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Agricultural Research for Development:

Potentials and Challenges in Asia

Edited by Barry Nestel

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OVERCOMING TECHNOLOGY GAPS

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Introduction

During the past three decades there have been many dramatic developments in agricultural technology. When referring to the challenge of overcoming technology gaps, I mean those gaps which separate the laboratory from the farm, and agricultural research centers at various levels, including the national and the international, from each other. The technology package to which we should aspire in order to overcome these gaps will have to be economically sound, socially acceptable, and environmentally appropriate.

International Agricultural Research

At the regional and international conferences, symposia, and seminars held among agricultural development professionals which I attended in the late 1950s and early 1960s, representatives from developing countries were usually the most vocal in stating the importance of science and technology for development. They were the most active in formulating recommendations to governments, international organizations, and agencies for strengthening the capabilities of developing countries to conduct their own agricultural research.

In the 1960s, however, it was not developing countries themselves but rather industrialized countries who responded to the proclaimed need to step up investment and to strengthen the global capacity for agricultural research. A number of industrialized countries were in a position to do so because of their colonial experience prior to World War II, the adequacy of their financial resources, and their supply on hand of trained and reasonably well-paid research staff. France, for example, established a group of research institutions which dealt with tropical agriculture:

1. IRAT (Institut de Recherches Agronomiques Tropicales et des Cultures Vivrières) for rice and food crops;
2. IRFA (Institut de Recherches sur les Fruit et Agrumes) for tropical fruit;
3. IRHO (Institut de Recherches pour les Huiles et Oléagineux) for oil palm, coconut and other oil crops in the tropics;
4. IRCT (Institut de Recherches du Cotton et des Textiles Exotiques) for cotton;
5. IRCA (Institut de Recherches sur les Caoutchouc) for natural rubber;
6. IFCC (Institut Français de Café, de Cacao et autres plantes stimulantes) for coffee, cacao, tea and cola crops;
7. IEMVT (Institut d'Elevage et de Médicine Vétérinaire des Pays Tropicaux) for tropical animal health and production.

In addition to these institutes there are a number of other agricultural research centers (ARCs) in developed countries which specialize in tropical agriculture such as the Royal Tropical Institute in Holland and the Tropical Products Institute in Great Britain. Also, a number of European universities are well organized to provide advanced studies and training in the field of tropical agriculture. Many American universities have shown increased interest in international agricultural research, and Japan established a tropical agricultural research center in 1968. Since one-third of the Australian continent has soils and environmental conditions quite similar to those of most of the developing countries, it is not surprising that Australia has developed special capabilities in animal husbandry and rainfed agriculture in varied soils and environmental conditions suitable to the agricultural development efforts of the developing countries.

In the late 1960s there was a new thrust in international agricultural research when the IARC (international agricultural research center) concept came into being. There are now 13 IARCs, 11 of which are located in tropical or sub-tropical parts of developing countries. Their situation enables them to generate a "body of knowledge" about tropical agriculture from within a tropical environment. Some of the IARCs have already established a prestigious reputation. They have had a substantial impact on the food production of the world in general, and of the developing countries in particular.

The IARCs now provide a significant source of "improved technology" for world agriculture. They also act as an important source of advice and consultation to national agricultural research systems (NARS) and centers (NARCs). It was not surprising that during the 1960s and the 1970s the centers of excellence for solving problems of agricultural development in the developing countries were primarily the NARCs and the IARCs.

National Agricultural Research Systems

In the 1970s world agricultural production greatly increased because of greater research expenditures in developing countries. National agricultural research systems in developing countries, which had been the weakest link in the global research effort, began to organize themselves better and to develop their own identities.

The thrust in industrialized countries in the 1960s to bolster their own agricultural research capacities and the subsequent establishment of a network of international agricultural research centers financed by the Consultative Group on International Agricultural Research (CGIAR) triggered the emergence and revival of national agricultural research systems in developing countries. This development may have influenced the international donor community to give a higher priority to providing assistance in the field of agricultural research.

Some of the national agricultural research systems in Asia which already had an adequate scientific manpower base started to strengthen their research organization and management, to improve their research programs, and to establish effective working ties with both international research centers and national research systems in developed countries. Some of the less advanced national research systems had first of all to develop their research skills and to establish the infrastructure essential for their research before they could start streamlining their research programs and intensifying collaboration with foreign and international research institutions.

In Indonesia the 1973 State Guidelines for National Development decreed by the People's Consultative Assembly called for the strengthening of national capabilities in science and technology to support and provide orientation for national development. The government responded by establishing 14 agencies for research and development by presidential decree, most of them under the authority of existing ministries. One of these agencies, the largest in terms of manpower, budget, and work program, was the Agency for Agricultural Research and Development (AARD). AARD is one of the nine top echelon units within the Ministry of Agriculture. Its executive, the director general, reports directly to the minister.

In 1975 AARD embarked on a program to absorb and integrate all previously existing research institutes within the Ministry of Agriculture. There was a gradual merging of research personnel and program planning to affect greater efficiency in the production of new technology. By 1976 AARD administrators were directly managing their own budget, personnel, physical facilities, and research programs.

External Support

Let me cite an example with which I am very familiar. The level of international and bilateral support to the Indonesian agricultural research system has been and continues to be encouraging. World Bank and USAID support dates back to the first year of AARD's existence. The World Bank gave a loan in 1975 to supplement the government's budget to finance the upgrading of scientific staff, and to build or renovate the physical facilities of four research institutes: one on rice and another on vegetables in Java, and one on rubber and another on estate crops in Sumatra. A more substantial loan was added in 1980 to strengthen AARD's scientific manpower base further and to improve research facilities for food, industrial crops, fisheries, and forestry.

In 1976 USAID provided loan and grant funds to supplement the budget for the establishment of the Sukarami Research Institute for Food Crops in West Sumatra, and its network of experimental farms and research stations on Sumatra. In 1981 USAID gave loan and grant aid to help AARD in establishing and strengthening the research infrastructure in Kalimantan, Sulawesi, and the eastern part of Indonesia.

The Australian government through the Australian Development Assistance Bureau (ADAB) made generous grant funds available to establish the Animal Husbandry Research Institute at Ciawi, West Java; to strengthen Indonesian research capabilities in animal husbandry, animal health, and forage crops; and to devise ways to make more efficient use of fertilizers. Japan, through the Japanese International Cooperation Agency (JICA), continued its support of research on rice and mariculture.

Yet, despite increased research expenditures in developing countries, as illustrated by the Indonesian example, it is sobering to note that developing countries themselves still only spend about one-third as much of their gross domestic product on agricultural research as developed countries do. In terms of research expenditure related to agriculture per capita, disparities between developed and developing countries are even more striking (World Bank, 1981).

The International Federation of Agricultural Research Systems for Development (IFARD) and the International Service for National Agricultural Research (ISNAR) – the organizers of this present conference – were created in the 1970s to help strengthen the NARS and overcome the technology gap between the IARCs and the ARCs of industrial countries on the one hand, and the NARS of developing countries on the other. I suggest that what IFARD and ISNAR can do to bridge this technology gap should be taken up as a topic for our discussion today.

Technology Transfer from ARCs and IARCs to NARS

Experience during the last two decades indicates that the low research capacity of developing countries has limited the effectiveness of technology transfer from centers of excellence to the developing world. This in turn has reduced the dividends from well-intended IARC investments. Developing countries lag behind in acquiring highly technical expertise in agricultural research. More alarming is the growing disparity between the financial incentives for research between the national systems of developing countries and the IARCs.

To provide a basis for subsequent discussion, I would like to refer to an experience of cooperation and technical assistance which we have had with IRRI (International Rice Research Institute). It has been a successful experience from which we can all learn a great deal.

IRRI's involvement with the Indonesian rice research program dates back to 1967 when the high-yielding varieties IR5 and IR8 were introduced into the country. A formal cooperative research and technical assistance contractual arrangement between the Ministry of Agriculture and IRRI, with financial support from USAID, was signed in 1972. Initially to last for five years, it was extended for a second five years in 1977 and reached an end in June 1982.

The following achievements can be noted (Sadikin and Cowan, 1982):

1. the working relationship established between IRRI and CRIFC (Central Research Institute for Food Crops) of AARD made it possible for the Indonesian research system and its scientists to follow how IRRI planned, carried out, reviewed, and evaluated the results of its research program;
2. through its liaison scientist and resident scientists (in Indonesia) IRRI had continuous and prompt feedback on Indonesian rice production challenges and needs;
3. through this cooperative arrangement, 21 Indonesian scientists received Ph.D. degrees, 30 received M.Sc. degrees, and a total of 332 participants received short-term training in new technologies abroad (primarily at IRRI) in some 38 different training programs;
4. the area planted in IRRI and Indonesian high-yielding varieties increased from 168,000 ha in 1968 to 1.3 million ha in 1973, and then to over 5.5 million ha in 1981;
5. the rate of growth in rice production was 4.6% per year during 1970 to 1981, and 6.1% for 1975 to 1981.

In January 1981, one and one-half years before the cooperative arrangement terminated, AARD and IRRI agreed to maintain a continuing working relationship through a collaborative research program. Certain research program areas such as rice-based cropping and farming systems, water management, and upland rice may well be more productive if carried out through collaborative research with Asian NARS. Research activities could then be assigned according to who has the comparative advantage to do the research best. For upland rice research, for example, AARD has experimental stations located in wet and dry climates as well as at high and low elevations. IRRI still does not have land for expanding its research to meet the upland rice production challenge. AARD can provide sufficient land for research on water management (irrigation) in an important irrigation common area. Its research institutes have developed expertise in corn, sorghum, grain legumes, tuber crops, vegetables, fish, and poultry – all important components in a rice-based cropping and farming system.

Indonesian scientists and administrators view this opportunity for expanded and intensified collaborative research with high expectations. We will also use our experience of cooperation with IRRI to establish new and similar working relations with other IARCs and ARCs in industrial countries.

We look to IFARD and ISNAR for inspiration, counsel, and support in these anticipated activities.

In my view the IARCs and ARCs can help promote the transfer of technology to the NARS in the following ways:

1. by setting a high priority for training in the work programs and budgets of the IARCs and ARCs in order to facilitate an increase in the technical capability of the national organizations;
2. by sending invitations to the leadership and staff of NARS to participate actively in the planning and implementation of IARC programs, as well as in their review and evaluation;
3. by including collaborative research with NARS in the core programs and budgets of IARCs and ARCs;
4. by giving service and assistance to NARS in the collection, botanical and agronomic characterization, conservation, and distribution of germplasm;
5. by rendering assistance to NARS in information and bibliographic services;
6. by arranging regular consultation among leaders of NARS, IARCs, and ARCs.

We must deal forthrightly with criticisms frequently directed toward agricultural research if research is to remain an essential, ongoing dimension of agriculture as an industry. We should remember Ruttan's comment about the IARCs:

> If the international institutes develop a capacity to link the national systems into a carefully articulated international system, they will assure their own continued viability. If they become viewed as being competitive with national research systems, they could fade away into mediocrity.The effectiveness of the international system depends on the development of strong national systems (Ruttan, 1982).

Channeling Technology Transfer: Laboratory to the Farm

It is important for us to remember the "links in the chain" necessary to develop technology and to transfer it into an effective use pattern. This chain is only as strong as its weakest link!

There are several steps:

1. generation of research;
2. technology evolution;
3. technology transfer;
4. audience – farmers, community leaders/managers of agriculture firms, policy-makers, and universities/agricultural schools.

It is important for us to have an organizational structure, physical facilities, personnel, and a government commitment before we can have an agricultural research program. From our research we are able to develop packages of technology for our farmers which will permit them to produce greater quantities of high-quality food and other agricultural commodities more efficiently. This, in turn, will increase their family incomes. Those of us administratively responsible for the generation of research and technology cannot permit the process to stop at this point! If the knowledge which our scientists gain from their research is not put into a form which can be utilized by the farmer then we have not succeeded. I think we will all agree that we have made some substantial progress. There does still remain a "technology gap," however, and it is for this reason that we are addressing ourselves to this topic today.

There is frequently a tendency among many of our professionals to think that farmers are our only audience. They are indeed our prime audience. We must never forget that fact. Yet, there are others, too, who play an extremely important role in minimizing and reducing the technology gap.

Once we have technology it must be channelled effectively, efficiently, and promptly to the farmers in a form which they can comprehend. Each nation's system for transferring research results to its farmers may, by necessity, be different. The ultimate goal is always the same. Optimism prevails among scientists and policy-makers that there will continue to be a good response by Asian farmers to "new technology packages," such as the introduction of high-yielding varieties with the associated use of fertilizers and agricultural chemicals, and the appropriate application of water and relevant farm-management practices. The transfer or introduction of technology must be supported by incentives to make its application profitable for the farmer. I would like now to review four channels to illustrate some basic concepts which can aid in expediting technology transfer and reducing the technology gap.

Extension

The first channel is extension, a time-honored educational approach, well known to all of you. The Indonesian extension staff have employed some methodologies which have proven very effective and fruitful. One of the most widely recognized and accepted sequences has been technology generation, verification through on-farm demonstration, extension assistance, and application by the farmers. In rice production an integrated scheme known as the BIMAS program was developed. This consisted of a package of inputs, among which were extension, credit, good seed, fertilizers, and insecticides. The "technology package," which included land preparation, good seeds, fertilizer, and the appropriate and timely application of plant protection and crop management practices, was first tried by students of IPB (Bogor Agricultural University) on a 50-ha verification-and-demonstration plot on farmers' fields. The yield increases obtained encouraged these farmers to experiment further, eager to exploit the new techniques fully. Using the experience of the IPB students, the provincial agricultural services, through their extension arm, launched a large-scale introduction of this technology package, directed first to well-irrigated areas with adequate infrastructure and, a point of exceeding importance, to good farmers who were known innovators. It was a capable, effective, and low-risk campaign. Inputs were made available at the farm gate, and on time; irrigation water and plant protection were assured; marketable surplus flowed to buyers; and farmers organized themselves to tackle day-to-day problems cooperatively.

The campaign soon demonstrated remarkable yield increases well above the national average yield plateau. The government supported the BIMAS program with research, training, extension, rural credit, inputs, and later with a floor-price policy. There were BIMAS management boards established at national, provincial, and district levels. The program had a large enough capacity to involve millions of farm families all over the country. Key farmers became a part of the educational team. The introduction of new high-yielding varieties of rice like IR5 and IR8, together with the BIMAS program in 1967 and 1968, brought about improved rice crops and encouraged the spread of the BIMAS program.

A severe drought in 1972 seriously affected the program. The explosive brown hopper outbreak in 1975 to 1977, as well as sporadic, localized droughts have also set back the Indonesian rice production program. Fortunately, the introduction of new varieties through the BIMAS package included rice resistant to biotype-1 and biotype-2 of the brown hopper. With the aid of a simple system for monitoring pest biotypes and an integrated pest control system, farmers managed to overcome the brown plant hopper infestation. Over the years the BIMAS program has undergone continual change. Improvements have resulted from reviews, reorganization, and adjustments. Every effort has been made to help BIMAS farmers establish village unit cooperatives to facilitate the purchase of inputs and the sale of their produce.

The latest organizational development within the BIMAS program is called INSUS. INSUS, a special intensified production program, involves a group approach to extension, relying heavily on the active participation of farmers in decision-making about inputs to be purchased, fertilizer application rates and times, plant protection schedules, and water management. There is a guaranteed price for the rice produced. The BIMAS and especially the INSUS programs are excellent demonstrations of how an attractive and profitable technology package can be adapted and adjusted by farmers themselves to suit their own needs. This is an illustration of the "laboratory to farm" channeling of a new package of technology which has been successful. There was no technology gap! The smooth transfer of new ideas and/or materials is confirmed when we observe that substantial increases have taken place in the use of high-yielding varieties fertilizer consumption, average rice yields, and total rice production during the last two decades.

Based on Indonesia's positive experience with rice, the BIMAS and INSUS approaches are now being adapted to production programs for other commodities, including corn, grain legumes, vegetables, and poultry.

Direct Approach

A second channel for technology transfer is the direct one which leads from the NARS (national agricultural research system) to agricultural firms (government or private) or to progressive farmers who have the capability to verify and adapt technology to their local needs. The introduction of new varieties or clones should of course be cleared first through the National Seed Board or equivalent organizations. Successes of such operations are catalytic to the widespread adoption by farmers of new varieties, clones, and accompanying technologies. Examples of direct technology transfer in Indonesia include the introduction of new clones and their complementary technologies in the cases of: rubber, tea, coffee, oil palm, potatoes, lowland tomatoes, hybrid cabbages, running water systems in fish production, and development of shrimp hatcheries.

The expansion of the research infrastructure and the establishment of additional research institutes and experimental farms in varied agroclimatic regions and environments in Sumatra, Kalimantan, Sulawesi, and the eastern parts of Indonesia has stimulated, strengthened, and expedited this approach to disseminating research results.

The NES (nucleus estates smallholders) projects for both new and replanted estate and industrial crops also serve as a good vehicle for the channeling of new technology to the user.

The NES model can have a multiplier effect by illustrating to neighboring farmers the wisdom of adopting a better technology. This approach has merit for many situations with food crops, fish, and animal production programs as well.

Decision-Makers

A third channel can be to and through policy- and decision-makers at both the national and the provincial level. Decision-makers should be thoroughly conversant with the nature and particularly the concept of the technology being evolved, and with possible new technologies about to be made available for implementation. It must be recognized that these persons play a very important role in influencing change. Therefore the results of research must be translated into a form that will be comprehensible to them but that in no way distorts the authenticity and accuracy of the results. Such translation can only be done by professionals. Otherwise a technology gap will remain.

Research results must be supplied to national and provincial agricultural leadership on a continuous basis to aid them in policy formulation and in making adjustments to planning and programming. These findings should provide substance and objectivity to the packaging of planned agricultural development policies and anticipated programs. Policy- and decision-makers must be kept informed of research findings which are to be disseminated so that researchers may solicit their understanding and the full support of their authority, influence, and counsel. At the same time research workers must make it their business to appreciate the challenges and constraints which policy-makers face.

This is an important dimension of overcoming the technology gap. Wherever possible the impact or the anticipated impact of innovations must be taken into account when presenting research results and/or research programs to decision-makers. Bankers must have some such measure before they will seriously consider advancing credit, a shortage of which is sometimes the limiting factor in effectively introducing a new package of technology.

Universities and Agricultural Schools

A fourth channel for technology transfer involves universities and agricultural schools. In most countries these institutions are responsible to the ministry of education, and may be somewhat isolated from the research agency of the ministry of agriculture. Universities and agricultural schools have responsibility for training future scientists and development professionals. If they are to do this job well, they must be aware of what the research system is doing. Therefore there must be a close liaison. It is a two-way street.

The traditional procedure for scientists is to record the results, interpretations, and philosophies of their research in scientific papers which are published in scientific journals, or the proceedings of symposia or workshops. This is an important mechanism for communication among scientists. Published results must be made available promptly to our university colleagues so that wherever appropriate such new knowledge may become "part and parcel" of the training of future scientists and agricultural leaders.

If teaching is to be well founded, of necessity it must have a research program to support it. Graduate students will, of course, carry out thesis research. This research will most likely be of a fundamental nature. The staff of the NARS should be aware of theses work which is being done, because it could provide useful information in support of much of their own technological research.

All too frequently researchers overlook the importance of good communication techniques. We know these skills are essential but often fail to devote sufficient attention to their development. If we are to minimize the technology gap, we must have an efficient technology transfer system. This requires professionals who understand the business of communication, particularly to agricultural audiences. The role of such professionals may be every bit as important as that of scientists. Once a scientist has obtained information from his research, and analyzed and interpreted it, it may be necessary to translate his findings further into accessible forms.

Decision-makers need information in a form which gives them an economic measure of its potential value. Extension workers need facts presented in such a way that they can be readily used in educational programs with farmers. The general public is likely to prefer information in the kind of digestible form characteristic of journalists or reporters from television or radio. In every instance, however, universities and agricultural schools are responsible for training "communicators" to convey what has to be conveyed appropriately.

Priority Topics for Asian NARS

In order to encourage discussion during this session, I would like to suggest that agricultural research in Asia can be classified into four different groups depending on crop or topic. For the first group there are three areas where we in Asia have been pre-eminent in research: rice, rubber, and cropping/farming systems research. I believe that any major advances in these crops and systems in the foreseeable future will be made at research stations in Asia.

The second group includes typically Asian commodities where, as things stand at present, major research advances are not likely in Asia. Now would seem an opportune occasion to suggest that there is a need for Asian NARS to improve their research capacity in these commodities which number among them coconut, cassava, oil palm, tropical fruits, lowland vegetables, water buffalo, and ducks. I would like to invite ISNAR and IFARD to participate in a review of our existing research capabilities for these commodities. This review would identify the strengths and weaknesses of our NARS relevant to these commodities and then suggest how we in Asia might improve our research institutes. As the first step in this review, I want to propose that Indonesia host conferences on coconuts, tropical fruits, cassava, and ducks in 1983 and 1984. These conferences would help plan strategies for the development of an Asian research capability in these commodities.

The third group includes topics or areas which are not typically Asian and for which I feel, although it is important to do so, we have not yet developed adequate expertise . This group includes fresh- and brackish-water aquaculture, tropical soils, forests in the humid tropics, and small ruminants. Here, clearly, it is up to the Asian NARS to improve our research capacity. I can only pose the question, what should we do about these topics?

The final group covers research on the social and economic systems of Asian farmers in the environment in which they must make day-to-day decisions on how to maximize their incomes. Do we have the capacity in each of our own countries to improve the quality of this research? ISNAR and IFARD might be able to recommend how to improve our research in the fields of economics and sociology.

Criticisms of Agricultural Research

As the final part of my paper, I would like to direct attention to five common criticisms of our research efforts. We must respond to these criticisms if we are to maintain viable agricultural research systems.

1. Agricultural research is expensive and not all Asian countries can afford it. It would be valuable if ISNAR and IFARD could prepare a convincing analysis to prove that the returns from agricultural research are excellent in developing countries. This would facilitate our annual research funding discussions.

2. Agricultural researchers are not practical enough to solve farm-level problems. The difficulty is not that research is insufficiently practical, but rather that there are too many important problems for study. Our limited resources force us to select only a few high-priority problems for investigation. We must be sure that those problems are the ones of greatest relevance to our countries' national planning.

3. Research is a long-term investment and developing countries need rapid returns from existing knowledge. We require case studies to prove that agricultural research is not just a long-term investment, but can also yield quick dividends from specific activities.

4. Research is only for policy-makers, not for farmers. This criticism is that we respond only to national problems at the request of policy-makers, paying too little

attention to farmers and officials at the regional level. The problem is one of limited facilities, funds, and personnel. Our resources do not permit us to respond to all problems in all localities. We are forced to be selective in our choice of problems at the farm level. Here again the matter of setting priorities is important.

5. The link between farmers and researchers is weak. Organizational linkages are different in each country. Some NARS do not have a mandate to give extension assistance to farmers. Yet, the essential thing is for research results to reach farmers rapidly. Thus the research/extension link becomes of paramount importance.

These are only five examples of criticisms about our agricultural research. There may be others in your own countries which we should also discuss today.

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