido pelo Ministério da Agricultura em lista tríplice elaborada pela Confederação Nacional dos Trabalhadores da Agricultura;

Dois membros escolhidos pelo Ministerio da Agricultura que não pertençam ao quadro de pessoal do Ministério nem aos das entidades da Administração Federal indireta a ele vinculadas.

As principais atribuições da COMPATER, como instrumento de coordenação do Ministério da Agricultura são as seguintes:

Proceder à compatibilização de planos e programas anuais e plurianuais da EMBRAPA e EMBRATER;

Aprovar os planos e programas, antes referidos bem como os respectivos orçamentos;

Acompanhar e execução e avaliar os resultados dos planos e programas citados;

Coadjuvar o Ministério da Agricultura na supervisão em relação as entidades referidas;

Estabelecer critérios para alocação de recursos financeiros da União, destinados ao desenvolvimento das atividades de pesquisa, assistência técnica e extensão rural.

Instrumentos Básicos Elaborados pela EMBRAPA

A elaboração e a execução da Política Agrícola Nacional, expressa no II PND, PBDCT e Planos de Trabalho pela COMPATER, estão afetas ao Ministério da Agricultura e respectivos órgãos de ação direta e indireta comandados pelo Senhor Ministro da Agricultura.

No que diz respeito a Pesquisa Agropecuária, já se caracterizou ser a EMBRAPA o instrumento governamental criado para cuidar específica e intensivamente do setor.

Norteada pelos objetivos e estratégias dos instrumentos antes mencionados e segundo as orientações do Ministério da Agricultura, a EMBRAPA estabelece critérios e coordena a elaboração do Plano Indicativo para a Pesquisa Agropecuária e do Programa Nacional de Pesquisa Agropecuária-PRONAPA.

Plano Indicativo para a Pesquisa Agropecuária

Alicerçada num diagnóstico das condições técnicas, econômicas e sociais do País e ampla interpretação das diretrizes estabelecidas nos Planos do Governo, a Diretoria Executiva da Empresa (composta por um Presidente e três Diretores), define as normas, prioridades e diretrizes básicas para a programação da pesquisa, bem como as orientações de caráter metológico e operacional.

Este conjunto de definições constitui o Plano Indicativo para a Pesquisa Agropecuária.

Programa Nacional de Pesquisa Agropecuária

Tendo como marco de referência o Plano Indicativo, que obrigatoriamente é compatibilizado com as Diretrizes Estaduais de Programação de Pesquisa, as Unidades Operativas da EMBRAPA iniciam a elaboração do Programa Nacional de Pesquisa Agropecuária PRONAPA, que é a resultante da consolidação dos projetos nacionais.

O PRONAPA, detalha os projetos e as atividades a serem desenvolvidas num período de dois anos e a dinâmica do processo proporciona a sistemática revisão do segundo ano, do programa anterior, que é acrescido da programação de um novo ano. Na parte referente ao primeiro ano, os projetos e as atividades são relacionados de acordo com as disponibilidades do orçamento-Programa.

Além destes instrumentos básicos a EMBRAPA contra com o seu Orçamento-Programa, que representa a versão anual do Orçamento Plurianual de Investimentos - OPI, onde consta o detalhamento especificações e vinculação de recursos aos Programas e Projetos, nos diversos níveis.

Resta mencionar o Subprojeto, que é a unidade de referência do ponto de vista do Sistema de Programaçao e Orcamentação.

O Subprojeto, que perde detalhamento na consolidação dos níveis mais elevados, constitui-se em instrumento básico à orçamentação, contabilização de custos e, consequentemente, avaliação da pesquisa e da tecnologia. Tal como o PRONAPA, o Subprojeto é elaborado a nível de

Unidade Operativa pelos pesquisadores, para um período de dois anos.

5. CRITÉRIOS UTILIZADOS PARA A ALOCAÇÃO DE RECURSOS

5.1. A ESTRATÉGIA GOVERNAMENTAL

A EMBRAPA como principal instrumento do Ministério da Agricultura para promover a pesquisa agropecuária engaja-se na estratégia agropecuária traçada pelo Governo Federal, definida no Plano de Desenvolvimento Econômico e Social - II PND.

Espera-se que a Agricultura e Pecuária passem a desempenhar um novo papel na estratégia nacional de desenvolvimento. Uma contribuição mais significativa à expansão do PIB, com menor preço para o consumidor, maior renda para o agricultor e melhor padrão de vida para o trabalhador, são algumas das características do novo papel do Setor Agropecuário.

A agricultura atualmente é responsável por 15% de renda interna apesar de continuar sendo o setor básico de sustentação nas regiões menos desenvolvidas.

O novo desempenho da Agricultura propiciará uma elevação mais rápida da sua renda liquida que ajudará a sustentar o alto dinamismo da econômia global, através da demanda por insumos e por bens de consumo, além de contribuir mais intensamente para redução do deficit na balança do comércio.

Conforme foi explicado no II PND, a estratégia agrícola será orientada no sentido de:

1. Criar as facilidade e dotar o setor de instrumentos para o pleno aproveitamento de seu potencial produtivo;
2. Ampliar o estoque de recursos produtivos pela

Concentração setorial de incentivos;

Estratégia social para o setor rural.

Do exposto depreende-se que a participação direta ou indireta da pesquisa nas grandes áreas de atuação definidas na estratégia governamental.

Com relação ao Plano Básico de Desenvolvimento Científico e Tecnológico - PBDCT, que considera o desenvolvimento científico e tecnológico juntamente com a política de recursos humanos com relação a estratégia, muito mais do que um programa setorial; é necesário salientar que a Tecnologia Agrícola é uma das prioridades do Plano.

Relativa a outra prioridade, o PBDCT, espera alcançar principalmente através da EMBRAPA (ligada à nova empresa de extensão rural, EMBRATER), a realização de um programa permanente e intensivo de pesquisas para os produtos básicos das diferentes regiões, a fim de dispor-se continuamente de novas espécies rentáveis e de formas de combate as doenças, programa de tecnologia de alimentos; pesquisa de cerrados.

5.2. CRITÉRIOS UTILIZADOS PELA EMBRAPA

Acima da Diretoria Executiva da Empresa está a COMPATER, cujos objetivos e atribuições já foram explanados no item 4.1.3 deste trabalho.

A Comissão por haver sido constituida recentemente ainda não definiu os critérios e mecanismos que adotará para a destribuição dos recursos para pesquisa aplicada, o que ocorrerá a partir de 1975.

Portanto, cabe à Diretoria Executiva definir os critérios a serem observados. Estatutariamente as normas gerais quanto a destribuição dos recursos é a seguinte:

Compabilização de sua programação com o Plano Nacional de Desenvolvimento Econômico e Social do País, à política nacional de ciência e tecnologia e as prioridades estabelecidas pelo Governo;

Adequação de seus programas, projetos, subprojetos, e atividades, a política establecida pelo Ministério da Agricultura para o desenvolvimento do setor agrícola;

Revisão de sua programação, em face da avaliação de programas anteriores;

Observância, na elaboração de programas, projetos e subprojetos e atividades, da situação de cada região no que se refere a recursos produtivos, inclusive quanto as diferenciações sub-regionais;

Articulação com outros órgãos ou entidades públicas ou privadas, que se dediquem as atividades de pesquisa, objetivando evitar paralelismo ou dispersão de esforços e recursos;

Destrição e tradução, em tèrmos financeiros, para efeito de elaboração do orçamento-programa, das diversas etapas dos programas, projetos, subprojetos e atividades;

Acompanhamento e avaliação da execução dos programas em vários níveis, a fim de verificar o respectico cumprimento, bem como dos custos reais e da eficácia dos processos adotados;

E válido enfatizar que, quanto aos critérios a serem utilizados na destinação dos recursos, desde os primeiros documentos tendentes à criação da Empresa alguns conceitos e principios foram manifestados e atualmente estão em plena adoção.

Na própia Exposição de Motivos (3), dos Ministérios à Presidência da República, que concluiu por uma profunda reformulação institucional dos órgãos de pesquisa agropecuária, foram levantados aspectos que se transformaram em critérios utilizados pela EMBRAPA, que são:

O ajuste da pesquisa agropecuária aos objetivos e metas centrais do Governo previstos no Plano de Desenvolvimento Econômico e Social e, em forma particular às prioridades da política agrícola;

A organização do sistema setorial de pesquisa agrícola em conformidade com a orientação geral do ato do Governo que criou um mecanismo nacional de promoção e apoio ao desenvolvimento da ciência e tecnologia;

Criação de um mecanismo de captação e manejo de recursos financeiros que possibilite ampliar, em forma considerável, as atividades de pesquisa e dar-lhe flexibilidade e dinamismo de que necessita para cumplir eficientemente seus objetivos;

Proporcionar os meios e instrumentos indispensáveis para que a pesquisa exerça suas atividades em forma mais eficiente e expedita;

Estabelecimento de condições propícias para estimular, ampliar e consolidar a coordenação entre os diferentes setores que realizam pesquisa agropecuária no País;

Estabelecer os vínculos necessários de coordenação em forma estável, entre a pesqüisa e os mais importantes organismos do setor público que promovem o desenvolvimento agrícola, especialmente os de asistência técnica, de financiamento e de comercialização;

Mobilizar a participação e o apoio do setor privado (industria, produtores organizados e outros), na realização da pesquisa agropecuária;

Proporcionar as medidas que assegurem um processo sistemático e contínuo de programação das atividades da pesquisa com o controle e avaliação dos seus resultados;

Estabelecer as políticas nacionais para a pesquisa setorial e assegurar a execução de programas e projetos de impacto no processo produtivo da agricultura, mediante a execução descentralizada com o emprego máximo dos recursos já existentes nas distintas regiões do País;

Ciar condições essenciais para que, por sua eficiência e resultados, a pesquisa agrícola adquira importância, prestígio e reconhecimento atualmente observados em outros setores científicos e tecnológicos do desenvolvimento nacional.

Para a consecução do que expressam os Estatútos da Empresa salientam-se alguns principios que norteiam desde 1973 as ações até então desenvolvidas, que incidem no processo de tomada de decisões e, consequentemente, na mobilização de recursos humanos, materiais e financeiros.

Definiu-se que o PRONAPA terá como objetivo básico a produção de informações que permitam introduzir mudanças no processo de produção com o fim de apoiar as políticas e metas agropecuárias do Governo.

Atualmente, foi estimado que o crescimento do Setor Agropecuário deve ser da ordem de 7%, com as lavouras desenvolvendo-se entre 6 e 7% e a pecuária numa taxa superior aos 7%, para com isto assegurar o crescimento global da econômica e correspondente desenvolvimento do País.

Deverá ainda, o PRONAPA, proporcionar os conhecimentos que visem a aumentar a eficiência econômica e social na realização do proceeso produtivo na agropecuária.

Esta eficiência tem como caracteristica principal propiciar o aumento da produtividade da terra e do capital, pela racional utilização da mão de obra e pela obtenção de uma rentabilidade suficiente para garantir uma satisfatória distribuição da renda.

A metodologia usada pela EMBRAPA, para atingir a tais propósitos, fundamenta-se no principio de que a programação de pesquisa deve ser calçada em critérios de prioridades alinhadas por produtos.

Além disso, busca-se na abordagem em base a sistemas integrais de produção, o meio de assegurar a conveniente aplicaçao dos recursos da Empresa.

5.2.1. <u>Prioridades da Pesquisa</u>

Do exposto anteriormente, neste documento, se depreende que a definição das prioridades da pesquisa agropecuária aplicada é decorrente das diretrizes estabelecidas nos instrumentos básicos da ação governamental.

A concentração de recursos é propositadamente orientada para determinados produtos ou áreas do conhecimento humano, que venham a contribuir decisivamente para o cumprimento das metas estimativas pré-estabelecidas.

Existe hoje enorme preocupação atinente aos produtos da agropecuária que são exportáveis e aqueles que asseguram a normalidade do consumo interno.

Sem perder de vista os objetivos da economia nacional, como um todo, a EMBRAPA, prioritariamente dirige sua ação para os seguintes pontos:

Concentração de recursos institucionais, humanos e financeiros para a execução de projetos de pesquisas que visam a aumentar a produtividade da agricultura nacional com vistas ao atendimento das necessidades alimentares da população, de desenvolvimento industrial e do incremento das exportações;

Execução de pesquisas que objetivam desenvolver recursos pouco conhecidos, especialmente nas Zonas de Trópico Unido, na Região do Pantanal, nas Zonas Semi-Áridas e nos Cerrados;

Execução de pesquisas que assegurem o crescimento da produtividade de mão-de-obra e, que proporcionem maior participação do trabalho na renda gerada pelo sector.

Desta forma busca-se cumprir a finalidade principal da pesquisa de produzir conhecimentos técnicos e científicos que permitan gerar e aperfeiçoar as tecnologias adequadas para o aprimoramento dos processos produtivos.

A Empresa, ao definir os seus critérios para seleção de prioridades, não perde de vista o desenvolvimento que existe, da finalidade antes mencionada, com os fatores intrinsicamente associados que são:

Crescimento;

Equidade;

Redução de risco.

O primeiro fator refere-se ao contínuo aumento da produção dos produtos agropecuários, indispensável ao atendimento das necessidades da população, cuja taxa de crescimento é aproximadamente 3%; e ainda, o aproveitamento desejado, das possibilidades dos mercados externos cuja demanda tender a ser crescente.

O segundo fator está intrinsicamente relacionado com os objetivos sociais, voltados para a elevação do bem-estar do homem e portanto, a equidade deve estar presente no sentido de que, os benefícios alcançados pelo crescimento e os resultados do processo econômico alcancem a todos.

O ultimo fator, redução de riscos, pode ser igualmente importante, como os démais, na caracterização dos objetivos da pesquisa. Além disso, a redução de riscos e incertezas é fundamental em primeira mão, para os intereses da sociedade, muitas vezes atingida pelas frustrações de safras e dificultades econômicas generalizadas, e em segunda, para o interesse restrito dos produtores individualmente.

A determinação de prioridades na pesquisa agropecuária é essencial uma vez que os recursos são escassos e os desejos humanos são ilimitados, no que diz respeito ao conjunto de bens e serviços.

Também deve-se considerar as peculiaridades dos países em desenvolvimento, onde a multiplicidade dos problemas frente a escassez de recursos humanos (qualificados), e dos recursos de capital exige a racional seletividade dos problemas a espera de solução.

Sob o ponto de vista metodológico, a definição das prioridades defronta-se com sérias dificultades das quais ressalta-se a agropecuária em processo bioeconômico, em constante dinamismo afetado por variáveis e fatores imprevisíveis e mesmo incontroláveis pelo homem.

A determinação de prioridades da pesquisa na EMBRAPA, é realizada através de duas abordagens:

Prioridades por produto;

Prioridades por linha de pesquisa.

Entende-se por linha de pesquisa, a uma figura auxiliar de programação, destinada a agregar diferentes disciplinas científicas às técnicas do conhecimento.

Com a finalidade de definir as prioridades da Empresa, foram selecionados os critérios, a seguir relacionados, que foram os considerados como viáveis. Note-se que nem todos foram aplicados em decorrência da falta de informações e dados confiáveis, o que se espera seja sanado em futuro próximo.

Importância do produto
Participação na dieta alimentar
Elasticidade na renda da procura

Participação na balança de pagamentos

Possibilidade de respostas mediatas (margem de retôrno)

Procura industrial

Movimentação de preços

Disponibilidade e uso de recursos

Possíveis beneficiários

Equidade regional

Riscos e incertezas

Tecnologia utilizada (conhecida e potencial)

Capacidade competitiva na produção de tecnologia

Possibilidade de importação e adaptação tecnológica.

A Empresa em 1974, definiu as prioridades da pesquisa por produtos e por linhas para os níveis estadual, regional e nacional, que foi distribuido a todos os pesquisadores como documento básico orientador.

Por não haver possibilidade de uso de todos os indicadores selecionados optou-se por utilizadas diversas fontes de informações, principalmente, objetivando atender aos principais produtos a nível de Estado de Federação, onde se obtém séries históricas sobre a produção e área colhida.

Praticamente a participação no valor total de produção estadual e a área ocupada foram os principais parâmetros utilizados. Estes mesmos indicadores combinados permitiram a indicação das prioridades Regionais.

As indicações regionais foram grupadas para a definição das prioridades nacionais sendo então, agregado um terceiro critério principal, expresso pela participação na balança de pagamentos.

Após definidas as prioridades a nível nacional foi introduzido um quarto critério referente às variações do preço dos produtos recebidos pelos produtores. Este critério serve apenas para reforçar ou alterar a ordem em que os produtos se apresentam na seleção anterior.

Para a execução deste trabalho, além dos especialistas lotados nos Departamentos do Nível Central da EMBRAPA, foram constituidos grupos de trabalhos com os pesquisadores, até mesmo de outras instituições para determinar as prioridades.

6. GRUPOS QUE DEMANDAM RESULTADOS DE PESQUISA

O principal interessado e coparticipante na obtenção de resultados da pesquisa é o propio Governo, seja a nível Federal, Regional, Estadual ou Municipal. Em todos estes escalões existem diferentes organismos que estão estreitamente vinculados ao setor Agropecuário, cuja atuação implica não só em execução de pesquisa, mas também nos resultados alcançados.

A atividade da EMBRAPA não terá o menor significado se o seu produto final não for levado a quem de direito, ou seja, aos usurários dos resultados da pesquisa agropecuária.

Este objetivo somente será conseguido sob alguns aspectos, através de uma poderosa estrutura adequada para exercer a difusão da tecnologia.

Desta forma, os usuários da pesquisa que caracterisam os mais importantes grupos de demanda, quer no campo quer nas cidades deverão ser melhor atendidos quando as Empresas Publicas estiverem em pleno funcionamento, submetidas as atribuições definidas pela COMPATER.

Para atender aos grupos que expressam a demanda pelos resultados da pesquisa, e consequentemente cumprir com suas finalidades os própios Estatutos da EMBRAPA (6), estipulam os seguintes aspectos:

Manter estreita articulação com o Sistema Brasileiro de Extensão Rural, hoje transformado na Empresa Brasileira de Assistência Técnica e Extensão Rural - EMBRATER, e outros serviços de assistência técnica, públicos e privados para efeito de difusão de tecnologia que houver desenvolvido diretamente ou por intermédio de convenios, contratos ou ajustes;

Colaborar com entidades públicas, federais e estaduais que se dediquem à pesquisa agropecuária visando à harmonização de programas;

Articular-se com entidades de direito privado, quando devidamente aparelhadas, para execução de trabalhos de pesquisa, mediante contratos;

Evitar duplicação de investimentos na execução de atividades de pesquisa, mediante a sistemática mobilização da capacidade já instalada em outras áreas, especialmente nos Estados e nas Universidades;

Promover ou apoiar a formação e o aperfeiçoamento de pessoal especializado nos vários tipos de pesquisa a que deve dedicar-se e realizar o treinamento sistemático de seu pessoal técnico e administrativo;

Conceder financiamento para atividades de pesquisa, diretamente ou em articulação com mecanismo financeiros especificos. É facultado à EMBRAPA desempenhar suas atividades mediante convênios, contratos ou ajustes, inclusive com pessoas jurídicas estrangeiras ou internacionais. Deverão ser remunerados os serviços concernentes as atividades de pesquisa que a EMBRAPA prestar a órgãos públicos e entidades privadas.

Para atender ao preconizado anteriormente a Empresa utiliza a figura do Projeto Especial que define a forma através de qual outras instituições solicitam auxilio técnico e/ou financeiro para o desenvolvimento de atividades da pesquisa.

O própio Modêlo Institucional (7), preconiza que a EMBRAPA deverá ter como orientação básica o desemvolvimento de uma atuação caracterizada pela busca constante das mais diversas formas de cooperação e pelo apoio que irá emprestar aos diferentes organismos que realizam pesquisa agropecuária. Será, assim, sempre aberta e sensível ao esforço cooperativo.

A Empresa deverá aliar-se com órgãos e entidades do Governo Federal, com as Universidades, com os Estados, com o setor privado, e de modo especial com a indústria que utiliza produtos agropecuários e com produtores de insumos.

Essa cooperação irá, certamente, possibilitar a adoção de diferentes formas de execução de projetos, promovidas diretamente pela Empresa, mediante acordo ou por delegação e através da contratação de pesquisa.

Relativamente a integração nos Sistemas Estaduais das Universidades e estabelecimentos de ensino Superior atépreconizar o que segue:

Formacão e treinamento de recursos humanos; orientando estudos em aspectos de pesquisa de interesse nacional, regional, estadual e local;

Contratação das entidades, para execução de trabalhos conducentes à geração de tecnologia especifica;

Obtenção de assessoria especial para seleção de modêlos de tecnologia básica já existente e para condução de trabalhos de adaptações desses modelos;

Com respeito a iniciativa privada, onde o campo de atuação é vastissimo para a execução de programas e atividades de pesquisa, dois aspectos realssados:

Geração de tecnologia especifica em colaboração com o sistema

Compra de tecnologia gerada ou adaptada pelo sistema.

A EMBRAPA, através dos Sistemas Estaduais, desenvolverá atividades que tenderão a reforçar os laços de integração institucional, pois estão voltados para os seguintes aspectos:

Manter estreita articulação com entidades publicas e privadas de assistência técnica, para efeito de difusão de tecnologia;

Estimular, apoiar e desenvolver programas de capacitação de técnicos de nível médio e superior, considerados essenciais para o desenvolvimento de pesquisa;

Utilizar a capacidade instalada disponível na área a fim de evitar a duplicação desnecessária de investimentos;

Adotar conceitos científicos de planejamento e administração no desenvolvimento das respectivas atividades.

7. CONSIDERAÇÕES FINAIS

Por mais ambiciosas que sejam as metas estipuladas pela Empresa e ainda que exista uma eficiente e eficaz estrutura operativa no prazo de dois anos, em se tratando de pesquisa agropecuária, nao se pode esperar e avaliar resultados sem considerar os profundos problemas das novas orientações.

O Sistema Nacional de Pesquisa Agropecuária atravessa um marcante período de transição, no qual as vantagens do novo Modêlo Operacional ainda se fazem sentir e a efetividade do modêlo anterior foi abalada pela introdução de outros mecanismos.

Medidas energéticas estão sendo tomadas no sentido de realizar as transformações previstas no Modêlo Institucional de Execução de Pesquisa Agropecuária, no Sistema de Planejamento e outras preconizadas em áreas, como por ejemplo de Recursos Humanos.

A Diretoria Executiva está apoaida, a Nível Central nas seguintes regiões:

Superintendência de Administração e Finanças

Departamentos:

Diretrizes e Métodos de Planejamento

Projetos Especiais

Técnico Científico

Informações e Documentação

Difusão de Tecnologia

Processamento de Dados

Recursos Humanos

Conforme evidenciado no Relatório de Atividades de 1973 (5), do conjunto de açoẽs desenvolvidas no periodo merecem destaque especial:

-A realização de inventário do pessoal, bases fisicas, equipamentos e dos trabalhos de pesquisa a serem transferidos ou aproveitados pela Empresa;

-O inicio de execução de amplo programa de recursos humanos: pós-graduação e capacitação continua;

-O intenso trabalho de informação e contatos diretos com instituições e setores interessados em pesquisa agropecuária - informação sobre a Empresa e estabelecimento de programas de ação integrada;

-Atividades relativas a formação do orçamento de 1974 e estudos para a acriação de novos mecanismos ã captação de recursos;

-Elaboração e implantação de um novo sistema de programação de pesquisa, incluindo também, trabalhos de preinversão e análise de projetos prioritários de pesquisa;

-Inicio da implantação da estrutura técnica, científica, administrativa e financeira, possibilitando a Empresa assumir todo o acervo do Departamento Nacional de Pesquisa Agropecuária -DNPEA, extinto por lei.

Somente contando com número de pesquisadores devidamente capacitados é que se conseguirá a almejada modernização da agricultura brasileira. A ação da Empresa no que se refere a Recursos Humanos pode ser evidenciado pelos resultados da ação do Departamento específico.

Em 1971, haviam 810 pesquisadores no DNPEA que organizou o acervo recebido pela EMBRAPA. Destes 636 optaram pela Empresa.

Atualmente a força de trabalho está constituida da seguinte forma: (dados fornecidos pelo Departamento de Recursos Humanos):

	N°	%
Pessoal Técnico Científico	915	22,12
Pessoal de Apoio a Pesquisa	2.295	55,47
Administração Geral	927	22,41
TOTAL	4.137	100,00

Dois programas estão sendo desenvolvidos para o aperfeiçoamento do pessoal: Pós-graduação e Capacitação contínua.

Em 1974, o contingente de técnicos em pós-graduação atinge as seguintes cifras:

	Brasil	Exterior	Total
M.S.	253	25	278
Ph.D.	20	19	39
TOTAL	273	44	317

Finalmente, resta mencionar os aspectos relativos aos recursos Financeiros, considerados como o mais importante fator do sucesso e dinamização da Empresa.

Embora existindo dotações orçamentários especificas cabe a Diretoria Executiva responsabilizar-se pela realização do orçamento. Espera-se através da estrutura de Empresa Pública minimizar os trâmites decorrentes da existência de múltiples fontes de financiamentos para a Pesqüisa Agropecuária, o que sobrecarrega significativamente a atuação da Superitendência da Administração e Finanças e os órgãos de administração descentralizantes.

Neste momento está sendo aprovado um novo Sistema Orçamentário do qual se opera a flexibilidade suficiente para agilizar e datar a Empresa de adequado meio de contrôle financeiro e contábil, básico para a captação de recursos.

Apresenta-se, a seguir, os quatitativos previstos no I PND para dar suporte a EMBRAPA, o que mais uma vez se ressalta, traduzem a consciência e o interesse do Governo Federal, em realmente industrializar a

Empresa para o desempenho de seu papel fundamental no processo de desenvolvimento do País.

	Cr$ milhões
1975	500
1976	650
1977	800
1978	900
1979	950
TOTAL	3.800

Levando-se em considerações que em 1973, a Empresa, contou com recursos no montante de Cr$ 125,5 milhões e em 1974 a estimativa é de ordem de Cr$ 186 milhões evidencia-se o impulso que os recursos financeiros proporcionarão a partir de 1975.

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CRITERIA FOR ESTABLISHING RESEARCH PRIORITIES AND SELECTING RESEARCH PROJECTS

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Criteria for Establishing Research Priorities and Selecting Research Projects

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Events of the past decade have firmly fixed in the minds of national decision-makers the critical role of agricultural research in the world's fight to feed itself. The advent of the green revolution with its heralded "miracle wheats and rices" was made possible by scientific achievement. In fact, so striking were these products of research that many were led into false optimism on the world food situation. Expectations from research were overemphasized and the seriousness of the problems research was to remove was minimized. Droughts, floods, frosts and other adverse weather phenomena of the past three years have jerked us back to reality. We now know that research can provide a basis for phenomenal increases in agricultural yields, but we also know that research takes time and money, and that it is only one of a complex series of inputs, all of which must be present if sustained changes in crop and animal production are to occur.

THE TWO-PRONGED APPROACH

During the past decade, we have witnessed the development of a two-pronged approach to agricultural research aimed at solving food production problems in the developing world. The most widely publicized approach is that of the network of international agricultural research centers such as CIAT, host for this conference. In theory, these centers bring to bear the best scientific talent, resources and facilities in the world to solve the food production problems of the developing countries. Located in regions where the problems are, these centers couple scientific expertise with reality of the problems of the peasant.

The second, less well-heralded approach to agricultural research is that of

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the national research organizations in the developing countries. Although they receive much less publicity than do the international centers, these national research units have the ultimate responsibility of doing the research which will be most meaningful to the cultivator. Furthermore, their problems of planning and implementing effective research programs are more complex and difficult to solve. In comparison with those at the international centers, resources of these national organizations are limited, their manpower less well-trained and their facilities inadequate. Also, because of the independence of comparable organizations in neighboring countries, research in these units tends to be little coordinated with that of research units in nearby countries.

These two basic approaches to agricultural research, coupled with the complexities of the many food production problems in the developing world, provide an almost inexhaustable list of researchable problems. The total need for new knowledge to help farmers produce more food dwarfs the resources available to support and to do the research needed to gain that new knowledge. As a consequence, priority setting becomes paramount. No only must wise choices be made as to what problems must be attacked first, but decisions must be reached as to where the research is to be done - at national institutes, at one or more of the international centers, or through collaborative efforts of more than one organization.

CURRENT SITUATION

There is much to be desired in agricultural research priority setting, especially that of national research organizations. Unfortunately, relatively little attention has been given to agricultural research planning and management in the developing countries. Too often patterns developed in the more affluent countries are followed, patterns which in most instances are not properly suited for the developing countries.

The imitation of researchers in the more developed countries is evident, especially at universities and at selected research institutes in the developing world. Having received their graduate education at a university in the United States or Europe, the professors or scientists in the developing countries are prone to continue the type of research they did for their graduate thesis. In some cases, this has meant continuation of research which has little if any practical meaning to the social and agricultural problems of the country in which the research is done. Research areas which may be of keen interest to a major professor in California, Illinois, New York or Great Britain may have little or no relevance to the solution of problems facing farmers who produce cassava, cowpeas, rice or guinea grass in Latin America, Africa or Southeast Asia.

In other instances, scientists trained abroad essentially cease doing research when they return to their home country. The nature of their overseas training is such that they either are not capable of handling applied problems or they do not have the equipment or funds to continue the type of research work for which their graduate training prepared them. Also, quite often they find themselves with little support, a ridiculously low salary and little authority to change the bureaucratic systems in which they work. In still other cases, their overseas training seems to have left them with the conviction that the mundane applied research chores needed to increase agricultural productivity is beneath their dignity. The problems for which they were educated and trained to solve remain unsolved. The country may even be worse off for their having been sent abroad. They give their national leaders a sense of security since they are well-trained and should have the capability to carry out high-quality research. Unfortunately, the circumstances in which they find themselves make this achievement unlikely if not impossible.

To complement the research at universities and research institutes are the applied research trials being carried out at small outlying stations, which in some countries are numerous. Characteristically, these stations are poorly staffed and equipped to carry out their assignments. They are commonly under the direction of an applied researcher with a B.S. degree. He is assisted by technicians with a high school or trade school diploma. Applied field trials are initiated but due to inadequate financial support, scarcity of chemicals and other inputs and inadequate supervision, the quality of research is low. Often the research station will double as a seed production facility, a function in the minds of farmers and politicians which is more important than research.

Some of the regional research stations may have small plant breeding programs. Too often, however, their efforts are not coordinated as a part of a national crop improvement program. There is reluctance on the part of the scientists located at these stations to exchange seeds with their counterparts elsewhere for fear that they will not be given proper credit for their research efforts. Also, the small size of the stations prevents the employment of an interdisciplinary team of scientists to work with the plant breeder in improving the crops under investigation. Here too, there appears to be a great waste of talent and financial resources.

May I hasten to point out that there are some notable exceptions to the situation just described. There are a few examples of national research programs which do not fit the situation I have described. In these cases there is notable national research coordination. Effective long-range plans have been developed and are being implemented. Well-trained researchers are being effectively utilized and are training younger personnel to take their places. Even so, the situation I have described all too often pertains and is a serious stumbling block to effective use of science in the developing world to increase food production.

My reason for focusing on the situation as it now exists, gloomy as it may appear, is to emphasize that, if overall national policies do not give higher priority to agricultural research, the setting of research priorities may be meaningless. To consider criteria for setting research priorities in a theoretical, abstract framework would be too foolhardy. Certain conditions must be present before any kind of priority setting can be effective. We must recognize the organizational, financial and social constraints on agricultural research at the national level. While steps must be taken to remove these constraints, to the extent they are not removed, they must be considered in any type of priority setting procedure. This does not mean that the procedure and the resulting priorities exclusively should be determined by the constraints, but at the same time, realistic priorities should not be set ignoring the constraints. The ultimate aim is to see that the needed research is planned and performed -- not just to set up a theoretically-sound priority setting mechanism.

RESEARCH AND SOCIAL GOALS

Agricultural research cannot be considered in isolation from the basic human needs of society and perhaps more importantly from the perception of those needs by national leaders. Food production and a viable agricultural base to provide that production may be important, but this importance will not be translated into action unless it is perceived by national leaders. For this reason, I suggest that national social goals as perceived by national leaders and decision-makers must provide a basis for determining the direction of research programs and of the specific priorities within these programs.

Traditionally, agriculture has not always received the highest priority among national social goals. To many political leaders, agriculture and agriculturalists represent the lowest rungs of the socio-economic ladder. To them, agriculture represents a preoccupation of the past from which a developing country must move if it is to achieve development. It generally takes second place to industry in national priorities. Seldom are the better qualified college students encouraged to take up agriculture as a career. Most of the sons and daughters of the well-to-do study medicine, law, economics or liberal arts. They do not aspire to become agriculturalists.

Perhaps the best example of comparative priorities is seen in comparing emphasis placed on research institutes devoted to atomic energy research and those concerned with agriculture. Invariably the agricultural unit takes a back seat. In one country I visited recently, I was told that there were eleven entomologists associated with biological research at the national atomic energy facility. An agricultural conference held at this location revealed entomology to be one of the subjects most poorly covered in the agricultural research program in that country. The agricultural research institutes could not hire entomologists since their salary scale was considerably below that of the atomic energy unit. When I inquired as to the research accomplishments of the eleven entomologists, I found they were sadly lacking. The accomplishments which had been made appeared to have no bearing on the food production needs of the country.

The current world-wide food crisis is doing much to place in proper perspective the importance of national food production goals. Hopefully, behind the smoke screen of political statements and grandoise plans for world food reserves, consideration is being given to the world's long range dependence on food production in the developing nations and the role to be played by research and education if yield plateaus are to be permanently raised.

Research administrators have a rational responsibility to help decision-makers identify national goals relating to agriculture and more specifically those relating to agricultural research. One of the most significant challenges is to force national leaders to think in terms of the future. They are forced to give priority attention to the realities of the present -- to seek solutions to the immediate problems facing them and their constituents. Two years ago they may have had only passing interest in research. Consequently, they seriously consider only those actions which give promise of immediate results. This means they tend to concentrate on "action" type programs or on extension programs aimed at bringing about action. Also, their preoccupation with current problems forces them to think of only those research inputs which promise immediate results. By so doing they by-pass or eliminate long-range research planning and concomitantly the setting of meaningful research priorities.

The job then is to convince decision-makers that research must be oriented to the future -- dividends may be returned next year or the year after but more likely 5 or 10 years hence. Only if this is done will consideration be given first of all to the true role of research, and secondly, to the setting of priorities for this research.

An important task of the research administrators and other decision-makers is to clearly identify the extent to which agricultural research can contribute to the attainment of social goals of a nation or region. To do this agriculture's overall goals must be clearly established on as long a time frame as possible. Decisions must be reached as to national production goals for specific crops and animal products and a target date established for meeting these goals. Ideally, agricultural scientists should participate in setting these goals to clearly establish their practicability and to help identify the role that science can play in meeting them.

The desire for national self-sufficiency, especially with respect to food crops, sometimes leads to the establishment of unrealistic and economically unsound production goals. Economists as well as biological scientists have a role to play in clearly identifying the agricultural areas in which a given country has a comparative advantage. For example, in some countries, programs to develop wheats and barleys adapted to tropical conditions have been stressed to help the countries become self-sufficient in these crops. While the attainment of this goal may be biologically possible, and politically and socially satisfying, limited research resources might better be utilized on food crops which are well-adapted to tropical climates.

To identify means of meeting social goals, agricultural research administrators must know the limitations which society imposes on the agricultural industry.

These limitations may relate to factors such as environmental quality, land use, and the availability and cost of agricultural inputs. Restrictions on the use of pesticides, and the cost and availability of these chemicals will help shape research priorities. Likewise, public policies on the relative prices for chemical, land and financial inputs, on the one hand, and for the crop or animal products of the farm on the other, will determine the nature of the research effort.

Lastly, religious and other social constraints must be taken into consideration. Research on beef in India, for example, where cows have a special religious significance, would be considered in a different light than similar research in Nigeria or Brazil where such animals play a different social role.

In some cases, science is given the responsibility of expediting changes which may be more easily attained by other social and political means. For example, input/product price ratios which are subject to political manipulation can determine the relevance of research on the inputs. Low prices for fertilizer and high prices for rice have helped Japan produce a high proportion of its rice needs through the decades. At the same time, research to increase efficiency of fertilizer utilization has received relatively low priority in the past. The recent increase in fertilizer costs has made such research more attractive.

Other actions which can alter the need for and relevance of different research efforts are decisions relating to land reform, irrigation development, credit cost and availability, and improved marketing channels. Research leaders can influence such decisions by citing experience of others and by making special studies to assist national policy-makers.

PROCESS FOR MAKING RESOURCE ALLOCATION DECISIONS

I have outlined in Figure 1 a generalized procedure for determining appropriate resource allocation for agricultural research. It is assumed that overall social goals will include goals that can be met only through the agricultural sector. In turn, agriculture's goals will require inputs from agricultural research as well as other components

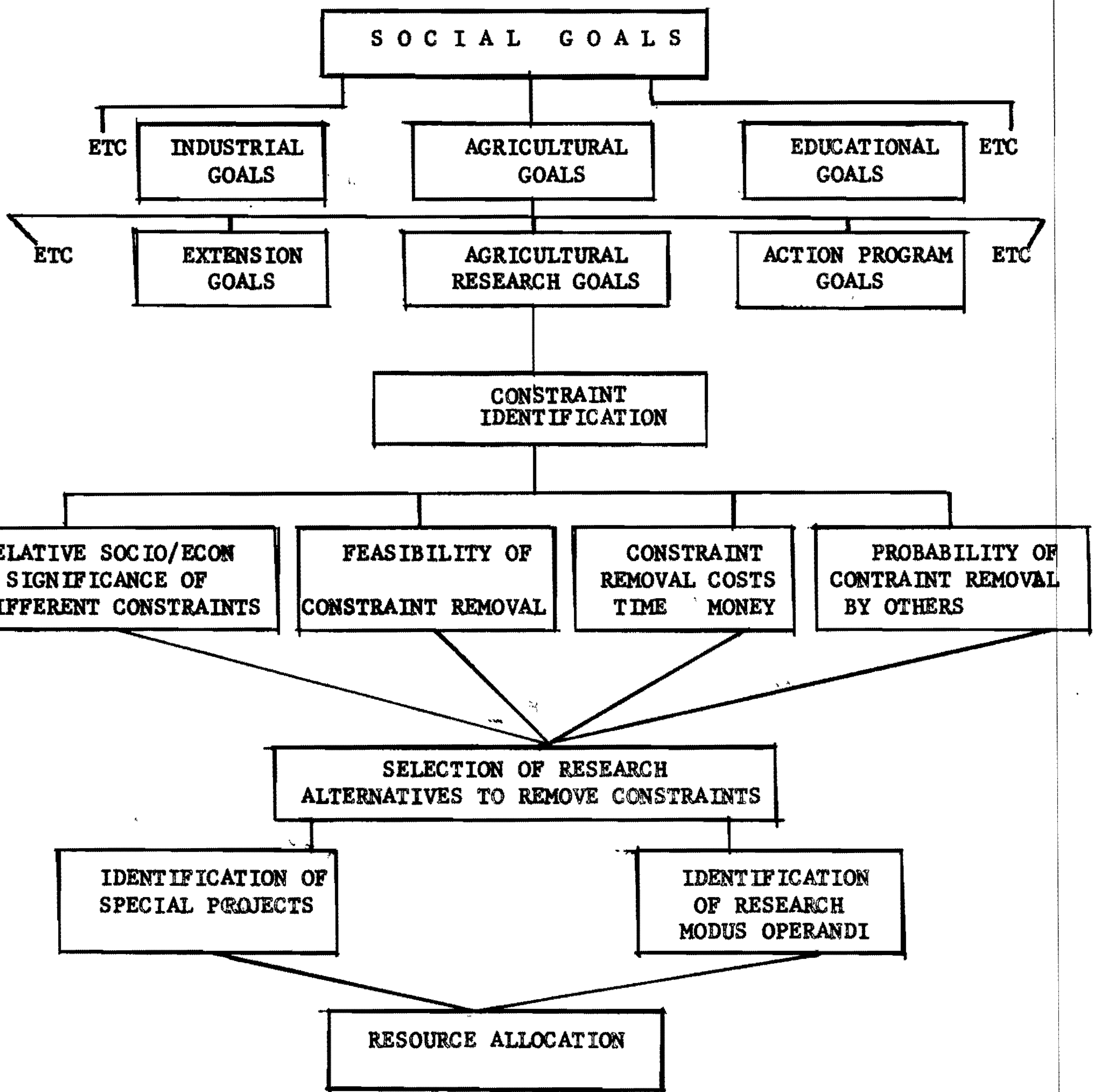

Figure 1. A generalized procedure for determining appropriate resource allocation for agricultural research.

of this industry. Agricultural research goals generally relate to the identification and removal of a series of constraints, perhaps biological, economic, social or political. Our task is to determine the relative importance of these constraints, ascertain the feasibility of research's being able to remove them, determine the removal costs in terms of time and money, and be certain that others cannot remove them more quickly and less expensively than we.

Using these general criteria, it is possible to select a series of research alternatives and to give them different levels of priority. Within each alternative, specific research projects can then be prepared and pertinent research methodologies developed. These become the research instruments to which funds and human resources are allocated.

It is obvious that this approach grossly oversimplifies the actual problems of resource allocation. It assumes the availability of human resources, first to be wise enough to assess the constraints, to set criteria for their removal and to select priority research alternatives; and secondly, to plan and carry out specific research projects once a decision has been made. It also assumes resource allocation for overall agricultural research support in relation to the importance of this research in meeting the agricultural goals and in turn the social goals of the country. It gives little attention to scientific, discipline-oriented research and assumes that in a developing country research that is not in some way related to the solving of pressing human problems would not receive high priority. Also, it does not do justice to the many interactions which must occur at all levels of the decision-making process. Even so, if the general procedure outlined in Figure 1 were followed, there would be great improvements in resource allocation for agricultural research and for the specific programs and projects to be undertaken.

MAJOR CRITERIA FOR SETTING RESEARCH PRIORITIES

In Figure 1, four major criteria are envisaged as being most important in setting research priorities and in ascertaining which specific projects are to be planned and initiated. These all deal with constraints on agricultural production, processing and marketing, and with means of removing these constraints. They will be considered in order.

<u>Relative significance of different constraints</u>

The extent to which the removal of a given constraint would contribute to the achievement of important agricultural, and in turn, social goals is perhaps the most significant long-range criterion for research in developing countries. The relative socio-economic significance of the constraint to be removed is of paramount importance in setting research priorities. Thus, research in India to increase the production of that country's two most important food crops, rice and wheat, would have a higher priority than would research on the biochemistry of photosynthesis. Likewise, research on corn or beans in most Latin American countries would receive higher priority than research on a secondary crop such as strawberries.

More specific factors to be considered in determining the social significance of removing different constraints to the attainment of agricultural goals are the size of populations and of crop and land areas, and the number of institutions potentially affected by the proposed research. Also, effects on income distribution, effective land utilization and other socially worthwhile goals would receive attention. The problem is to identify those constraints, whose removal would be most meaningful to agriculture and to society generally. Unfortunately, the combined wisdom to reach such judgements is not always available.

<u>Feasibility of Constraint Removal</u>

The feasibility of removing through research different constraints on agricultural production, processing and marketing is an important criterion. Determination of this feasibility will depend upon a number of factors including the nature of the constraint to be removed, the availability of scientists sufficiently well-trained to carry out the research, and progress already made in related research areas.

The breeding of corn hybrids having superior protein levels and amino acid balances and which are adapted to specific conditions in South America appears to be feasible. On the other hand, the development of techniques to control soil-borne organisms on small farms by treatment with chemicals does not appear to be so feasible. The probability that research can provide technologies or methodologies to remove constraints must be taken into consideration.

The availability of well-trained manpower can markedly affect the implementation of a given research project and in turn, the removal of a given constraint. Unfortunately, scientists and research administrators do not always recognize limitations of scientists to carry out a given research project. Too often, peer and other social pressures force a scientist to take on a research project which he is not qualified to implement. Also, limitations in financial resources and their rate of delivery can adversely affect a scientist's ability to perform, as can an inefficient system of procurement of supplies, equipment and supporting personnel. All these factors realistically must be considered when assessing the feasibility of removing a given constraint through research.

Cost of research to remove the constraint.

The required inputs in terms of financial and human resources and of time needed to accomplish the research are important criteria, especially in relation to the expected results. The financial benefit/cost ratio has been commonly used as an important criterion to determine research priorities. Unfortunately, however, benefits from agricultural research cannot always be quantified in economic terms. For example, research aimed only at social benefits may have no economic implications. Also, some research may be economically beneficial to one social group and harmful to another. Research to improve one crop which normally competes with another may help one group of farmers and be detrimental to another.

With all its limitations, benefit/cost ratio analysis is an important tool for evaluation research priorities. It provides at least a general guide to s society's chances of benefiting from human and financial inputs. Also, it gives a relative yardstick for comparing the probable benefits of one research approach with that of another.

Aside from the benefit/cost analyses, research costs alone are important criteria for determining research priorities. Even with very high probable ultimate returns on research investment, poor countries may not be able to afford large financial and personnel inputs for agricultural research. The return on this investment, even if it is large, will likely be several years in accruing. Poor countries, with heavy current financial burdens find great difficulty in investing for costly research programs regardless of their likely long-term payoff.

The time requirement for research accomplishment is, therefore, a most significant factor. If the nature of the research requires a minimum of 5 to 10 years before significant results can be obtained, it will likely receive low priority even if its long-term payoff potential is high. This is most unfortunate since the need for such payoff will likely be much greater in 5 to 10 years that at present. The challenge for a research administrator is to insist that some funds and manpower be allocated to projects which have high long-term potential, even though the immediate return probabilities may be low.

<u>Probability that others will do the research</u>

There is a tendency for each research organization to operate in a vacuum, not taking into consideration the research capabilities of others. This is true especially in national agricultural research programs for several reasons. In the first place, there is national pride of accomplishment which forces a scientist and his administrator to want to do the research at home. Also, political and agricultural leaders may insist that research be implemented by their national research organization, not only to be certain that it is applicable to local conditions, but to be able to exert whatever control they think is necesssary on the research efforts.

National research organizations in developing countries must give consideration to the research which is being done, and which can be done elsewhere. Regional cooperation must be encouraged to permit interchange of crop and animal strains, as well as published research results. The network of cooperators in the international wheat improvement program is a good example of an effective world-wide system of research collaboration.

International research institutes are also confronted with questions on duplication of research. The temptation is to expand into those areas for which funds are available without full regard for the work of national researchers or of scientists at other international institutes. To succumb to this temptation would be wasteful of human and financial resources.

One criterion that has been suggested is that international agriculture institutes engage in only those research activities which are clearly in their mandated area of responsibility and for which they have a comparative advantage. If someone else can do the research more effectively, more inexpensively or in less time, the international centers should seek the outside help and cooperation.

Other practical considerations

In addition to the four major criteria presented in this paper, there are a number of practical criteria which must receive attention. For example, the urgency of the research to be done is an important factor. If a new disease threatens a crop or animal population, the urgency of the situation may demand immediate attention. Although the problem may not be of great national importance at the time, the pest could spread and become a serious problem later on. Timely research and action programs now may contain or remove the problem, thereby justifying research inputs that normally would not be made.

Research administrators must be on guard to prevent the "urgent" problem-solving research projects from dominating the research programs. Failure to do so may mean that "fire-fighting" soon takes most if not all their research resources, making it difficult, it not impossible, to mount effective long-range programs.

Another factor, which at the research institute level must be used as a criterion for selecting the research programs to be implemented, is staff competence. Regardless of national and agricultural goals and of known constraints to meeting these goals, financial resources should not be allocated to scientists known to be incapable of implementing the research. Unfortunately, in following this restriction, research administrators sometimes find themselves allocating research funds entirely on the basis of the known competence of their scientists. While this situation may be justified in the short run, eventually a mix of trained manpower must be recruited to do the research which criteria other than those related to staff competence suggest should be done.

METHODS OF DETERMINING CRITERIA

It is not so difficult to identify the general procedures by which criteria and, in turn, priorities can be determined. The difficulty arises in implementing the procedures. There are widely differing opinions among politicians, planners, research administrators and scientists at each level of decision-making as shown in Figure 1. Certainly this difference is noted in determining the social goals and in turn the part agriculture is to play in meeting these goals. Similarly, there is considerable difference in opinion on agricultural research goals and on factors constraining their achievements. The major challenge then is to focus a blend of judgements at each level in the research priority, decision-making process.

The setting of broad social goals is the funcstion of society generally, but usually is accomplished by political leaders and national planners. Scientists and science administrators can and should provide background information for these decision-makers, not only to determine the social goals but goals for agriculture as well.

Agricultural scientists and research administrators should be intimately involved in setting agricultural research goals. They should have prime responsibility for identifying agricultural constraints, the role of research in removing these constraints, and the specific criteria to be used in developing agricultural research priorities. Likewise, they should have major responsibilities for developing these priorities and allocating resources to implement the priority research programs.

Various methods have been tried to determine the criteria for setting resource priorities. In most instances, research administrators use their judgment in setting criteria and in turn research priorities. In others, panels may advise the administrator, but the final decision is made by the administrator. In still others, panels of experts decide on the criteria to be used and identify the research priorities.

There are strengths and weaknesses with each of these procedures. Unaided, the research administrator can make good choices or bad ones, depending on his judgment and lack of bias. With help from an advisory panel, his judgment is broadened and yet he has the final responsibility for decision-making. Shifting this responsibility to an inter-disciplinary panel, which should include some non-scientists, further broadens the decision-making base, but also may open the door for unnecessary compromises which provide at least a little for everyone, whether or not such distribution is justified.

In spite of the weaknesses of criteria and priority setting procedures which involve scientists, the advantages of such procedures far outweight the disadvantages. While it may be inappropriate to give the scientists the sole responsibility for criteria and priority setting, his knowledge of the potentials of science for problem-solving must be fully exploited.

CONCLUSIONS

CONCLUSIONS

1. Criteria should not be set in the abstract but should consider the practical social and organizational conditions which exist in the country or region in which the work is to be implemented.

2. Agricultural scientists and administrators have the responsibility of helping political and social leaders identify social and agricultural goals to the attainment of which agricultural research can contribute.

3. Criteria for priority setting in agriculture can be considered in the frame - work of constraints on agriculture with emphasis on the following:

a. The extent to which removal of different constraints contributes to the attainment of agricultural and other social goals.

b. The feasibility of being able to remove the constraints through research.

c. The costs in terms of time and financial inputs to accomplish the research, especially in relation to the expected benefits and the probability that others can and will do the research with less expense, time and manpower utilization.

4. The establishment of criteria as bases for agricultural research priorities is not an easy task, but the effective use of these criteria is even more difficult to attain. This is due to the marked differences of opinion as to the weights which should be given criteria in setting priorities.

5. The urgency of the research and the training of existing manpower tend to be dominant criteria for setting research priorities in many developing countries. While each of these factors is important, they should not prevent the attainment of long-range research goals.

6. Scientists should play a big but not dominant role in establishing criteria and in setting research priorities. In doing so, however, they should not merely compromise with each other to ensure that each gets his share of the research funding pie.

THE DECISION-MAKING PROCESS FOR RESOURCE ALLOCATION IN PRIVATE AGRICULTURAL RESEARCH

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Northrup, King & Co.

Paper presented at a Workshop on Methods Used to Allocate Resources in Applied Agricultural Research in Latin America
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The Decision-Making Process for Resource Allocation in Private Agricultural Research

Alexander Grobman
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BASIC CONCEPTS

The private firm in the agribusiness sector undertakes research for the express purpose of developing marketable or saleable products, which through added revenues contribute to growth of the firm.

Competition creates the need for innovation and research, but the search for new products transcends this simple explanation. The continued quest in research in the modern firm is nowadays part of its very reason for existence, as research has become an integral part of the operational structure of the firm and one of the foundations of its expectations of profit which in turn should be considered as a payment of society for the firm's service to it. The Research Department or Division of the modern agribusiness firm is charged with the responsibility of maintaining the company on the mainstream of the technology relevant to its purposes, and in the front line of applying this technology. This is done by tapping the internal capabilities of the firm both in human and physical resources, in sensing the advances of technology and science in other institutions, and after assessing their value to the firm and to society, deciding courses of research and development actions.

The operational interrelationships in a firm are shown in Figure 1. It may be seen that the flow of actions and operations is ultimately reflected in the balance sheet -- and profit and loss statement at the end of each fiscal year -- which measures the relative success of all the operations of the firm.

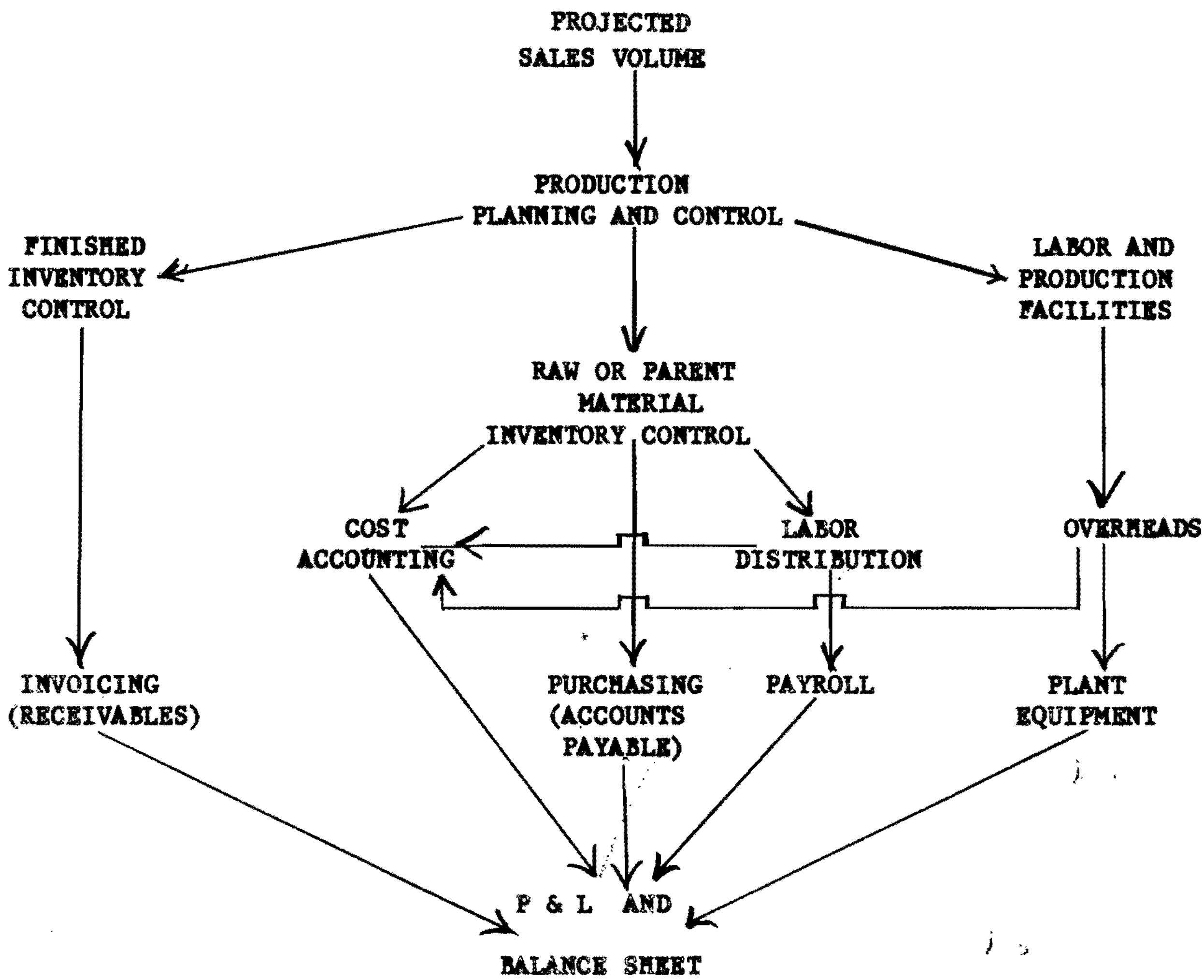

Figure 1. Operational inter-relationships in a model business firm.

As research in the firm is part of its integrated operational structure, its orientation and purposes are therefore primarily set up to maximize future profits.

That the growth of the firm is a function of the acceptance of its products by the sector of society it serves is easily evident. In other words, the firm's goals are basically compatible with those of society and are dependent upon society's goals.

The growth function of a firm capitalizes the following four types of opportunities:

a. Growth markets, which are related to population increases and demands.

b. Capital accumulation, which brings forward monetary resources and capable management, which in turn act as multiplying factors for growth.

c. Technical advance, through the creation of new products and processes.

d. Creative merchandising, which tends to create market penetration and acceptance for the products developed by the firm.

The performance of a firm is then finally measured through:

a. <u>Profitability</u>, both current and potential.

b. <u>Productivity</u>, in terms both of functions and opportunities.

c. <u>Position</u>, as related to the other firms in its field, as a yardstick of performance.

d. <u>Products</u>, in terms of their consumer acceptance.

e. <u>Planning</u>, in terms of creative ideas, growth and expansion.

f. <u>Personnel</u>, defined by manpower skills and talents.

g. <u>Policies</u>, both internal and external, and especially the development and maintenance of initiative at the operational levels.

h. <u>Progress</u>, in terms of both current and potential rates.

We have tried here to present an overall view of the context into which the development of new products by the agribusiness firm takes place. New product development is not a simple proposition. It entails risks. Management in the firm is aware of it, tries to evaluate the nature and magnitude of the risk, and after quantifying it, and comparing it to profit opportunities, makes the decision as to an acceptable level of commitment of the resources of the firm in research and development leading to the production of new products and processes.

This is the basis and background for the decision-making process in the private firm, which we will consider in the next sections.

THE PROCESS OF RESEARCH AND DEVELOPMENT

The sub-functions of the research and development system are presented in Figure 2. They are:

a. Basic or fundamental research, which processes scientific information on causality relationships (why, how, when, which?).

b. Applied or product research, which seeks to find those basic knowledge or information matrices required to reformulate them in terms which may be useful for the solution of process or systematization problems and for the creation and the design of new products.

c. Product development, which establishes production parameters, evaluates the system in which the problem follows and develops solutions, constructs prototypes and facilitates test and evaluation of the prototypes.

d. Product design, is the final stage in the planning of products, and incorporates all corrections that might arise from the evaluation of the prototype, its market tests, and the interaction with the consumers.

PRODUCT ANALYSIS

As stated before, products or processes are objectives of private research, but as a difference with results of public or institutional research, the concrete difference is the requirement of saleability of the product or process.

The product has a life cycle characterized by various phases or stages, such as (a) introduction, (b) growth, (c) maturity, (d) saturation, and (e) decline. During this cycle, the volume of sales and profit margins evolve, gradually reaching independent peaks, and declining later (Figure 3). Provisions for product improvement or

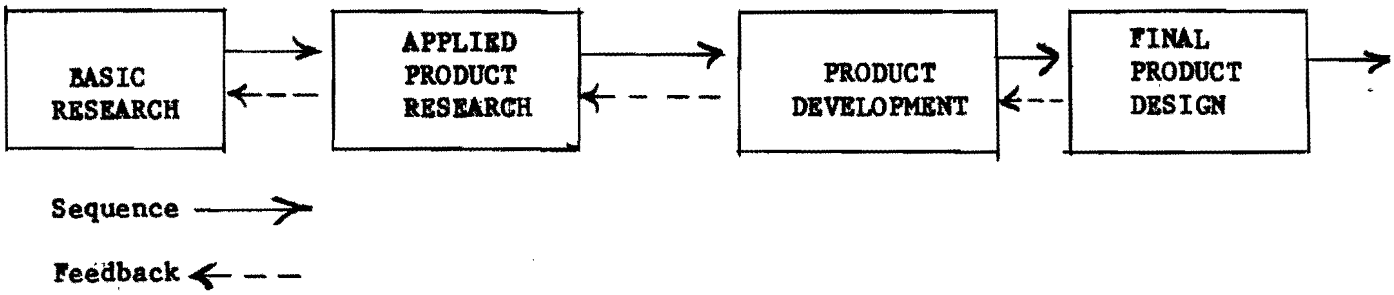

Figure 2. Process flow of research and development.

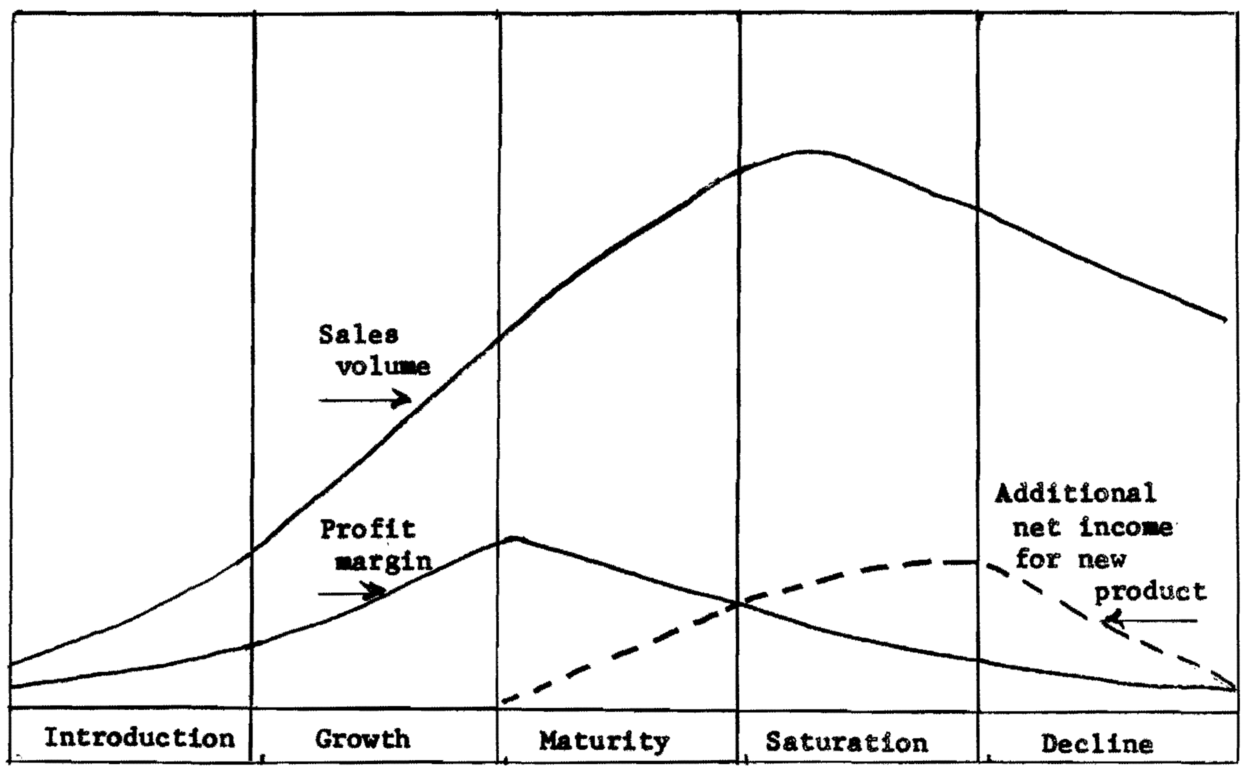

Figure 3. Life cycle of a new product.

substitution are figured out so as to prevent total profit evolution from disappearing.

The research and development function varies with the type and complexity of the product, taking into consideration market demand, market growth, competition, research costs, demands, and profit expectations.

Some of the overall consideration involved in the analysis of design and development of new products follow:

1. Marketing aspects, taking into account the market demand existing or to be created.
2. Product characteristics, insofar as the following aspects are considered:
a. Functional aspect (versatility and security).
b. Operational aspect (easiness of handling).
c. Quality and dependability aspect.
d. Aesthetic aspect (presentation, packing, etc.).
3. Economic analysis, which delves into the detailed cost-profit interrelationships on volume projections over a time scale. The following aspects are taken into consideration:
a. The profit consideration.
b. The 3S Effect: standardization, simplification and specialization.
c. The break-even analysis.
4. Production aspect, which considers all decisions involving the organization of a production stream.

PRODUCT DEVELOPMENT

The phases and operational flow in product development, starting from basic research, going through applied research, to the appearance or generation of a product idea, development, pilot production and market research, on a time scale, are presented in Figure 4.

The following 11 steps make up the product development process.

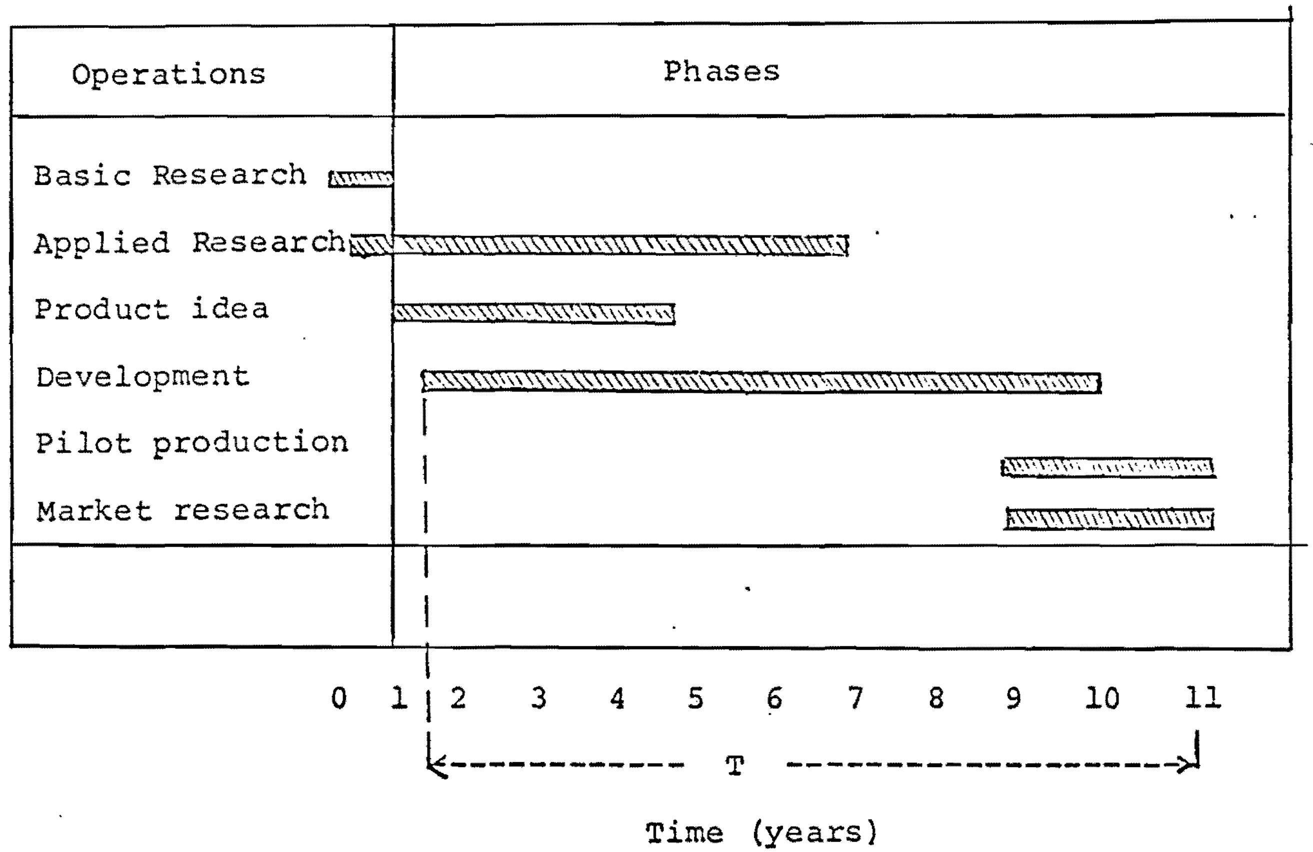

Figure 4. Product flow sequence during research and development.

1. Information. Access to outside scientific and technological information and developments bearing on the firm's interest is of primary importance, especially when coupled with market information and surveys.

2. Product development orientation. Management's attitude is important, when it considers the strengths and weaknesses of the organizational performance, its capacity to carry on research, its manpower research, development, production and marketing skills, its capital and its assets.

3. Clear-cut information of objectives, both in regard to product specification and basic production assumptions, including production with goals, methods of operation in production and marketing and their alternatives, present and future competition.

4. Analysis of the economics of the new product. As research expense projections are matched to expected sales volume, fixed and variable costs can be estimated on a time scale, for products likely to come out of the research. Financial analyses can be made, giving with some degree of precision the most likely profitability index for the investment (P/V = profit—volume ratio).

The P/V ratio denoted by p is explained as follows:

$$p = \frac{\text{Fixed Costs}}{\text{Volume at break-even point}} = \frac{(\text{Profit}) + (\text{Fixed Costs})}{\text{Volume}}$$

The substitution of a new product for an old one establishes the following relation:

$$D = \frac{p_1}{p_2} = \frac{\text{P/V Ratio of Old Product}}{\text{P/V Ratio of New Product}}$$

If the market does not allow for further expansion and penetration of the new product, it is clear that p_2 must be increased, if there is to be the production for a changeover.

5. Setting up a priority on the product, and study of value of the product to the company, time, money and other resources required, extent to which the product will fit into the company's present marketing operations and expansion plans, availability of qualified manpower, potential customer demand, chances of consummation of the research project.

6. Selling the idea to top management, entails going through committee evaluation in all mentioned aspects and gaining the approval and the green light to move on, which means a budget authorization and reduction of the idea to an operational project.

7. Execution of the research and development, involves the research leading to the design of the product according to accepted specifications, test in laboratory, experimental plots and commercial fields, at several levels, maintenance of a work schedule, and a cost structure within the budget, preparation of summary reports to Research and Development (R & D) management, namely the executive vice president in charge, maintenance of relationships with finance and production departments on related aspects.

8. Evaluation of market acceptance of product, should be done with realism, stating the performance statistics of the product and their conformation to the predicted parameters.

9. Test-marketing and production of the product, with a complete evaluation of the problems encountered, which might lead to the eventual approval of large scale production and stocking operations, and major utilization of capital in the bona fide commercial production and marketing phases.

10. Release and production of the product, which involves a major production and marketing commitment.

11. Evaluation. At Texas Instruments (Teal, 1962), the overall measure of effectiveness of research is measured with the following formula:

    a. Index of return on research and development: $N/25 \times S$ is the net profit during the life of the product (N) divided by 25 times the

R & D costs (25S). If this index is 1, there was a satisfactory return of R & D; 25 is the index of return on R & D collected by NSF.

b. Index of return on assets: N/13.5%A, in which A is the assets required for R & D. A return of 13.5% is believed to be a favorable return.

c. Index for dollar volume, is obtained by dividing the billings made possible by the product (b) by the total BILLINGS/25: b/B/25.

d. Index of market capture: b/M/2. A capture of 1/2 of the total available market is worthwhile.

A product of 1.0 or more when multiplying the 4 indices will give an index of research effectiveness, which indicates that this was a worthwhile project.

ANALYSIS OF THE DECISION-MAKING PROCESS IN R & D

A premise that is established in R & D operations in a company is a "new product policy" which, as stated by Gregg 1958: "should define the limits within which the business will operate in the new product activity." These limits should be so clearly defined that "they can be understood and carried out by each company function without constant referral to higher authority.

Policy, however, is not a fixed body of thought and action, but rather, it experiences a constant re-evaluation and adjustment to circumstances and opportunities. It takes the form of determining: (a) the acceptance, continuation and duration of research commitments; (b) the allocation of research funds on a selective target basis; (c) the levels of specialization or expansion in product lines; (d) return factors; (e) investment factors; (f) maintenance of research capability in the company, and (g) research image of the company.

After policy delineation and establishment of corporate goals are reached, research management is called upon to establish what Villers (1964) has named the alternatives of Programmatic and Non-Programmatic Research. Certain corporations establish the first as those which are scheduled, and a beginning and end are established within a flexible plan of action. Non-programmatic research is not scheduled.

Villers (1964), also on the basis of a survey conducted on 34 companies and with 269 individuals interviewed in the companies -- many of them (7) in the agro-industrial field -- established the existence of Pre-product oriented research and Product-oriented research. The first is synonymous with basic research.

The research director of the organization has considerable judgment in allowing or restricting these various types of research, in consultation with technical committees, taking into consideration the long and short-term objectives of the corporation, and financial and manpower resources.

Research management is necessarily on the alert -- collecting, collating, storing and distributing facts and information within the organization, and maintaining an awarenes within the research community of the corporation of research opportunities. The opposite flow of information also occurs reciprocally.

As ideas for the development of new products, or improvement of old ones appear, originating either in the R & D Division, or in the Marketing or Production Divisions, or in the top management, and as projects are presented for evaluation and approval, an overall decision-making set-up is established, and several phases of an evolutionary process leading to the development of a product take place.

A case study presented by Johnson and Jones (1957) on communications within the company for effective product development is shown in Figure 5. A correlation is established between:

a. phases of evolution in the development of a product,

b. decision points, and

c. interdepartmental responsibilities.

The planning structure, once the idea of the product is approved and the decision has been made to invest resources in R & D leading to its creation, has the following

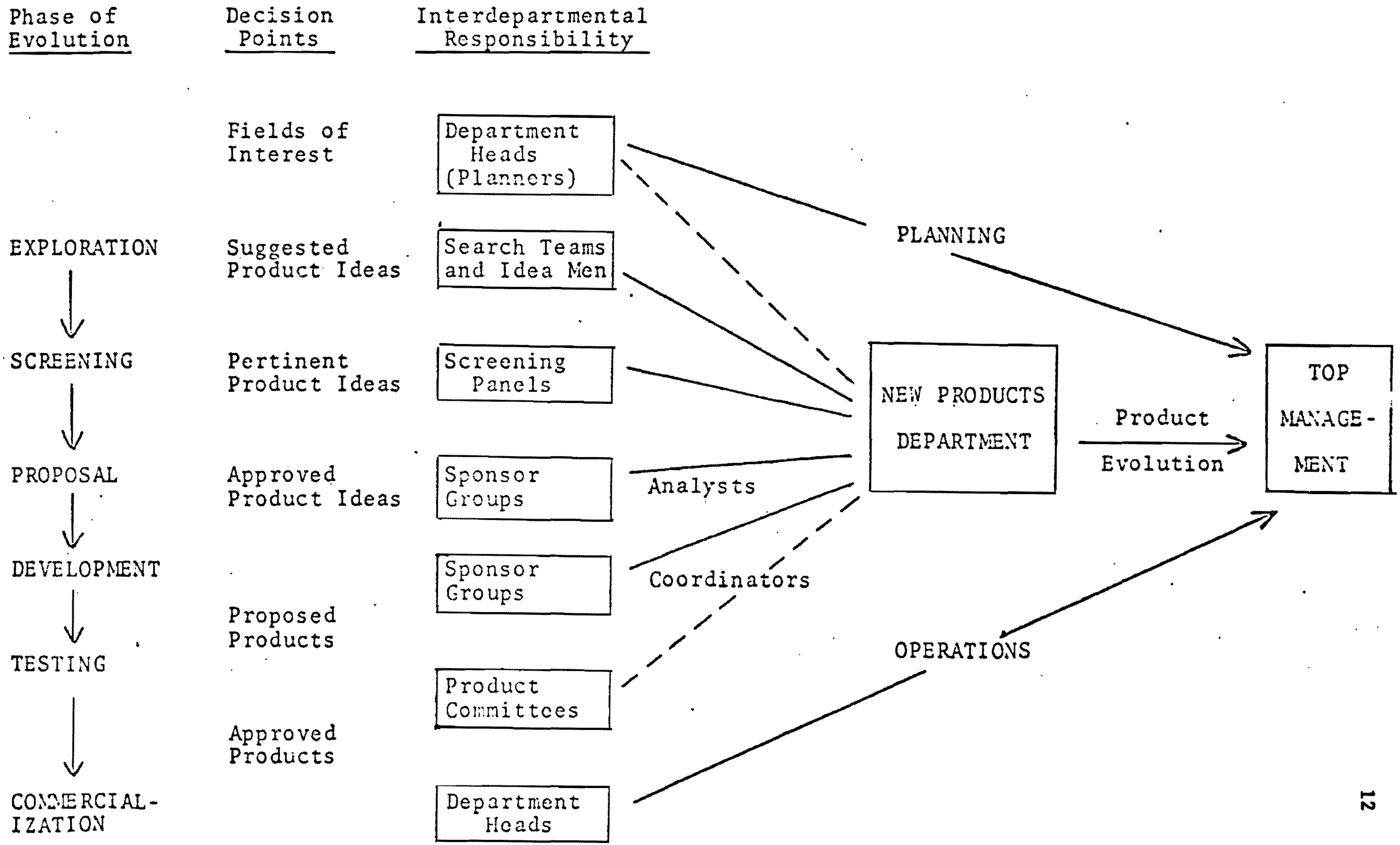

Figure 5. Communication within the business firm for effective new product evolution.

3 main leads:

a. Targets

b. Timetables

c. Techniques

Management and the technical force should define quite well the targets desired to achieve, the timetables in which their actions will lead to results and the methods and techniques for conducting research and development.

In Figure 6, a structure and organigram of product planning for the corporation, is suggested as a possible system of coordinating the manpower in the firm. Methods of organization other than this are possible, not necessarily in a pyramidal system, but depending very much on the administrative philosophy, its previous experience and type of operation.

The manpower required to carry through the R & D assignment is evaluated through the following yardstick for ability in the various aspects and roles required of it, namely:

1. Ability to perform in the assigned function.
2. Capacity for increased responsibility.
3. Preparation for increased responsibility.
4. Degree of subordination of other interests to his job at hand.
5. Ability to inspire associates to higher levels of performance.

THE ALLOCATION OF RESOURCES TO A R & D PROJECT

The problem of allocation of resources to a R & D project involves considerations both of resources needed and resources available, and their partial and proportional distribution throughout the spectrum of products at whose creation the project aims.

A typical layout of resource allocation is presented in Table 1, where the factors are given a proportional quantitative value. A linear programming function is then described, and optimized such as:

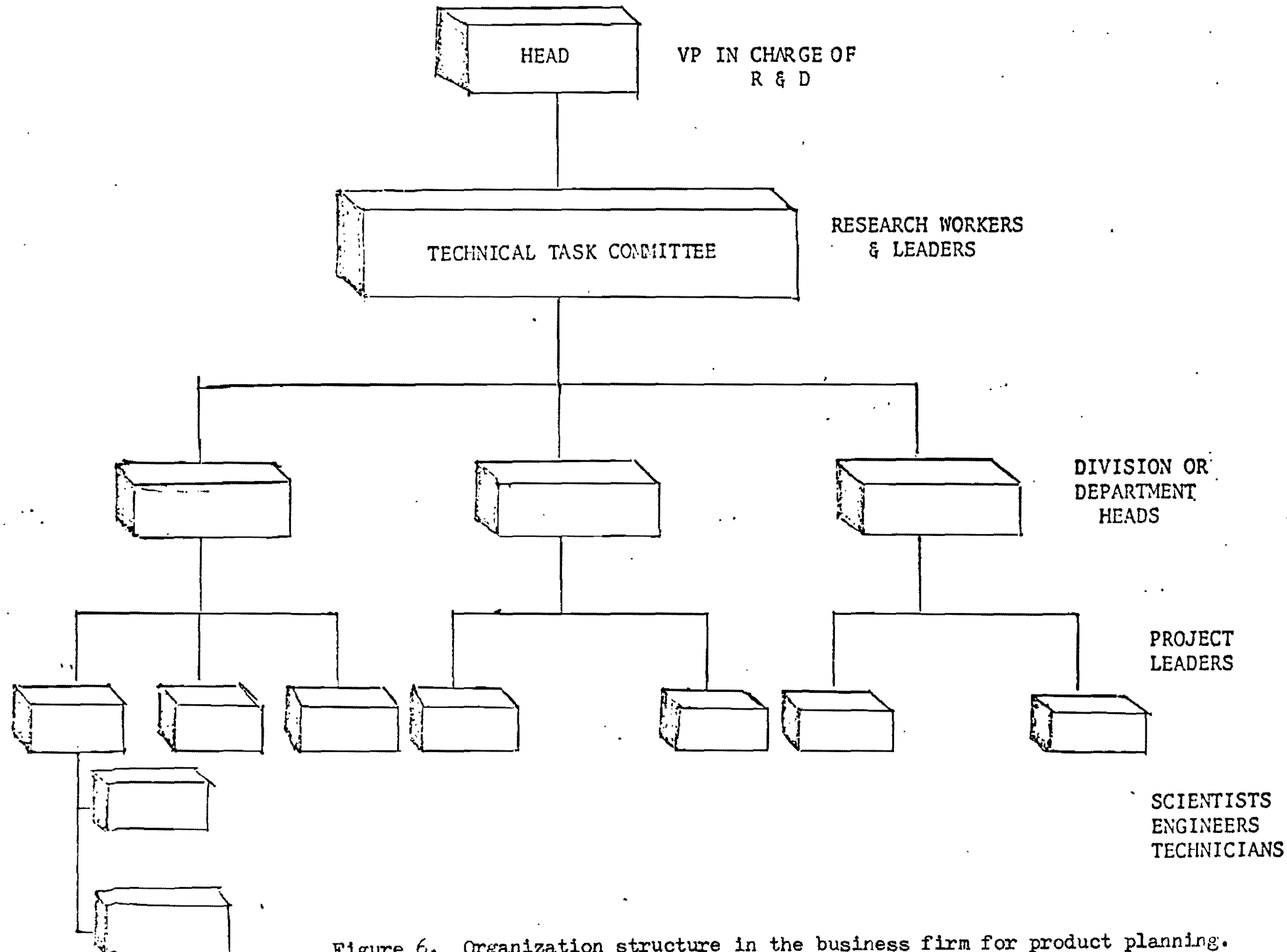

Figure 6. Organization structure in the business firm for product planning.

Table 1. Allocation of resources to a research program.

RESOURCES		PRODUCT						RESOURCES AVAILABLE
		A	B	C	D	E	N	
		x_1	x_2	x_3	x_4	x_5	x_6	
r_1	1							a_1
r_2	2							a_2
r_3	3							a_3
r_n	n							a_n
M		M_1	M_2	M_3	M_4	M_5	M_6	

r_1 = Technical personnel

r_2 = Capital for operations

r_3 = Fixed assets

r_n = Other resources

M_n = Market potential value of product

$$z = \sum_{j=1}^{6} cj\ xj$$

$$\text{or} \quad z = M_1x_1 + M_2x_2 + \ldots + M_6x_6$$

In Figure 7, the expenditure function is presented in its various phases along a time scale, indicating the relative costs in percent of total for the various factors appearing in Table 1. In the planning phase, the cost involved is limited, but after the decision to implement a project is taken, costs start to mount. Discontinuation of a project at a given phase shows the relative cost in people, operating costs and hardware required.

The budgeting and planning relationships for the short-, medium- and long-term are presented in Figure 8, including considerations on capital investment, profit, costs and financing.

CONDUCTION OF THE R & D TASK

The implementation of the R & D task assumes the form of critical conducts and their relationship to a task definition. These take the following steps:

a. Problem formulation and possible solutions, which should adopt clear-cut definitions and alternative solutions.

b. Plan and design of research, in which methods, techniques, background, bibliography, company experience and other scientific and technological factors are considered.

c. Implementation of research, in which critical task assignments are formulated and assigned to individuals.

d. Results and implementation of conclusions should be reported when scheduled, analyzed, and their follow-up assumed as an integrated responsibility.

e. Preparation of reports should follow scheduled opportunities, or otherwise, when judged important or convenient.

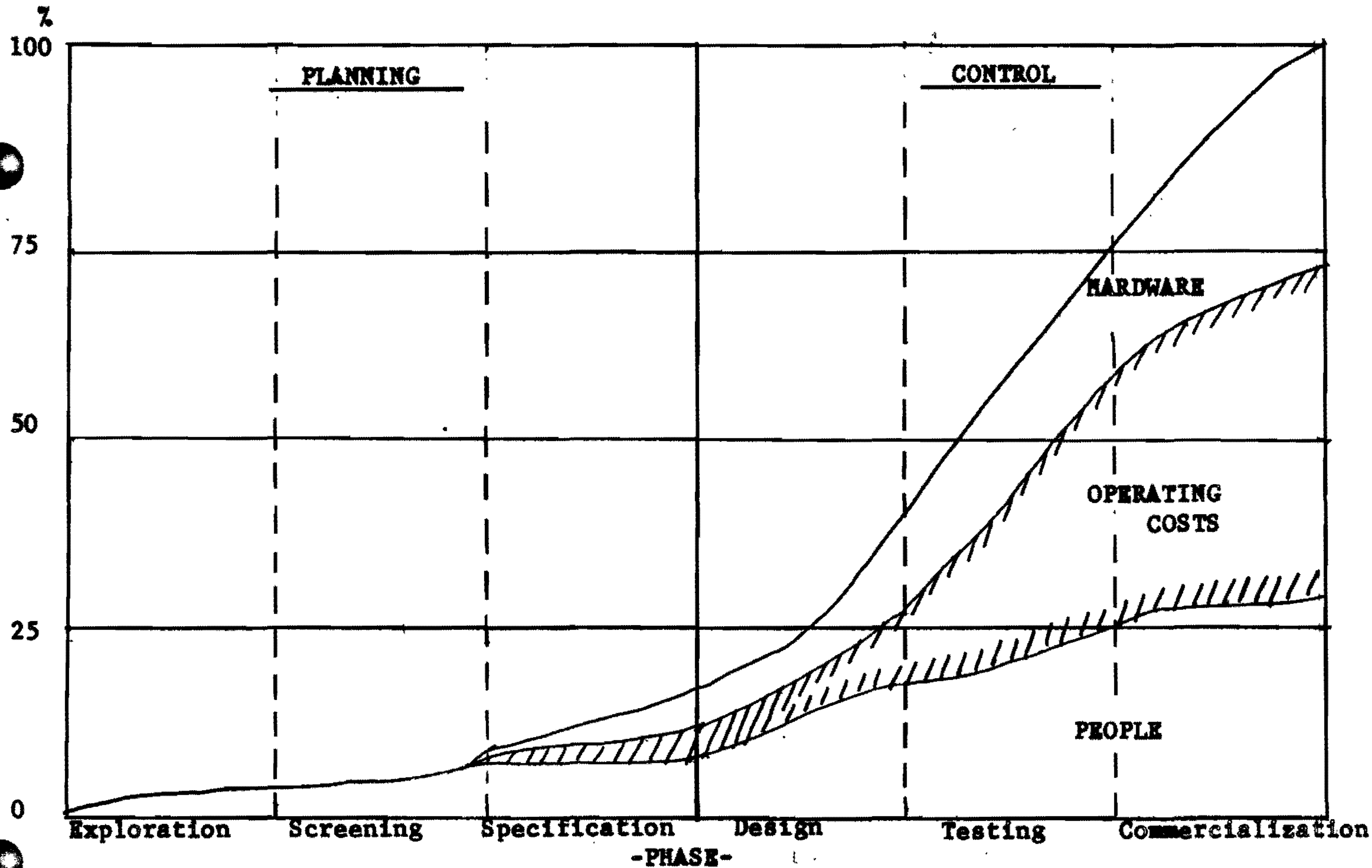

Figure 7. Percentages of new product development costs allocated to various functions over time.

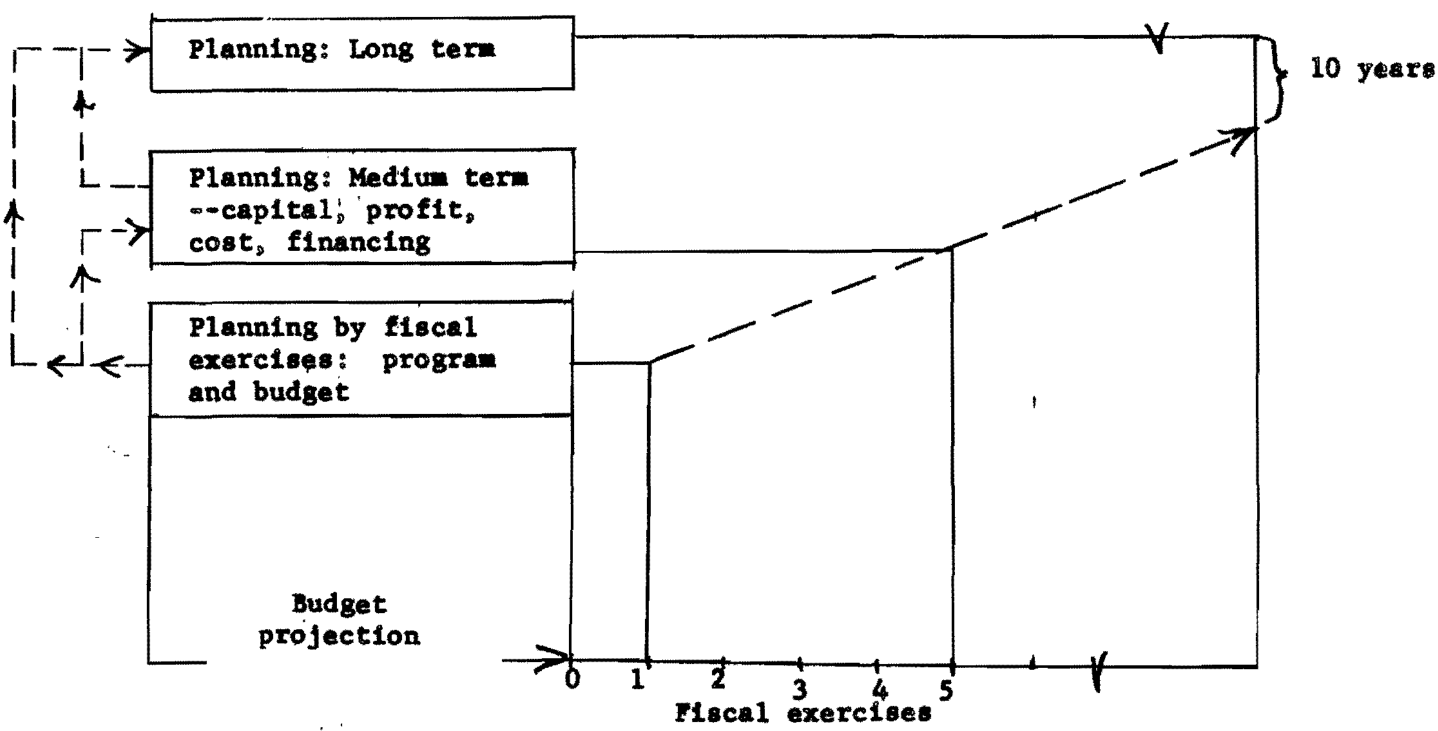

Figure 8. Decision system in the business firm for budget planning.

f. Administration of the research project, to insure the timely availability of the resources and the integral performance of tasks as scheduled.

g. Organizing responsibility of the project leader, who, when teamed up with administrators, insures that the assigned task is performed.

h. Personal responsibility of the research worker, for the phase of the creative process in which the organization relies on his skill.

MEASURES OF PRODUCT PERFORMANCE

The final performance of the product created through R & D is subjected to experimental tests, market tests and ultimately to consumer acceptance -- the final and only valid test of total performance.

It is not often realized how dependent the firm is on this final measure of performance and acceptance of its products, which transcends intermediate certification by public institutions. This is why the firm doing R & D work in the agribusiness sector needs a final confirmation of acceptance, by the consumer, to which market tests, laboratory and plot tests can approach, and give expectations of, but cannot ever really substitute for. The consumer usually finds value in a product where others do not, and in turn, may find faults, which could not be predicted accurately by the R & D group.

The measurement of product performance if conditioned by:

1. Consumer acceptance.
2. Satisfactory performance.
3. Economical production.
4. Depth and breadth of its distribution.
5. Effective merchandising

6. Ease of utilization and handling.

7. Adequate servicing.

8. Ultimate replacement.

The value of the product to the consumer and to the firm are thus highly compatible. It is only when this compatibility is maximized, that the firm attains an optimization of its own objectives expressed in a maximum profit on its investment through service to its clients and to society.

Thus, decision-making in resource allocation in the firm is a highly critical process, unique among the different types of research institutions, because it deals not only with the production of outputs as a result of allocation of inputs, but is highly sensitive to the response of the consumer, the feed-back of consumer-product interaction to its own organization and its future actions, to the performance and life expectation of the product and to the marketing and economical outlook of the firm as a whole.

RETURNS TO AGRICULTURAL RESEARCH IN COLOMBIA

JORGE ARDILA, REED HERTFORD,
ANDRES ROCHA and CARLOS TRUJILLO

Paper presented at the Workshop on Methods Used to Allocate Resources in Applied Agricultural Research in Latin America
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CENTRO INTERNACIONAL DE AGRICULTURA TROPICAL (CIAT)

Cali, Colombia

RETURNS TO AGRICULTURAL RESEARCH IN COLOMBIA [1/]

Jorge Ardila, Reed Hertford,
Andres Rocha and Carlos Trujillo

INTRODUCTION

This paper summarizes and compares results of four recent studies of the economic returns to varietal research on rice, cotton, wheat and soybeans in Colombia. The four programs analyzed have formed a part of a larger national program of agricultural research, extension, and education which has been administered since about 1950 by the Colombian Agricultural Institute (ICA) and its predecessor agencies, the Department of Agricultural Research (DIA) and the Office of Special Studies (OSS).

Our main hypothesis was based on returns calculations previously made for Colombia, the United States, and other countries. For Colombia, Harberger had estimated that the average rate of return on all capital had ranged from 8 to 10.5 per cent from 1960 to 1968 and that the opportunity cost of public funds was of the order of 10 per cent in the late 1960's.[2/] There were also the rates of return for agricultural research calculated by Griliches [3/] and Peterson [4/] for U.S. programs and by Ardito for Mexico [5/],

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1/ A revised version of the paper presented in CIAT's Workshop on Methods Used to Allocate Resources in Applied Agricultural Research in Latin America. This version was presented at the Conference on Resource Allocation and Productivity in International Agricultural Research held at Airlie House, Virginia, January 26-29, 1975. If benefited from comments of participants to the CIAT workshop and from suggestions made by Norman R. Collins and Alain de Janvry.

2/ A. C. Harbeger, "La Tasa de Rendimiento del Capital en Colombia", Revista de Planeación y Desarrollo, Vol. I, No. 3 (October, 1969).

3_/ Zvi Griliches, "Research Costs and Social Returns: Hybrid Corn and Related Innovations, "Journal of Political Economy", Vol.66, No.5 (October, 1958), pp. 419-432.

4/ Willis Peterson, "Returns to Poultry Research in the United States,"Journal of Farm Economics, Vol. 49, No. 3 (August, 1967), pp.656-669.

5/ Nicolas Ardito-Barletta, "Costs and Social Benefits of Agricultural Research in Mexico" (Ph.D. dissertation, University of Chicago, 1971).

Ayer and Schuh for Brazil,[6/] and Duncan for Australia.[7/] These clearly established that rates of return to varietal improvement had exceeded 10 per cent and suggested that returns obtained abroad had been somewhat higher than those obtained in the United States. Correspondingly, we hypothesized that the estimated rates of return for the four Colombian varietal improvement programs not only exceeded the opportunity cost of capital in the country but also those rates of return (of about 50 per cent) [8/] previously reported for similar U. S. programs.

This hypothesis derived additional support from the common-sense notion that, because Colombia had entered the agricultural research field after the United States and other developed countries, it should have been able to draw on a large stock of knowledge about plant breeding techniques and extensive international collections of plant materials in ways which reduced the gestation periods and development costs of its programs. Assuming roughly comparable organizations and competencies of the research enterprises in the two countries, this should have increased the cost effectiveness of the research activity and the returns of it. Of course, there was also an alternative view -- one which stressed the existence of important socioeconomic and structural constraints in Colombia that could have prevented its earning higher returns to investments in varietal improvement, even if technical break-throughs had been more easily made.

6/ Harry W. Ayer and Edward G. Schuh, "Social Rates of Return and Other Aspects of Agricultural Research: The Case of Cotton Research in Sao Paulo, Brazil," American Journal of Agricultural Economics, Vol. 54, No. 4 (November,, 1972), pp.557-569.

7/ R. C. Duncan, "Evaluating Returns to Research in Pasture Improvement," Australian Journal of Agricultural Economics, Vol. 16, No.3 (December, 1972), pp.153-168.

8/ See, for example, Willis Peterson, "The Returns to Investment in Agricultural Research in the United States," in Resource Allocation in Agricultural Research, ed. by Walter Fishel (Minneapolis: University of Minnesota Press, 1971), p. 160.

These contrasting views of our main hypothesis, together with the nature of the data available for analysis, led us to a methodology which could assist in distinguishing the contributions of biological, socioeconomic, and structural factors to the calculated returns to research. "Social benefits" of varietal research were estimated in the usual ways as changes in consumers' and producers' surpluses resulting from shifts in product supplies generated by the use of improved seeds.[9/] But the shift in supply itself was taken as the product of two separately estimated variables: a difference in yields between two (average) farm plots of one hectare each, one plot being planted entirely to the improved seeds and the other to the unimproved varieties, multiplied by the per cent of cropland actually planted in the improved variety. We then associated the first of these variables, the "yield advantage" of the improved variety, with the biological determinants of returns and the second-- equivalently, the rate of adoption-- with the socioeconomic and structural determinants, as well as the biological determinant, recognizing that a large yield advantage can be a primary cause of rapid and high levels of adoption.

Because it was our impressions at the outset that the technical and biological work of the four Colombian varietal improvement programs had been well done, we felt that our main hypothesis would only be rejected by low rates of adoption, reflecting rather major constraints of a socioeconomic and structural nature. The only crop of the four studied which evidenced such constraints was wheat. It had been grown under near-subsistence conditions by small, traditional farmers in some of Colombia's poorest agricultural areas. Also, for a number of years massive wheat imports had been made under P. L. 480. These had depressed the relative price of wheat.

9/ By "usual ways" we refer to the methodology followed, for example, by Griliches, op. cit., Peterson, op. cit., and Ardito, op. cit. The formula used to calculate social benefits in the cases discussed in this paper was the one developed by Ardito, given non-extreme values of the price elasticities of demand and supply; otherwise the formulas used by Griliches were employed.

Our final proposition concerned the way the yield advantages was to be calculated. We felt that any simple estimate of the yield advantage based only on comparisons of yields obtained on plots seeded to new varieties and others seeded to unimproved varieties would be biased upwards because of strong, positive interactions of the new variesties with such inputs as chemical fertilizers and water. Therefore, in comparing yields and calculating the yield advantages of new varieties, we attempted to factor out the effects of other inputs by estimating a production relation between yields, seed variety, and other variables which may have interacted with the variety of seed employed.

The next four sections of this paper take up the cases of rice, cotton, wheat and soybeans, respectively. In addition to presenting information relevant to the estimates of the costs and benefits of the varietal improvement programs, some background materials are included in each section which relate to the reasons the particular program was established, the directions it took once established, and those people on the side of production who may have expropriated the surpluses it ultimately generated. The final section of the paper then provides a comparative analysis of our main results and summarizes our principal conclusions.

RICE [10/]

Colombia's rice research program is of relatively recent origin, having been initiated in 1957 by ICA's predecessor agency. Its establishment coincided with a sharp rise in rice imports occasioned by an outbreak of the hoja blanca disease,[11/]

10/ This section draws heavily on the work by Jorge Ardila, "Rentabilidad Social de las Inversiones en Investigación de Arroz en Colombia"(unpublished M.S. Thesis, ICA/National University Graduate School, Bogota, 1973).

11/ Until 1957 Colombia's imports of rice were running around 2,000 metric tons annually. The 1956 crop was down about 10 per cent from 1955 (from 324,000 tons in 1955 to 300,000 tons in 1956), and the 1957 crops was up less than 8 per cent from 1955, in part because of a fall in yields. In 1957 Colombia then imported 10,200 tons of rice. In 1958 and 1959 imports returned to "normal" levels. Refer, for example, to relevant issues of the FAO Rice Report for these and related data.

a virus of Latin America--with symptoms like the stripe disease of Japan--which first caused substantial losses in Venezuela in 1956 and in Colombia itself in 1956 and 1957.[12/] Correspondingly, the initial objectives of the research program included varietal selection and breeding for higher yields and resistance to the hoja blanca virus.

Rice varieties with resistance characteristics were collected throughout Colombia as a first step; in addition, 2,200 varieties were selected and imported from the U.S. Department of Agriculture's World Collection of Rice in Beltsville, Maryland. By 1959 about 400 of these varieties had shown promising resistance to the virus.[13/] Because they were mainly japonica varieties previously not consumed in Colombia, the research program adopted an objective of breeding the virus resistance of japonica into the local long-grain varieties.[14/] It was estimated that this objective might be satisfied in four to five years. As an interim measure, Gulfrose, the one superior-yielding U.S. variety which had shown some virus resistance, was multiplied and released in 1961.

The first improved variety, Napal, to be produced by the Colombian research program was actually released in 1963 or just four years after the program began. Napal had the long-grain characteristics of Bluebonnet 50, the most preferred non - traditional variety, but was resistant to hoja blanca.[15/] Unfortunately, Napal was subjected to a heavy attack of Bruzone (rice blast disease) in 1965 and thereafter disappeared from commercial production. In the same year, Tapuripa, earlier imported

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12/ S.H.Ou, Rice Diseases (England: Commonwealth Mycological Institute, 1972), pp.28-33. Apparently, the attack was least severe where the Colombian red rice was grown; see Philippe Leurquin, "Rice in Colombia: A Case Study in Agricultural Development," Food Research Institute Studies, Vol.VI, No.2 (1967), p.231.

13/ The means by which the disease was transmitted were not identified with the insect, Sogotodes, until 1958.

14/ Chemical control of the virus proved somewhat effective--but very expensive--among partially resistant varieties; see G.E. Galvez, "Hoja Blanca Disease of Rice," The Virus Diseases of the Rice Plant (Baltimore: Johns Hopkins Press, 1968), pp.35-49.

15/ Bluebonnet 50 was first imported to Colombia in 1954. The history of its introduction and rapid adoption is discussed by Leurquin, op.cit., pp.250 and 251.

from Surinam, was multiplied and distributed to farmers as an alternative to Blue-bonnet 50 and Gulfrose. It was long-grained and flinty with some resistance to blast disease and hoja blanca.

In 1966 the Colombian rice research program added an objective which reflected leads of the International Rice Research Institute (IRRI): to develop dwarf varieties with a high grain-to-straw ratio and resistance to lodging. About 3,000 additional varieties were imported from IRRI, and an order went out to retain only those varieties already in the Colombian collection which outyielded the most prevalent local variety by 100 per cent.

A year later (in 1967), ICA's program joined forces with the rice program of the International Center for Tropical Agriculture (CIAT). Personnel, facilities, budgetary resources, and objectives were shared under informal agreements between the two institutions. These had the effect of reinforcing the ties of the Colombian program with IRRI as the head of CIAT's rice work had served on IRRI's staff.

In 1968, CIAT and ICA introduced IR-8. Its adoption advanced well even though the medium-type chalky grain sold generally at a 30 per cent discount, and showed susceptibility to blast disease. IR-8 did prove resistant to hoja blanca. Following strong commercial trade interest, CIAT and ICA also introduced IR-22 in 1970 and recommended it to farmers in irrigated tropical areas.

Between 1966 and 1970, ICA released independently only one additional rice variety, ICA-10. It never assumed any commercial importance, however, because its yields were inferior to the IRRI varieties --while being superior and/or less variable than either Gulfrose or Napal--and its grain quality was less desirable than Tapuripa.

In 1971, CIAT and ICA released the CICA-4 variety. It was more disease-resistant and had greater water and air temperature adaptability, good grain appearance and cooking qualities, and slightly superior yields. Simultaneously, CICA-4 appeared in Ecuador as INIAP-6, in the Dominican Republic as Advance 72, and in Peru under the name of Nylamp.

Yields recorded in commercial field trials of the seven major rice varieties released by the Colombian and joint CIAT-ICA program after 1957 are shown in Table 1, together with data obtained from the same source on yields of the check variety, Bluebonnet 50. The 665 individual trials which are the basis for these yield statistics include all that are available for the 15-year period, 1957-1971. It should be mentioned that ICA's commercial trials or pruebas regionales are conducted on parcels of commercial farms which agree to collaborate with the Institute's programs. Farmers run the trials, but materials and instructions are provided by ICA.

The three rice varieties released prior to 1966 show average yields in these data of 4.1 metric tons per hectare representing a yield advantage over Bluebonnet 50 of about 33 per cent. Varieties introduced after 1966, including ICA-10, just double that yield advantage bringing it to 65 per cent above Bluebonnet 50.

In view of these yield data, it is interesting to note in Table 2 that the area planted to improved rice varieties did not become a significant proportion of all riceland until the second, or post-1966, stage of the research program. Data in the table on the percentage of acreage sown to a given variety were estimated in the following way. First, available information on sales of certified seeds by variety were converted to hectare equivalents by dividing by estimates of seeding rates provided by ICA's Director of its National Rice Program. Second, lacking data on farm-produced seeds of the improved varieties, it was assumed that the proportion of all acreage planted to certified seeds of any variety was equal to the proportion planted to later generation seeds produced outside the seed multiplication and certification program. This estimating procedure was followed here, as well as in the cases of wheat and soybeans, to estimate total area planted to improved seeds because it produced the simplest and "best fit" between available data on certified seed sales and "expert opinion."

In order to estimate the shift parameter of each new variety--its yield advantage over Bluebonnet 50--production functions were fit to the pruebas regionales data using

TABLE 1

Colombia: Average Rice Yields From Commercial Trials by Variety
1959-1971

Year	Variety							
	Bluebonnet 50	Gulfrose	Napal	Tapuripa	ICA-10	IR-8	IR-22	CICA-4
	kilos per hectare							
1959	1,927	a/						
1960								
1961	2,893	3,071						
1962	2,967	4,065						
1963	3,875	5,391	4,420					
1964	4,336	4,138	5,166					
1965	3,462	2,739	4,343					
1966	1,580		2,436	3,645				
1967	2,893			2,690	4,707	6,098		
1968	3,208		5,356	4,600	4,789	5,890		
1969	3,544		5,110	4,625	5,450			
1970	3,339			4,500	3,852	5,180	5,420	6,125
1971	3,164			3,610	4,234	4,748	5,080	4,600
Average	3,099	3,880	4,344	4,025	4,441	5,473	5,250	5,362

a/ Blanks indicate no regional trials were undertaken.
Source: Jorge Ardila, "Rentabilidad Social de las Inversiones en Investigación de Arroz en Colombia" (unpublished M.S. Thesis, ICA/National University Graduate School, Bogota, 1973). Table 5.

TABLE 2

Colombia: Land Area Planted to Six Improved Varieties of Rice as a Percentage of the Total Area Planted in Rice
1964-1973

Year	Variety						All improved varieties
	Napal	Tapuripa	ICA-10	IR-8	IR-22	CICA-4	
	per cent						
1964	2.5	a/					2.5
1965	2.1						2.1
1966		0.1					0.1
1967		3.2	0.1				3.3
1968		21.2	0.6	0.3			22.1
1969		18.0	0.5	3.7			22.2
1970		12.4	0.2	18.2			30.8
1971		6.9		21.1	3.1	5.0	41.1
1972				18.9	10.1	18.3	47.3
1973				20.1	24.3	12.6	57.0

a/ Blanks indicate less than 0.1 percent.

Sources: Jorge Ardila, "Rentabilidad Social de las Inversiones en Investigación de Arroz en Colombia" (unpublished M.S.Thesis, ICA/National University Graduate School, Bogota, 1973), Table 11 for the years 1964-1971; also, after 1971, ICA, Director of the National Rice Program.

standard least-squares procedures. In the final round of estimation, reported yields (kilos per hectare) were taken as a function of 20 variables: size of the trial plot, seeding rate, 7 seed variety variables, 2 variables to distinguish different time periods, 4 variables relating to irrigation and its interactions with seed variety, and 5 variables to differentiate locations and their interactions with variety. Only the first two of these variables entered as continuous arguments. Other continuous variables (relating particularly to "cultural practices") were either discarded of respecified in noncontinuous form in the final results presented in Table 3.

Because CICA-4 was taken as the check variety, the estimated coefficients on the variety variables are to be interpreted as their "yield disadvantage" in kilos per hectare compared with CIAT-4. On interpreting results this way, it is evident that the Colombian rice research program has produced through time continuous and substantial improvements in yields. Again, the superiority of the varieties released after 1966 is evidenced.

The large and significant coefficient on the variable adjusting for the location of the pruebas regionales indicates that the yield advantage of some locations is 1.2 tons. This location effect appears to be somewhat larger for the Napal. Gulfrose, and IR-8 varieties since the location-variety interaction variables for those varieties are positive.[16/] The fact that the corresponding interaction term is negative and about equal to 1.2 tons in the case of CICA-4 leads to a conclusion that it is the only variety which is less location specific.

Results suggest, however, that yields of CICA-4, as well as those of IR-8 and IR-22, are very positively influenced by irrigation. The coefficient on the irrigation variable indicates that yields of all varieties are increased by about 1.2 tons with average irrigation practices. Roughly another ton is added on top of this when irrigation is applied to IR-8, IR-22, or CICA-4 as indicated by the

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16/ The location variable assumed a value of one when a trial fell into areas which could be classified as tropical dry forest, subtropical humid forest, or very dry tropical forest, and zero otherwise. This classification was suggested by the Director of ICA's National Rice Program.

coefficients on the variables of interaction of those varieties with irrigation. This evidence from the production functions, coupled with data which show that dryland rice yields increased 7 per cent during the 1961-1972 period while those of irrigated rice increased 133 per cent, 17/ leads to an inference that the newer varieties have benefitted mainly the irrigated rice areas. The other side of the same coin, of course, is that adoption of improved varieties was assisted by the existence of irrigated cropland. 18/

Most of ICA's research has been focused on the irrigated rice areas. Its largest programs have been located at the Palmira and Espinal experiment stations. While about 75 per cent of all riceland is irrigated today (1974) in Colombia, almost 100 per cent has been traditionally irrigated within the areas served by Palmira and Espinal. 19/ Underscoring this point is the fact that 84 per cent of the pruebas regionales were performed with irrigation. Also, among the 48 locations used for experimentation, upland rice trials were the only type performed in 14 locations while 30 were used only for trials with irrigation. This emphasis on the irrigated areas may have been induced by expectations of the sort of variety-irrigation interactions found in the regression results. More plausible is the common-sensical explanation that ICA's creditability would have been seriously threatened had it not produced varieties which yielded well in the irrigated areas of Colombia since the controlling interests of the rice growers and commercial trade are found there. 20/

17/ FEDEARROZ, Informe de Gerencia al XIII Congreso Nacional, Bogotá, Colombia, 1971, p. 32.

18/ In 1948 Raul Varela Martínez, Industria y Comercio de Arroz en Colombia (Bogotá: Ministerio de Agricultural y Ganadería), p. 15 estimated that 18 per cent of all riceland was irrigated and 16 per cent was partly irrigated. By 1974, it is estimated that the percent of riceland irrigated had increased to about 75 per cent.

19/ See, for example, Leurquin, op. cit., Tables 5 and 11.

20/ The exception to this procedure was taken in estimating CICA-4's yield advantage since, given the specification of the regression, the yield advantage of CICA-4 equals simply the negative value of the coefficient on Blubonnet 50.

TABLE 3

Colombia: Production Function Estimates for Rice
Based on Commercial Trial Data, 1957-1972

Independent variable	Estimated coefficient	Estimated statistics
1.Size of trial plot	- 0.15	- 2.30
2.Seeding rate	2.46	1.58
3.Bluebonnet 50	-1,609.66	- 3.45
4.Gulfrose	-1,486.56	- 1.31
5.Napal	-1,742.79	- 1.83
6.Tapuripa	- 884.31	- 1.80
7.ICA-10	- 536.93	- 1.13
8.IR-8	- 798.97	- 1.54
9.IR-22	- 589.97	- 0.72
10. Irrigation	1,220.20	5.84
11. Irrigation * IR-8 interaction	1,278.09	3.21
12. Irrigation * IR-22 interaction	700.44	0.89
13. Irrigation * CICA-4 interaction	1,061.87	2.11
14. Location	1,185.26	7.12
15. Location *Gulfrose interaction	991.98	0.94
16. Location *Napal interaction	940.33	1.06
17. Location *IR-8 interaction	428.22	1.24
18. Location *CICA-4 interaction	-1,340.16	-3.14
19. Time I	1,228.03	6.74
20. Time II	- 509.78	- 2.20
Intercept	2.028.30	3.64
	R^2 = 0.67	n = 665

Source: Jorge Ardila,"Rentabilidad Social de las Inversiones en Investigación de Arroz en Colombia"(Unpublished M.S.Thesis,ICA/National University Graduate School, Bogotá, 1973), Table 13.

Regression results were used to produce one estimate of the overall shift parameter--the percentage change in rice supply attributable to the yield advantage of all the improved varieties over Bluebonnet 50. It was estimated as a weighted sum--divided by average commercial yields--of the regression coefficient of each improved variety minus the coefficient corresponding to Bluebonnet 50, with weights equaling the percentage of all rice-land planted which was sown in each variety.[21/] This estimate is shown in column 2 of Table 4, along with the "simple" estimate of the yield advantage of the improved varieties (shown in column 1 of the table) which is based only on the average annual yield data for each variety obtained in the pruebas regionales and already presented in Table 1.[22/]

The fact the the simple estimates of the shift parameter exceed the estimates which include just varietal effects from the regression is consistent with the finding that only the improved varieties of rice interacted with other variables of the production function. Since those interactions were on balance positive and are included in the simple estimate but not in the varietal-effects estimate, the former overstates the shift parameter by as much as 7 percentage points.

The simple and varietal-effects estimates were combined with assumed values of the price elasticities of supply and demand to provide upper and lower bound estimates of gross social benefits of the new seed varieties for the period 1964-1971.[23/] Values

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21/ The exception to this procedures was taken in estimating CICA-4's yield advantage since, given the specification of the regression, the yield advantage of CIAT-4 equals simply the negative value of the coefficient on Bluebonnet 50.

22/ The varietal effects estimate shown here evidences lower values for the shift parameters than the source (Ardila, op.cit., Tables 17 and 20) by reason principally of the omission here of adjustments for "time." Ardila originally added to the yield differentials estimated from the production functions appropriate values of the coefficients on the time variables in each year. Since those coefficients are on net strongly positive for the 1964-1971 period, the effect was to increase estimated values of the shift parameters.

23/ Calculations based on the varietal effects plus interaction effects shift parameters are not included here but can be inspected in Ardila, op.cit., Table 27.

TABLE 4

Colombia: Alternative Values of the Supply Shift Parameter for Rice Attributable to Improved Varieties, 1964-1971

Year	Estimate: Simple	Estimate: Varietal effects
	1	2
	percent	
1964	1.05	-0.16
1965	1.01	-0.15
1966	0.13	0.03
1967	-0.17	1.07
1968	10.99	5.73
1969	12.81	5.98
1970	14.89	7.42
1971	15.96	10.38

Source: Based on Jorge Ardila,"Rentabilidad Social de las Inversiones en Investigación de Arroz en Colombia" (unpublished M.S. thesis,ICA/National University Graduate School, Bogota,1973), Tables 5, 11, 12, 13, 17, and 20.

considered for the price elasticities of supply were 0, 0.2347, and infinity, the intermediate value being derived from the only supply study available for Colombian rice;[24/] values considered for the price elasticity of demand were -0.5, -1.372, and -2.0, the intermediate value again having been estimated in another study.[25/] Maximum gross benefits resulted from using the simple estimates of the shift parameter and price elasticities of demand and supply, respectively, of -0.5 and 0; minumum benefits correspond to price elasticities of demand and supply of -2.0 and infinity and the varietal-effects estimate of the supply shift parameter. Both estimates of benefits are shown in Table 5 for the 1964-1971 period.

Costs of the research program for the same period, also shown in Table 5, include direct costs, indirect costs, and complementary costs, definitions given these terms being those earlier used by Ardito.[26/] Direct costs of the rice program were available only after 1964. For this reason available cost data were regressed on the number of employees assigned to the rice program and ICA's total expenses for all research programs; the resulting regression coefficients and available data on the two independent variables of the regression were then used to estimate the direct cost data for the missing years, 1957-1965. Complementary costs associated with the new program--those it incurred with other collaborating programs--were estimated for this study by the Director of the National Rice Program. Included were costs associated with the entomology, plant physiology, plant pathology, soils, and extension programs. Indirect costs were taken to include staff training costs,[27/] opportunity costs of the services of fixed capital and land, management costs, and the costs of "international cooperation" including a prorated share

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24/ Nestor Gutierrez and Reed Hertford, Una Evaluación de la Intervención del Gobierno en el Mercado de Arroz en Colombia, Folleto Técnico No.4 (Colombia:Centro Internacional de Agricultura Tropical, 1974), Table 3.

25/ Ibid., Table 4.

26/ Ardito, op. cit.

27/ One staff member of the rice program was trained through the Ph.D.,and four others were trained through the M.S. Costs of training personnel of the National Federation of Rice Growers at the National University/ICA Graduate School were also included.

TABLE 5

Colombia: Estimated Benefits and Costs of the Rice Research Program, 1957-1980

Year	Estimated benefits		Estimated costs
	Maximum	Minimum	
	1	2	3
	1,000 (1958) pesos		
1957	a/		15
1958			193
1959			235
1960			286
1961			429
1962			441
1963			252
1964	3,733	- 563	445
1965	4,750	- 699	538
1966	553	127	519
1967	- 827	5,157	867
1968	61,659	27,291	937
1969	60,872	23,675	2,074
1970	69,444	27,883	2,779
1971	107,470	52,225	4,165
1972-1980	107,543	52,225	4,202 b/

a/ Blanks indicate no benefits.

b/ Figures for subsequent years were estimated by assuming 4,202 grew 10 per cent annually.

Sources:

Cols. 1 and 2: Based on preceding tables.

Col. 3 : Jorge Ardila, "Rentabilidad Social de las Inversiones en Investigación de Arroz en Colombia" (unpublished M.S. thesis, ICA/National University Graduate School, Bogota, 1973), Tables 44 and 46.

of personnel costs of Rockefeller Foundation staff stationed in Colombia from 1958 through 1968 and, most importantly, the total costs of the CIAT rice program from 1969 to 1972 estimated by the head of that program. This latter item was the major cost. The simple sum of total costs for the 1957-1971 period equaled 14.2 million 1958 pesos, and the costs of international cooperation were calculated at 5.0 million pesos or 35 per cent of the total. 28/ All costs for the rice program in 1971 represented about 12 per cent of ICA's total expenses for research.

Recognizing that the current stock of new varieties will continue to produce into the future, costs and benefits of the Colombian rice program were projected forward for nine years to 1980 using assumptions, when necessary, which would bias downward the estimate of internal rates of return. On the cost side, for example, it was assumed that the real value of the cooperative CIAT-ICA rice program would increase at a rate of about 10 per cent per year, primarily on the grounds that programs which are relatively new and reputedly successful tend to grow. 29/ On the side of the projection of gross benefits, it was assumed that the value of production during the 1972-1980 period will average 581 million pesos, a sum which equals the value of the rather good 1971 crop (in 1958 pesos); that the adoption rate of the new rice varieties after 1973 will stabilize at the estimated 1973 level of 57 per cent; 30/ that the per cent of riceland planted to IR-8 will trend downward linearly to 0 by 1980; that the percentages

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28/ Costs of international cooperation are still probably understated since benefits derived from the "capital stock" of IRRI and other institutions have not been charged to the Colombian program. More is said about this elsewhere in this paper.

29/ Since this assumption was made, ICA's budget has been severely cut and CIAT's rice program has been phased down. Nonetheless, we hold to the initial assumption in order not to overstate the final estimate of the internal rate of return.

30/ This is a more moderate assumption than that caused by Ardila, op. cit., Table 35, who assumed that the percentage of area sown in improved rice would fall between 72 per cent and 84 per cent by 1980. The data of the U.S.Department of Agriculture, Economic Research Service, Development and Spread of High-Yielding Varieties of Wheat and Rice in the Less Developed Nations, FAER No.95, 1974, Table 38, indicating that adoption rates in the Philippines, Malaysia, and India are topping out at rates well under 60 per cent, plus the analysis by Robert Evenson, "The 'Green Revolution' in Recent Development Experience," American Journal of Agricultural Economics, Vol.56, No.2 (May,1974), pp. 387-394, suggest that the use of improved varieties may never reach 70 per cent in Colombia and that an assumption of 57 per cent is more conservative and probable.

of all riceland sown to IR-22 and CICA-4 will be equal after 1973; and that the increase in the shift parameter these assumptions would imply will about equal increases in commercial yields over the period 1971-1980.31/

The resulting internal rate of return corresponding to the stream of maximum gross benefits was found to be 82.3 per cent; the rate estimated on the basis of the minimum gross benefits stream was 60.1 per cent.32/

COTTON 33/

Cotton has turned in a striking growth performance in Colombia. Since the mid-1930's, yields have about quadrupled--in fact, their pattern of change has been broadly similar to that of the United States. Currently, Colombian cotton yields are comparable to U.S. yields and roughly twice as high as average yields for all South America (Table 6). In an earlier comparative analysis of changes in cotton yields, it was concluded that Colombia ranked fourth in yield increases in the 1950-1960 period among those 24 countries of the world which produced 97 per cent of all cotton in 1960.34/ Production after the mid-1930's increased at least 15 times or from about 30,000 bales in 1937-38 to over 500,000 bales in the early 1970's.35/

31/ The increases in yields would be 14 and 11 per cent, respectively, for the maximum and minimum values of the shift parameters.

32/ Ardila, op. cit., placed a range on the internal rate of return of 53.0 to 53.4 per cent. The minimum (and the maximum) reported here would have been lower and lower that Ardila's estimates had the additional costs of the new varieties to farmers been netted out of "gross benefits". Data on those costs were simply judged to be too weak to include, however.

33/ This section is based largely on the work by Andrés Rocha, "Evaluación Economica de la Investigación sobre Variedades Mejoradas de Aldogón en Colombia" (unpublished M.S. thesis, ICA/National University Graduate School, Bogotá, 1972).

34/ Leurquin, "Cotton Growing in Colombia: Achievements and Uncertainties," Food Research Institute Studies, Vol. VI, No.2 (1966), p. 145.

35/ These and other production and trade data cited in this section were obtained from the relevant number of Cotton-World Statistics published by the Secretariat of the International Cotton Advisory Committee, Washington, D.C.

TABLE 6

Comparative Cotton Yield Statistics
1934-35/1938-39 to 1973-74

Year	Colombia		United States	South America
	All crops	Cotton		
	1	2	3	4
	index	pounds per acre		
1934-35 to 1938-39	a/	133	212	181
1947-48	100	152	267	163
1950-51	115	167	269	175
1951-52	102	150	269	203
1952-53	109	227	280	197
1953-54	119	317	324	212
1956-57	143	319	409	178
1959-60	152	377	462	207
1962-63	176	398	457	231
1965-66	158	352	526	244
1966-67	164	470	480	232
1967-68	176	516	447	267
1970-71		463	437	222
1973-74 b/		470	519	249

a/ Blanks indicate no data available.
b/ Preliminary.

Sources:

Col. 1: U.S. Department of Agriculture, Economic Research Service, Changes in Agricultural Production and Technology in Colombia, FAER No. 52, 1969, Table 30.

Col.2-4: Secretariat, International Cotton Advisory Committee, Cotton-World Statistics (Washington, D.C.), various issues.

Yields and production advanced most rapidly in two different but not widely separated periods of time: 1951-1954 and 1957-1959. Yields about doubled in the first period. Although they did increase in the second, production evidenced a much larger increase of 167 per cent. Developments in both periods appear to have been the direct result of changes in government policies.

The first period of rapid development followed the reopening of the Colombian Ministry of Agriculture in 1948 and new policy pronouncements emphasizing the need to substitute imports of food and fibers with local production. In the case of cotton, this involved some protection--notably a requirement that the textile industry consume stated allotments of national cotton--which resulted in an 82 per cent increase in the farm price between 1948 and 1951. 36/ When the local textile industry was faced with the prospect of consuming larger quantities of national cotton, it promoted the establishment, in 1948, of the Cotton Development Institute (IFA) to improve the quality and uniformity of local cotton through research and the control of ginning. 37/ IFA, eventually a government institute with its own budget, also assumed responsibilities for cotton extension, seed distribution, and dredit.

The second surge in production, occurring at the end of the 1950's, paralleled changes in exchange policies. The official exchange rate in Colombia was 2.5 pesos per U.S. dollar from 1951 through May, 1957. The free rate was 3.0 to 3.5 pesos through 1954 and then edged up to 6.9 pesos by mid-1957. On June 18, 1957, the official rate was increased to 7.6 pesos. Through the 1951-1957 period, the Colombian textile industry was permitted to import raw cotton and capital items at the official exchange rate. As a result, imports steadily built up to a level of 77,000 bales in 1957; production stood at 95,000 bales in that same year. In 1958, following reforms, production jumped

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36/ U.S. Department of Agriculture, Economic Research Service, Changes in Agricultural Production and Technology in Colombia, FAER No.52, 1969, p. 76. In the same source it is shown that the price of rice rose 41 percent, and the price of sugarcane rose 49 per cent. Rice and sugarcane compete with cotton for the same farmlands in many areas of Colombia.

37/ Leurquin, "Cotton Growing in Colombia....," pp. 158 and 159.

to 220,000 bales and, in 1959, reached 256,000 bales. Imports fell to 36,000 bales in 1958 and to slightly less than 2,000 bales in 1959, at which time Colombia also showed its first exportable surplus of cotton in several decades. During the early 1960's, exports averaged about 100,000 bales and by 1968 had reached a level of almost 300,000 bales.

As producers of cotton attained national prominence and power for satisfying domestic consumption and exporting a growing surplus, the National Federation of Cotton Growers (FNA) began to absorb IFA's functions. In 1968, IFA was dissolved completely; and its research and extension activities were passed on to the ICA. Others of its activities were absorbed by the Ministry of Agriculture.

IFA's inheritance was meager when it assumed responsibilities for organized cotton research in 1948. On the advice of an English mission, some cotton research was begun in the Cauca Valley in 1928 but was later suspended when attention there turned to the prospects for sugarcane research by a visiting mission from Puerto Rico. Some research was established later (1934) in Armero, State of Tolima, to introduce and test U.S. Uplands and some Peruvian varieties. Most progress, however, up until 1948 had been made in improving the perennial tree cotton. A station near Barranquilla on the north ~~coast~~ is reported to have obtained yields of 350-400 kilos per hectare or at least twice the then prevailing average yield.[38/] Nonetheless, one of the first things IFA did was to close that station as the quality of the tree cotton was considered inferior to imported cotton and tree cotton had become infested with diseases which threatened the introduction of annual varieties.

From the beginning, the Institute's sole research objective was the introduction, testing, and manipulation of improved U.S. cotton varieties. No attempt was made to produce a national variety until 1961, and that effort appears to have languished until IFA's research was absorbed by ICA in 1968.

ICA stated the first objective of its cotton research program to coincide identically with IFA's but added a second objective--the development of a national cotton variety through selection and hybridization. ICA also improved the design of research,

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38/ Ibid, p. 154.

expanded experimentation beyond the three locations used by IFA (at Buga, Espinal and Codazzi), and undertook more trials on a commercial scale as pruebas regionales.

Actually the first U. S. cotton variety was introduced into Colombia well before the establishment of IFA. Deltapine 12 was imported by cotton producers in 1941 and came into general use in Tolima State during the 1940's. The year before, a Brazilian variety had been introduced, Expresso do Brazil; it likewise gained acceptance in Tolima during the 1940's. In the late 1940's and the 1950's, Deltapine 15, Earlystaple, Coker 124, and Deltapine Smoothlead were introduced. These so-called "T" type cottons came to account for about 93 per cent of all cotton production by 1959; Deltapine was certainly the most important among them. Another 6 per cent of production, mostly in the Cauca Valley, was a longer, finer "V" type cotton. The remainder was "L" type tree cotton from the north coast and a short, staple length "S" type cotton (Lengupa) from Peru.[39/] For 1961-62, IFA reported data showing that 92 per cent of all production was from the Deltapine 15 variety; 5 per cent from Coker 124; and the balance from Deltapine Smoothleaf, Deltapine 16, tree cotton, Lengupa, Delfos, Plains, and unspecified varieties.[40/] By 1971, Deltapine 15 was no longer in use but Deltapine 16 accounted for 42 per cent of all cotton acreage and Deltapine Smoothleaf for 38 per cent, Acala 1517 BR-2 for 8 per cent, and Stoneville 213 for 8 per cent, with the remaining 4 per cent being accounted for by Deltapine 45 and Coker 201.[41/]

Because of the different nature of the cotton research program--namely, its emphasis on the selection and multiplication of promising U.S. varieties rather than on the development of improved national varieties--contributions of research to yield increases and the specification of the shift parameter were envisaged differently than in the case of the Colombian rice program. Specifically, the shift parameter was seen

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39/ U.S. Department of Agriculture, Foreign Agricultural Service, The Cotton Industry of Colombia, FAS M-113, 1961, p.8.

40/ Instituto de Fomento Algodonero, Colombia: Su Desarrollo Agrícola (Bogotá, Editorial Andes, 1962), pp. 51 and 52.

41/ U.S. Department of Agriculture, Foreign Agricultural Service, Cotton in Colombia, FAS-M 239, 1971, p. 11.

to include three different factors.

First, if the cotton program successfully encountered and released U.S. varieties which out-yielded the Deltapine 12 and Expresso do Brazil varieties in general use when IFA was established, there would have occurred an increase in yield--analagous to the shift parameter defined for rice--and equal in a given year to

$$\sum^{n} \left(\frac{R_{di} - R_a}{R_t} \right) P_{1i}, \qquad (2)$$

where

R_{di} = yield of the ith improved variety

P_{1i} = percentage of cotton land planted to the ith variety

R_a = average yield for Deltapine 12 and Expresso varieties

and

R_t = average commercial yield of all cotton.

A second element to consider would be the change in yields which would have occurred had new varieties been introduced and diffused by farmers in the abasence of an organized research establishment, i.e.,

$$\sum^{n} \left(\frac{R_{di} - R_a}{R_t} \right) P_{2i}, \qquad (3)$$

where P_{2i} is the per cent which would have been planted in the ith cotton variety. This expression would be subtracted from (2) in calculating the net shift parameter attributable in a given year to the cotton research program. It was hyphesized that (3) would be positive valued in view of certain characteristics of the Colombian cotton industry. For example, the demand curve facing producers has been highly elastic because of the existence of an export market. Also, Colombian cotton production appears to have been concentrated in the hands of a small group of farmers. As of 1958, 422 farmers accounted for 61 per cent of total production;[42/] in 1967, 343 producers were reported to have accounted for 40 per cent of all output.[43/] The elastic demand curve would have served as insurance to individual innovators that prices and profits would not be eroded from increased production brought about by the diffusion of their innovations. Also, because the industry was one of a few large farmers, it is more probable that a single individual or small group could have anticipated large enough rewards from search and research efforts to justify undertaking them.

A third and final factor to be considered in the specification of the shift parameter is the yield change which might have been brought about through the introduction by unorganized research efforts of varieties different from those observed to have been in use. This yield change can be expressed as

$$\sum_{n+1}^{m} \left(\frac{R_{di} - R_a}{R_t} \right) P_{3i}, \tag{4}$$

where P_{3i} denotes the adoption rate of the ith improved variety not currently in use; all other variables are defined as above. This factor, like (3), would be subtracted from (2) in the complete specification of the shift parameter (k) in any given year, i.e.,

$$k = \sum_{1}^{n} \left(\frac{R_{di} - R_a}{R_t} \right) (P_{1i} - P_{2i}) - \sum_{n+1}^{m} \left(\frac{R_{di} - R_a}{R_t} \right) P_{3i}. \tag{5}$$

42/ Idem, The Cotton Industry of Colombia, p. 9

43/ U.S.Department of Agriculture, Economic Research Service, Agricultural Production and Trade of Colombia, ERS-Foreign 343, 1973, p. 31. It is interesting to note that, at prevailing average yields, this would have implied that each large cotton producer was harvesting about 550 acres, given total production for Colombia of 465,000 bales in 1967. The data for 1958 imply that each of the 422 farmers was harvesting in that year only about 200 acres of cotton, suggesting that large cotton producers were major contributors to the increase in production which occurred between 1958 and 1967.

It was assumed that the last element considered, (4), would be so small that it could be neglected. This was equivalent to assuming that the organized research efforts of IFA and ICA left no stones unturned that would have been by the less organized, independent efforts of individual farmers.

Note that what is then left in (5), namely,

$$k = \sum^{n}\left(\frac{R_{di} - R_a}{R_t}\right) \quad (P_{1i} - P_{2i}) \qquad (5')$$

could be zero valued in either of two circumstances: (a) if (R_{di} - R_a) were negatively correlated with (P_{1i} - P_{2i}) or (b) if R_{di} were equal for all varieties (although greater than R_a) since Sum (P_{1i} - P_{2i}) = 0 by definition.

The first of these two possibilities requires that farmers undertaking research independently would have been more effective in securing the adoption of the higher yielding, improved varieties that IFA and ICA. That, in turn, would require that farmers would have been more effective at identifying new varieties, importing them into the country, testing them, multiplying the most promising types, and releasing them to fellow farmers. Both organizations of research might have been equally fast testers of new imported varieties. But is has already been assumed that IFA and ICA were as efficient at identifying new varieties as individual farmers would have been. Further, because of their "official" status, the two institutes probably were able to import new varieties more easily and rapidly into Colombia; likewise, they were able to exercise absolute control over the distribution of improved seeds.[44/] Thus, it seems unlikely that a farmer-based research effort would have outperformed IFA and ICA and that the shift parameter in (5') have been zero valued in any year as a result of a negative correlation between (R_{di} - R_a) and (P_{1i} - P_{2i}).[45/]

44/ IFA controlled all cotton gins.

45/ Note, however, that one of the implications is that it was the special privileges and franchises IFA and ICA possessed as official government agencies--not "pure differences" in the organization of research--which lead to this conclusion.

That the shift parameter in (5') might also be zero valued if yields of improved varieties were equal can be understood intuitively in the following terms. IFA's and ICA's programs were founded on a premise that yield differences existed among improved U.S. cotton varieties when cultivated in Colombia. A claim was made that it would be worthwhile to identify the value of these differences and key programs of seed multiplication and distribution on them in order to increase any positive correlation between $(R_{di} - R_a)$ and $(P_{1i} - P_{2i})$ in (5'). If, on the other hand, yields of all U. S. varieties harvested in Colombia were equal, then there would be no payoff to a program of varietal selection and distribution. Any farmer individually could import a variety of U. S. cotton selected at random and hope to obtain as good results as he would have obtained through an organized program of research like IFA's and ICA's. 46/

In order to explore this possibility more carefully, all available data were obtained on the IFA and ICA commercial trials which were comparable in design to those earlier reported for rice. The trials covered the period 1953-1972 and included 523 individual experiments. They are summarized in Table 7 which presents mean values of yields obtained for each of 10 cotton varieties. Additional trial data were destroyed when IFA's research was absorbed by ICA. Presumably they included information on the two check varieties, Deltapine 12 and Expresso do Brazil.

It is evident from the data of Table 7 that gross differences in yields are not appreciable and that it would be difficult to reject the hypothesis that they were all, in fact, equal. For this reason a more refined test was made by estimating production functions from the trial data. In the final round of estimates, 23 variables

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46/ There is another instance in which the IFA and ICA type of program would not pay, namely, when the distribution of yields by variety is the same in the United States and Colombia.

TABLE 7

Colombia: Average Yields of Seed Cotton by Variety Obtained from Commercial Trials Conducted in the 1953-1972 Period

Variety	Number of observations	Yield kilos per hectare
Deltapine 15	193	2,312
Deltapine Smoothleaf	71	2,369
Stardel	18	2,296
Stonville 213	39	2,375
Coker 124 B	12	2,634
Acala BR-2	48	2,287
Deltapine 45	9	2,693
Deltapine 45 A	40	2,575
Deltapine 16	42	2,457
Coker 201	27	2,568
Total/average a/	523	2,366

a/ Excludes 24 trials on other varieties.

Source: Andrés Rocha, "Evaluación Economica de la Investigacion sobre Variedades Mejoradas de Algodon en Colombia" (unpublished M.S. thesis, ICA/National University Graduate School, Bogota, 1972), Table 10.

TABLE 8

Colombia: Production Function Estimates for Cotton Based on Commercial Trial Data, 1953-1972

Independent variable	Estimated coefficient	Estimated standard error of coefficient
1. Nitrogen	2.58	0.53
2. Irrigation	606.56	48.71
3. Parcel type	-471.41	61.41
4. Rain deficiency	-1,150.22	47.60
5. Stardel	-241,43	89.09
6. Coker 124 B	-214.75	109.08
7. Alcala BR-2	-331.64	59.23
8. Location 1	381.53	88.86
9. Location 2	189.13	80.78
10. Location 3	600.73	94.34
11. Location 4	1,094.14	149.39
12. Location 5	349.18	91.05
13. Location 6	-649.88	116.68
14. Location 7	-408.99	181.04
15. Location 8	991.48	71.77
16. Location 9	408.49	62.74
17. Location 10	1,167.86	77.85
18. 1953	-218.53	106.79
19. 1954	-268.37	81.12
20. 1967	-428.55	1560780
21. 1970	363.15	61.72
22. 1971	366.96	70.66
23. 1972	452.88	75.20
Intercept	2,081.20	/ Unavailable
	$R^2 = 0.82$	n=523

Source: Andres Rocha,"Evaluacion Economica de la Investigacion sobre Variedades Mejoradas de Algodon en Colombia"(unpublished M.S.Thesis,ICA/National University Graduate School, Bogota, 1972),Table 3.

entered the regression; their estimated coefficients and related statistics are shown in Table 8. The first variable measures the quantity of nitrogen applied per hectare, the second indicates simply whether or not irrigation was applied, the third adjusts for the fact that some of the trials were undertaken on plots which were "small" by pruebas regionales standards, the fourth is an index used by attending agronomists for the lack of rainfall, variables 9 through 17 adjust for the location of the experiments, and 18 through 23 adjust results for abnormal years.

Regression results indicated that only 3 varieties out of the 10 tested yields significantly different from Deltapine 15 were--Stardel, Coker 124B, and Alcala BR-2; in each case their adjusted yields were lower than those for Deltapine 15 and lower by rather similar and "small" amounts. On the basis of these results, it is concluded that no significant, positive benefits were derived from the Colombian cotton research programs. 47/

WHEAT 48/

In an earlier study of production trends of Colombia's major crops, it was claimed that "the wheat situation in Colombia contains a number of paradoxes. Despite good experimental development and government programs to expand production, both acreage and output have declined sharply in recent years." 49/ Other more refined data now

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47/ This is not to deny the role of improved U.S. varieties in increasing Colombian cotton yields. There are several references to their importance in the available literature. One of the strongest is International Bank for Reconstruction and Development, The Agricultural Development of Colombia (Washington,D.C.,1956),p.86: "...it is the policy and program of the Cotton Institute to provide the full seed requirements for the entire cotton crop annually. Largely as a result thereof, the average yield per hectare of the cotton crop has doubled in four years."

48/ This section is based on the research of Carlos Trujillo, "Evaluación Economica de la Investigacion en Trigo" (unpublished M.S. Thesis,ICA/National University Graduate School, Bogota, 1974).

49/ U.S. Department of Agriculture, Changes in Agricultural Production...., p. 12.

available--developed, in part, on the premise that the answers to some of the paradoxes might be the result of data errors--continue to show that both acreage and production have declined over the past 20 years. The area cultivated in wheat fell steadily from 175,000 hectares in 1953 to about 70,000 hectares in 1973; over the same period production was halved. Yields increased by about 25 per cent in the 1953-1958 period but stabilized at just above 1,000 kilos per hectare until 1972. In the most recent two years for which information is available (1972 and 1973), yields may have again increased-- by about 20 per cent.50/ Still, the average yield increase over the whole 20-year period has been rather unimpressive.

The best explanation currently available for the fall in acreage planted is that increasing P. L. 480 sales have served to dampen incentives of Colombian farmers to either maintain or increase farmland devoted to wheat production.51/ The quantity of wheat imported has increased over the 1953-1973 period from a third to almost three times the quantity of total wheat production.52/ The modest rise in yields may be attributable to the same forces and a shift in the regional distribution of wheat production from the higher-than-average-yield State of Boyaca to the State of Nariño in Southern Colombia where farms are small and poor and yields have traditionally stood below the national average. (Our impression is that production possibilities are limited in Nariño). In the Espiga de Oro maximum wheat yield trials, for -

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50/ Data on production, land area planted, and yields of wheat prior to 1971 are from Roger Sandilands, Algunos problemas en la selección de datos estadísticos para trigo, cebada y papa, Informe Tecnico No.14, ICA (Bogota, 1974). Data for 1971-1973 are from the National Department of Statistics, DANE, Bogota.

51/ Many of the important issues involved are discussed by Leonard Dudley and Roger J. Sandilands, "The Side-Effects of Foreign Aid: The Case of P.L. 480 Wheat in Colombia", National Department of Planning (Bogota, 1972, mimeo).

52/ The wheat import data are from the Food and Agriculture Organization of the United Nations, Trade Yearbook, various issues.

example, sponsored by the Agricultural Credit Bank in 1967, the average yields reported by the 10 best wheat farmers in Boyaca and Cundinamarca were about 10 per cent higher than yields obtained by the best farmers in Nariño.)[53/]

The wheat improvement program is one of Colombia's oldest, dating from 1926 with the establishment of the La Picota experiment station in central Colombia (State of Cundinamarca) for the purposes of improving yields and other characteristics of wheat, barley, oats, and rye. Through 1951, at least half of the total costs of the activities of La Picota were absorbed by wheat. In 1947, "cold climate" wheat research expanded out from La Picota to two more locations-- one at Bonza in Boyaca and another at Isla in Cundinamarca. A few years later, additional locations for research were acquired at Tabaitata (Cundinmarca) and Obonuco (Nariño). Following the addition of the Surbatá Station in Boyaca in 1959 for cold climate wheat research, activities were consolidated there, in Tibaitata, and in Obonuco--in just three locations.

Colombia's wheat research has received important assistance from a number of different foreign and national organizations. In 1948, program personnel were sent to Mexico to study methods of wheat breeding with staff of the OSS in Mexico City, then supported by the Rockefeller Foundation. Later, in 1950, Rockefeller personnel were assigned to collaborate with the Colombian research program; the Foundation's assistance continued until the mid-1960's. In 1953, wheat seed distribution and multiplication programs received a lift from the Colombian Agricultural Credit Bank which ultimately assumed responsibility for them. In 1955, the National Federation of Rice Growers provided some support for research on the potential for wheat production in the warmer tropical areas traditionally destined to rice production; similar support was received in the same year from INA, the National Marketing Institute. PROCEBADA, a federation of barley producers, contributed to the budget of the wheat program in the 1959-1961 period for purposes of supporting an expansion of the pruebas regionales

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53/ Trujillo, op. cit., Table C.5

effort; support was received for the same purpose from FENALCE, a federation of Colombian cereal producers. In the 1967-1971 period, the wheat program benefited from inputs provided by personnel of the University of Nebraska Mission, financed by a consortium of international assistance agencies, including USAID and major U.S. foundations.

Data compiled on the costs of the wheat improvement program reflect these injections of complementary support from outside and provide a profile of the development of the program. Table 9 presents data on the direct, complementary, and indirect costs of the program--comparable in all respects with the cost data earlier shown for the rice improvement program-- plus data on the additional cost to farmers of the improved wheat seeds which were adopted after 1952. It is seen that, beginning in 1927, total costs built up slowly to a level by 1935 which was subsequently maintained for about 15 years. Following establishment of the joint Colombian-Rockefeller Foundation program, direct, complementary, and indirect costs again built up to a level which was maintained until 1964 with the exception of three years--1959, 1963, and 1964, the latter two of which were years of reorganization of the research agency. Investments began to drift upwards after 1964 and then increased sharply during the period of the University of Nebraska Mission's presence, falling off after the Mission began to leave Colombia in 1971. From 1968 through 1971, total costs of the program represented only 5 per cent of ICA's research budget but fully 3 per cent of the value of wheat production. In these latter terms, wheat research had become an expensive program.

Activities of the research program revolved around four kinds of wheat: (1) cold climate, (2) warm climate, (3) Triticales, and (4) Durums. By all odds, the first has been the most important in terms of the time and the resources that have been devoted to it.

When the research program began in 1927, some promising cold climate wheats were introduced from the United States and tested over a six-year period, resulting in the release of 15 to farmers from the La Picota experiment station in 1933. By the early

TABLE 9

Colombia: Cost of the Wheat Research Program by Major Category 1927-1973

Year	Costs				Total costs
	Direct a/	Complementary b/	Indirect c/	Added costs of new seeds d/	
	1,000 (1972) pesos				
1927	184	e/	9		193
1928	236		9		245
1929	287		11		298
1930	338		12		350
1931	389		15		404
1932	441		17		458
1933	492		48		540
1934	543		52		595
1935	598		58		656
1936	653		63		716
1937	708		69		777
1938	709		78		787
1939	709		108		817
1940	710		120		830
1941	711		135		846
1942	670		143		813
1943	630		156		786
1944	589		170		759
1945	548		189		737
1946	508		207		715
1947	467		239		706
1948	416		255		671
1949	365		279		644
1950	315		351		666
1951	403		394		797
1952	492	88	440		1,020
1953	580	117	315	655	1,667
1954	669	74	349	2,638	3,730

(Continued on next page)

TABLE 9--continued

Year	Costs				
	Direct a/	Comple-mentary b/	Indirect c/	Added costs of new seeds d/	Total costs
	1,000 (1972) pesos				
1955	758	93	385	242	1,478
1956	1,169	238	511	1,680	3,598
1957	1,117	232	562	282	2,193
1958	996	271	584	1,058	2,909
1959	841	265	483	1,170	2,759
1960	1,202	319	500	2,182	4,203
1961	914	388	510	3,002	4,814
1962	828	277	396	2,599	4,100
1963	615	280	280	2,717	3,892
1964	1,229	487	1,146	2,628	5,490
1965	1,889	658	585	5,548	8,680
1966	2,427	592	957	4,129	8,105
1967	2,150	993	2,307	8,731	14,181
1968	2,919	915	1,261	7,050	12,145
1969	3,045	1,314	2,768	5,623	12,750
1970	2,352	1,446	3,106	3,343	10,247
1971	2,020	1,603	3,260	2,901	9,784
1972	1,501	1,467	2,407	1,507	6,882
1973	1,570	1,385	2,354	1,626	6,935

a/ Salaries, supplies, and office materials directly related to the wheat varietal improvement program.

b/ Represents costs of the plant pathology, soils, entomology, biometrics, extension, and plant physiology programs incurred on behalf of the wheat improvement program.

c/ Includes costs associated with the use of experiment station facilities, agricultural machinery, and land as well as costs of administration and training of program staff.

d/ Equals the difference between the average price of certified wheat seeds and the price received by farmers times the quantity sold of certified seeds; for the period 1927-1949, improved varieties relevant to this study were not planted.

e/ These costs were included in direct costs (1927-1951).

Source: Carlos Trujillo,"Rendimiento Economico de la Investigacion en Trigo" (Unpublished M.S. Thesis,ICA/National University Graduate School, Bogota,1974), Tables 4.1, 4.2, 4.3, 4.4, and 4.5.

1940's, the number had increased to 24. The best seven of these included Klein, General San Martin, Klein 40, Marzuolo, Pentad, Florence, Barcino Barbado, and Bola Picota. Because the latter two were in most widespread use by the mid-1940's, they are considered as check varieties in this analysis. The first reference to their yields indicated that between 850 and 1,500 kilos per hectare could be expected from them, while the other five of the best seven available varieties could be reasonably expected to produce 1,800 to 2,800 kilos per hectare under experimental conditions.54/

The vast majority of promising wheats were obtained by crossing local criolla varieties. This led to a conclusion in the early 1940's that available foreign varieties were inferior to local Colombian wheats and resulted in the program's turning inwards until the arrival of foreign personnel in the early 1950's. When, with Rockefeller Foundation support, the OSS was established in Colombia, 11,000 varieties were immediately imported from the Rockefeller Mexican program. Selections were made from these imports primarily on the basis of their resistance to the yellow, black stem, and leaf rusts. These rusts had become the major preoccupation of the Colombian wheat improvement team as a result of data produced in 1949 which showed that wheat yields were being cut 6 per cent by leaf and stem rusts and by 14 to 41 per cent as a result of yellow rust.55/

The first commercial release of a new wheat variety after the establishment of the joint Colombian-Rockefeller Foundation program was of Menkemen 52. Distributed in 1953, it was the product of crossing varieties from the Mexican collection, including

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54/ Estación Agrícola Experimental La Picota, Informe de labores de la sección experimental e industrial realizadas en 1936 (Bogota, 1937); also, ibid., 1941 (Bogotá,1942).

55/ Estación Francisco José de Caldas, Influencia de las royas sobre el rendimiento del trigo, Proyecto I-SF-1949 (Bogota, 1951).

Mentana and Kenya. It reduced time to maturity by 35 days, was somewhat resistant to the major rusts, had strong stems, and outyielded Bola Picota by 30 per cent. Two years later a second variety, Bonza 55, was released. It was the product of two Rocamex varieties, Yaqui and Kentana. Because it was especially resistant to yellow rust of Nariño State, it was most widely distributed there. A third variety, Nariño 59, was released in 1959; again, it was particularly well-adapted to the State of Nariño, being resistant to its variety of yellow rust. Three years later (1962), several new varieties produced by the joint Colombian-Rockefeller Foundation program were released, including Miramar 63, Bonza 63, Crespo 63, Napo 63, Tiba 63, and Tota 63. At the time this release was made, the industry was advised that the re - search program would attempt to make "batch releases" (i.e., releases of more than one variety) in the future in order to reduce susceptibility to new wheat rusts. Millers are reported to have reacted adversely to this announcement on the grounds that a single mill could not handle more than two varieties of wheat; an appeal was made to the research team to revise its strategy. As it turns out, the wheat program for cold climates made only one more additional release anyway, in 1968, Sumamuxi 68, Zipa 68, and Samacá 68 were distributed simultaneously.

The Colombian wheat plant began to change as the result of the introduction of dwarf varieties from Mexico in 1958. The effort to incorporate the smaller plant type characteristics did not, however, gain force and importance until about 1964. By 1970, 60 per cent of all materials in the Colombian wheat research program included dwarf wheats. Of the 13 improved varieties released to farmers after establishment of the joint Colombian-Rockefeller Foundation program, small plant characteristics were incorporated in 9 varieties; Bonza 63, Miramar 63 and 64, Napo 63, Tiba 63, Tota 63, and the 3 varieties released in 1968. In this regard it is important to mention that practically none of Colombia's wheat is irrigated and that fertilizer use is negligible.

In 1971, ICA published the data shown in Table 10 comparing yields obtained under experimental conditions on small plots of lands for 12 improved varieties and Bola Picota. The reported yield advantage relative to the Bola Picota variety was in excess of 500 per cent for the highest yielding wheats but not less than 250 per cent for any improved variety. By international standards, these yields of the Colombian varieties also appeared to be quite good. Referring to Table 11 and data published on the results of the International Wheat Trials of 1968, three of Colombia's most recently released wheats outyielded the best of the Mexican wheats, Azteca 67. The average level of these yields, however, is extremely high even by experiment station standards in Colombia (e.g., those reflected in Table 10).

With reference to the second category of wheat research, namely, that undertaken on "warm climate" varieties, it is worth mentioning that large areas of wheat had existed in the clima cálido or warmer climates since the Colonial Period. However, these wheat areas were practically eliminated in the mid-1930's as a result of attacks by stem rust. Thus, in 1955 when the first rust-resistant varieties were available, the Federation of Rice Growers persuaded the research agency to experiment with Bonza and Menkemen in the Cauca Valley and Tolima State. Although the rust resistance of the new wheats was confirmed in these early experiments, they were not continued because of the unpromising levels of wheat yields obtained. It was felt at the time that, in order for wheat to compete with rice, 2,500 to 3,000 kilos of wheat per hectare would be required. Commercial yields averaged 1,500 kilos, and maximum experimental yields did not exceed 2,750 kilos per hectare.[56/]

56/ Mario Zapata, "Informe General del Programa de Trigo en Clima Cálido," (Bogota, 1969, mimeo.).

TABLE 10

Colombia: Comparative Wheat Yields for 13 Varieties
Obtained Under Experimental Conditions, 1970

Variety	Area planted	Reported yields	Reported yields compared with Bola Picota yield
	hectares	kilos per hectare	percent
Menkemen 52	0.095	2,820	427
Bonza 55	0.123	2,360	358
Nariño 59	0.106	1,700	258
Bonza 63	0.153	2,220	336
Miramar 64	0.101	2,535	384
Crespo 63	0.163	1,570	238
Napo 63	0.274	2,770	420
Tiba 63	3.740	3,017	457
Tota 63	0.200	2,680	406
Zipa 68	0.134	3,000	455
Samacá 68	0.050	3,700	561
Sugamuxi 68	0.223	2,300	348
Bola Picota	0.132	660	100

Source: Colombian Agricultural Institute (ICA), Informe del Programa Nacional de Trigo (Bogotá, 1970), Appendix 4.

TABLE 11

Colombia: Comparative Wheat Yields Obtained for Colombian and Mexican Varieties in the International Nursery Trials,1968

Variety	Country of origin	Reported yields kilos per hectare
Sugamuxi 68	Colombia	6,232
Crespo 63	Colombia	6,215
Samacá 68	Colombia	6,217
Azteca 67	Mexico	6,110
Tota 63	Colombia	6,054
Napo 63	Colombia	6,044
Tiba 63	Colombia	5,894
Penjamo 62	Mexico	5,833
Centrifén	Chile	5,755
Norteño	Mexico	5,538
Lerma Rojo 64 x Sonora 64	Mexico	5,349
Sonora 64 x TZ.PP Nai.60 (B)	Mexico	5,249
Bonza 63	Colombia	5,233
Jaral	Mexico	5,166
Zipa 68	Colombia	5,166

Source: Colombian Agricultural Institute (ICA), <u>Informe del Programa Nacional de Trigo</u> (Bogota, 1968), p.13

The wheat program first experimented with rye as a rust-resistant, high-protein, water-saving alternative to wheat in 1937; and experiments with triticales were initiated in La Picota in 1946. Interest in triticales appears to have languished until very recently (1970). The wheat program has also evidenced interest through time in the Durum wheats. Work actually began on Durum in 1952 and was stepped up somewhat in the mid-1960's. However, successes have not been reported primarily because of the high humidity which prevails in Colombia's wheat areas, the short daylength, and the sometimes heavy rainfalls which occur when the grains are maturing.

Again, as in the cases of rice and cotton, available data on the pruebas regionales were collected in an attempt to quantify the shift parameter and gross social benefits attributable to the Colombian wheat research program. The collection of these data was much more difficult in the case of wheat, however, because the information had been scattered by changes in the affiliation of the research program with outside agencies. In the final analysis, results of only 1,016 individual trials were obtained for the 1953-1973 period; many more were undertaken on the major improved varieties.

Most of the results obtained (about 80 per cent) related to six varieties: Bonza 63, Crespo 63, Menkemen 52, Napo 63, Nariño 59, and Tota 63. By region, the bulk of the data related to two states, Cundinamarca and Nariño. Only about 5 per cent are from the State of Boyaca. The Director of the National Wheat Program has stated that this does not reflect any slighting of the Boyaca wheat regions because there are many in Cundinamarca and Nariño which are fully representative of the areas in Boyaca. Given that wheat production in Boyaca has declined most sharply, the facts here are important, although difficult to establish and qualify. Finally, it should be noted that most of the pruebas regionales data obtained (70 per cent) were for five years including 1963, 1964, 1968, 1971, and 1972.

Table 12 summarizes the data collected for 13 improved wheat varieties and 2 check varieties, Bola Picota and "150." Mean yields in kilos per hectare are reported by variety, together with the estimated standard error of yields, the range of trial yields corresponding to a 5 per cent level of probability, and the coefficient of variation of yields. When compared with the data of Table 10, it can be seen that these data assign rather different relative yield ranks to specific varieties. For example, in Table 12 the yield Menkemen 52 puts it in twelfth place among the improved varieties, while its yield in Table 10 ranks it in third place. Also, the average level of yields reported in Table 12 is lower than the averages of Tables 10 and 11, and the yield advantage of the improved varieties is noticeably less than indicated by Table 11.

The range in yields of most improved varieties in Table 12 includes the upper bound yields reported for Bola Picota and "150." The only exceptions to this are the Samacá 68 and Bonza 63 improved varieties, lower bound yields for which are well above the upper bound yields of the two check varieties, indicating a significant yield advantage. The yield advantages of Samacá 68 and Bonza 63, as a percentage of the average yields of "150" and Bola Picota, are 83 and 75 per cent, respectively; the corresponding value for all improved varieties shown in Table 12 is 50 per cent.

In order to adjust these estimates of the gross yield advantage of the improved wheat varieties for the effects of other determinants of yields, production functions were estimated from the commercial trials data. The final version of the production function is shown in Table 13. Thirty-nine variables entered: 12 represented zero-one adjustment variables for the location of the trials; 14 adjusted for the effects of variety; 4, measured as indices above a certain threshold level and zero otherwise, accounted for major diseases reported (vaneamiento, foot and root rot, stem rust, and dwarfing virus); 1 adjusted for seeding rates of 80 kilos per hectare (only two rates were actually reported--80 and 111 kilos per hectare); 2 each were used to adjust for soil type and reported weather; and 1 variable each adjusted for how well the soil had been worked prior to planting, for weed growth, and for the application of lime. Coefficients on the noncontinuous variables shown in Table 13 need to be read with some

TABLE 12

Colombia: Comparative Wheat Yields for 15 Varieties Obtained in Commercial Trials 1953-1973

Variety	Number of observations	Output per hectare				Coefficient of variation of yields
		Mean	Standard error	Range at 5 percent probability		
				Lower bound	Upper bound	
		kilos				percent
"150"	8	1,624	1,022	771	2,476	62.9
Bola Picota	8	1,194	895	448	1,941	74.9
Samacá 68	47	2,584	1,592	2,117	3,051	61.6
Bonza 63	106	2,460	1,197	2,230	2,690	48.7
Miramar 63	29	2,348	1,218	1,885	2,812	51.9
Zipa 68	31	2,190	1,382	1,684	2,697	63.1
Bonza 55	77	2,172	1,504	1,831	2,513	69.2
Crespo 63	129	2,115	1,369	1,876	2,353	64.7
Tiba 63	51	2,110	1,265	1,754	2,466	59.9
Nariño 59	119	2,106	1,351	1,861	2,352	64.1
Napo 63	136	2,097	1,340	1,869	2,324	63.9
Sugamuxi 68	12	1,973	1,157	1,238	2,708	58.7
Tota 63	104	1,893	1,283	1,643	2,142	67.8
Menkemeń 52	138	1,836	1,237	1,627	2,044	67.4
Miramar 64	21	1,643	1,496	960	2,326	91.1
All varieties	1,016	2,099	1,340	2,027	2,175	66.1

Source: Carlos Trujillo, "Rendimiento Economico de la Investigacion en Trigo" (unpublished M.S. thesis, ICA/National University Graduate School, Bogota, 1974), Table 5.7.

care. Since the regression package reparameterized all variables by imposing a restriction that the sum of the regression coefficients equal zero, an estimate of the corrected mean yield associated with a given noncontinuous variable should be calculated by adding its estimated coefficients to the overall mean value of yields, which was 2,099 kilos per hectare.

The statistical significance of the variety variables entering the regression was surprisingly low. Only the estimated coefficients on the Bonza 63 and Crespo 63 varieties were very positive and significant. In an independent estimate made of the partial contribution of the variety variables as a group to the explanation of the variance of yields, their significance was found to be less than that of any other single variable or group of variables (e.g., the variables adjusting for location).

Also, the values of the estimated yield advantages of most of the improved varieties are lower on the basis of the regression of Table 13 than on the basis of the unadjusted estimated of mean yields earlier presented in Table 12. The largest and most significant yield advantage of any improved variety in the regression--that of Bonza 63-- is only 36 per cent more than the adjusted yield of Bola Picota, or roughly half the value implied by the unadjusted yield estimates of Table 12.

Table 14 presents summary statistics on the use of the improved varieties of wheat. Urderlying these summaries are data for each improved variety used in weighting shift parameters taken from the estimated production function to arrive at an average annual estimate of the percentage yield increase over average commercial yields attributable to improved wheats. Two estimates of these weights were considered, and their implications for overall rates of adoption are reflected in Table 14 in the "upper bound value" and the "most probable value" of the per cent of wheatland planted to improved varieties. The first simply assumed that the total use of an improved variety in any year equaled two times its reported sales in certified form and that the average seeding rate was 120 kilos per hectare for all varieties. As can be seen in the table, this assumption results in levels of adoption in the late 1960's which are

TABLE 13

Colombia: Production Function Estimates for Wheat Based on Commercial Trials

Independent variable	Estimated coefficient	Estimated t statistic
1. Vaneamieanto	- 13.8	- 6.98
2. Foot Rot	- 11.1	- 5.75
3. Stem Rust	- 8.6	- 3.18
4. Dwarfing Virus	- 15.8	- 3.73
5. Plot Size	- 48.5	- 5.88
6. Seeding rate	- 225.0	- 3.69
7. Good soils	482.7	8.10
8. Poor soils	- 340.2	- 4.31
9. Poor prior soil preparation	- 157.1	- 2.68
10. Heavy weed growth	- 300.6	- 6.79
11. Unfavorable weather	-1,333.9	- 10.20
12. Favorable weather	895.4	8.43
13. Lime applied	154.1	2.35
14. Location 1	- 732.0	- 3.21
15. Location 2	3,672.8	16.40
16. Location 3	692.4	7.37
17. Location 4	1,604.9	9.24
18. Location 5	- 466.9	- 2.29
19. Location 6	-1,084.6	- 4.44
20. Location 8	- 349.1	- 3.12
21. Location 9	- 644.9	- 5.38

(Continued on next page.)

TABLE 13--continued

Independent variable	Estimated coefficient	Estimated t statistic
22. Location 10	- 831.1	- 6.60
23. Location 11	- 812.2	- 1.94
24. Location 12	- 856.6	- 3.05
25. Location 13	49.1	0.56
26. Menkemen 62	- 113.2	- 1.20
27. Bonza 55	98.8	0.89
28. Nariño 59	163.8	1.70
29. Miramar 63	- 375.5	- 2.17
30. Bonza 63	340.5	3.27
31. Miramar 64	- 300.3	- 1.46
32. Crespo 63	210.9	2.12
33. Napo 63	131.7	1.44
34. Tiba 63	- 169.2	- 1.28
35. Tota 63	- 80.7	- 0.77
36. Zipa 68	- 152.8	- 0.92
37. Samacá 68	196.9	1.22
38. Sugamuxi 68	210.3	0.80
39. Bola Picota	- 303.5	- 0.91
Intercept	2,460.8	15.73
	R^2 = 0.53	n= 1.016

Source: Carlos Trujillo, "Rendimiento Economico de la Investigación en Trigo" (unpublished M. S. thesis, ICA/National University Graduate School, Bogota, 1974), Table 5.14.

TABLE 14

Colombia: Selected Data on Employment of Improved Wheat Varieties, 1953-1973

Year	Total certified seed sales	Wheat land in improved varieties	
		Upper bound value	Most probable value
	tons	percent	
1953	147	1.4	0.9
1954	1,039	8.9	5.6
1955	113	0.9	0.5
1956	639	5.2	3.3
1957	599	5.5	3.4
1958	1,610	22.0	13.7
1959	3,050	43.4	27.1
1960	2,149	28.7	17.9
1961	2,830	33.7	21.1
1962	2,470	31.7	19.8
1963	2,100	31.8	19.9
1964	1,864	27.0	16.9
1965	2,782	38.6	24.1
1966	3,113	45.0	28.1
1967	3,795	66.6	41.6
1968	4,494	83.2	52.0
1969	2,809	72.0	44.6
1970	1,694	56.5	35.1
1971	1,641	56.9	35.3
1972	1,528	40.4	25.3
1973	1,429	33.0	20.5

Source: Carlos Trujillo, "Rendimiento Economico de la Investigacion en Trigo" (unpublished M.S. thesis, ICA/National University Graduate School, Bogota, 1974), Tables B.3, 5.17, and 2.10.

high by known standards for unirrigated wheat. The second estimate--and the one used in this study--maintained the assumptions that the total seed use of any variety would equal two times its certified sales and that seeding rates averaged 120 kilos per hectare, but set the germination rate of certified seeds at 86 per cent and the corresponding rate for seeds retained and planted by farmers from prior harvests at 39 per cent. These low rates of germination, based on several ICA studies,[57/] were not encountered for either rice, cotton, or soybeans. Since the sum of the two germination rates is 125 per cent, the effect of this procedure was to assume that the real, post-germination rate of employment of an improved variety was 1.25 times the quantity of it sold in certified form.

Estimates of the yield advantage of each improved variety taken from the regression, divided by average commercial yields in each year and weighted by the appropriate adoption rate, produced two streams of gross benefits for the 1953-1973 period of the Colombian wheat improvement program. In each case it was assumed that the c.i.f. import price of wheat was the relevant "price" at which to value the crop.[58/] However, in one of the estimates, it was assumed that the price elasticity of supply of wheat equaled 0.55 and that the price elasticity of demand was -0.04. These values of the price elasticity parameters were derived from estimates of two independent studies.[59/] For the second estimate of gross benefits, it was recognized that wheat was imported throughout the 1953-1973 period and that the value of gross benefits should thereby not include a surplus to consumers.

57/ Trujillo, *op. cit.*, Table 2.10

58/ Because of the overvaluation of the Colombian peso, this assumption results in an underestimate of the gross benefits of research. It was found, however, that the estimated internal rate of return to the wheat improvement program would increase by only 4 per cent if instead the (higher) price received for wheat by farmers was used.

59/ The price elasticity of demand estimate is from ICA, *Un método de proyectar la producción y demanda para productos agrícolas en Colombia*, Boletín de Investigación No.15 (Bogota, 1971); the price elasticity of supply estimate is from Roger Sandilands and L.Dudley,"The Side-Effects of Foreign Aid: The Case of P.L. 480 Wheat in Colombia," National Department of Planning, Bogota, 1972 (mimeo).

The two estimates of gross benefits, as well as total costs earlier shown in Table 9, were then projected through 1976 on assumptions similar to those used in the case of rice. The internal rate of return estimated for the "closed economy" case corresponding to the stream of new program benefits (gross benefits minust costs) for the 1927-1976 period was 11.9 per cent. When allowance was made for the fact that wheat was imported, the estimated internal rate of return was reduced to 11.1 per cent.

SOYBEANS 60/

Soybean production in Colombia has experienced very rapid growth in recent years. The total area cultivated was only 16,000 hectares in 1962; production stood at 25,000 tons, and yields were 1,500 kilos per hectare in the same year. By 1972, or just 10 years later, the area harvested had increased to 58,000 hectares, production was 116,000 tons, and yields had risen by a third to 2,000 kilos. 61/ This rapid development is attributed to the fact that soybeans are excellent in rotation with several major crops (cotton, in particular) and that the demand for soybeans has been strengthened by a fast-growing poultry industry. The crop is cultivated in Colombia only in the Cauca Valley, and its location there has been attributed to the nearness of the feed industry. An equally important explanation, however, is that available high-yielding, disease-resistant soybean varieties produced by the ICA experiment station at Palmira have been adapted to conditions of the Cauca Valley.

ICA did not initiate activities in soybean research until 1960, and the work was restricted to the Palmira station. In about seven years, however, the research effort succeeded in producing three new varieties with superior yield potential and resistance

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60/ Based on the research by Gabriel Montes, "Evaluación de un Programa de Investigación Agrícola: El Caso de la Soya" (unpublished M.S. thesis, Faculty of Economics, University of the Andes, Bogota, 1973).

61/ *Ibid*, Table 4.

to major diseases, the principal one being cercóspora, a fungus which attacks and destroys almost all parts of the soybean plant. Table 15 summarizes experimental data relating to yields of four soybean varieties obtained for this study. Unfortunately, data generated from commercial fields or pruebas regionales were unavailable; thus, the information used in Table 15 and elsewhere in this section relates to small experimental plots of the Palmira station.62/ The ICA Pelican, Lili, and Taroa varieties were successive releases of the experiment station. The Mandarin variety was imported earlier from the United States and by 1967 had come to occupy about four-fifths of all soybean acreage. In terms of the data previously shown for cotton, rice, and wheat, the yield superiority of the improved varieties in Table 15 is not particularly outstanding.

Nonetheless, adoption of the new varieties has been nothing short of spectacular. Table 16 presents the percentages of soybean acreage planted to each of the four main varieties grown in the 1967-1971 period. These data were estimated using a procedure analagous to the one followed for other crops included in this paper; i.e., total acreage planted to a variety in a given year was taken equal to two times certified seed sales of that variety divided by an estimate of the seeding rate. The important point to note about the data of Table 16 is that roughly three-quarters of the area planted in soybeans was in the Mandarin variety in 1968 and 1969, while by 1971--just two years later-- Mandarin had practically disappeared, and ICA Pelican and Lili varieties had come to be used on 84 per cent of all acreage.

The major reasons for the rapid and high levels of adoption of the improved varieties were at least the following two: First, there was a severe outbreak of the cercóspora fungus on the Mandarin variety in 1969. ICA found itself in 1970 in the enviable position of having two high-yielding, fungus-resistant varieties available

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62/ The use of experimental data is somewhat less troublesome in the case of soybeans because of the high level of technology and improved practices used by farmers in the Cauca Valley.

TABLE 15

Colombia: Average Soybean Yields From Experimental Trials by Variety 1967-1971

Year	Unimproved variety, Mandarin	Improved varieties		
		ICA-Pelican	ICA-Lili	ICA-Taroa
	kilos			
1967	2,068	2,406	a/	2,490
1968	2,329	2,373	2,700	2,650
1969	1,756	2,138	2,525	2,400
1970	1,751	2,373	2,300	2,500
1971	1,828	2,578	2,410	3,034
Average	1,946	2,455	2,483	2,622

a/ No experiment reported.

Source: Gabriel Montes, "Evaluación de un Programa de Investigación Agrícola, el Caso de la Soya" (unpublished M.S. thesis, Faculty of Economics, University of the Andes, Bogota, 1973), Table 3.

TABLE 16

Colombia: Land Area Planted to Improved Varieties of Soybeans as a Percentage of the Total Area Planted in Soybeans, 1967-1971 a/

Year	Variety					Total
	Mandarin	ICA-Pelican	ICA-Lili	ICA-Taroa	Other	
	per cent					
1967 b/	89	1	c/		10	100
1968	77	13			10	100
1969	71	18	5		6	100
1970	35	29	24		12	100
1971	2	43	41	2	12	100

a/ Estimates derived from data on certified seed sales, assuming that the total use of a variety of seeds equaled two times its sales in certified form.

b/ Only data on ICA-Pelican use were available. The Mandarin estimate was derived on the assumption that "other" varieties occupied 10 per cent of all acreage planted in 1967 as they did in 1968.

c/ Blanks indicate less than 0.5 per cent.

Source: Gabriel Montes, "Evaluación de un Programa de Investigación Agrícola: El Caso de la Soya" (unpublished M.S. thesis, Faculty of Economics, University of the Andes, Bogota, 1973), Table 6.

for distribution and plenty of seed. Second, it was easy for this news to get around; the only Colombian farmers interested in soybean production are located in a relatively small geographic area with some of the best communication and infrastructure facilities that exist in the country. The farmers themselves are among Colombia's most modern.

As in the cases of cotton, rice, and wheat, an attempt was made to generate more refined estimates of the yield superiority of the new soybean varieties by means of the identification of a relation between yields and their major determinants, including seed variety. Final results of this effort are shown in Table 17 reporting on a re - gression of experimental yields on three independent variables for the major improved seed varieties (observations on the check variety, Mandarin, were included in the re- gression, of course), the number of tiemes the experiment was weeded, kilos per hectare of active herbicide and insecticide ingredients applied, millimeters of rainfall, the presence of cercospora fungus measured as an index with a range of 0 to 5, and an index (likewise with a 0 to 5 range) which reflected essentially the ratio between the ob- served plant density and the seeding rate. Signs of all estimated coefficients are those which were hypothesized at the outset, and the significance of most coefficients is seen to be high. One exception, the estimated coefficient for rainfall, reflects the fact that rainfall variability was limited because most experiments were under - taken in a small geographic area. The statistical strength of the plant density/seeding rate variable is attributable to the fact that it is capturing the effects of several unspecified cultural practices used in the experiments.[63/] The fact that the coefficients on the improved varieties increase in value from Pelican (the first released) through Lili to Torao (most recently released) indicated substantial progression in ICA's re- search program. A test of the null hypothesis that the estimated coefficient on the

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63/ This variable may thereby have adjusted to some extent estimated coefficients on the improved varieties for the experimental nature of the data-- the high levels of technology and intensive use of improved cultural practices.

TABLE 17

Production Function Estimates for Soybeans
Based on Experimental Data
1967-1971

Independent variable	Estimated coefficient	Estimated t statistic
1. ICA-Pelican	268.44	3.06
2. ICA-Lili	418.31	3.93
3. ICA-Taroa	436.95	4.37
4. Number of weedings	86.93	2.43
5. Herbicide use	78.45	2.35
6. Rainfall	113.11	1.75
7. *Cercospora*	-107.30	-3.68
8. Plant density/Seeding rate	200.80	4.58
Intercept	692.08	a/
	$R^2 = 0.70$	n=68

a/ Unavailable.

Source: Gabriel Montes, "Evaluación de un Programa de Investigación Agrícola: El Caso de la Soya" (unpublished M.S. Thesis, Faculty of Economics, University of the Andes, Bogota, 1973), Table 8.

Pelican variety equaled that of the Lili variety was rejected at the 99 per cent level of significance. Similarly, the hypothesis that the coefficients estimated for the Lili and Taroa varieties are equal was rejected at the 95 per cent level.

The yield advantage of the improved varieties taken from the production function, divided by commercial yields and weighted by the percentages of the land area planted in each variety, led to a "varietal effect" estimate of the shift parameter. The yield advantage of the improved varieties estimated directly from the data of Table 15, likewise divided by commercial yields and weighted by the percentages of the land area planted in each variety, led to a "simple" estimate of the shift parameter associated with the soybean research program. These two estimates of the shift parameter were combined with plausible values for the price elasticities of demand and supply--respectively, -0.77 [64/] and infinity--to yield a range of gross benefits in each year for the 1967-1971 period. These two streams of gross benefits are shown in Table 18 along with estimates of the costs of the soybean research program which include the same categories of expenses included in the cases of the other three commodities considered in this paper. Costs and benefits were projected nine years beyond 1971 on the assumption that in real terms they would both remain about constant. The resulting internal rate of return for the smaller benefit stream was 79 per cent, while the rate for the larger one was 96 per cent. These rates did not change appreciably when program costs were assumed to increase 10 per cent per year after 1971.

COMPARISONS AND CONCLUSIONS

At the outset we hypothesized that net internal rates of return to varietal improvement of rice, cotton, wheat, and soybeans in Colombia had been higher than the opportunity cost of public funds (10 per cent) and, in fact, higher than return rates of

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64/ The price elasticity of demand estimate was suggested by the results of James P. Houck, "A Statistical Model of Demand for Soybeans," The Journal of Farm Economics, Vol. 46, No. 2 (May, 1964), pp. 371 and 372.

the order of 50 per cent calculated for similar programs in the United States. Among the four programs, somewhat lower estimated returns were expected for wheat because its domestic price had been under pressure from P. L. 480 imports; and production had relocated in less productive areas of Colombian agriculture.

To more carefully examine this latter possibility--as well as the roles of socioeconomic and structural constraints generally on the estimated returns to research--the total shift in product supplies caused by the use of improved varieties generated through research was divided into two parts: an estimate of the "yield advantage" of the new over the old varieties and an estimate of the rate of adoption of the new varieties. Low returns attributable to socioeconomic and structural constraints were then associated mainly with low rates of adoption; the role of the biological determinants of the return to research was associated principally with the calculated yield advantage of the improved varieties. The yield advantage was estimated with regression techniques which were designed to factor out assumed positive interaction between the improved varieties and such inputs as fertilizers and water.

Our main results are summarized in Table 19. Estimated net internal rates of return were found to exceed 50 per cent in the cases of soybeans and rice. Returns calculated for the wheat improvement program turned out to be much lower-- in fact, well below the 50 per cent level; and gross returns to cotton research were found to have been negligible. In all cases, the estimated yield advantage was smallest when interactions of the improved varieties with other variables were factored out.

The very high rates of return estimated for soybean research were explained by a large shift in product supply caused principally by the rapid uptake of the new varieties and their virtual displacement of the unimproved Mandarin seed. The calculated yield advantage of the new varieties was not spectacular. The striking adoption of the improved soybeans was attributed to the strength of product demand, derived in the main from a fast-growing poultry industry, the geographic concentration

TABLE 18

Colombia: Estimated Benefits and Costs of the Soybean Research Program, 1960-1980

Year	Gross benefits: Based on "varietal effect" shift parameters	Gross benefits: Based on "simple" shift parameters	Total costs
	1,000 (1958 pesos)		
1960	a/		40
1961			41
1962			37
1963			39
1964			33
1965			37
1966			40
1967	49	62	57
1968	1,288	2,230	98
1969	3,102	6,187	179
1970	7,847	16,300	463
1971	10,217	28,643	267
1972-1980	10,217	28,643	267

a/ Blanks indicate no benefits during this period.

Source: Gabriel Montes, "Evaluación de un Programa de Investigación Agrícola: El Caso de la Soya" (unpublished M.S. thesis, Faculty of Economics, University of the Andes, Bogota, 1973), Tables 14 and 21.

of production in a small area (the Cauca Valley) which facilitated the rapid diffusion of information concerning the improved varieties, the expected severity of the attacks by the cercospora virus to which the improved varieties were resistant, and the fact that soybean producers figure among Colombia's most modern farmers. That soybean yields have been practically equal in Colombia and the United States in recent years (Table 19) reinforces our characterization of the industry as a modern one.

The Colombian cotton industry has evidenced similar characteristics. Yields of cotton in Colombia have not only equaled U. S. yields but even surpassed them in some recent years. Adoption of the improved U. S. varieties of cotton was practically instantaneous as a result of the government's ownership of gins and control over seed distribution. Yield increases since the early 1950's, when improved varieties came into widespread use, have been spectacular. Still, in spite of these similarities with the case of soybeans, it was concluded that returns to the cotton research program had been negligible.

This apparent contradiction was explained in terms of the organization of the research effort. The Colombian textile industry, long accustomed to importing U.S. cotton, partly as a result of a preferential rate of exchange, was made "to buy Colombian" by a change in government policy. Textile firms then sponsored establishment of research which would lead ultimately to the local production of U. S. varieties of cotton. The final organization of the research program involved merely the importation, local testing, and the distribution to farmers of the highest yielding U. S. varieties. This organization was justified on a premise that yields obtained locally from the U. S. cotton would vary by variety; thus, there would be a payoff to identifying those kinds of cotton which yielded best under local conditions.

Our data did not sustain the premise, however. Information compiled on about 500 commercial field trials undertaken in Colombia on over 10 varieties of improved U.S. cotton indicated that differences in yields by variety were minimal. Thus,

TABLE 19

Colombia: Selected Comparative Data on the Rice, Cotton, Wheat and Soybean Varietal Improvement Programs

Concept	Unit	Rice	Cotton	Wheat	Soybeans
1. Estimated net internal rates of return	per cent	60-82	0[a]/	11-12	79-96
2. Estimated value of the supply shift parameter, 1971	per cent	10-16	b/	16	17-35
3. Estimated yield advantage, 1971	per cent	25-39		46	17-36
4. Land area planted to improved varieties, 1971	per cent	41	100	35	98
5. Average yields, 1971 Colombia/United States	ratio	0.68	1.03[c]/	0.53[c]/	1.01[c]/
6. Total research costs/ value production, 1968-1971	per cent	0.5	0.1	3.0	0.1

(Continued on next page.)

TABLE 19--continued

a/ Since gross benefits were negligible, this net rate should be negative.

b/ Blanks indicate no data available.

c/ 1970-1972 average.

Sources:

1-4: Based on summary of previous tables in this study.

5: For Colombia

Jorge Ardila, "Rentabilidad Social de las Inversiones en Investigación de Arroz en Colombia" (unpublished M. S. thesis, ICA/National University Graduate School, Bogota, 1973).

Gabriel Montes, "Evaluación de un Programa de Investigación Agrícola: El Caso de la Soya" (unpublished M.S. thesis, Faculty of Economics, University of the Andes, Bogota, 1973).

Andres Rocha, "Evaluación Economica de la Investigacion sobre Variedades Mejoradas de Algodon en Colombia" (unpublished M. S. thesis, ICA/National University Graduate School, Bogota, 1972).

Carlos Trujillo, "Evaluación Económica de la Investigacion en Trigo" (unpublished M.S. thesis, ICA/National University Graduate School, Bogota, 1974).

For the United States

U. S. Department of Agriculture, Agricultural Statistics, 1973, p. 441.

6: Ardila, op. cit.; Montes, op. cit.; Rocha, op.cit.; and Trujillo, op. cit.

the main research activity--local testing of imported varieties-- appears to have not been necessary. U. S. varieties could just as well have been selected at random for distribution in Colombia. Therefore, even though the widespread use of U. S. cotton increased yields, resulting surpluses were not attributed as benefits to the cotton research program.

As already mentioned earlier in this section, net internal rates of return found for the rice research program were high by any standard of comparison. Yet, in light of the comparative data of Table 19, they are a puzzle. Although the ranges of estimated rates of return for the rice and soybean program overlap, for example, we see that the range of the calculated supply shift parameter for rice is significantly lower than the corresponding range for soybeans, principally because of differences in the levels of adoption of the improved rice and soybean varieties. Also, it can be observed that estimated rates of return to rice were much higher than those for wheat, even though the calculated values of their supply shift parameters were roughly comparable. Why then were estimated net rates of return to the rice research program so very high?

An important answer lies with the cost side of the net rates of return calculations and with the organization of the rice improvement program. We believe that the direct costs of rice research to Colombia were effectively reduced by the program's having tapped into the accumulated stock of plant breeding capital--general knowledge, improved breeding techniques, and plant materials--available in the two international centers, CIAT and IRRI, and in the World Collection of Rice. Without that accumulated capital, the costs of achieving comparable shifts in the supply of rice would have been higher and the corresponding net rates of return would have been lower.

This characteristic of the rice program was also found in the wheat research program. In fact, wheat had a longer history of using the accumulated foreign stock of plant breeding capital than did rice. Linkages with the Rockefeller Foundation-

Mexican program dated from around 1948, and additional collaborative support was provided the program during the late 1960's and early 1970's by the University of Nebraska Mission to Colombia. Judged from a purely technical and biological point of view, these foreign inputs were associated with success as they were in the case of rice. The estimated yield advantages of the improved wheat varieties were found to be large, even after the effects of variables which interacted with the new wheat varieties had been factored out. If they were included, the improved wheats could be shown to outyield the unimproved varieties by more than 250 per cent! Also, in international nursery trials the Colombian wheats easily outyielded the Mexican wheats from which they were largely derived.

Thus, the low estimated returns to the wheat research program were not the result of obvious technical failures in plant breeding. Rather, part of the explanation for the low returns lies with patterns of on-farm adoption of the improved seeds. The uptake of the new wheat varieties was notoriously slow. From the time the first improved varieties of wheat were sold commercially in 1953 until they were in use on roughly one-quarter of all wheatland, fully 12 years elapsed. Rates of adoption peaked at 50 per cent in 1968 and then began a downward trend. Current (1974) levels of use of the improved varieties are estimated to barely include a fifth of all cropland planted to wheat. The slow uptake of the new seeds and the low levels and distressing trends in their use were attributed primarily to socioeconomic and structural constraints on production, especially the depressed domestic market results from continued P. L. 480 imports at levels which represented a large multiple of national production.

Two additional explanations for the low estimated rates of return to wheat research should also be stressed, however. One is that it became a very expensive program in later life--in the middle and late 1960's. Annual investments averaged fully 3 per cent of the total value of wheat production, a figure which was not even remotely approximated by investments made in the other three varietal improvement programs

(Table 19). A second explanation related to the program's long gestation period. The Colombian wheat program dates from 1927. Yet, our review of that history indicated that a well-organized research effort probably did not get underway until 1948, and the first improved varieties were not released on a major scale until 1953. Thus, investments (albeit at reduced levels) were being made for almost a quarter of a century before offsetting benefits were realized. This affected adversely the calculated net rates of return for wheat research.

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AN ECONOMIC MODEL
FOR ESTABLISHING PRIORITIES FOR AGRICULTURAL RESEARCH
AND A TEST FOR THE BRAZILIAN ECONOMY

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CENTRO INTERNACIONAL DE AGRICULTURA TROPICAL (CIAT)

Cali, Colombia

An Economic Model for Establishing Priorities for Agricultural Research and a Test for the Brazilian Economy

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Determining the sources of economic growth continues to be an important economic problem. Technical progress has been recognized as one of the important sources of economic growth because of the increases in efficiency or productivity of conventional resources associated with it.

The potential contribution of technical change to agricultural development has been recognized for some time now.1/ However, it has only recently been fully appreciated that technical change can take alternative routes in its resource-saving effects, and that the particular route taken is conditioned by relative factor scarcities. This immediately implies the concept of an efficient path for technical change, and suggests the importance of allocating scarce research resources in such a way as to direct technical change along such an economically efficient path.

Although the notion of an efficient path for technical change (in the resource dimension) can serve as an important basis for allocating research resources, it alone is not sufficient. As noted above, technical change has important income distribution consequences. For one thing, the extent to which its benefits redound to the consumer or to the producer depends importantly on the conditions of demand and supply for the product. In addition, the extent to which the benefits that do redound

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1/ Important contributions to the literature include Schultz (18 and 19), Ruttan (15), Griliches (9), Hayami and Ruttan (10).

to the producer are distributed among particular factors of production will depend on both the "direction" which the technical change is taking (in the resource-resource dimension) and the conditions of demand and supply in the individual factor markets.

Increasing attention is being given to the problem of management of research resources, and to the importance of allocating such resources according to specified criteria or to some sense of priority. This increasing concern is probably in part a result of the growing recognition that the research activity is indeed an economic activity to be organized. But in addition, it probably reflects as well the growing consensus that technical change is a key element or input in the development process and that resources for this purpose are scarce.

The problem to which the present study is addressed is the development and testing of a model which would provide a basis for establishing priorities for agricultural research. If such a model can be developed and successfully implemented, it will provide a basis for making more efficient use of scarce research resources, and in turn enable the resulting technical change to make a larger contribution to agricultural and economic development.

The remainder of this paper is developed in four sections. The first section contains the conceptual model. The empirical results are reported in the second section, and the economic and policy implications of these results are discussed in the third section. Finally, a review of principal conclusions is presented.

THE CONCEPTUAL MODEL

The analytical model is built up within a framework that considers the distribution of the benefits from a technical change between producers and consumers and, given the producers' share of the benefits, how they are distributed among the factors of production. The research direction is given by the relative factor prices. And,finally a two-sector general equilibrium model is used to give the adjustment between the sectors.[2/]

Distribution of Benefits from Technical Change between Producers and Consumers.

Originally defined by Depuit and brought into the current economic literature by Marshall, Hicks, Patinkin and Mishan[3/], the concepts of consumers' and producers' surplus have been dealt with extensively in the literature. Consumers' surplus has been defined as the area above the price line and below the demand curve. Producers' surplus, in a somewhat symmetric manner, has been defined as the area below the price line and above the supply curve. As either the supply and/or demand curve(s) shift, there will be a change in producers' and consumers' surplus, with a possible resulting gain or loss to specific groups in the society.

These concepts have been used to evaluate the welfare effects of public and private investments in agricultural research. The basic analytical model for a closed economy is given in Figure 1.

Suppose that prior to some technological innovation the equilibrium price and quantity is P_0 and Q_0. In addition, suppose that the supply curve were perfectly elastic. The gain to society from a technological change which lowered the supply curve to S_1' would be the gain in consumers' surplus, A + B + C. If the initial supply curve were perfectly inelastic, on the other hand, a shift in the supply curve from Q_0S_2 to Q_1S_2' would result in both a change in producers' surplus (F+G-(A+B), and a change in consumers' surplus, (A + B + C). However, if the supply curve has a positive slope, the net gain will be B + C + E + F, since the change in producers'

2/ This model is presented in Appendix A.

3/ Currie *et al* (5)

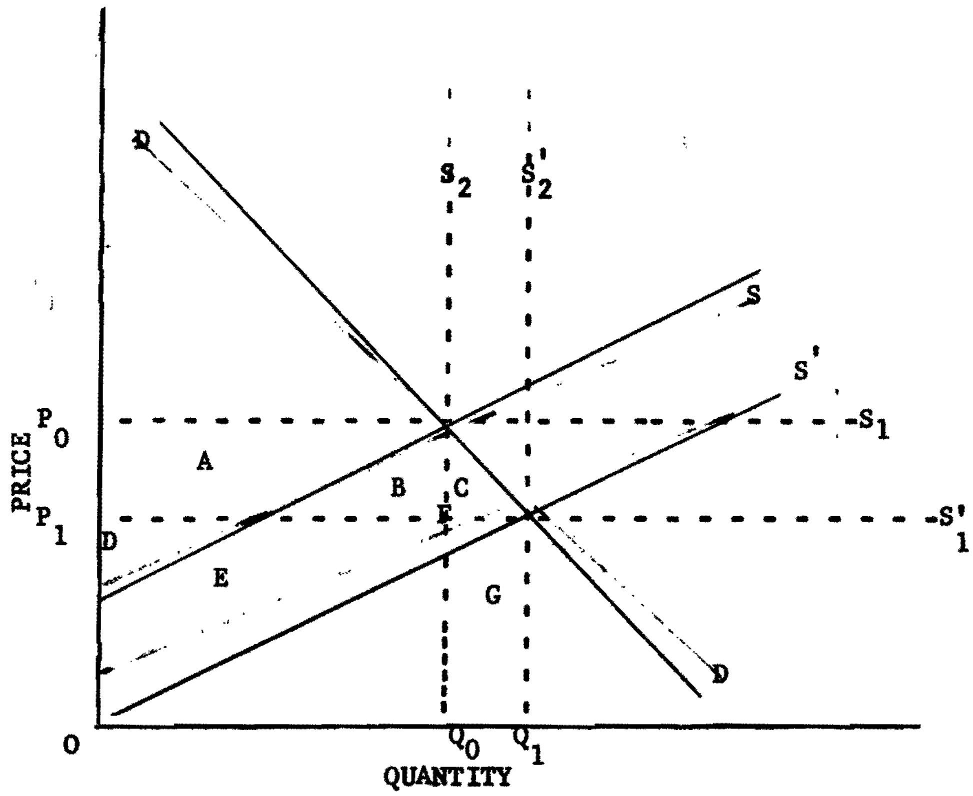

Figure 1. Effects of a Shift in the Supply Curve as a Result of Technological Change in a Closed Economy.

surplus is (E + F)-A, while the gain in consumers' surplus is A + B + C.

The two extreme cases of a perfectly elastic and perfectly inelastic supply curve were used by Griliches (8) to estimate the social rate of return on investments in hybrid corn research in the U.S. Peterson (13) and Ayer and Schuh (1), on the other hand, have assumed a positively sloped supply curve in estimating the social rate of return to investments in poultry research in the U. S. and cotton research in Brazil, respectively.

If the assumptions are changed to that of an open economy, the distribution of benefits can be understood by means of Figure 2. In the open economy case the export multiplier becomes an additional mechanism through which social gains are realized. These gains are derived from the increased exportable surpluses made available by the new technology. With a shift in the supply curve the elastic demand curve implied by an open economy[4/] will not allow for gains in consumers' surplus if the product has traditionally been exported. If the product was not exported prior to the technical change, there may be some gain in consumers' surplus as a result of the initial shift of the supply curve. This would occur, for example, if prior to the technical innovation the domestic prices were above the world price and "protected" either by transportation costs or trade policy.

It can be seen from Figure 2 that all economic surpluses will accrue to the producers if the product has been traditionally exported. If not (i.e., if it is the first time the product is exported and the internal price was previously above the world market), the producers will share some economic surplus with the consumers for the initial shift in the supply curve. Both the closed and open economy models described above suggest that the proportion of the gain accruing in the form of producers' and consumers' surplus will depend on the elasticities of demand and supply.

4/ The "small" country assumption is implied, or that the country is relatively unimportant in world markets so that its exports will not affect world prices.

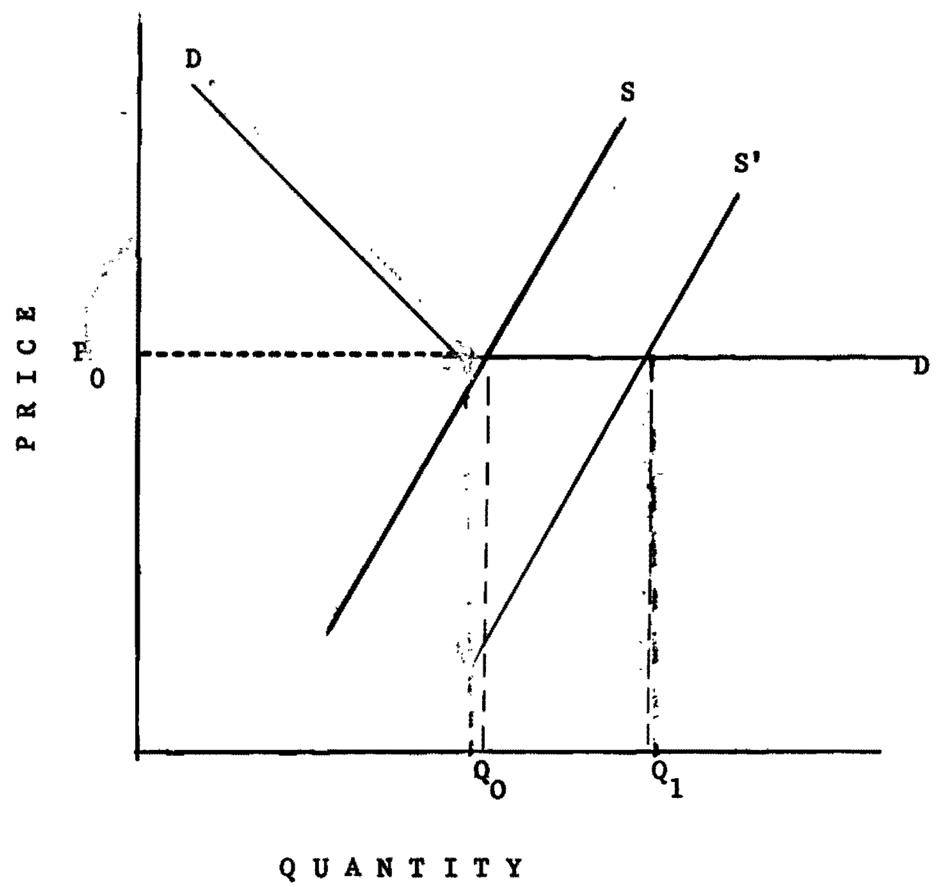

Figure 2. Effects of a Shift in the Supply Curve as a Result of Technological Change in an Open Economy.

These concepts are useful tools for analyzing the return to investments in research, as illustrated by Griliches, Peterson and Ayer and Schuh. Hence the basic framework provides a means of selecting the products to which researchers should give priority in their research efforts. In addition, it provides a means of establishing priorities in terms of more specific goals established by policy-makers. Knowledge of demand and supply elasticities will provide a basis for determining whether flow of benefits from a given technical change will be realized as a producer surplus or as a consumer surplus. Then, depending on whether the policy-makers prefer to favor the producer or consumer, research resources can be allocated accordingly.[5/]

Technological Change and the Neoclassical Theory of Distribution

In the previous section a model was discussed which showed how the benefits from agricultural research are distributed among consumers and producers. Since an important aspect of the present study is also to determine how the benefits of technical change are distributed among the factors of production, we now turn to an analytical framework that provides the basis for such an analysis and which also provides a means of hypothesizing what the expected aspects of the levels of employment will be.

The neoclassical theory of distribution, which is derived from the theory of production, provides the analytical tools for analyzing the problem at hand.

The problem in using pure neoclassical theory is that the analysis is restricted to two factors. One possible way to proceed is to define an aggregate production function for the agricultural sector in separable form, where the degree of substitutability among inputs is assumed to be greater than one within the postulated subfunctions, but is less than one between subfunctions.

5/ For an analytical discussion of the problem of defining priorities in agricultural research programs see Schuh (17).

In other words, assume that

$$Y = F \left[f \, (L^*, K^*_L,) \; g \, (T^*, K^*_T) \right]$$

where Y is the aggregate agricultural output, T and L are land and labor inputs, respectively, K_L is laboresque capital (mechanical) and K_T is landesque capital (biological, chemical and agronomic), and where (*) indicates that the factor in question is measured in "effective" units, e.g., $L^* = t_L L$, where t_L is an index of non-neutral technological change which increases the quality, or "effective units," of the nominal input L. The further assumptions of fixed input prices, homogeneity, and weak separability[6/] allow us to define subfunction price indices for the subfuctions on the basis of which the optimization process can be performed in two separable stages.

By doing the necessary derivation[7/] it is possible to arrive at elasticities which give the effect of non-neutral technological change on the income to individual factors, the functional distribution of income, and the employment of factors of production. This can be done on the basis of the aggregate inputs, which represent an aggregation of the inputs in an individual subfunction, or on the basis of the elementary inputs which enter a particular subfunction.

EMPIRICAL RESULTS

This section is divided into three parts. In the first part the potential gains from a specified, technologically-induced shift in the supply curve for selected crops is estimated, together with estimates of the distribution of these gains between producers and consumers. In the second part the estimates of the

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6/ Weak separability implies that change (infinitesimal) in the quantity of an input employed in one group of inputs (or subfunction) does not affect the marginal rate of substitutions between inputs in any other group. See Leontief (12).

7/ For the derivation as well as the complete model, see Ramalho de Castro (14).

elasticities of substitution for the production function are presented.

Total Gains from Assumed Technological Changes and their Distribution Between Consumers and Producers

Allocation decisions with respect to agricultural research are generally made on a crop basis, with the decision concerned about whether and in what proportions resources should be allocated to specific crops. The following analysis is designed to provide information which will help in making that decision, on the assumption that the total flow of benefits expected from a given technological change is important, and that policy-makers or research managers have some notion with respect to what extent they desire to benefit producers and consumers.

Two criteria were considered in selecting crops for further analysis.[8/] The first was their relative economic importance, as measured by value of total output, total area planted to the crop, and the geographic spread of the crop over the country.

The second criterion was the magnitude of the price elasticity of demand. This parameter was considered because it was shown in the conceptual section that the relative share of benefits going to consumers and producers depends on the size of this elasticity. An important determinant of the magnitude of this elasticity is whether the product has export potentials. If it does, then the demand elasticity will be relatively high[9/] and a major share of the benefits from technical change will go to the producers.[10/] Therefore, it was decided to choose some products that have

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8/ The livestock sector was not considered in the analysis because of data limitations and the fact that so little is known about demand and supply parameters for this sector.

9/ This statement implies that the small-country hypothesis applies, or that the country is so unimportant in world trade for the given crop that it is unable to influence price.

10/ Indirect effects through the export multiplier, which could benefit the consumer, are ignored in the present study.

only a domestic market, and others which have either been exported in the past, or which have the potential to be exported. By this means it was possible to conduct the analysis under a rather wide range of values for the structural parameters.

The crops that met these criteria, and yet which kept the problem manageable, were: cotton, sugar-cane, rice, edible beans and manioc (cassava).11/ During the period 1966-1970 these crops accounted for 46 per cent of the total output from crops and 74 per cent of the total acreage. Moreover, each of them was grown rather extensively in Brazil.

Cotton and sugar-cane are two of the traditional export products from Brazil. Rice and corn have been exported occasionally, bur not on nearly as large a scale as cotton and sugar-cane. They are produced primarily for the domestic market. Edible beans and manioc are traditional staple foods, and for the most part, have not been exported. Hence, the analysis focuses on two crops that have been traditionally exported, two that have export potential, and two that are produced primarily for domestic consumption.

To estimate the gains is was assumed a shift of 10 per cent in the supply schedule due to a technical change.

The estimation of consumers' gains, producers' gains and total gains are presented in Tables 1 through 6.12/

The results presented in Tables 1 through 6 show that the expected gain to society from the postulated, technologically-induced shift in the supply curve is

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11/ Coffee would have been a candidate for inclusion on the basis of its relative economic importance. However, the prevalence of sizable government interventions in this sector and the relative importance of Brazil in world markets complicate the analysis and caused us to drop it from consideration.

12/ The derivation of the equations used to estimate the gains is presented in Appendix B.

Table 1. Consumers', Producers' and Total Gain from Postulated Technological Change, Expressed as a Percent of Total Output, Cotton, Brazil (1966/70 base).

		Supply Elasticities								
		.19			.94			1.57		
Demand Elasticities	Benefi-ciary	Con-sumer	Pro-ducer	Total	Con-sumer	Pro-ducer	Total	Con-sumer	Pro-ducer	Total
2.00	Consumer	.88			3.30			4.29		
	Producer		9.21			7.02			5.85	
	Total			10.09			10.32			10.44
5.30	Consumer	.35			1.57			2.43		
	Producer		9.74			8.83			8.18	
	Total			10.09			10.40			10.61

Table 2. Consumers', Producers' and Total Gain from Postulated Technological Change, Expressed as a Per Cent of Total Output, Sugar-cane, Brazil (1966/70 base).

Demand Elasticities	Beneficiary	Supply elasticities .10 Consumer	.10 Producer	.10 Total	.60 Consumer	.60 Producer	.60 Total
	Consumer	1.65			5.24		
.56	Producer		8.40			4.90	
	Total			10.05			10.15
	Consumer	.38			1.99		
2.5	Producer		9.66			8.26	
	Total			10.05			10.24

Table 3. Consumers', Producers' and Total Gain from Postulated Technological Change, Expressed as a Per Cent of Total Output, Rice, Brazil (1966/70 base).

Demand elasticities	Beneficiary	Supply Elasticities .31 Consumer	.31 Producer	.31 Total	1.17 Consumer	1.17 Producer	1.17 Total	2.34 Consumer	2.34 Producer	2.34 Total
	Consumer	1.99			8.86			9.43		
.16	Producer		8.06			1.21			.64	
	Total			10.05			10.07			10.07
	Consumer	1.73			4.52			6.37		
1.50	Producer		8.39			5.80			4.08	
	Total			10.13			10.33			10.46

Table 4. Consumers', Producers' and Total Gain from Postulated Technological Change, Expressed as a Per Cent of Total Output, Corn, Brazil (1966/70 base).

Demand Elasticities	Beneficiary	Supply Elasticities .15 Consumer	Producer	Total	.58 Consumer	Producer	Total	3.32 Consumer	Producer	Total
.30	Consumer	3.35			6.66			9.30		
	Producer		6.70			3.44			.84	
	Total			10.05			10.10			10.14
.66	Consumer	1.86			4.73			8.56		
	Producer		8.20			5.42			1.71	
	Total			10.06			10.15			10.28

Table 5. Consumers', Producers' and Total Gain from Postulated Technological Change, Expressed as a Per Cent of Total Output, Edible Beans, Brazil (1966/70 base).

Demand Elasticities	Beneficiary	Supply Elasticities .15			Supply Elasticities .31			Supply Elasticities .43		
		Consumer	Producer	Total	Consumer	Producer	Total	Consumer	Producer	Total
.32	Consumer	3.21			4.96			5.78		
	Producer		6.84			5.12			4.31	
	Total			10.05			10.08			10.09
.50	Consumer	2.32			3.87			4.67		
	Producer		7.74			6.23			5.44	
	Total			10.06			10.10			10.12

Table 6. Consumers', Producers' and Total Gain from Postulated Technological Change, Expressed as a Per Cent of Total Output, Manioc, Brazil (1966/70).

Demand Elasticities	Beneficiary	Supply Elasticities .11 Consumer	.11 Producer	.11 Total	.47 Consumer	.47 Producer	.47 Total	.96 Consumer	.96 Producer	.96 Total
.10	Consumer	5.25			8.28			9.10		
	Producer		4.77			1.76			.95	
	Total			10.03			10.04			10.05
.30	Consumer	2.69			6.16			7.71		
	Producer		7.35			3.93			2.41	
	Total			10.04			10.09			10.11

equal to approximately 10 per cent of the total value of output from a crop, with cotton having the highest gain (10.61 per cent) and manioc the lowest (10.03 per cent). The annual flow of (gross) benefits ranges from a low of Cr$ 88 million for cotton and edible beans to a high of Cr$ 157 million for rice.

The results support the notion that the technological shifts for crops that have a relatively high price elasticity of demand, and especially crops with export potential, will tend to favor relatively more the producer. However, it should be noted that it is the relative magnitude of the elasticities that is important. If the supply elasticity were larger than the demand elasticities, independently of the absolute size of the demand elasticity, the consumer would tend to receive a larger share of the benefits.

A further inference that can be drawn, therefore, is that if policy-makers desire to benefit consumers, while still recognizing that export promotion is important and that expanded research efforts can help attain this goal, they might want to attempt to increase the supply elasticity. To the extent that the supply response is technologically determined, the research effort might be directed at least in part to this end. In this way both consumer and producers might benefit from a technological thrust.

Estimates of the Elasticities of Substitution

Table 7. The Estimates of the Elasticities of Substitution.

Labor-Laboresque	Land-Landesque	Inter-Subfunctions
.605	.933	.90

The results are not consistent with the hypothesis about the size of the elasticities of substitution. In estimating those parameters with a time series from

1950 to 1971 the results suggest that there was what might be called a technological turning point sometime around or shortly after 1960. This was indicated by breaking down the time series.

The explanation for the turning point as well as the size of the elasticities of substitution seems to be that during the decade of the 1950's the modern inputs of fertilizers and machinery were still used at relatively low levels. In the case of machinery, both level and kind of mechanization were such that it was highly complementary with labor, and in effect, increased the demand for the latter. In the case of fertilizer the complementarity with land was not quite so high. In fact, fertilizer application may have been doing little more than replacing nutrients removed by crops.

During the decade of the 1960's however, the use of both fertilizers and mechanization appear to have reached the point where they were land-and-labor substituting, respectively. This change in structure has very important implications for research policy and the establishment of research priorities.

The Factor Prices

The examination of the trends in the factor prices would give a indication about the direction of the research in the factor-factor dimension.

The recent trends in the prices of land and labor, the two principal inputs in Brazilian agriculture, are graphed in Figure 3. The figure indicates that between 1966 and 1973 the price of land services has been increasing faster than the price of labor. These data suggest that in recent years land has become increasingly scarce in relation to labor. Therefore, a tentative conclusion is that the agricultural research program should give special attention to the development and adoption of land substitutes.

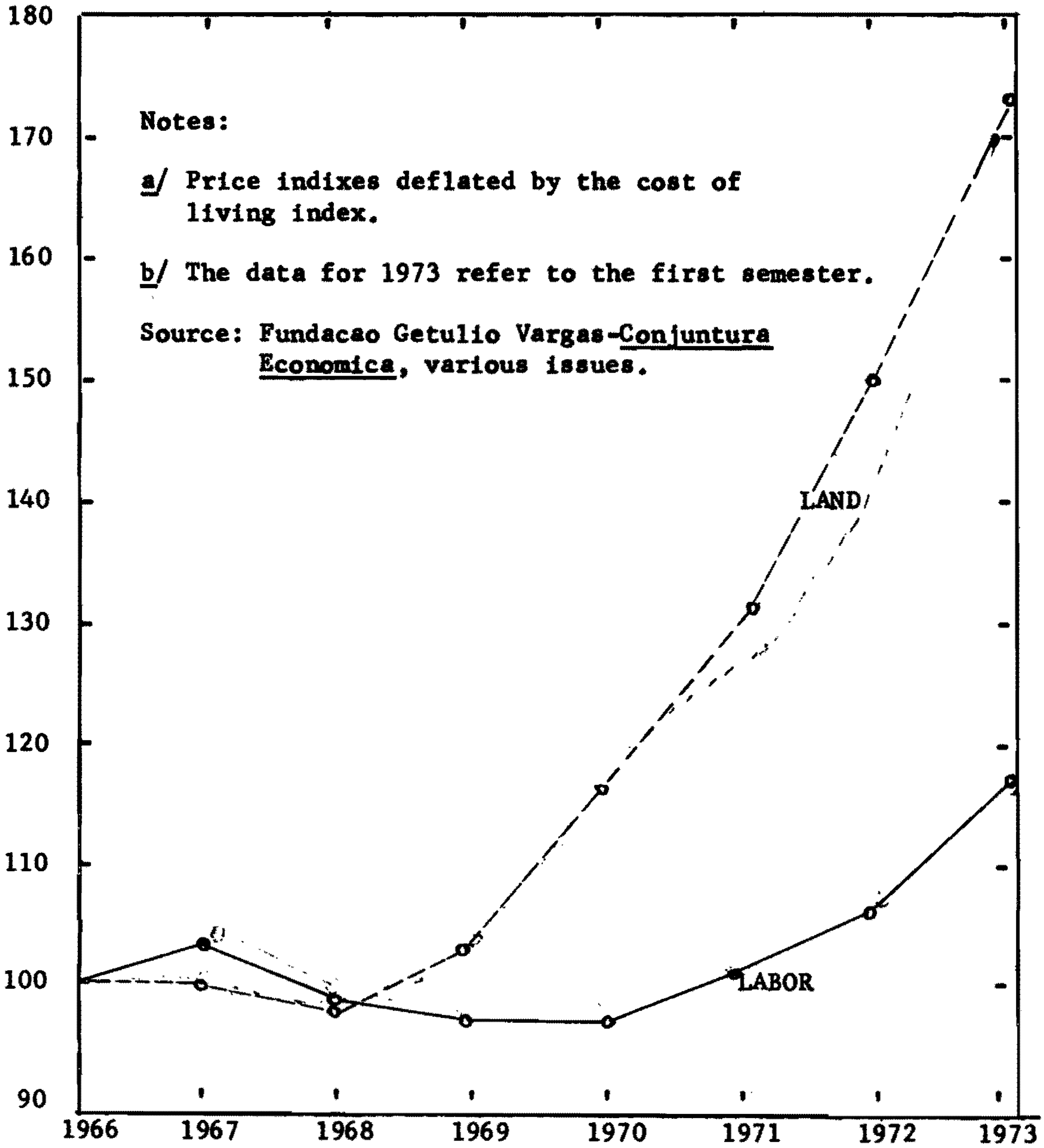


Figure 3. Recent Trends in Factor Prices in Real Terms. a/
Brazilian Agriculture, 1966-1973. b/

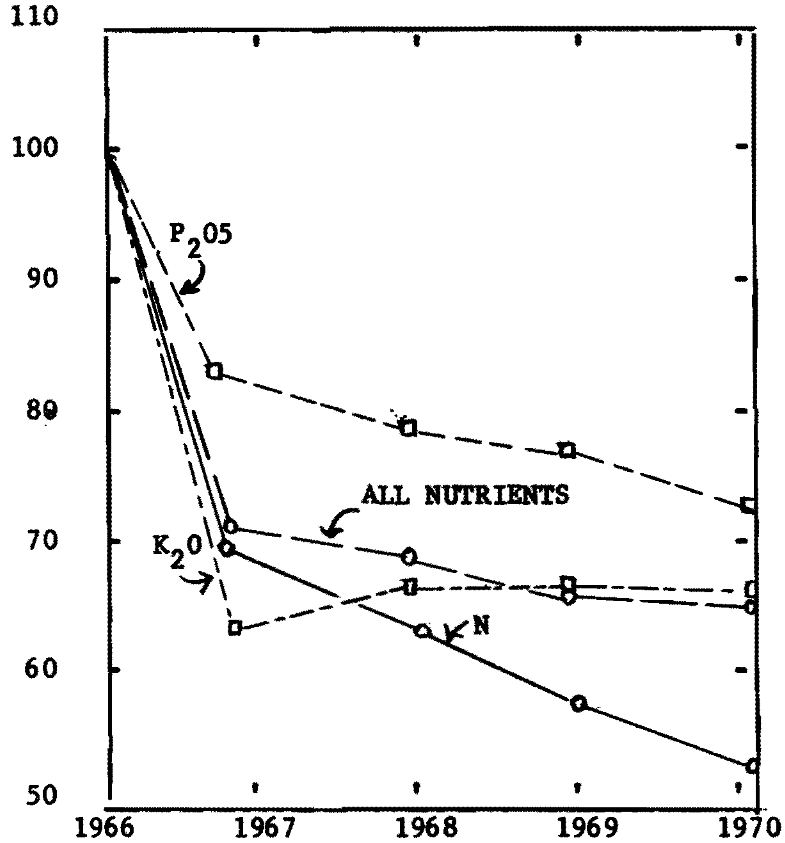
However, this conclusion should be drawn with a certain degree of caution, because Brazil is not basically a land-scarce country. It still has large areas of unsettled land, and the government is making sizable investment to open up new areas, especially in the vast Amazon region. Hence, it is possible that the relative scarcity of land and labor can change, especially if the recent rapid rates of industrialization continue into the future.

The trends in the prices of the close substitutes of labor and land--tractors and fertilizers, respectively--provide additional insights with respect to what direction research should take. Figures 4 and 5 indicate that in general the weighted price of fertilizer has been declining relatively more than the price of tractors. The real price of fertilizers in the aggregate declined some 35 per cent from 1966 to 1970, while the price of tractors declined on the order of 25 per cent. Among the plant nutrients, nitrogen has declined the most, followed by potassium, with the price of phosphorus (an important nutrient under Brazilian conditions) declining the least.

A consideration of the recent trends in factor prices alone, therefore, suggests that research on the land subfunction--the development of improved varieties, increased knowledge about pesticides and fertilizers, etc.-- should receive high priority. It should be noted that recent efforts of the Brazilian government to strengthen its agricultural research arm are therefore in the right direction. Moreover, the large road-building program designed to open up new areas are also consistent with the need to ease what appears to be a growing land constraint.

ECONOMIC AND POLICY IMPLICATIONS

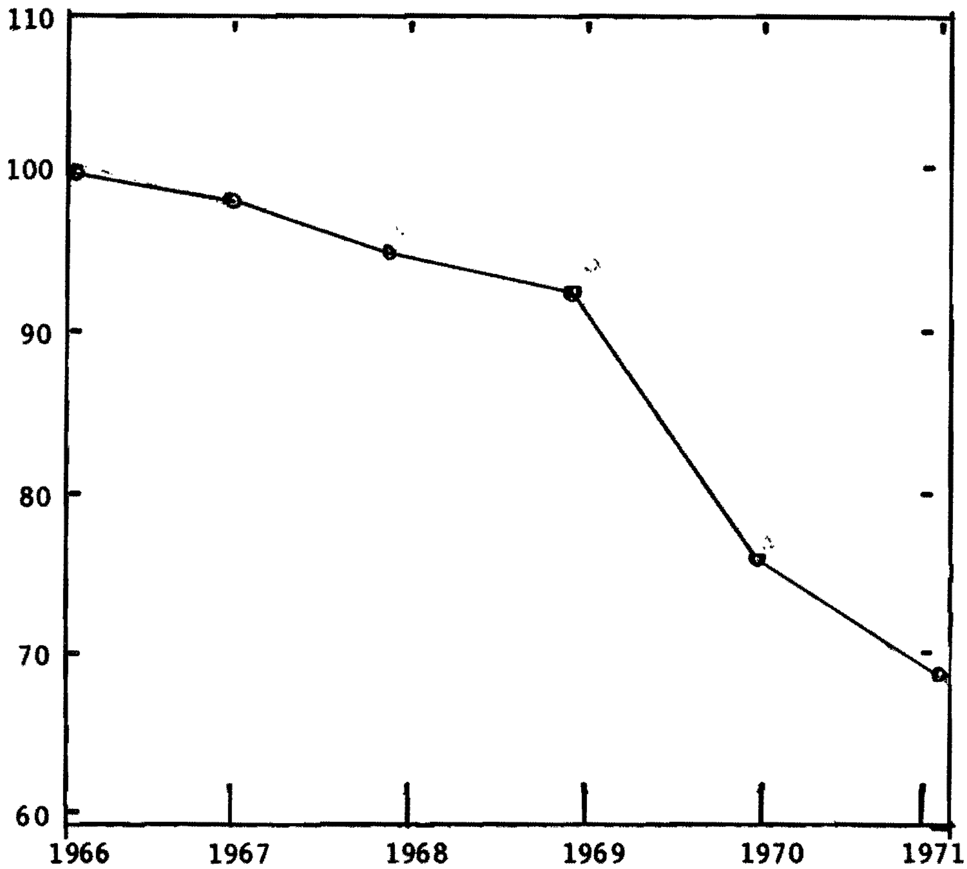
The primary objective of this section is to discuss the economic and policy implications suggested by the analytical framework and the empirical results. The results are not such as to provide conclusive recommendations on research priorities, since considerations such as the expected costs of making a given technolo-



a/ Price index deflated by the cost of living index.

Source: Fundacao Getulio Vargas, Conjuntura Economica, (various issues).

Figure 4. Recent Trends in Fertilizer Prices, in Real Terms[a/], Brazil 1966/1970.



a/ Price index deflated by the cost of living index.

Source: Fundacao Getulio Vargas, Conjuntura Economica, (various issues).

Figure 5. Recent Trends in Tractor Prices, in Real Terms,[a] Brazil 1966/1971.

gical advance are not considered. However, they are suggestive of emphasis that might be considered in defining priorities for the allocation of a given research budget among alternatives in such a way that goals established by the policy-makers can be met.

Primary guidance for the analysis is provided by two basic assumptions. The first is that, as pointed out by Kaldor (7), the demand for new knowledge is derived from the contribution it is expected to make to the achievement of individual and collective goals, or to the solution of private and public problems. The second assumption is that the rate of return to investment in agricultural research is expected to be high.13/

Therefore, new production technology is treated as if it were an input in the development process, and not an end in itself. This implies that the relative emphasis on products as well as the direction that research should take in the factor-saving direction should change with the set of goals specified for both the agricultural and non-agricultural sectors. An important problem with this criterion is the instability that these goals tend to have, since research in general, and agricultural research in particular, takes time in order to obtain results.

Four alternative sets of goals may be specified for the agricultural sector according to the stage of development of the economy, the particular development model the government is implementing, and the specific economic policies it used to implement this model.14/ These sets of goals include: (1) to increase aggregate income

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13/ Even though the number of empirical studies dealing with this subject is still fairly limited, to the best of our knowledge all have found a relatively high rate of return. Ayer and Schuh (1) report approximately an 80 per cent social rate of return in real terms to investments in cotton research in Sao Paulo, Brazil, For rates of return on investments in research in other countries see Griliches (8,9), Evenson (6), Barletta (4) and Tang (20).

14/ For a discussion of these points in the context of establishing priorities for agricultural research, see Schuh (17).

to the agricultural sector; (2) to increase income and employment of agricultural labor; (3) to enlarge agriculture's contribution to general economic development; and (4) to increase consumers' welfare.

These goals are not mutually exclusive, not are they exhaustive. However, they do represent relatively distinct policy emphases that a government might make over time as it responds to changing economic conditions.

With the above guidelines as a basis the following analysis will be carried out in four parts. First the direction of research in the factor-factor dimension and its income distribution implications will be analyzed. Then the direction of research in the product-product direction will be evaluated. This will be followed by a consideration of the potential for technological change in the crops considered. And finally, some considerations for the two-sector general equilibrium framework will be discussed.

The Direction of Research in the Factor-Factor Dimension and its Distributive Implications.

Hayami and Ruttan[15/] have argued that if a country fails to follow the correct technological path in its pursuit of output its society will bear a high cost and its development will be retarded. In the context of their induced innovation model the correct technological path is that which eases the particular factor scarcity that is constraining output expansion. In their framework the factor scarcities which may be limiting are primarily land and labor, which they define as the primary inputs. They prove no role for a capital limitation in their model.[16/, 17/]

15/ Hayami and Ruttan (10).

16/ The explanation for this particular emphasis may be the (implicit) assumption that over time capital has been generated through the combination of the traditional factors. This implicitly involves in addition a more basic assumption that the supply curve for capital is relatively elastic.

17/ In the case of the Brazilian economy at least superficially labor and land would appear to be relatively abundant, with capital appearing to be the scarce or limiting factor to further output expansion. The relative scarcity has to be understood in the context of the supply price at which additional quantities of the individual factor can be supplied to the economy, however.

If we assume that the adoption of new production technology at the farm level involves basically the investment of capital in land and/or labor substitutes, the movement along the correct path involves the substitution of such inputs for the primary factors, and the goal of the research effort should be to facilitate this substitution. The criteria for substitutions would be the trends in relative factor prices and resource endowments.[18/] Data on these were presented in the previous section and provide strong clues with respect to the direction that research should take.

These data show that in the aggregate there tended to be an increase in the price of land relative to the price of labor in the period 1966-1973. This suggests that relatively more emphasis should be given in research efforts to the land subfunctions and, more specifically, to research which helps bring more land into production (soil research, for example) or which facilitates the substitution of land substitutes for land. This latter could be soils research, including more work on such problem soils as the cerrados[19/], or the development of varieties that are highly responsive to fertilizer.

Other factors are of course important, however. For example the ultimate beneficiary of the development process is without doubt man or the human agent. Therefore, the output per man should be an important consideration in devising an

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18/ Within the Hayami-Ruttan framework the correct choice of production technology would be that which eases the constraint imposed by the resource that is most inelastic in supply. It should be noted in passing that an alternative framework could be postulated in which an *ex ante* rate of return was the decision variable. Hayami and Ruttan implicitly assume that technology which eases the relatively more elastic factor supply would be the high pay-off investment.

19/ The cerrado soils for the most part highly leached out latosols with a high degree of acidity, low nutrient levels, and apparently some problems of toxicity. They cover large areas of Brazil and very little is known about them.

appropriate research strategy.[20]

Consider the following relationship:

$Y/L = (Y/T) \quad (T/L)$

where Y is gross output, L is Labor, and T is land. Increases in labor productivity (Y/L) can be achieved either by raising land productivity (Y/T), by increasing the land-worker ratio (T/L), or by some combination of the two. The tentative conclusion reached above, which was to focus research efforts on the land subfunction, will concentrate primarily on increasing the productivity of land. However, it should be noted that by virtue of the above equation, increasing the productivity of land is one way of increasing the productivity of labor. This may have special relevance in the case of the Brazilian Northeast, where the land frontier is almost closed and where, according to the 1970 Census, 63 per cent of the economically active population was in the agricultural sector.[21] (For Brazil as whole this percentage was 44 per cent, and in the Southeast it was about 27 per cent).

These large regional disparaties also suggest that in a country as large as Brazil it would be difficult to arrive at a single policy recommendation that fits the needs of the country as a whole. The case of the Central-West frontier in Brazil further stresses this point. In that region labor is in relatively short supply, which in turn provides incentives for the use of tractors and mechanical equipment. Sanders (16) argued that there were two principal reasons for mechanization on the Mato Grasso and Goiás frontiers. One was the cost of obtaining and controlling seasonal labor, and the other was the difficulty (due to hardness) of working the soil.

20/ In other words, since labor is a major input in the Brazil agricultural sector, and since increased labor productivity leads to a higher per capita income and standard of living, policy makers want to give it major consideration.

21/ The Northeast also has approximately one-third of the Brazilian population.

In addition to factors such as these, the effect of the demand for land in the old regions due to the government's highway construction program in the Central-West and Amazon regions should also be considered. These investments facilitate labor mobility and the colonization of those regions. Hence, the single conclusion to work on the land subfunction may not be as obvious as it at first appears, at least for Brazil as a whole.

Figures 6 and 7 show recent trends in the prices of land and labor in selected regions. The data presented in these figures indicate that in the old regions (Northeast, East and South, the land prices have been increasing at a faster rate than in the more recently opened region, the Central West. Trends in the price of labor tend to be more uniform due to its greater mobility. But even despite this tendency, wages in the Central West have been increasing more sharply in the last couple of years than in the other regions, which supports the hypothesis of a growing shortage of labor in the new regions.

Another interesting finding is that the price of labor in the East region has been above the price of labor in the other regions during most of the period since 1966. The explanation for this tendency is that the states which comprise this region (Minas Gerais, Espírito Santo and Rio de Janeiro) are all located close to the industrial complexes of Guanabara and Belo Horizonte. Both of these are important, rapidly growing urban-industrial complexes, and migration out of agriculture in the surrounding regions has been fairly extensive in recent years.

To summarize, the above discussion suggests two basic conclusions if output growth is the primary goals of technology policy. First, in the aggregate, primary attention should be directed to the land subfunction in order to ease what appears to be a growing land constraint to output expansion. However, given the rather wide regional disparities in resource endowments within Brazil, a case can be made for differential regional emphases in research policy. More specifically, less emphasis

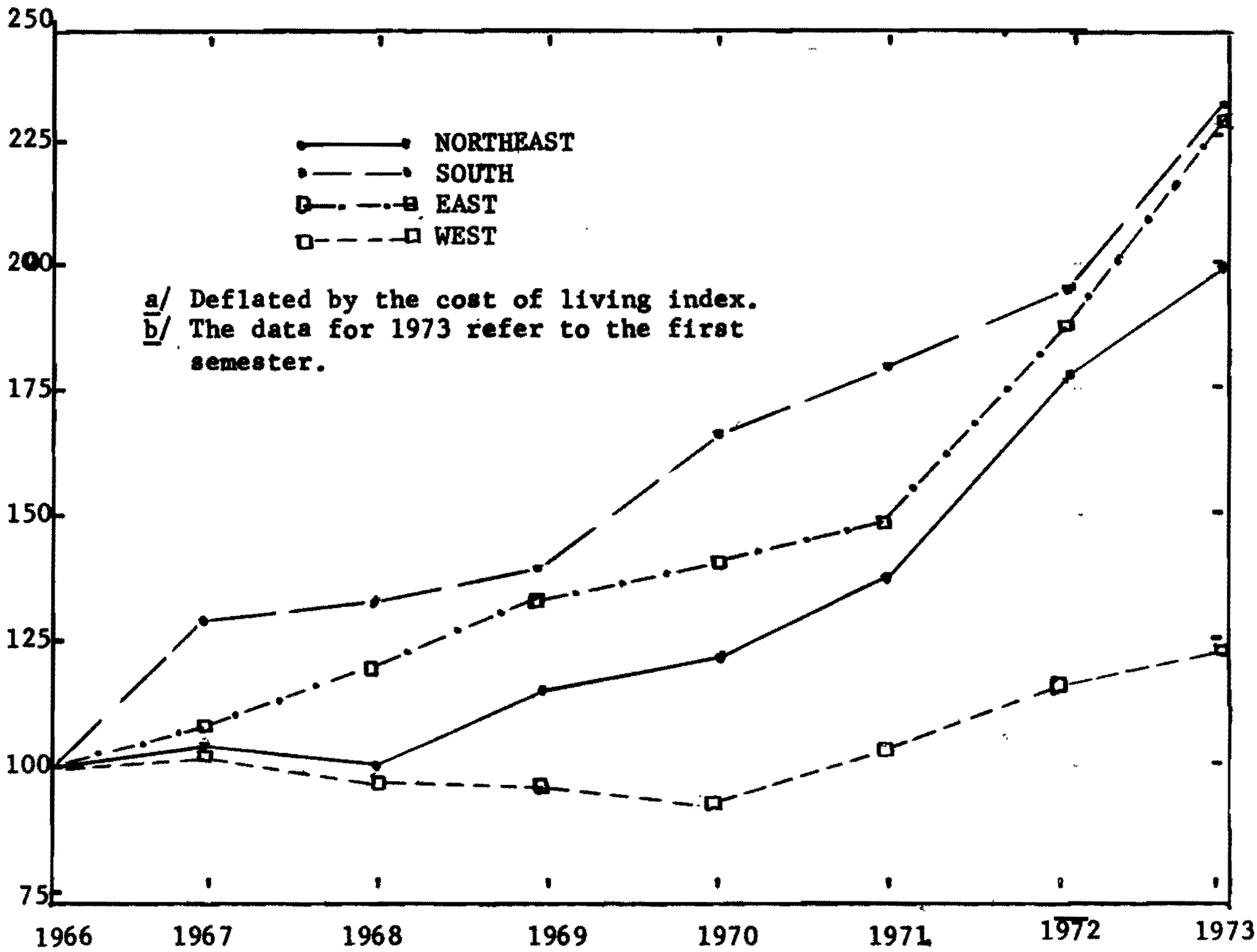
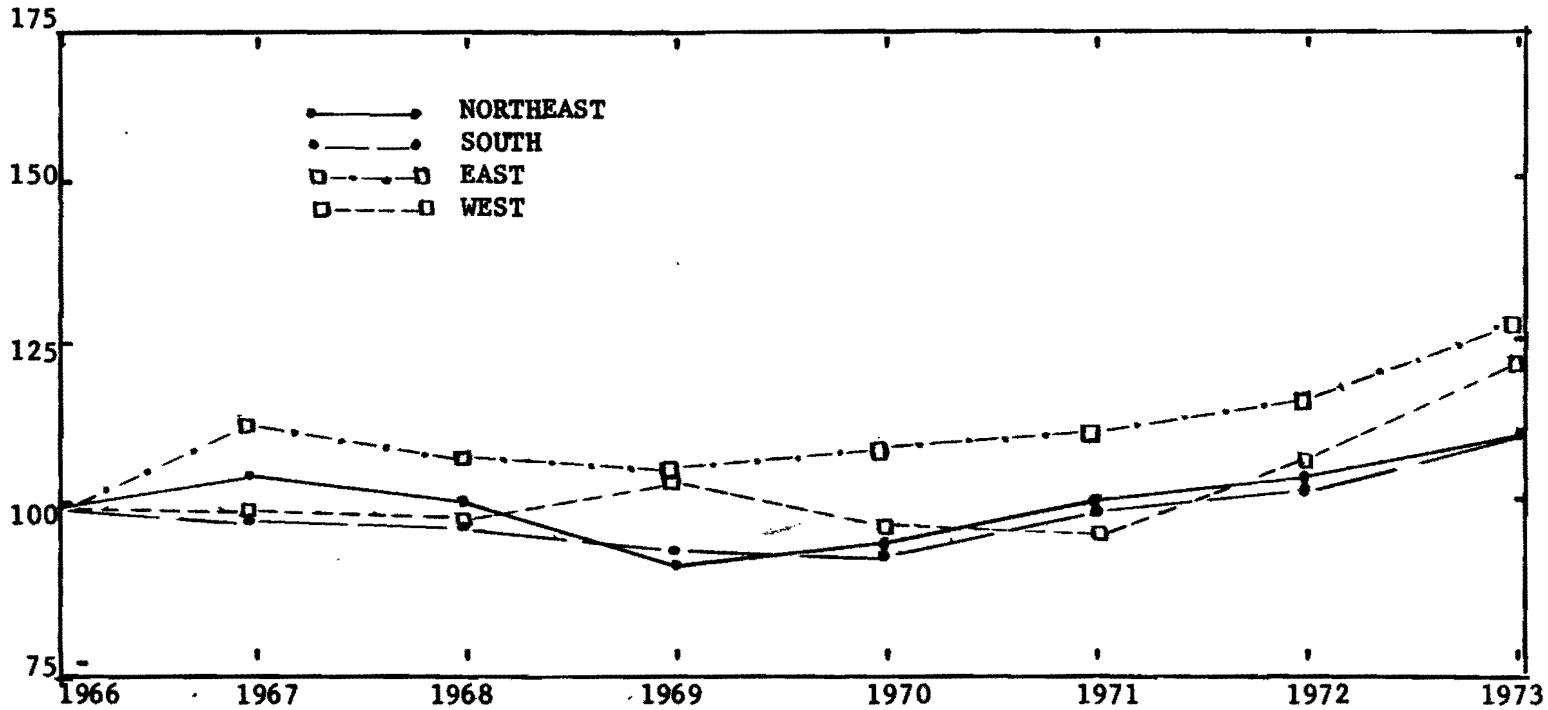


Figure 6. Recent Trends in Land Prices in Selected Regions, Real Terms,[a/] Brazil, 1966-1973.[b/]



a/ Reflected by the cost of living index.

b/ The data for 1973 refer to the first semester.

FIGURE 7. Recent Trends in Labor Prices for Selected Regions, Real Terms,[a/] Brazil 1966/1973.[b/]

should be given to raising land productivity in the Central West[22/] and more attention should be given to raising labor productivity in the region by means of mechanization. In the other three regions, major attention should be given to raising land productivity, although if the economy continues to expand as rapidly as it has in the past, mechanization may become increasingly important, especially in the East.

Finally, the estimated elasticities of substitution for the subfunctions suggest additional factors that might be considered in establishing research priorities. In both cases the estimated elasticities of substitution are less than one. This implies in the case of the land subfunction that particular attention might be given to developing varieties that are more responsive to fertilizer in order to facilitate the substitution of fertilizer for land. In the labor subfunction it suggests that more research might be directed to developing mechanization under Brazilian conditions.

So far the factor-saving direction of research has been discussed only in a growth or development context, without considering its effects on the functional distribution of income. However, the analytical framework provides a means of analyzing the distributional effects of a technical change under the assumption that elasticities of substitution within the subfunctions are greater than one, and the elasticity of substitution for the inter-subfunction is less than one. The empirical results for the Brazilian agricultural sector in the aggregate suggest that the latter assumption was valid ($\sigma = .9$), while the former was not ($\sigma_T = .933$ and $\sigma_L = .605$) (Table 7). Furthermore, they suggest the existence of a change in the technical epoch (in Brown's (3) sense). This change in the technical epoch leads us to believe that there may be a further change in the intra-function elasticities of substitution over time in response to changing economic conditions and/or the relative prices change.

Even though part of the a priori hypothesis did not prove to be valid, the analytical framework is still appropriate since the price elasticity of demand is the

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22/ This conclusion is also consistent with the notion that new lands tend to have relatively high natural fertility, at least for a period of time.

key parameter. In addition, at the aggregate input level[23/] it is the elasticity of substitution of the inter-subfunction which enters the equations in addition to demand elasticity, and the estimate of this parameter was consistent with a priori expectations.

When interest focuses on the elementary input level, however, the third parameter, the intra-subfunction elasticities of substitution enters the equations. In this case the demand elasticity has to be of such a magnitude as to compensate the low elasticities of substitution within the subfunctions. Therefore, the selection of products, which will be considered in the next section, is crucial in determining the distributional effects of technical change. For example, if the policy-maker's goal is to increase the return to labor, even though the technological path chosen in terms of the growth objective is to ease the scarcity of land, the products chosen to receive expanded research efforts should be those with a price elasticity of demand greater than .9. Among the six products considered is this study, two crops that are likely to have such high demand elasticities are cotton and sugar-cane.

The finding that elasticity of substitution in the labor subfunction is less than one (.605), plus the conclusion that one way to increase output per unit of labor is to increase the land/labor ratio, suggest that there is a place for research on the labor subfunction, if the goal is to raise labor productivity and income. In this case, however, particular attention should be given to research on mechanization for land preparation, which is not expected to greatly affect the displacement of agricultural labor. This consideration is important, since with the exception of the Central West (and possibly the East) labor is not the constraint

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23/ The aggregate input level refers to the combination of inputs within a subfunction.

to output expansion.

The Product-Product Dimension [24/]

The price elasticity of demand is an important parameter in determining the gains to society at large from technological change, as well as in determining its effects on the functional distribution of income. Therefore, the relative priority in research that is given to the individual products plays an important role in the attainment of the goal established by the policy-makers with respect to the agricultural sector. The four alternative sets of goals referred to at the begining of this section will serve as the basis for the present discussion.

If policy makers choose to increase the income to the agricultural sector as the primary goal, the analytical model and the empirical results suggest that products that should be considered are those with a large price elasticity of demand. Among the six products considered in this study, cotton and sugar-cane would be the first candidates, since they have been traditionally produced for the world market. The second candidates would be corn and rice, especially if the research results would be of such a nature and magnitude as to make Brazil more competitive in the world markets for these crops.

The annual flow of gross benefits to be expected from the first two crops would be approximately Cr$ 195 million of the 1966-1970 base of the value of output, while the second two crops would give a gross flow of benefits of approximately Cr$ 300 millions. The differential in the expected flow of gross benefits is large. If in addition to this finding it is also recognized that corn and rice are produced more widely over the country, which implies a more ample distribution of benefits from

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24/ The analysis will be carried out for the country as a whole. However, the reader should keep in mind that regional considerations could change the conclusions.

such research, the decision to increase the investment in cotton and sugar-cane research is not so obvious. Apparently, a key factor that should be considered in making the decision is how close the present Brazilian technology is to making corn and rice competitive in world markets.

A third product that might be considered is manioc. It presently is mainly a staple food, and is consumed largely by low income groups. However, it has the potential to become an export product, given the growing feed grain shortage in world markets. And again, manioc is produced rather widely in the country, which suggests that it also should be considered as a potential candidate for expanded research efforts if the goals is to distribute the benefits of the production technology over as wide a geographic area as possible.

The same set of conclusions would apply if the goal were <u>to increase the income and employment of agricultural labor</u>. If the technological change is in the land subfunction (e.g., a technological package that involves varieties that are more responsive to fertilizer), then it is sufficient that the price elasticity of demand (η) be greater than .9 in order for the specified goal to be attained. However, it should be noted that η must be large for any kind of technological change to attain this goal.

To attain the goal of <u>increasing consumers' welfare</u>, the policy to be implemented has a quite different perspective. The products to be selected are those with a low price elasticity of demand and those that are consumed by low income groups. Corn and rice, given their large flow of gross benefits, would be candidates for high priority, under the condition that the technological change does not alter their current competitive position in the world market. If the latter were the case, then producers might benefit relatively more than consumers. However, the consumers still might benefit indirectly as a result of the higher rate of economic growth which the increase in exports would help finance.

Edible beans and manioc, the second in line of priority, given this goal, present a different picture, since both are staple foods with either an income elasticity of demand close to zero or negative. However, manioc has the potential to eventually become an export product. Therefore, edible beans is the crop for which technical change will tend to benefit the consumers more, while manioc may or may not, according to the realization of not of its export potential. The gross flow of benefits from these two crops is the smallest (Cr$ 186 millions) among the three groups here considered.

The attainment of the goal of enlarging agriculture's contribution to general economic development is a bit more complicated, since it depends on easing the constraints which prevent the economy from realizing its potential. Five subsets of this goal can be considered: (1) to keep the price of food relatively low so that nominal wages can be kept low without depressing real wages, or possibly while permitting an increase in the real wage[25/]; (2) to increase the supply of exchange earning; (3) to supply capital to the economy, especially for expansion of the non-farm sector; (4) to provide a market for the products of the non-farm sector; and, (5) to supply labor for the expansion of the non-farm sector.

The recommendations for attaining the first subset that are suggested by the results of this study are the same as those for the goal to benefit the consumers, which was specified above. Emphasis would be given to corn, rice, edible beans, and manioc. Even though corn is not a direct food except on a limited scale, its contribution would come indirectly through the livestock sector.

The recommendation suggested for attaining the goals of increasing agricultural income and/or to increase the income and employment of agricultural labor can

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25/ This should provide added incentive to the expansion of the industrial sector.

be applied to meet the subsets of goals (2), (3) and (4). However, different emphases should be given according to the respective weights given to each of these subsets of goals.

Finally, the last subset of goals -- to supply labor for the expansion of the non-farm sector -- has to be analyzed in both the short- and long-run. In the short-run the empirical results suggest that labor has not been a scarce factor in the agricultural sector. Therefore, these results implicitly imply that the demand for labor from other sectors is not increasing rapidly.26/

In the long-run, as the non-agricultural sector expands and requires the release of labor from the agricultural sector, two quite different strategies might be pursued. First, research could be focused on the labor subfunction, and second, the research could be directed to those crops with a low price elasticity of demand. These two actions together would release labor from agriculture rather rapidly. However, the second strategy would tend to depress the income of those individuals employed in the agricultural sector, which in turn would bring negative effects to the development process. Therefore, the specific set of goals in terms of what is expected from agriculture for the economy as a whole are crucial in defining research priorities in the product dimension.

The Potential for Technical Change

So far the analysis has, for the most part, been made under the implicit assumption that comparable investments in research directed to each of the crops would produce comparable results. However, to obtain the same yield increase for each crop would likely require different amounts of expenditure. Therefore, *ex ante* knowledge of the rate of return to such investments would be useful information in deciding how

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26/ Whitaker (21) has argued that the non-agricultural sector of the Brazilian economy has not been able to absorb the labor released from the agricultural sector.

many resources should be allocated among the various crops.

In the absence of such knowledge other kinds of information may be considered. One such type of information is the potential for improvements in yield, which can be evaluated at least in part by means of a comparison of Brazil's yields with international standards. Another criterion would be the availability of, or the ease with which, international technology can be adopted to Brazilian conditions. And finally, an evaluation could be made of the research under way in Brazil in order to determine how close researchers currently are to obtaining a breakthrough.

With respect to the transfer of technology, the most promising potential would appear to be with those crops that have received attention from the International Centers. For example, the International Rice Research Institute in the Philippines has generated an improved germplasm for rice which appears to be rather easily adaptable to Brazilian conditions. However, to the best of our knowledge little has been done to adapt this source of improved plant material to Brazilian production areas.

At least one example of such adaptation and further development of plant material has occurred in Brazil. The cotton research in the State of Sao Paulo started out basically with imported varieties, and proceeded to adapt and develop them to suit local conditions. The social rate of return to this program was quite high, Ayer and Schuh (1).

General Equilibrium Considerations

A final word is in order. The above analyses have been cast in a partial equilibrium framework. A shift of resources from one crop to the other, as well as between sectors, should be expected when a technological breakthrough is obtained. Therefore, considerations from a two-sector general equilibrium framework may be useful in making any final decisions with respect to allocating research resources.

The two-sector general equilibrium model described in Appendix 4 not only examined the output and factor reallocation effects of technical change, but by incorporating the elasticity of product demand, provided the means for deducing conclusions on the changes in the distribution of income to be expected between the two factors of production, labor and capital. By combining this model with the analytical framework derived from a separable production function, some effects in the two-sector general equilibrium can be drawn.

The discussion will be conducted in two steps. First, the agricultural sector will be analyzed in relation to the non-agricultural sector. And second, groups of crops, defined on the basis of their price elasticity of demand will be considered in relation to the rest of the economy.

Let us assume, first of all, that the economy is in equilibrium. Then assume a technical change in the agricultural sector as a whole with, for example, a land-saving technology. The empirical results of the second section show a relatively large elasticity of substitution between the subfunction (.9) and a relatively low elasticity of substitution (.625) and (.933) for the labor and land subfunctions, respectively. In a closed economy the price elasticity of demand for the agricultural sector in the aggregate is expected to be low. As a result of these conditions a decrease in labor incomes is expected from the technical change. Therefore, it is expected that labor will be forced to leave the sector to seek better opportunities elsewhere. Depending on the output effect of the new technology, agricultural output could even decrease.

The above reasoning implies that even a technical change which apparently is not labor displacing will cause the displacement of labor, given the negative effect of output on the (sectoral) distribution of income to agriculture. This finding has important policy implications. It indicates that investments in research will eventually displace labor no matter what kind of technological path is chosen, if the demand for the product is inelastic.[27/] Therefore, policy measures designed to facilitate this process of adjustment should be considered by policy-makers. These measures

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27/ This will tend to be the case unless exports are important.

should be directed to increase the labor absorptive capacity of the non-farm sector, as well as to increase the mobility of labor.

If the assumption of a closed economy is relaxed, the weight of exports in the total output of the product and in the use of labor could alter these conclusions. However, this would require that the technological change be concentrated on those products for which exports are relatively more important.

Similar conclusions follow if the analysis is conducted at a more disaggreagated level. Consider the group of products which are produced primarily for the domestic sector, such as rice, corn, edible beans and manioc, and which tend to have relatively small price elasticities of demand. For the same reason described above, a technological change for any one or all for these crops will release labor when the technical change takes place. Therefore, there will be an increase in the supply of labor to the rest of the agricultural sector and to the non-agricultural sector, and adjustments will be required if a new equilibrium is to be obtained.

On the other hand, if the products selected are cotton and sugar-cane, which have high price elasticities of demand, then the expected outcome is to increase the return to labor, which in turn should attract labor from the other activities. A new equilibrium will be established in which the labor share will likely have increased.

To conclude, the analysis of this section stresses an additional point that should be considered when decisions are made with respect to the allocation of resources to agricultural research. This new aspect is the problem of employment and the associated adjustment problems that are associated with technological change. Because of the importance of these problems, specific policies should be implemented to facilitate the adjustment process so that labor does not have to bear the full burden of the adjustment process, and so that both the benefits and costs of technical change will be more equitably distributed.

CONCLUSIONS

The principal conclusions are:

1. The choice of products which should have priority in the research effort will depend upon the goals of the government.

a. If the goals is to increase income to the agricultural sector, the products to be selected are those with a high price elasticity of demand. An important class of such products are those with a comparative advantage in world markets, such as cotton and sugar-cane.

b. If the goal is to increase the income and employment of agricultural labor, the choice would be the same products.

c. If the goal is to increase consumer welfare, the products to be considered must be those with a low price elasticity of demand, such as corn, rice, edible beans and manioc.

d. If the goal is to enlarge agriculture's contribution to general economic development, the choice will depend upon the prevailing constraint at the particular point in time. If, for example, the constraint is capital, the products to be selected are those which give the greater flow of gross benefits, which are corn and rice. On the other hand, if the constraint is exchange earnings, cotton and sugar-cane would be higher on the priority list.

2. The results suggest that the bulk of research should go to increase land productivity. However, there is room for research on the labor subfunction if the research is directed to activities which are not strongly labor displacing (for example, research with tractors to improve land preparation).

3. The results obtained in estimating the parameters of the production function with time series data suggest a basic change in the production technology in the early 1960's. Modern inputs such as fertilizer and machinery, which appear to have been complementary to their corresponding primary inputs in an earlier period, became substitutes of the primary inputs in the more recent period.

4. Finally, the adjustment problem in the labor market between the agricultural and non-agricultural sectors is expected to be large if research is directed to the crops with a low price elasticity of demand, such as corn, rice, edible beans, and manioc, even though the research is designed basically to improve land productivity. On the other hand, if research were directed more to those crops such as cotton and sugarcane which are produced for the world market, the demand for labor will be expected to increase if the research is focused on the land subfunction, and/or the labor subfunction, if the technical change that results is not strongly labor-displacing.

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APPENDIX A

A Two-Sector General Equilibrium Model

In order to provide a general view of the effects of technological change in one sector of the economy on employment and the returns to factors, a two-sector general equilibrium model will be specified.[1/] Assume the economy to be divided into two sectors, A and B. The first is assumed to be labor-intensive, while the latter is capital-intensive. Furthermore, it is assumed that the elasticity of demand for sector A's product is less than unity.

The first step in the analysis is to introduce a neutral technical change into the A sector, holding the factor prices constant and letting the product prices change. As shown in Figure 1, the introduction of a neutral technical change causes an increase in the output of the A sector. Since the technology is neutral, the (K/L) ratio is not affected in the A sector. Thus, there is no change in the allocation of factors between the two sectors, and therefore there is no change in the output of the B sector. On the other hand, the production of A industry has been increased proportional to the technical progress measured in terms of the decrease in the per unit cost of production.

In order for the factor shares to remain in the same proportion as prevailed prior to the technical change, the elasticity of demand in the A sector would have to be equal to unity. Since it was assumed that the elasticity of demand for the A industry is less than unity, however, a fall in that industry's profits is expected.

1/ All basic assumptions of the neo-classic theory are assumed here. For a detailed view of the model see Johnson, Harry G., The Two Sector Model of General Equilibrium, Aldine Atherton, Inc., 1971.

Therefore, since the industry is labor-intensive, the share of income going to labor has to fall vis-a-vis the capital share of income.

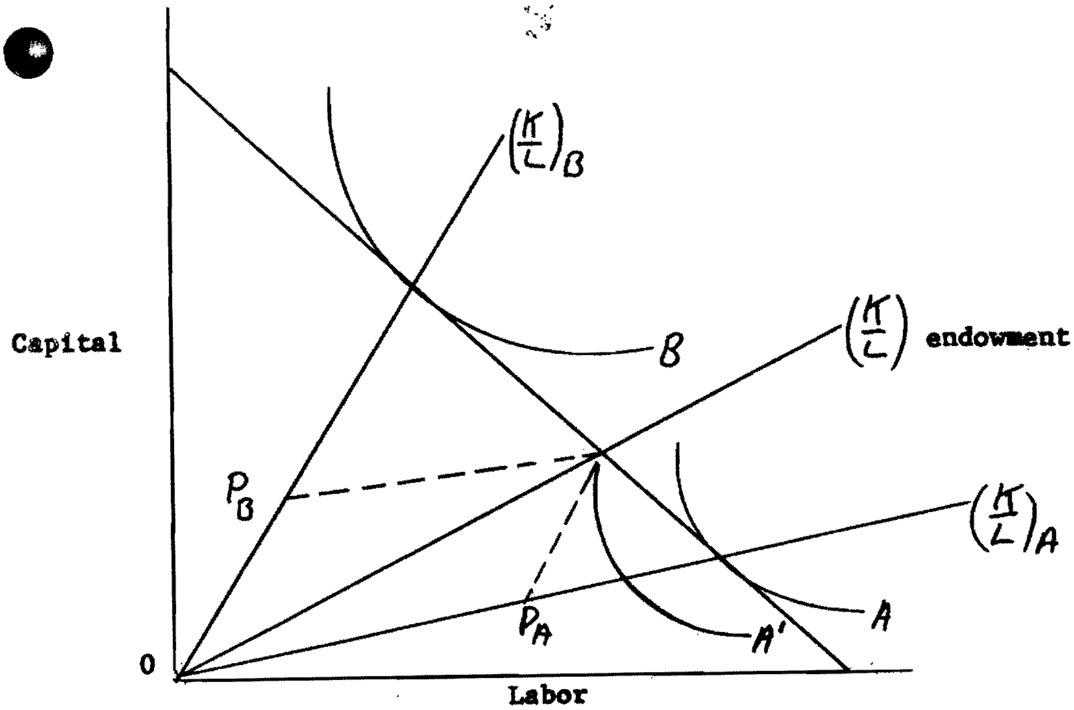
If a labor-using technology is introduced, as shown in Figure 2, the outcome is different. The decrease in the capital-labor ratio associated with the innovation requires a redeployment of both capital and labor out of the A sector into the B sector in order to maintain the full employment of the factors.2/ This is shown in Figure 2 by the movement from P_B to P'_B and from P_A to P'_A.

The output of the B sector must rise, while that of the A industry may fall or rise, depending on whether the resource exodus is or is not great enough to offset the improvement in productivity due to the innovation. In any case, the critical value of the Hicksian elasticity of demand for A, which determines the movement of relative shares and of absolute shares, is something less that unity.

It is also possible to examine the introduction of a labor-intensive technology in the A sector with an alternative model which holds product prices constant but allows factor prices to change. The labor-intensive technological change in the already labor-intensive sector lowers the K/L ratio as shown in Figure 3. In order for the product price to remain constant the factor price must change. The tangency points between the old A-sector isoquant and the new A-sector isoquant and the (W/r) line indicates that the K/L ratio rises in the B sector and the (W/r) rises also. The rationales of this is that as the marginal productivity of labor increases in the A sector, with the product prices constant, the price of labor is bid up. At the same time capital is released from this sector. These two features induce the B sector to substitute capital for labor, thereby increasing the (K/L)

2/ The reason for this is that capital is released from the A sector with the decrease in the capital-labor ratio, and by assumption the capital-labor ratio in the B sector does not change. Then some labor has to be released from the A sector in order to maintain full employment.

Figure 1. A Neutral Technological Change with Factor Prices Constant.



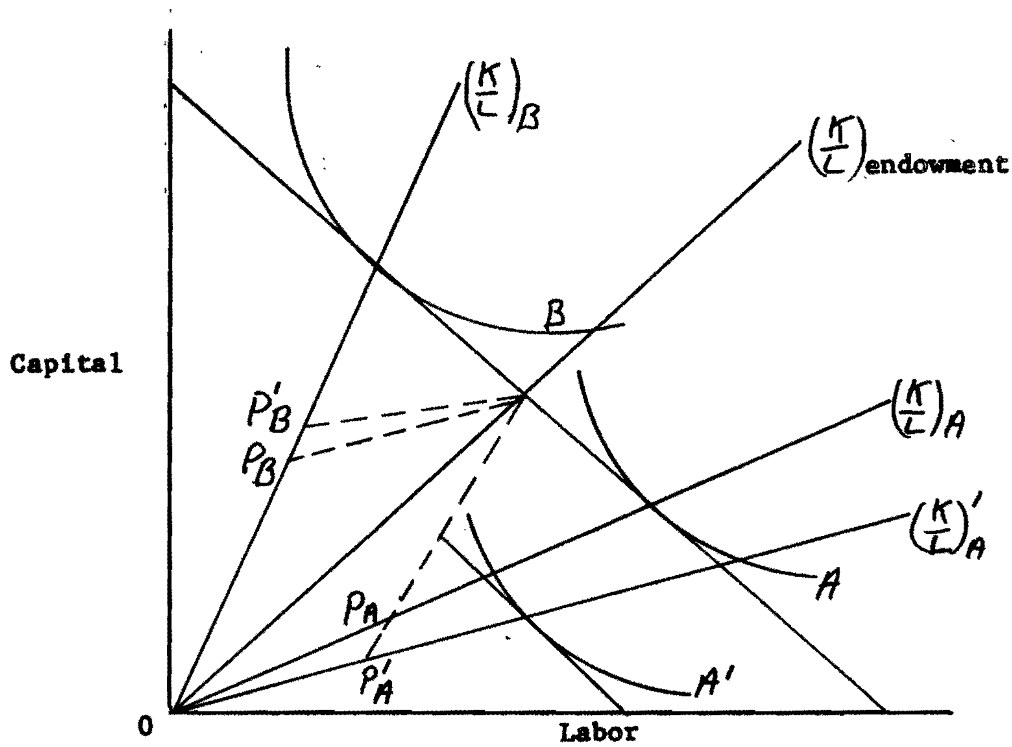


Figure 2. A Labor-using Technological Change with Factor Prices Constant.

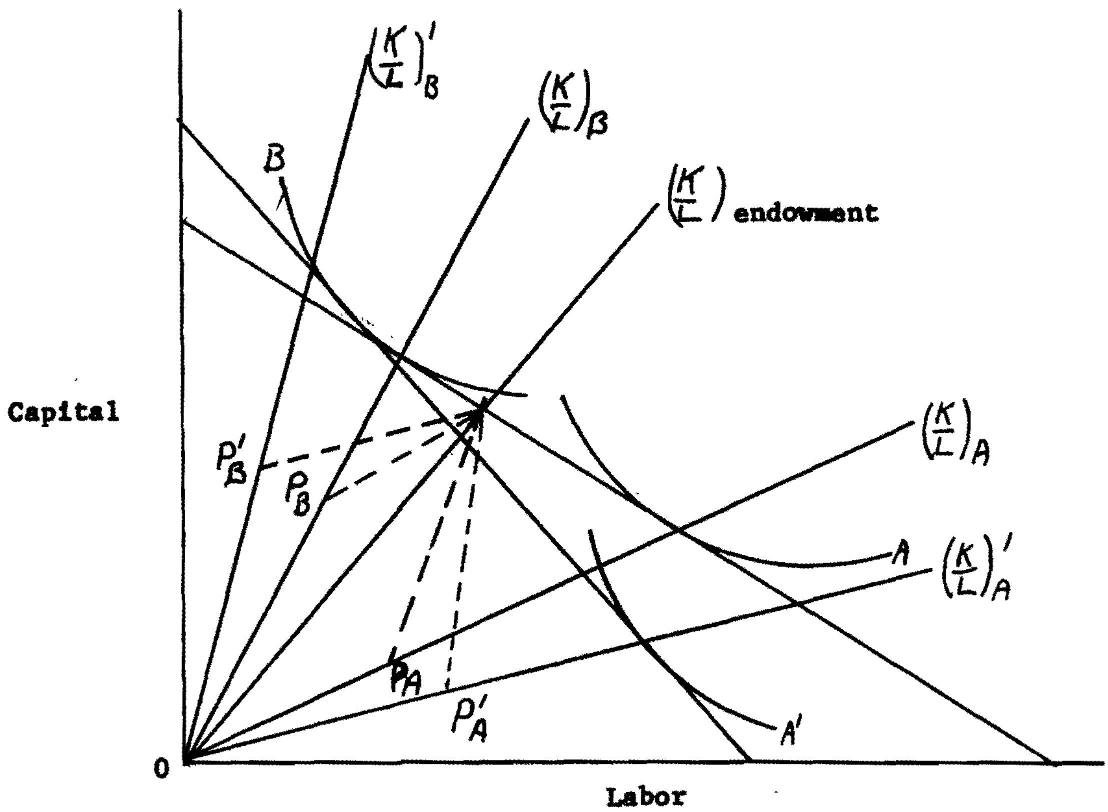


Figure 3. A Labor-using Technological Change with Product Prices Constant.

ratio and bringing the (W/r) ratio into equilibrium.

Holding product prices constant and assuming full employment of both factors of production, the share going to labor increases. However, to keep the A prices constant will depend on the adjustment in the factor market between the two sectors, as well as the increase or decrease of output in both sectors, and the elasticity of demand for their output. Two outcomes are possible. First, there may be an increase in the output of the B sector and a decrease in the A sector. In this case, with elasticity of demand greater than one for the B sector and less than one for the A sector, is is expected that the labor share will increase vis-a-vis capital.

The second outcome is to decrease the output in the B sector and increase it in the A industry. With the elasticities of demand described above it is expected that the capital share will increase vis-a-vis labor.

So far, perfect competitition in both markets and full employment of the factors has been assumed. If the assumption of full employment of labor in the A sector is relaxed, with a labor-using technological change no re-deployment of factors is needed and the expected outcome is to increase output in the A sector. Since it is assumed that the elasticity of demand is less than one, it is expected that the share of labor will decrease vis-a-vis capital.

If at the same time we assume that some subsidy is given to capital in the A sector, some substitution of capital for labor is expected. To the extent that the subsidy is enough to bring the (K/L) to the initial point despite the labor-using technology, the expected outcome will be similar to the case in which the technological innovations were of a neutral type. As a consequence, the share of income going to labor has to fall vis-a-vis capital.

APPENDIX B

Derivation of Alternative Expressions for the Concepts of Economic Surplus

For part of the empirical work reported in this thesis it was desired to have simple equations which could be used to calculate separately the consumers' and producers' surpluses and the total net gain from a technologically-induced shift in the supply curve, given only the shift parameter of the supply equation, observations on price and quantity at an initial equilibrium in the market, and estimates of the demand and supply elasticities. The following material describes the derivation of such equations.

As indicated in Section 1, the consumers' surplus (Figure C.1) that results from a shift of the supply curve (S to S') is measured by the area A + B + C. Producers' surplus is measured by area E + F - A, and the total gain is B + C + E + F.[1]

Assume that the parameter shift is $k_s = P_o - P_2/p$. [2] Given this parameter, what is desired is an estimate of the percentage change in price, $P_o - P_1/P_o$, and an estimate of the percentage change in quantity, $k_q = Q_1 - Q_o/Q_o$. Since $P_o - P_1/P_o - P_2 = E_s + \eta$, where E_s and η are the supply and demand elasticities, respectively, then

$$\frac{\dfrac{P_o - P_1}{P_o}}{\dfrac{P_o - P_2}{P_o}} = \frac{E_s}{E_s + \eta}$$

therefore,

1/ Linear demand and supply curves are assumed throughout the analysis.

2/ This assumes a shift in the saupply curve of the $P_o - P_2$ magnitude, expressed in percentage terms.

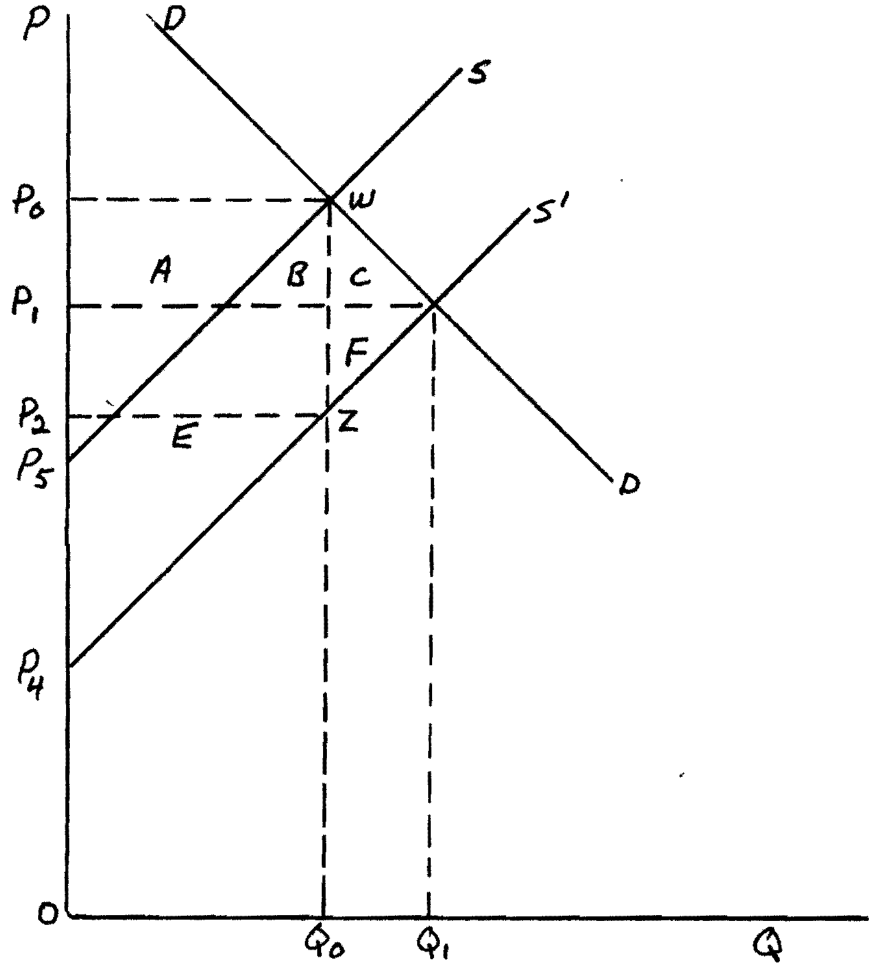


Figure C.1. Consumers' and Producers' Surplus Given a Shift in the Supply Curve.

Therefore, from equation (C.) we have

$$\frac{P_o - P_1}{P_o} = k_s \qquad \frac{E_s}{E_s + \eta} \qquad (C.1)$$

which is an estimate of the <u>percentage change in price</u>.

By definition the arc elasticity of demand is:

$$\frac{\dfrac{Q_1 - Q_o}{Q_o}}{\dfrac{P_o - P_1}{P_o}} = \eta.$$

Therefore, from equation (C.1) we have

$$k_q = \eta k_s \left(\frac{E_s}{E_s + \eta} \right) \qquad (C.2)$$

as an estimate of the percentage change in quantity.

Given equations (C.1) and (C.2), the consumers', producers', and total surplus can be derived. The <u>consumers' surplus</u>, (C.S.) is

$$C.\ S. = A + B + C$$

where $A + B = (P_o - P_1)\ Q_o$ and $C = \frac{1}{2}\ (P_o - P_1)\ (Q_1 - Q_o)$.

From equation (C.1) and (C.2) we can state that

$$(P_o - P_1) = P_o \ \frac{k_q}{\eta}$$

and

$$Q_1 - Q_o = Q_o k_q$$

Therefore,

$$C.S. = P_o Q_o \ \frac{k_q}{\eta} + \frac{1}{2}\ P_o Q_o \ \frac{k_q^2}{\eta}$$

Factoring the above expression,

$$C.S. = \frac{k_q}{\eta} P_o Q_o \left(1 + \frac{1}{2} k_q\right). \qquad (C.3)$$

The total surplus (T.S.), is given by

$$T.S. = B + E + C + F$$

where

$$B + E = (P_o - P_2)Q_o$$

from the fact that the triangles $P_2 Z P_4$ and $P_o W P_5$ are equal, and

$$C = \frac{1}{2} (P_o - P_1) (Q_1 - Q_o)$$

and

$$F = \frac{1}{2} (P_1 - P_2) (Q_1 - Q_o)$$

Therefore,

$$T.S. = (P_o - P_2) Q_o + \frac{1}{2} (P_o - P_1) (Q_1 - Q_o) + \frac{1}{2} (P_1 - P_2) (Q_1 - Q_o).$$

Factoring $(Q_1 - Q_o)$ we have

$$T.S. = (P_o - P_2)Q_o + \frac{1}{2} (Q_1 - Q_o) (P_o - P_1 + P_1 - P_2).$$

Therefore,

$$T.S. = (P_o - P_2)Q_o + \frac{1}{2} (Q_1 - Q_o) (P_o - P_2)$$

By definition of k_s we have that $(P_o - P_2) = P_o k_s$. Then,

$$T.S. = k_s P_o Q_o + \frac{1}{2} k_s P_o Q_o k_q .$$

Factoring, we have

$$T.S. = k_s P_o Q_o \left(1 + \frac{1}{2} k_q\right) \qquad (C.4)$$

The producers' surplus (P.S.) is given by

$$P.S. = E + F - A,$$

which is equation (C.4) minus equation (C.3).

Therefore,

$$P.S. = k_s P_o Q_o \left(1 + \frac{1}{2} k_q\right) - \frac{k_q}{\eta} P_o Q_o \left(1 + \frac{1}{2} k_q\right).$$

Factoring,

$$P.S. = P_o Q_o \left(1 + \frac{1}{2} k_q\right) \left(k_s - \frac{k_q}{\eta}\right) . \qquad (C.5)$$

LA ASIGNACION DE RECURSOS PARA INVESTIGACION AGRICOLA APLICADA EN LA AMERICA LATINA: EL CASO DEL BID*

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* Trabajo presentado en el Seminario sobre "Métodos para asignar recursos en la Investigación Agrícola Aplicada en América Latina". CIAT. Cali, Colombia

26 - 29 de Noviembre, 1974

** Banco Interamericano de Desarrollo, Washington, D.C.

1. <u>Propósitos de este documento</u>

En el presente documento se trata de examinar la experiencia obtenida por el Banco Interamericano de Desarrollo en relación con la asignación de recursos para apoyar programas de investigación agrícola. Este examen se centra en varias preguntas fundamentales: En qué forma considera el BID el problema de asignación de recursos a la agricultura? Cuáles son las prioridades dentro del Banco para apoyar la investigación agrícola en América Latina? Cuál ha sido la filosofía que orienta la toma de decisiones en la asignación de recursos? Cuáles son las áreas que, en el futuro el Banco, debo promover en materia de investigación agrícola?

2. <u>La acción del BID en el campo agrícola</u>

A lo largo de la historia del BID, la institución ha copperado en forma intensiva en el financiamiento del desarrollo de América Latina, habiendo asignado un énfasis muy especial al sector agrícola de todos sus países miembros, por lo cual se ha constituído como fuente principal de recursos externos para el desarrollo agrícola de la región. A la fecha, la cartera del Banco, en el sector agrícola, representa un 23 por ciento del total. Hasta hoy, el Banco ha colaborado en el financiamiento de 180 proyectos en sus países miembros por un monto superior a los 1.500 millones de dólares, cuyo custo total se aproxima a los 6.000 millones de dólares. Entre las áreas principales se destacan los proyectos de irrigación y los préstamos a instituciones de crédito agrícola, además de programas de cooperación técnica que, con fines de desarrollo agrícola integral, ganadería y sanidad animal, se realizan en acción coordinada con instituciones nacionales.

El Banco Interamericano de Desarrollo, así como otras organizaciones internacionales de financiamiento, se da cuenta de que el mundo está comenzando a apreciar los resultados de una generación de paciente investigación, de los trabajos de extensión agrícola y del apoyo financiero concedido por gobiernos nacionales e instituciones internacionales. En América Latina, durante los últimos años, de la década de los sesenta, la producción total de alimentos de los países en proceso de desarrollo creció a una tasa cercana al 8 por ciento anual. En muchos países de la región, así como en otras áreas del mundo, se encontró que las nuevas variedades de ciertos cultivos eran tan productivas como se había prometido y que los rendimientos se podrían incrementar rápidamente.

Sin embargo, en diferentes regiones del mundo, comenzaron a surgir problemas de otro tipo que podrían frenar las esperanzas para solucionar el problema del hambre. Este tipo de problemas, que se han designacomo como problemas de "segunda generación" de la revolución verde, han obligado a los organismos internacionales a prestar mayor atención a los programas nacionales de extensión agrícola y de transferencia de tecnología.

Hagamos una rápida revisión de la situación de América Latina al finalizar el año de 1973. El crecimiento económico de América Latina se acercó a un 7 por ciento, o sea, la misma tendencia del desarrollo acelerado de muchos países de la región, durante los últimos 5 ó 6 años. Se reconoce que los factores primordiales para ese crecimiento han sido: el aumento de la inversión interna, la diversificación y aumento de las exportaciones y el flujo de capitales, con inversiones a largo plazo procedentes del exterior. Un factor de suma importancia lo constituye el fortalecimiento logrado por varias instituciones nacionales que tienen a su cargo la formulación y aplicación de la política económica. Los sectores de manufactura industrial registraron el mayor incremento en su tasa de crecimiento. El desarrollo del sector agropecuario, en cambio, ha sido insuficiente para mantener esa tasa creciente de desarrollo.

En términos del valor agregado, la tasa de crecimiento del sector agropecuario fué lenta, igual a 3.4 por ciento en el período 1969 a 1972. Como consecuencia de ese estancamiento relativo se destaca la incapacidad del sector para retener, en forma productiva, el aumento de la fuerza de trabajo rural y para transferir al sector urbano los alimentos necesarios para satisfacer una mayor demanda.

La importancia del sector agropecuario se manifiesta plenamente cuando se considera la amplitud que tiene la población que depende de la agricultura y la magnitud de la fuerza laboral que dicho sector debería sostener económicamente. La fuerza laboral del sector agropecuario de América Latina llegaba a más de 31 millones de personas en 1970 ó sea, el 39 por ciento del total. Aunque la proporción de la población económicamente activa vinculada a la agricultural disminuyó en 1 por ciento de 1970 a 1972, en realidad, su número creció en unas 600 mil personas.

El Banco Interamericano de Desarrollo, actuando como organismo internacional de financiamiento, en su acción de apoyo a programas de investigación agropecuaria, procura: 1) ayudar en la identificación de prioridades de investigación a nivel nacional y regional, dentro del sector agropecuario; 2) proporcionar la experiencia de alto nivel en áreas especializadas de que carecen algunos países; 3) proveer los incentivos para desarrollar programas nuevos de largo alcance y con efecto multinacional; 4) coordinar la acción simultánea de varias instituciones nacionales que actúan en forma aislada sobre el análisis de problemas similares; y 5) proveer los fondos suficientes para llevar a cabo esos programas y poner los resultados de los mismos al alcance de los países, dentro de sus respectivas áreas de acción.

El Banco, en su acción de promoción del desarrollo de América Latina, actúa principalmente de dos formas: otorgando financiamiento y dando asistencia técnica.

A fines de 1973, el BID había alcanzado una nueva cifra en sus operaciones habiéndose autorizado, durante el año, un volumen total de US$884 millones en préstamos, con un total acumulado igual de US$6.309 millones. En términos globables, los países de América Latina y el Caribe aportan aproximadamente el 87 por ciento del total de las inversiones mientras que el 13 por ciento restante proviene de fuentes de financiamiento internacional. En el caso de los proyectos que el Banco ayuda a financiar, se debe destacar que la institución aporta en promedio un dolar por cada 3 dólares que se invierte.

En el sector agropecuario, específicamente, los préstamos autorizados por el Banco en 1973 ascendieron a un total de US$187 millones, de los cuales US$107 millones correspondieron al financimiento de proyectos de riego. Estas operaciones beneficiaron, específicamente, obras de irrigación en Argentina, República Dominicana, El Salvador y México.

La cooperación técnica que ofrece el Banco es la otra forma, tan importante o más que la primera, en que el BID puede ayudar a programas nacionales de desarrollo. La cooperación técnica que el Banco extiende a sus países miembros, simultáneamente con sus operaciones de préstamo, ha sido un factor decisivo para el éxito en las actividades realizadas por la institución. El Banco ha fortalecido sus programas de cooperación técnica con el propósito de que ésta beneficie al mayor número de países. Esta cooperación técnica facilita la preparación de proyectos, el fortalecimiento o mejoramiento de las instituciones encargadas de ejecutarlas, el adiestramiento de profesionales en disciplinas vinculadas al desarrollo, la programación de inversiones a nivel internacional y el avance de los esfuerzos de la integración económica en los países miembros.

La cooperación técnica que el Banco otorga puede ser de carácter reembolsable, sujeta a recuperacion contingente, o en forma no reembolsable. La cooperación técnica reembolsable se otorga en forma de préstamos directos a organismos nacionales para la ejecución de estudios específicos o como parte de operaciones de préstamos, para facilitar la ejecución del proyecto al cual se refiere el crédito respectivo.

La cooperación técnica sujeta a recuperación contingente se otorga bajo la condición de que será reembolsable, si conduce a la ejecución de un proyecto. La cooperación técnica no reembolsable que otorga el Banco a sus países miembros se destina principalmente a financiar actividades de planificación y reinversión, a apoyar instituciones de desarrollo, a realizar programas de adiestramiento y a financiar tareas vinculadas a la integración económica.

Durante 1973, el Banco autorizó un total de US$32 millones para operaciones de cooperación técnica, cifra que incluye US$25.6 millones en operaciones reembolsables, tanto en forma de préstamos como de partes de los mismos y US$6.4 millones en operaciones no reembolsables o sujetas a recuperación contingente.

El Banco también ha estado promoviendo programas conjuntos de investigación agrícola y adaptación tecnológica, como por ejemplo, a la Universidad Agraria de la Molina, en Perú, o a la Escuela Nacional de Agricultura, en Chapingo, México. En la misma forma, desde el año de 1970, se realizan programas de adiestramiento de alcance regional en cooperación con el Centro Internacional de Mejoramiento de Maíz y Trigo, con sede en México, y con algunas entidades especializadas de este país, y con el Centro Internacional de Agricultura Tropical, con sede en Colombia. El programa de cooperación técnica con el Centro Panamericano de Fiebre Aftosa, en Río de Janeiro, para dar adiestramiento en producción y control de calidad de vacunas antiaftosa es otro ejemplo.

3. La asignación de recursos a la investigación agrícola

El proceso de asignación de recursos a esta actividad no siempre ha merecido un análisis cuidadoso de lo que, en ocasiones, ha dado como resultado que recursos escasos se hayan dirigido a áreas o subsectores de prioridad relativa.

Los recursos escasos que se asignan a este tipo de investigación se pueden observar y medir pero el valor que generan es de difícil aplicación. En general, se puede decir que el valor de este tipo de investigación depende de: 1) la satisfacción que puede dar a los individuos y a la sociedad y 2) la información que genera y que tiene demanda por otros sectores de la economía.

El proceso de asignación de recursos escasos, tanto dentro como entre programas de investigación, en ocasiones, no siempre responde a cambios en las condiciones de oferta y demanda de cada subsector de la investigación o, en algunos casos, se toman decisiones sin haber considerado en forma exhaustiva todos los componentes del sistema. Algunos ejemplos pueden ilustrar esa aseveración: varios países en proceso de desarrollo, en Asia y Africa, pudieron multiplicar su producción de granos, trigo y arróz, principalmente, mediante la adopción de nuevas variedades que dependían del uso de altas aplicaciones de fertilizantes. Con los actuales precios de los fertilizantes, resulta obvio que no se anticiparon los problemas de oferta y demanda de insumos por parte de los agricultores pequeños. Otros países, en cambio, dependen de sus inversiones en programas de riego que realizaron tiempo atrás para promover el desarrollo de su agricultura.

Existe un consenso general en el sentido de que la investigación agrícola organizada en México logró un adelanto notable durante los últimos 25 o 30 años, principalmente, como resultado de un programa cooperativo llevado a cabo entre el Gobierno Mexicano y la Fundación Rockefeller. Pero en general se desconoce que esos esfuerzos han sido mucho más exitosos para los programas de trigo que para los programas de maíz, a pesar de que el maíz es un cultivo mucho más generalizado en México y de que, en términos económicos, es un cultivo más importante. Sin duda alguna, lo anterior es también resultado de ciertos problemas en la asignación de recursos. En general, se reconoce que las áreas trigueras de México están concentradas en áreas de riego en las cuales hay disponibilidad de agua y el uso de fertilizantes comerciales se ha generalizado. Por otra parte, la producción de maíz en México no está concentrada en áreas especiales y la disponibilidad de agua y fertilizantes presenta problemas; el maíz se cultiva casi en cualquier lugar, principalmente, en pequeñas empresas agrícolas usualmente sin riego y se requieren nuevas y distintas variedades de maíz debido a la heterogeneidad de los suelos y de los climas en los cuales se cultiva este grano. Se podría concluír que es menos costoso responder a la demanda de mejores variedades de trigo que a las de maíz.

A medida que se moderniza la agricultural en América Latina, la demanda para la investigación agrícola se hace más fuerte y efectiva. La validez de esta proposición se demuestra por: a) una agricultura más comercial que hace que la producción para el sostenimiento familiar decline, tanto en términos absolutos como relativos; b) los agricultores orientados hacia el mercado obtienen información sobre nuevos insumos en forma más rápida y a menor costos que los agricultores que son autosuficientes; c) la comercialización de la agricultura también implica que los agricultores se vuelven cada día más dependientes de los insumos comprados; d) existe una mejor oferta de insumos agrícolas complementarios a nuevas variedades en aquellas áreas en las cuales la agricultura se ha transformado en operación comercial, en contraste con aquéllas en las cuales todavía es autosuficiente.

Considerando lo anterior el Banco Interamericano de Desarrollo, al impulsar la investigación agropecuaria aplicada en las instituciones internaciones y regionales de América Latina considera que esta acción no se puede lograr por una sola organización internacional de financiamiento y que, por lo tanto, se debe realizar una acción conjunta que incluya varios organismos que compartan la responsabilidad por el desarrollo agropecuario de la región. De hecho, se trata de dar una nueva filosofía al apoyo a la investigación agropecuaria en los países miembros del Banco. Muchos países de la región poséen recursos cuantiosos, no solo para autoabastecerse de alimentos sino también para contribuír a las necesidades de otras regiones. Existen países que todavía no han explotado, en su totalidad, la capacidad productiva del sector agropecuario; existen todavía amplias oportunidades para aumentar la superficie agrícola y aún más, para multiplicar los rendimientos para la aplicación de la tecnología moderna.

Las autoridades del Banco Interamericano consideran que esta nueva orientación en la promoción de la investigación agropecuaria se ajusta a los esfuerzos para encarar la actual crísis mundial de alimentos y de energía. Los pequeños agricultores de América Latina han tendido a producir en el pasado únicamente para su consumo interno, pero se reconoce que pueden contribuír, en forma significativa, a satisfacer las necesidades nacionales. Al mismo tiempo, estos agricultores requieren insumos menos costosos que permiten la economía de combustibles y de maquinaria, y utilizar intensivamente la tierra y la mano de obra. La experiencia ha demostrado, además, que si se les proporciona recursos equivalentes, los pequeños propietarios agrícolas, asociados a empresas productivas, ellos pueden ser tan eficientes como las explotaciones de gran escala en lo que se refiere a la obtención de cosechas de alto valor comercial.

4. <u>El apoyo del Banco a la investigación agrícola aplicada</u>.

El año 1974 marca una nueva etapa en la acción del Banco, en el apoyo a la investigación aplicada a la agricultura y ganadería de América Latina. En el mes de mayo de este año, el Directorio ejecutivo aprobó la contribución de un monto equivalente a 2 millones de dólares, en monedas nacionales, para contribuír al presupuesto básicos de los Centros Internacionales de Investigación Agrícola que se localizan en América Latina: el Centro Internacional de Mejoramiento de Maíz y Trigo (CIMMYT), el Centro Internacional de Agricultura Tropical (CIAT) y el Centro Internacional de la Papa (CIP). Al haber autorizado estas acciones, el Directorio del Banco demuestra el reconocimiento de la importancia que merece la investigación agrícola de alto nivelque se realiza en dichos centros y el beneficio que los resultados de la misma pueden llevar a los países miembros del Banco. Sin embargo, en virtud de que la investigación per se no es suficiente, en Agosto de este mismo año, el propio Directorio Ejecutivo autorizó sumas adicionales, nuevamente por un monto equivalente a dos millones de dólares en monedas nacionales, para financiar en forma parcial aquellos programas de adiestramiento y de transferencia de tecnología a los países que los mismos centros, CIMMYT, CIAT y CIP, pudieran desarrollar en beneficio de países de América Latina y del Caribe.

La decisión del Banco para asignar amplios recursos a estos programas de investigación se base primordialmente en la confianza que el BID siente en los Centros Internacionales de Investigación Agrícola y en la seguridad de que éstos son instituciones que tienen una gran responsabilidad en la búsqueda de soluciones para atacar problemas del hambre en el mundo.

Los centros internacionales mencionados están financiados por los miembros del Grupo Consultivo de Investigación Agrícola Internacional, del cual el BID es uno de ellos. Como resultado, el Banco siempre ha estado informado de las necesidades de los países en proceso de desarrollo respecto a las soluciones de los problemas de nutrición y producción agrícola que se les plantean para mejorar la salud de los ciudadanos y sus economías nacionales. Cada año, desde su creación en 1971, el Secretario del Grupo Consultivo había urgido al Banco a considerar contribuciones a los requerimientos de los programas básicos y de capital de los centros internacionales, particularmente, de aquellos localizados en América Latina. Sin embargo, fué hasta 1974, cuando la Administración del Banco decidió recomendar contribuciones formales en virtud de una clara definición de las necesidades de tales centros.

El costo de los programas básicos y de capital de los centros internacionales de investigación agrícola en América Latina, en su forma aprobada por el Grupo Consultivo para el año de 1974, ascendió a una suma superior a los 13 millones de dólares, a la que el BID contribuyó con los dos millones primeramente mencionados.

La contribución del Banco Mundial, que es también muy importante, es distribuye a escala mundial para cubrir las necesidades de todos los centros internacionales ya que existe una necesidad específica de tales recursos por parte de los nuevos centros que se están iniciando en otras partes del mundo. Desde el fin del año pasado, se concluyó que el BID debería apoyar los programas básicos y los fondos de capital de los centros de América Latina, a fin de acelerar el proceso de desarrollo agrícola y pecuario de los países de la región. De hecho, los dos bancos asignan una alta importancia a estos programas y es de esperar que esta acción continúe en el futuro.

Por otra parte, además de aceptar que el financiamiento de los programas de investigación básica de los centros internacionales merece la más alta importancia, se reconoce que hay otras formas en que el Banco puede apoyar programas que persigan la aceleración de la producción de alimentos. Si bien los centros internacionales pueden lograr resultados de investigación muy promisorios, es necesario hacer llegar hacia los países los resultados de esta investigación. Se considera que los centros no habrán cumplido totalmente su función, dentro del proceso de desarrollo, en tanto no hagan llegar a otros países los resultados de sus actividades. Una nueva variedad de trigo, de arroz o de papa, o un nuevo sistema de manejo ganadero, no tendrán valor alguno hasta tanto los agricultores y ganaderos de los países en desarrollo adopten las nuevas semillas y apliquen las mejores prácticas de manejo. De hecho, los programas de transferencia de tecnología constituyen la siguiente etapa en el proceso de obtención y aplicación de resultados a nivel nacional.

Es un hecho reconocido dentro del BID que la promoción acelerada de la producción agropecuaria en América Latina se ha venido fomentando principalmente a través de dos tipos de instituciones: Los Centros Internacionales de Investigación Agrícola, que actúan como centros de comunicación para la transferencia a nivel mundial de las innovaciones en la tecnología agropecuaria y las instituciones nacionales de investigación agrícola. El Banco desempeña un papel importante en el apoyo de ambos tipos de instituciones, especialmente en virtud de sus interrelaciones actuales y futuras. El interés del Banco en estos Centros no podrá ser nunca a expensas del apoyo a las instituciones nacionales de investigación agrícola; este apoyo tiene que ser en adición al fortalecimiento que el Banco haga a las instituciones nacionales de sus países miembros.

El Banco reconoce que las mejoras en la producción de cultivos alimenticios y productos ganaderos dependen, en gran parte, de la calidad y cantidad de los servicios que las instituciones nacionales de sus países miembros ofrecen a los agricultores. La capacidad de estas instituciones nacionales de investigación agrícola en la obtención de variedades más productivas de cultivos alimenticios y productos ganaderos depende, a su vez, en buena medida, del intercambio de información relacionada con las técnicas de investigación y sus resultados que tenga lugar entre las instituciones nacionales, así como dentro y entre los propios países.

A través de muchos de sus préstamos, el Banco ha ayudado a financiar el adiestramiento de profesionales de instituciones nacionales de investigación agrícola; ha financiado investigaciones y equipo y ha colaborado en la organización y operación de programas nacionales de investigación y extensión. En el Apéndice I se presenta una lista de préstamos que el Banco ha otorgado a sus países miembros para el financiamiento de proyectos o subproyectos específicos de investigación y extensión agrícola. En dicho apéndice podrá notar que, para estos fines, se han concedido préstamos por un total superior a los US$54 millones para financiar proyectos cuyo costo total se estima aproximadamente en US$116 millones.

El Banco Interamericano está consciente de que el CIMMYT, el CIAT y el CIP son instituciones altamente capacitadas para mejorar la aptitud del personal técnico profesional de sus países miembros en el incremento de la producción de cultivos básicos. Estos centros han venido desempeñando ese papel dentro del campo del adiestramiento y de hecho, se considera que el adiestramiento de profesionales es una de las metas más importantes asociadas con los objetivos de investigación. Además, los resultados de la investigación, el "paquete de tecnología" que se desarrolla para cada conjunto particular de condiciones debe llegar hasta el agricultor enseñándole a adoptar y a lograr el máximo de esa tecnología, en su propio beneficio y en el de su propio país.

Por otra parte, las funciones de dar apoyo presupuestario a los programas de investigación, financiar el adiestramiento de profesionales de instituciones nacionales y promover los programas de transferencia de tecnología, son acciones que no lograrán los objetivos esperados si no se aplica el criterio de ayudar al fortalecimiento institucional de las empresas del sector público de sus países miembros. Sólo de esta manera las instituciones nacionales podrán estar en capacidad de utilizar los nuevos conocimientos y tecnologías que producen los centros internacionales, así como hacer uso y aprovechar con más amplitud a los profesionales mejor adiestrados en beneficio de los agricultores y ganaderos, principalmente, los pequeños y medianos quienes constituyen la gran mayoría en el área latinoamericana. Para tal efecto, el Banco está en proceso de identificar las debilidades institucionales para lograr el establecimiento de verdaderos "sistemas" o "paquetes" de investigación, éstos, por un lado, se benefician a través de los conocimientos que se generan en los centros internacionales de alto nivel los cuales constituyen una verdadera cadena de transmisión de conocimientos hasta llegar a los pequeños y medianos agricultores y que finalmente, logren la aceleración de la producción a nivel nacional.

Por las razones anteriores, el Banco ha iniciado su acción en esta dirección. Una misión de asistencia técnica visitó los países del Cono Sur de la América del Sur para tratar de establecer un programa cooperativo interinstitucional de investigación y transferencia de tecnología, principalmente en materia de cereales. El informe de la misión en la que participó un grupo de expertos internacionales, está bajo la consideración de la Administración del Banco. Por otra parte, recientemente, una misión compuesta también por expertos internacionales, así como por funcionarios del Banco, visitó los países de la América Central y Panamá para tratar de identificar aquellos programas prioritarios de las instituciones nacionales de investigación de esos países para que, con la ayuda de asistencia técnica no reembolsable, puedan establecer verdaderos paquetes de producción de alimentos. En este último caso, la misión que visitó estos países, identificó como la primera prioridad, en América Central y Panamá, la producción de granos básicos para la producción de alimentos. Es de esperarse que, en un futuro cercano, varios países de la región presenten al Banco sus solicitudes de cooperación técnica las cuales recibirán la debida consideración.

5. Acción futura del BID

Todo lo anteriormente expresado indica que el Banco está consciente de que su papel en el apoyo a la investigación agropecuaria en la América Latina será mucho más importante en los próximos años de esta década. En el dircurso pronunciado en Roma, Italia, el 8 de Noviembre de este año, ante la Conferencia Mundial de las Naciones Unidas sobre la Alimentación, el Lic. Antonio Ortiz Mena, Presidente del Banco Interamericano de Desarrollo, declaró que: "en respuesta a los requerimientos de los países miembros, ante la situación económica del mundo actual, el Banco orientará su acción en el futuro inmediato en el campo agrícola hacia los objetivos siguientes:

1. Aumento de la producción de alimentos para consumo interno y el mejoramiento de nivel de ingresos de los sectores rurales mediante su ocupación en actividades productivas; y
2. Estímulo a la producción de alimentos para la exportación.

Teniendo en cuenta estos objetivos, el Banco asignará su capacidad de cooperación técnica y financiera dando atención preferente a las áreas siguientes:

el desarrollo rural integrado, en aquellos lugares en los cuales el Banco considera que puede cooperar más estrechamente con los países miembros para mejorar la calidad y los niveles de vida de la población campesina;

el agua y los fertilizantes que se consideran como componentes esenciales para el éxito de la denominada "revolución verde", por lo que el Banco continuará estimulando la mejor utilización de los recursos hidráulicos con propósitos múltiples;

el mejoramiento de la productividad y el aumento de la producción agrícola que deben ser apoyados con instalaciones de almacenamiento y comercialización, instalaciones para procesar alimentos así como para producir los insumos esenciales incluyendo fertilizantes, pesticidas y equipo de maquinaria agrícola. Finalmente, el propio Presidente del BID, en el mencionado foro internacional, indicó que "el Banco dará en los próximos años un firme apoyo a las actividades relacionadas con la investigación aplicada en el campo de la agricultura, tanto a través de los centros internacionales de América Latina como de los institutos regionales e instituciones nacionales".

APENDICE I

Información sobre la participación del Banco en la promoción de la Investigación y Extensión en países miembros

1. Préstamos que financian proyectos o subproyectos específicos de Investigación y Extensión Agrícolas.

País	No. Préstamo	Miles US$ Monto Préstamo	Miles US$ Costo proyecto	Ejecutor	Objeto
Argentina	230/SF	8.900	13.100	Instituto Nacional de Tecnología Agropecuaria (INTA)	Amplicar su capacidad operativa y acelerar actividades investigación y extensión mediante construcción de edificios y laboratorios, adquisición equipo, capacitación y asistencia técnica.
Costa Rica	239/SF	2.500	4.410	Ministerio Agricultura y Ganadería (MAG)	Mejorar capacidad MAG en investigación y extensión agropecuaria, mediante establecimiento Centros Agrícolas Regionales y Agencias; maquinaria, equipo y semovientes; especialización de personal.
Ecuador	245/SF	2.200	3.450	Instituto Nacional de Investigaciones Agropecuarias (INIAP)	Ampliar y mejorar capacidad operativa de 4 Estaciones Experimentales, mediante construcción; adquisición maquinaria, equipo y vehículos; capacitación del personal técnico en el exterior y en el país.

Venezuela	260/SF	8.200	29.080	Ministerio Agricultura y Cría (MAC)	Aplicación investigación mediante construcción 3 nuevos Centros y Estaciones Experimentales y de la Extensión mediante creación 200 nuevas agencias y fortalecimiento del centro de capacitación (CIARA)
Paraguay	295/SF	2.730	4.380	Ministerio Agricultura y Ganadería	Tecnificación de la Agricultura y Ganadería mediante fortalecimiento investigación y extensión y producción semillas y reproductores.
Colombia	303/SF	12.500	28.700	Instituto Colombiano Agropecuario (ICA)	Investigación y extensión. Ampliación dichas actividades en 17 centros y 41 nuevas agencias con inversiones similares a préstamos precedentes.
Honduras	310/SF	2.800	4.300	Dirección Desarrollo Rural Ministerio de Recursos Naturales	Ampliar y fortalecer investigación y extensión agropecuaria, creando 2 nuevas sedes regionales, elevando número de agencias a 64, ampliando o creando 3 centros o estaciones experimentales y actividades de fomento como producción de semillas y reproductores.
República Dominicana	350/SF	6.100	12.400	Secretaría de Agricultura y Universidad "P.H.Ureña".	Tecnificación de la agricultura y ganadería mediante establecimiento o mejoramiento 14 Centros, Estaciones o Subestaciones Experimentales, 28 nuevas agencias de extensión; un Centro de Capacitación y un Centro de Reproducción Ganadera.
	Subtotal	45.930	99.829		

2. Otros préstamos cuyos proyectos comprenden actividades de Investigación y Extensión *

Brasil	252/SF ATP/SF-1017	2.072	2.401	Fundación Rural Minas Gerais	Establecimiento de un Centro de Investigación y entrenamiento y servicios de extensión y capacitación y especialización en el país y en el exterior.
Brasil	327/SF	3.000	7.500	Coordinación de AGIPLAN Ministerio de Agricultura.	Investigación en tecnología de semillas,mejoramiento e investigación en 8 cultivos. Adiestramiento y perfeccionamiento de personal.

* Los montos que se indican son los dedicados a estas actividades.

Uruguay	375/SF	700	1.240	Comisión Honoraria del Plan Citrícola Ministerio de Ganadería	Fortalecimiento de la Estación Experimental Citrícola del Salto y precios de extensión a los productos cítricos.
Brasil	320/SF	2.500	5.000	FINEP 1/	Fortalecimiento de la Empresa Brasilera de investigaciones agropecuarias, capacitación de personal del país y en el extranjero y asistencia de consultores.
	Subtotal	8.272	16.141		
	Total general	54.202	115.970		

3. Además de los préstamos precedentes, hay proyectos en estudio de Chile, Nicaragua y Barbados y una asistencia técnica para Guatemala, con los cuales se fortalecerían las actividades de investigación y extensión de dichos países.

1/ Proyecto específico de un préstamo global.