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TECHNOLOGICAL IMPERATIVES AND AGRICULTURAL RESEARCH ORGANIZATION IN THE CARIBBEAN ISSUES AND ALTERNATIVES FOR THE 1990"S

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ABSTRACT

Technological change constitutes one of the critical elements for agricultural development and economic growth. In the Caribbean the importance of technology is enhanced by the limited availability of good quality natural resources which make technological intensification the only credible strategy for increased agricultural production and productivity.

However, these prospect have to be confronted with a number of specific institutional constraints that significantly limit the potential impact of technology. These problems are mainly related to the small size of the countries which makes uneconomical the development of full scale R & D Systems.

It is possible to completely solve the small country problem and its impact on the effectiveness of R & D Systems. But a number of policy and organizational alternatives can be implemented to diminish its implications. Among them are the concentration of efforts to optimize the impact of available resources ; better coordination of research and technology transfer activities ; improving private sector participation in R & D activities ; and horizontal cooperation and the networking of research activities.

RESUME

IMPERATIFS TECHNOLOGIQUES ET ORGANISATION DE LA RECHERCHE AGRONOMIQUE DANS LA CARAIBE ABOUTISSEMENT ET ALTERNATIVES POUR LES ANNEES 1990

Le changement technologique constitue un des éléments critiques du développement agricole et de la croissance économique. Dans la Caraïbe l'importance de la technologie est accrue par la disponibilité limitée de ressources naturelles de qualité qui fait de l'intensification technologique la seule stratégie crédible pour augmenter la production agricole et la productivité.

. Toutefois, ces perspectives doivent être confrontés à un certain nombre de contraintes institutionnelles spécifiques qui limitent significativement l'impact potentiel de la technologie Les problèmes sont principalement liés à la taille réduite des pays concernés, qui fait qu'il n'est pas économiquement possible de développer un système complet de Recherche et Développement.

Il est impossible de résoudre complètement le problème de la taille du pays et son impact sur l'efficacité du système de Recherche et Développement. Mais un nombre de politiques organisationnelles alternatives peuvent être appliquées pour diminuer son impact. Parmi elles, la concentration des efforts pour optimiser l'impact des ressources disponibles ; la meilleure coordination des activités de recherche et de transfert de technologie ; l'augmentation des capacités nationales pour l'accès aux aides extérieures ; l'accroissement de la participation du secteur privé dans la R et D ; la collaboration horizontale et la mise en réseau des activités de recherche.

INTRODUCTION

Technology and technological change are, without doubt, critical elements for agricultural development. It is only through the proper exploitation of scientific and technological opportunities that the full potential of the contribution of agriculture to economic growth can be realized. This has been recognized in the important efforts oriented to the development of domestic technology generation and transfer capacities implemented throughout the developing world since the mid-1950s, and reflected in the production and productivity increases that have taken place during this period.

Looking toward the 1990s, it is possible to identify a number of factors that make the potential contribution of agricultural reseach and technological development even more important. These elements pertain to the economic factors affecting the demand for technology, as well as to the scientific and institutional dimensions of the technology generation and transfer process, and they are related to the effects of the economic crisis of 1980s, as well as to the changing role of agriculture in economic development brought about by the modernization process. At the same time, there are also factors

limiting the possibilities of fully exploiting the potential contribution of science and technology to agricultural development and economic growth ; these are in large part related to the small economic dimension of most countries and the consequences of this for policy and organizational alternatives. This paper attemps to review briefly the main factors affecting the future demand for technology in the Caribbean region and some of the economic and institutional dimensions of the «small country problem» as a basis for the design of strategies which will allow taking full advantage of existing technological opportunities, both at the national and the multinational levels.

I. FUTURE TECHNOLOGICAL NEEDS

The growing importance of agricultural technology in the Caribbean is highlighted by the narrow land resource base of the region. With the exception of Guyana and Suriname, land per person ratios are among the smallest in the hemisphere, and today most of the good agricultural lands are already under cultivation. Under these conditions, technological intensification appears to be the only alternative left for increased agricultural production.

The economic crisis brings a number of new, or renewed, sources of demand for new technologies and consequently for investments in agricultural R & D. In the first place, it increases the need to maintain and expand traditional exports as the basic source of foreign exchange. Under the price and quota situation confronting their main export crops, there will be an increased need for cost-reducing/productivity-increasing technologies to assure the competitiveness of the region's production. As 1992 approaches, this will be necessary to assure that bananas from the region continue to enter European markets, but it will also comprise and essential component of any longterm strategy relating to the sugar subsector.

Foreign exchange needs can also be attented through export diversification, clearly a high-potential area for a tropical region such as the Caribbean. Current trends point in the direction of substantive market growth and opportunities in tropical fruits, vegetables and ornamental crops ; however, exploiting these opportunities implies the availability of appropriate technological packages.

A second effect of the crisis takes place through changes in relative prices and their impacts on costs of production and the economic viability of available technologies. Adjustment processes have increased the prices of capital and imported inputs in general relative to those of land, labor and domestically produced inputs, rendering obsolete many of the technologies currently in stock and increasing the competitiveness of peasant farming

systems vis a vis commercial undertakings. These trends make it necessary to review existing technologies so as to realign them with the new economic conditions.

The growing preoccupation with natural resources and the sustainability of agricultural production will have a substantive impact on the type of technologies to be developed, as the limited availability of good land enhances the priority of conserving and sustaining the existing base of production. This will imply a move away from input-intensive technologies and toward agronomic pratices and resource management technologies. The increasing preoccupation with diminishing the presence of dangerous chemical residues at consumer levels will act to reinforce this trend and highlight the importance of research in relatively new technological approaches likes organic farming and integrated pest management. This new emphasis will not only demand new research, but will also refocus attention on the public extension mechanisms, as they are essential for the transference of these disembodied technologies.

Parallel to the above, food security issues will continue to be critical. It is clear that given be the overall resource constraints, full food self-dependency will be very difficult to achieve. Not only are scale issues involved, but also many products, such as grains, require specific resources and a climate which in most cases does not exist in the island-countries. An effort to exploit available food production opportunities to the maximum will nevertheless be justified. In technological terms, this will mean not only developing the necessary production technologies but also some processing technologies to allow import replacement instead of import substitution, i.e. replacing wheat flour with cassava flour.

In addition to these factors, a number of other aspects will affect the demand for technologies and the type of research needed.

The processes of urbanization and agricultural modernization have acted to enhance the backward and forward linkages of agriculture, making it more interdependent with the other sectors of the economy. It is not only the increased use of industrially produced inputs, but also, and perhaps of greater impact, the increased importance of the postharvest stages in the composition of the aggregate value of food products at the consumer level. This points to the need for R & D in areas like storage, conservation technologies, packing and others, which so far have received very little attention, but are of critical importance if agriculture is to contribute effectively to the reactivation of the countries' economies.
Last, the needs of the small-farm sector continue to be a significant challenge, as small-farmer productivity lags behing that of the commercial

sector in spite of important efforts targeted to them. The importance of small farmers is clear ; in most of the countries, they represent the largest proportion of the farm population and produce the bulk of domectic food. Thus the effort required is fully justified, both on the basis of equity considerations as well as in terms of their impact on the food security problems.

Meeting the small farmers' technological needs, however, calls for a careful review of research and technology transfer strategies, as technological ,advances for small farmers cannot originate from piecemeal efforts, but from a comprehensive farming system approach. In pratical terms, this requires methodological as well as organizational adjustements that will move science to the farmer's fields and allow for the interdisciplinary approach needed fo fully reflect their complex agroecological and socioeconomic situation.

II. PROBLEMS AND OPPORTUNITIES FOR TECHNOLOGICAL INNOVATION

Together with the continued and increased importance of technological innovation in Caribbean agriculture, there are a number of aspects that act either as factors of opportunity or restriction for the technology generation and transfer process. Recent advances in the biotechnology fields open up a whole set of new possibilities, but also bring the prospect of possible negative effects. At the same time, a number of the institutional characteristics of the Caribbean R & D systems, especially their small size, impose serious restrictions on the effective functioning of the technological process in the region. This section reviews some of the policy and organizational alternatives that may help to capitalize on existing opportunities.

Biotechnology : opportunities an Restricting Factors.

Biotechnology, together with microelectronics and new materials, constitutes one of the cornerstones of an emerging new technological paradigm. The development process of this field, while still incipient, is inexorable. As it picks up speed and depth, it is significantly changing the scientific and institutional basis of agricultural technology generation and transfer, and at the same time modifying production opportunities and Agricultural comparative adavantages throughout the world.

In this context, it is important that developments in biotechnology are closely monitored both in regard to possible negative impact and to potential benefit. Among the negative impacts are the possibility of substituting natural products through the use of cell culture and large-scale purification processes, which would be particularly harmful to some tropical industries such as

coffee or cocoa, and the economic implications resulting from enhanced possibilities of protecting agricultural technologies with patents. There are, however, a number of important positive impacts that could be exploited to the countries' advantage. One of the most important in the Caribbeabn context is that biotechnology reduces the importance of natural resources for agricultural production, thus making less critical the land restriction characteristic of most of the countries in the region. At the same time, the greater possibility of «targeting» technologies to specific problems like nitrogen deficiencies, water availability, or resistance to specific pests and diseases, could open up production opportunities that were previously closed. In terms of particular techniques, micro-propagation and embryo manipulation appear to be of particular importance. The first could allow for reducing the costs of planting materials and making possible a rapid exploitation of new market opportunities in fruits and vegetables ; the latter would allow for a more rapid expansion of herd sizes, while maintaining quality, as well as for promoting the exploitation of unique materials, like the buffalypso of Trinidad and Tobago and the blackbelly sheep of Barbados.

From an institutional point of view, biotechnology has a number of characteristics that have to be carefully considered in developing R & D policy and organizational alternatives. The first is that biotechnology is radically differant from previous technologies because, for the first time, commercially relevant technical information is at or close to the frontiers of basic research in molecular and cell biology. This is changing the traditional dichotomy between basic and applied research and altering the whole structure of linkages in the flow of scientific information. Clear evidence can be found, in developed as well as developing countries, in the work now being done in biotechnological fields by universities and research centers with no previous experience in agriculture. Such a shift poses a significant problem for national research institutions in Latin America and the Caribbean , which have no links with these new centers of valuable technological information. A related problem is that biotechnological work requires scientific talents different from those available at the traditional agricultural technology generation institutions. Eventually, the greatest obstacle preventing developing countries' research institutions from participating effectively in biotechnology may very well be their relative lack of personnel trained in molecular and cell biology, virology and immunology (De janury, 1987 ; IICA, 1987).

A second important facet of biotechnology is its relationship with the private sector. During the Green Revolution, most essential components were handled through public (international or national) institutions, whereas in the case of biotechnology, the private sector, prompted by the proprietary nature of resulting technologies, is already an important force and will

probably increase its presence in the future. Even though universities are playing an important role, the development of the biotechnology industry in the industrialized countries is characterized by market incentives and massive private investment, both from multinational corporations and from venture capitalists supporting small biotechnology firms. Even though developments in the Caribbean do not attempt to compete with these initiatives, ,proper exploitation of the opportunities offered by biotechnology will require the creation of appropriate links between public and private sectors.

A third characteristic of biotechnology that sets it apart from the traditional approach is its non-product-specific nature. Technology has traditionally been product-specific, a key factor in shaping the organization of agricultural research and technology generation ; biotechnology, on the other hand, is process-based and cuts across products. This feature has very definite organizational implications ; however, it may be a critical advantage for the smaller countries, as it would become the basis for a more efficient use of certain scarce and highly specialized resources. Many countries may not be able to economically support product specific research programs for all crops, but the picture is different if the research system organization is process-based, with a small number of «process» units or programs such as tissue culture or fermentation technologies, working on several crops at the same time.

The Institutional Dimension : A Conflict Between Resources and needs

The exploitation of science and technology's potential contributions to agricultural development and economic growth is hindered in the Caribbean by the small dimensions of most of the region's economies.

A brief review of the national agricultural research and technology transfer systems of the region indicates that, in terms of some of the general indicators used to analyze the NARSs, they are in a relatively advantageous position. Both in terms of percentages of the value of agricultural production spent in research and technology transfer, as well as in terms of resources per man/year or research personnel per unit of land, most of the Caribbean countries rank at least par with other countries in Latin America, and in many cases they show better relations (ISNAR, 1989). Furthermore, the existence of a relatively strong university system, well articulated with the R & D systems, is an additional factor of strength not commonly found in other countries in the Americas. However, when analyzing the potential productivity of these systems and their capability to meet future technological demands, these factors have to be put in the context of the absolute quantity of

resources devoted (or that could be potentially devoted) to research.

The key issue here is the potential conflict between research needs and the amount of resources available to meet those needs. What is relevant is not the relative levels of investment, but rather how much R & D can be bought with available resources. unfortunately, overall economic size is such that, in most cases, resources are not sufficient to fund appropriately even small-scale R & D activities. Demands for research, on the other hand, are not totally determined by the size of the country.

A country's research needs are related to its size, but the relationship is not a direct one. Since agricultural technology is highly location-specific, some research capacity is essential to support agricultural development, no matter how small the country may be. At the same time, smaller countries do not necessarily have a smaller variety of crops in their agricultural production than larger countries. Quantities produced will be smaller, but not necessarily the number of production alternatives that should be included in agricultural research. A cursory look of what happens in the smallest countries, such as the island states in the Caribbean, show that the number of crops for which research is required is not significantly different from that of much larger countries with similar agroecological environments.
Another important consideration is the relative indivisibility of research efforts below a certain minimum critical mass. This is a difficult issue to discuss in general terms, but it can be safely stated that there is a minimum research effort below which no relevant results can be expected. This effort, which can be equated to a fixed-cost concept, will be approximately the same throughout a wide range of variation in the area planted to any particular crop. The work and costs required to develop a new variety or a new cultural practise would be about the same, whether a crop is planted on 10,000 or 100,000 hectares. In both cases, the basic core of activities and expertises required will be the same, and includes information on the country's natural resources, like soil and water surveys, plus some capacity in a minimum number of areas like agronomy, plant breeding, pest and disease control, physiology, and socioeconomics.

The size of a country's core research effort is also influenced by its climate and other environmental characteristics. Tropical agriculture tends to be more diversified than temperate agriculture and, as diversity increases, research needs will also increase, if for no other reason than the need to replicate experiments and to test results in a greater number of different production environments. So environment exacerbates the conflict between research needs and available resources ; most small countries in the developing world are located in the tropics.

Consumer demands also have an important impact on research needs, and they are not directly related to country size. Income and climatic factors have an effect, but whether a country is large or small will have little bearing on the numbers and types of products included in its diet. The need to reduce balance-of-payment deficits and the political importance of food self-sufficiency have made meeting food demand through local production a high priority in many, if not most, developing countries. this increases the pressure on the number of products a national research system must include in its program, whether a country is large or small.

Quite apart from research needs, the amount of resources a nation can devote to agricultural research is determined by its size and the importance of agricultural production within its economy. Furthermore, the profitability of investments in agricultural research are clearly related to the actual or potential area planted to a crop. Consequently, the larger the area over which the new technologies resulting from research can be diffused, the larger the economic returns and the larger the economic base to support the research effort.

This conflict between resources and needs is the most critical hurdle in the effort to set in place the technology generation and transfer infrastructure needed to mobilize the region's agriculture as part of its economic reactivation.

The quantitative dimension of the conflict is difficult to assess in general terms, because each country is unique. The required minimum capacity will vary depending on both institutional and technical issues. The type of problems requiring research and the possibility of using information generated for other purposes or available internationlly will be important factors to consider. However, some very broad estimate of the magnitude of the problem, done by comparing the costs of a hypothetical research module for some of the major crops against the actual value of production of them, suggested that not even key food crops like rice are large enough to sustain a minimum research effort (Trigo, 1988).

III. SOME POLICY AND ORGANIZATIONAL ALTERNATIVES

Even though there may be no absolute solution to the conflict between resources and research needs, there are a number of policy and organizational alternatives that can contribute substantially to reduce its impact. Through them, a country can effectively increase the resources available for its research effort and can affect the nature of the research needs it must attend to. However, none of them will be relevant in all cases. Many factors, such as level of economic development, climate geographical location, as well as historical and cultural factors, will differentiate one country from another and

in turn indicate particular policy options. A number of important general considerations can be made, however.

A.Concentration of Efforts to Maximize the Impact of Available Resources

Program dispersion, duplication, and research projects not addressing relevant production constraints are the most frequent causes of resource wastage. These problems are present in both small and large countries, but their impact is much more severe in the smaller ones. Any research alternative requires a certain minimum critical mass of resources if it is to produce results. With fewer total resources to invest in research, priority-setting becomes the cornerstone of a small-country research policy. Program coordination mechanisms and research problem identification, in close contact with the clients of research, are two other important elements for maximizing the impact of available resources.

At the priority-setting level, the issue is concentration of effort, recognizing that with limited resources only a limited number of needs can be addressed effectively. The alternatives to be selected should follow the country's overall national and agricultural development policy objectives. This, however, is not a simple decision-making process, as frequently the appropriate organizational framework is lacking and the criteria for setting priorities are unclear. Under these circumstances, it is important for the research system to take the initiative and present the policy decision-making levels with program alternatives for the use of presently available resources, including clear indication of what is being left out and what projects will be brought into program implementation if extra resources become available.

This approach can be an effective tool for improving the links between agricultural research policy-making, economic development planning and budget determination. At the same time, it can generate important information for program monitoring and evaluation and can put the research system in a much stronger position to seek additional ressources from both domestic an external sources.

B.Better Coordination of Research and Technology Transfer Activities

Together with the concentration of effort, the coordination of all potential providers of research and a close relationship between research and technology transfer activities can greatly increase the impact of limited resources. Universities, development projects, commodity organizations, and non-government organizations are often overlooked as important

potential providers of research support. In many cases, no one of them on its own has the resources required to address given research problems ; or, as is often the case with universities, they lack the linkages necessary to give their research efforts a production-problem orientation.

Coordinated research projects forcing scientists from different institutions to work together to plan and carry out experiments and other research activities can help in these situations. Close interactions between research, extension, and clients are essential for focusing research projects on significant production problems. On-farm activities as an integral component of the research process can enhance this interaction and can facilitate a rapid diffusion of research results. A successful example of how this can be achieved is the case of the Instituto de Ciencia y Technologias agricolas (ICTA) in Guatemala, where, through close collaboration with cooperating farmers, the research system has produced a mojor impact on the country's food production.

C.Increase National Research Capacities through Donor Assistance

Donor assistance is one of the most important resources available to a small-country research effort. External resources can contribute not only by directly adding to national research budgets, but also indirectly through the need to generate counterpart funding and by broadening the base of political support for agricultural research. In many cases, the possibility of generating much-needed foreign exchange resources through agricultural research projects will bring the support of groups and sectors of government that otherwise would not see the importance of or be interested in agricultural research. There are, however, some hazards in the extensive use of external and donor assistance to support national research programs. Small countries are particularly at risk because of the greater relative importance of external sources in the total available resources.

One problem is the impact of overreliance on external assistance on program orientation, and the long-term stability of the research effort. External sources tend to rely too heavily on the project approach. Well-defined projects can be very effective in concentrating efforts and producing high-impact results, but, at the same time, the project system may produce program fragmentation when many individual projects are independently negotiated with different assistance sources. This is especially so under the weak management conditions of many of the developing countries' research systems. In these circumstances, there is a strong chance that the result will be a collection of loosely-linked efforts with no coherent national strategy. The effects of abrupt adjustments resulting from changes in donors' priorities are also important for program continuity and long-term system development,

especially since domestic support is in many cases highly unstable.

Taking the initiative in the creation of a donor coordination mechanism appears to be an essential element of the agricultural research policy of a small developing country. An alternative is the formation of a country-level research support group bringing together all donor sources interested in assisting the country, with emphasis on long-term needs and goals and on the incremental steps required for implementation. The development of such a group and plan may prove to be a high-pay-off move, both for receiving countries and donors. For the recipient, it can be a very effective way of achieving the needed concentration of efforts, continuity of support, and reduction of administrative costs and management of external-resource workload. For the donor, it can reduce the costs of project searching and increase the return on investments by complementing and supplementing the national program, rather than wastefully competing for «good investment opportunities».

D.Developing Mechanisms to Increase Private Sector Participation in R & D Activities

As the modernization process progresses there is an increasing basis for private sector participation in R & D activities.

The possibility of private sector participation in agricultural technology generation and transfer represent a critical development for technology generation and transfer in the developing world. It represents both a source of knowledge in certain areas as well as a source of budgetary resources to complement public investments in this field. However, the possibility of private participation is not straightforward, except in a minority of cases usually related to specific input production and distribution or highly organized commodities such as sugar or bananas. In a number of situations, such as those related to the exploitation of new export market opportunities, there are a number of institutional barriers for an effective interaction between the public and the private sectors in the development of the needed technological packages.

In this context, institutional innovations are required to permit the development of joint ventures between the public and private sector and to facilitate the flow of private resources toward high-priority R & D areas. The model of R & D foundations that is being tried in a number of countries (Chile, Peru, Ecuador, Dominican Republic, Honduras, etc...) appears to be an initiative that should be carefully evaluated. Many of these institutions are serving as intermediaries between the private sector, institutions in the public sector and the universities, and are starting to play a key role in mobilizing available

scientific and technological capabilities to meet specific technological needs.

E.Integrating Research Capacities through Networking an International Cooperation

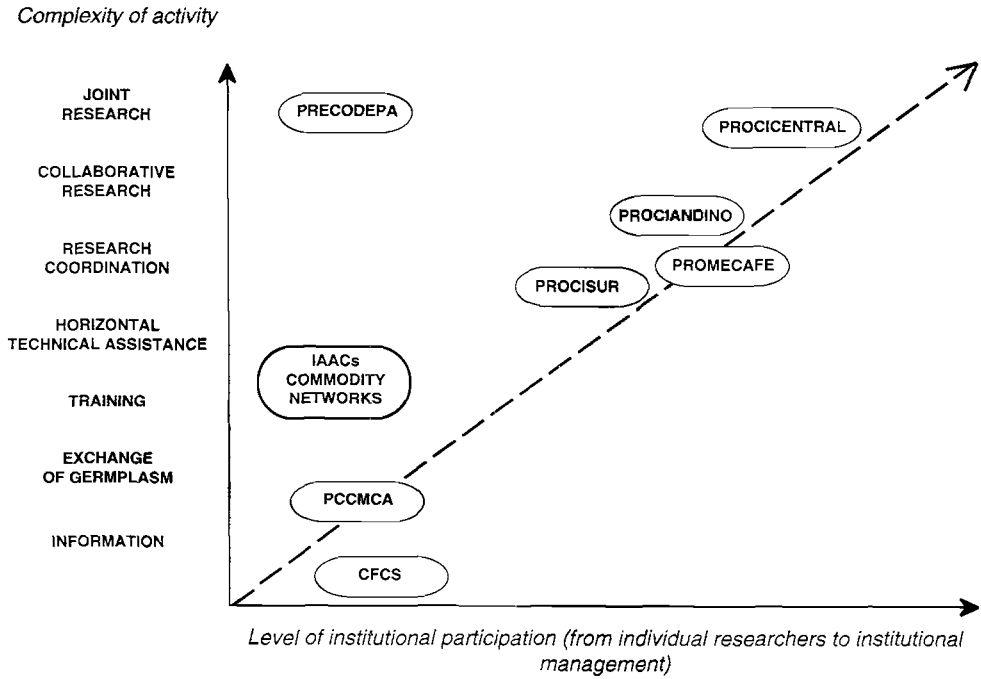
Even though applied agricultural research is highly location-specific, no country need undertake on its own all of the research needed for meeting the requirements of its agricultural development. As we move from applied to basic research, location specificity diminishes and, consequently, transferability increases, opening the possibility for a country to benefit from research conducted in other countries or at the international level. In this context every national agricultural research systems should be viewed as part of a world complex of research institutions and activities, all contributing to and benefiting from a common pool of information and knowledge.

The transferability of research results does not imply that a country can do away with all of its research needs. But it does open a number of opportunities for improving the efficiency of research resources and through networking and horizontal cooperation. Information exchange and/or the coordination and promotion of certain types of research are two very important ways to increase the scope of a small country's national agricultural research systems. Bringing together countries with common problems and characteristics, these mechanisms help avoid wasteful duplication and allow the specialization of resources and create a stronger economic base to support certain types of research that no participating country on its own could afford.

By pooling the strengths of each national program a research program of considerable strength can be developed.
In Latin America there is ample and rich experience in terms of networking and cooperative programs alternatives which could be extremely useful for the Caribbean countries. These experiences vary in terms of their coverage of products and activities and the level of institutional participation in the network's decision-making processes ; all these factors affect their effectiveness and the ways in which they contribute to national research capacities and meet the countries' technological needs.

Figure 1 graphically summarizes how the degree of complexity of the activities undertaken and the coverage and level of institutional participation interact in defining different types of networks and horizontal cooperation schemes, placing some of the experiences available in Latin America and the Caribbean in a context of ever-increasing integration and institutional complexity. The vertical axis runs from the exchange of information, the simplest form of cooperation implying the lowest level of involment and

Fig. 1 : Types of networks according to complexity of activities and level of institutional participation



commitment, to joint research where the parties agree to combine their resources for the solution of a common problem. The horizontal axis measures the level of institutional control over network activities. At first, participation and decision-making are essentially in the hands of participating researchers, but as we move away from the origin there is an increasing level of institutional control and participation ; usually product coverage also increases with institutional control, but that is not always the case (PCCMCA, CFCS, and PROMECAFE).

The commodity networks of the IARCs represent the typical research-based cooperation mechanisms. These schemes are essentially focused on germ plasm and information exchange under the Centers' coordination ; they have a low level of intensity of activities and a minimum of formalization, but represent an important way for and effective use of the international centers' national research support services. They represent practical alternatives for allowing national programs to concentrate their limited resources on the technology application end of the research chain. A policy of interaction of national scientists with international center through their training programs, can greatly contribute to the flow of relevant information.

PRECODEPA, PROCISUR and PROCIANDINO represent more complex forms of cooperation, where activities go all the way up to joint research, and decision-making takes place at the highest institutional level, that is, the Directors of Research.
The structure of these programs reflects the differences existing in participating countries, and what they imply in terms of needs and networking possibilities. In general, as we move from larger to smaller countries, the common or core component of the cooperative program becomes larger. This is because single country capabilities for both funding research and capturing a significant share of its benefits decrease. In turn, this has two consequences. First, the networking design becomes more complex in small, rather than larger, countries. Second, and related to the above, the necessary integration of efforts expands in the same direction, with a tighter coupling of network components imposing stricter planning, balancing and coordinating requirements.

PROCISUR, a cooperative program among essentially large countries, each having a fairly developed and autonomous agricultural research system, has focused mostly on complementary exchanges of research information, germplasm and training. The principle involved here has been mainly that of sharing among peers information of common interest.

PROCIANDINO brings together research efforts of a range of medium-sized countries at an intermediate state of development of both therir agriculture

and research facilities. Here networking involves the development of collaborative research in areas of common interest. Research projects are collectively designed, but implementation is done independently by each participating country. This mode of operation increases the complexity of the network, particularly in planning and monitoring of activities.

The proposal for the creation of a similar type of program for the Central American countries (PROCICENTRAL) which is presently being considered by IDB represents still another variation. It encompasses countries essentially too small to sustain on their own a critical mass of resources for research on key crops ; nevertheless, they maintain capabilities for the adaptive research component. Research efforts here would no longer depend on each country providing individual solutions to its problems. Rather, the weakness of participating countries and the relative high costs of necessary efforts points to a regional identification of problems and the formulation of joint research bearing on them. The proposal calls for the division of labor among countries for all activities except for those strictly at the adaptive level. Implementation of efforts, however, would still remain a country responsibility, within the framework of regional planning.

An important feature of PROCISUR, PROCIANDINO, and the PROCICENTRAL proposal is the inclusion of a coordinating committee integrated by the country Directors of Research as the decision-making authority with responsibility for setting priorities among commodities, as well as overall program monitoring, follow-up and evaluation. This characteristic is of particular importance in networking efforts involving collaborative or joint research activities in the smaller countries, as researcher-based networks lacking the broader institutional context and checks may have the unwanted effect of distorting national priorities. In the situation of highly restricted budgets confronting the smaller countries, relatively small amounts of resources can have big impacts on the selection of research projects. If network participation is at the researcher level, there is a strong chance that the scientific interests of the participating individuals will carry more weight than overall priorities in defining in-country network activities. If the country decision-making is in the hands of the Directors of Research, it will be assured that product selection and resource allocation fully reflect national priorities.

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