Food and Population: Priorities in Decision Making

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Policies and programmes for agricultural development: the role of economic-social science analysis and of research agencies in seeking solutions

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The rapid increase in world population makes it vitally urgent to increase food production. The governments of developed and developing countries must be willing to take action not only in the face of hunger, but concentrate on long range aspects of the food problem. World food supplies are, and probably will be, distributed in accordance with purchasing power or effective demand and not according to nutritional requirements. A permanent solution to the problem includes population control and major efforts to plan agricultural research directed toward a long term solution of the agricultural production and food supply problem, particularly in those climatic zones where very little research has been historically undertaken.

Agricultural research policy

An agricultural research policy must be based on the fact that the objectives of agricultural research are not academic or speculative. The objective when possible must be strictly practical and oriented towards the improvements of agricultural production and the living standard of the agricultural producer. A complete national research programme should take into consideration the nature of future innovations and technology; and proceed to evaluate the impact on, and the response of, the economic, social, and political sectors to these potential changes. The nature and the objectives of research programmes should be determined by the stage of development of the economy:–

Initial development stage Estimate present and future economic importance of various commodities and then divide research in proportion to the increase of economic importance of each of them.

Intermediate development stage Allocate research resources according to income elasticities for different agricultural products and various other aspects of products such as quality, quantity, services, convenience, etc.

Advanced countries Quantify potential growth targets of various crops based on visualised new technologies and divide research resources according to estimated marginal value of the new technology in relation to the existing level.

In general one can say there is no single method or technique on which decision

making could or should be based. The need for informed judgement must be accepted and that further exploration of methodologies is necessary.

Economic and institutional analysis in agriculture research

All problem-oriented research programmes must have an economics component directed specifically at the economic issues associated with the major technological problems to be attacked. First, economic analysis should evaluate the economic and social factors at the micro-level of generated technologies. These include: (a) design of physical/biological experiment to permit efficient economic analysis; (b) production function analysis of experimental and related data; (c) determination of optimal systems of farming; and (d) product and input price and marketing research.

In addition to micro-economic considerations, economists in association with other social scientists must consider aggregate macro-economic issues. Four of the most significant of these issues are: (a) internal and external supply and demand studies for food and other agricultural commodities given priority in research programmes; (b) internal and external supply and demand studies for inputs or factors of production; (c) regional disparities and other potential problems associated with implementation of new technologies; and (d) relative price structure of major agricultural inputs in relation to food and other agricultural products.

Other studies should evaluate the impacts of the research findings in terms of their effects on growth, equity and risk bearing potentialities of the new techniques created or to be created. In addition, in relation to the food shortage problem, a new approach has to be developed in evaluation of cost and real value of various food crops in terms of nutrients.

Theoretical considerations in agricultural research

The progress of agricultural research can best be understood with the help of theory and with examination of past experiences.

1. The Theory of Induced Innovation – According to this theory, factor endowments provide the motivating power for technical change in agriculture.
2. Social Interest Groups as Determinants of Research Policy – According to this theory, technical change is a cumulative process in which socio-economic and political-bureaucratic structures interact to define the demand for and the supply of new technologies. The United States and Japan, starting from entirely different factor endowment situations, had their agricultural research induced toward saving the scarce resources, land in Japan and labour in the United States.

In both theories a few elements play key roles. The first emphasises the natural supply and demand forces influencing the factor and product prices as the signals of scarcities. The second places emphasis on the socio-economic political structure. Both of them recognise the role of available scientific knowledge and of the body of trained personnel to sense the market orientation or to follow the commands of the governing structure. The power of the society plays an important role in the second model.

Formulating agricultural and food research programmes

A new organisational structure is proposed based on the concept of a 'mission-oriented systems approach'. The objectives would be:

(a) to develop conceptual definitions and methods for structuring agricultural research efforts toward improvement of food supply systems;
(b) to develop concepts and frameworks for establishing short and long range dynamic research and development (R and D) programmes, maximising the tangible benefits resulting from R and D.

Research planning is identified with the future consequences of present decisions. To increase the likelihood that useful information will, in fact, result from research activities, the research must be planned and a complete set of methodology has to be developed.

Research planning should begin with suitable identification and analysis of the system or systems of existing and potential production technology. The second stage should be an information analysis that reveals the existence and adequacy of available information on the system under study. Once all information available and needed has been established the research strategy should take into consideration the interrelationships between technical and economic change. The fourth step in agricultural research planning is to formulate a research programme whose goals cover the information needs of economically justified research.

Agricultural research in the United States

The value of agricultural research and technology development has been demonstrated in the United States and other developed countries. According to USDA published indices of agricultural productivity, the ratio of outputs to inputs per acre in 1972 as compared to the mid-1930s has risen by forty-five per cent. The production per man hour has more than doubled. The number of people supplied by each farmer has risen from fifteen to fifty-two. During this same time, the acreage harvested per consumer has been reduced by nearly one half. The rate of return on additional investment in agricultural research and extension has been

forty-five to fifty per cent per year over the past forty years. This has kept food prices low. Americans spend only about sixteen per cent of their income on food.

A considerable amount of the success was due to a continuous and large amount of effort directed to agricultural and related research that created the largest and most efficient agricultural production machine in the world.

Agricultural research in tropical regions

The low level of real research investment in the major developing country climatic zones, especially in the tropical and desert zones, partly explains the relatively poor agricultural performance of these regions. The relatively small amount of agricultural research effort undertaken and performed in tropical conditions till now did not show great food and other agricultural production possibilities.

Lately, many research institutes, national as well as international, are seen and recognised as promising contributors to boosting food production. The effect of increase in research investment was dramatised by the Green Revolution. It was realised that the unused available resources of land are not located where the imbalance in the rates of growth of population and food is more intense. This places additional burden on the need to increase yields of the available and already utilised resources.

The following are the first three of a list of ten recommendations of agricultural research priorities made by the United States Board of Agricultural & Renewable Resources:

1. Expand research on photosynthesis so as to increase crop productivity.
2. Strengthen research on biological nitrogen fixation to establish coordinated programmes for developing field demonstrations.
3. Develop techniques for genetic manipulation beyond those of conventional plant breeding, including *in vitro* techniques for asexual approaches and broad-crosses between crop species.

Tropical areas with abundant intensive solar radiation and continuous growing seasons with large amount of water supply present much higher potential for these kinds of experiments and the resulting technology than do temperate zones with limited growing seasons. Temperate zones are often deficient in solar radiation, growth and activities of soil bacteria are practically stopped for nearly half or a larger part of the year.

In addition, a large number of tropical plants until now very little exploited in terms of possible food production, present the greatest challenge for genetic architects to introduce desirable characteristics like increasing protein content of some tree crops.

Brazil and its commitment to agricultural R and D

The research and the rapidly growing literature on economic and agricultural development in Brazil shows that it holds untapped and underutilised agricultural resources that in due time could become one of the important breadbaskets to help feed the hungry world.

The development of agricultural research in Brazil has gone through four periods. The first period ran from the late nineteenth century up to the mid-1940s, when plantation agriculture was at its peak. The second period went from the mid-1950s to the mid-1960s; economic expansion of the industrial base was a clear prerogative in the allocation of resources. The third period began in the early 1960s and continued until the creation of the Empresa Brasileira de Pesquisa Agropecuària – EMBRAPA (Portuguese acronym for Brazilian Agricultural Research Corporation) in 1972. Since the creation of EMBRAPA, the Brazilian Federal Government has decided to invest heavily in research on agricultural sciences. The budget for 1976 exceeded 100 million dollars.

Technical assistance and rural extension activities in Brazil have long been fragmented. Since the early 1970s the government started taking positive steps to strengthen the extension system. In mid-1974, the Brazilian Enterprise for Technical Assistance and Rural Extension (EMBRATER) was created as an autonomous corporation within the Ministry of Agriculture. EMBRATER regards itself as a catalyst for bringing about technical, economic and social change in the agricultural sector. At the national level it coordinates its work with agencies handling research, rural credit, commercialisation, etc. The National Commission of Agricultural Research and Technical Assistance (COMPATER) has been set up as the coordinating link between EMBRAPA and EMBRATER and will be responsible at the federal level for synchronising, reviewing and coordinating programmes of both agencies. The main point of interaction between research and extension is intended to be at the farm level, where technological packages are to be prepared as a result of discussions between researchers, farmers and extension staff.

The tendency is to dissociate research from university teaching, thus advisory services tend to make the research programme mission-oriented and responsive to the needs of farmers and consumers rather than follow the scientific interest of the academic community.

The social, economic and political structure of the poor countries may be such that the price signals of the market get distorted and do not communicate the right indications to research investment. Their social and economic environment often ensures that research institutes do not respond to the needs of farmers and consumers.

EMBRAPA is a public corporation, which means that it operates like a private corporation. Thus it can use all types of financial and human resources and can sell its services to all kinds of clients. EMBRAPA's principal product is technology and its primary client, the federal government. National priorities are established

by the federal, and regional priorities by the state, governments in terms of products for export and domestic consumption. The major tool of execution for the whole programme is a centralised system of research planning that establishes a methodology which permits the setting of objectives and goals, the selection of the most appropriate measures for their attainment and the choice of ways and means to carry out the selected measures.

Brazil has accumulated a stock of knowledge that is useful to her agriculture. Extension people, farmers and researchers meet together on an informal basis, with the objective of organising available knowledge into technological packages for different classes of farmers. Training abroad and hiring foreign professionals are considered as being most applicable to the Brazilian situation. Out of some 1,200 professional research workers, more than 550 are doing full time graduate work. During the whole study period they are paid a full salary and educational allowance.

The role of the economist at EMBRAPA's Agricultural Research Centre embraces the following list of activities: establishing good working relationship with other research scientists; defining the existing production system; participating in development of technological packages; performing economic analysis of experimental data; making analysis of distributional effects of potential innovation; estimating labour requirement of new technology; quantifying of future technology; and assisting in planning of new research.

The importance of Brazilian model to other developing countries

The socio-economic structures in the rural areas of the developing countries will favour a centrally guided research system that is aggressive in visualising the directions its resource should be used. The idea of a centrally planned research organisation and programme has helped in Brazil to combine the scarce, highly trained scientists into strong and solid interdisciplinary research teams. When farmers do not communicate their needs to the research organisation, the central coordination should provide a lead to the research agencies in carrying out their task of furthering knowledge.

In Brazil, the association of the interdisciplinary teams with a systems approach to the farmers' problems has been adopted, and hopefully the time span from the understanding of the problem by researchers to the adoption of new technologies by farmers will be shortened.

The capacity for innovating in agricultural technology is essential for agricultural development. McDermott (1975) refers to research as a technological innovation process. The key is in the transfer and diffusion of agricultural technology from temperate to tropical ecosystems through problem oriented adaptive research. The capacity to transfer depends heavily on indigenous research capability. It is also important to specific countries that they know where potentially transferrable discoveries of technology and technical knowledge are

being made.

The Brazilian model of a centralised agricultural research system is a potential partial solution to the food crisis through increased food production in the tropics using the new technology which it hopes to produce. Agricultural research-based activities taking into consideration geo-climatic diversity and furnishing the location-specific evidence must be the basis of innovation and new technological packages for all developing countries.

Unanswered questions and unsolved problems

The application of advances in agricultural technology, such as those associated with the Green Revolution, seem to increase in both absolute and relative terms the income disparities between poor and rich farmers in developing countries. The new challenge is to create labour-intensive, land and capital saving technology for small scale farmers in developing areas. Whether the modern technique of plant design through genetic architecture based on somatic or body cell reproduction can or cannot create this technology is an open question.

This paper offers an optimistic view on the solution of the food crisis as a production problem. However, it has some reservations:

1. a rural development strategy designed to improve the economic and social life of the rural poor is still an unsolved problem;
2. the role of the social scientist has not been clearly defined within the context of the food crisis and also constitutes an unanswered question.

Final remarks and policy recommendations

Despite the great difficulty inherent in trying to predict the future, the author of this paper believes that current decisions concerning agricultural research, particularly in developing countries, will be instrumental in producing food in the future.

Two broad groups of research can be recognised:

1. research that serves the scientific community;
2. research that serves the public.

The latter kind of research must be mission-oriented or problem solving research. Over the years the agricultural research programme, which was strongly production-oriented, has made a significant contribution to farming efficiency in the United States and thereby, directly and indirectly to the whole world. This also helped in concentrating food production in temperate zone on a worldwide basis. In the long run, increased understanding of the biological principles underlying agricultural

productivity will serve as a major contribution. In the short run, however, problem-oriented adaptive research can considerably increase agricultural and food production. Research should focus on ways of decreasing dependence upon chemically synthesised nitrogen fertiliser and on increasing the supply of biologically fixed nitrogen by forage and grain legumes and nitrogen-fixing associations of micro-organisms with grasses, shrubs trees, lichens and marine organisms and the design of new cropping systems.

As far as social science policy is concerned, the action-oriented research must shift its focus from the character and personality of the farmer to the socio-economic conditions that lead him to accept or reject change. Certainly we need to know far more than we do about the economic, social and political relations in agriculture and more about the relations between the rural farm and urban groups. These for most part are untouched territory. Research on resource development and public policy can also stand expansion.

The chief objective of agricultural research and development must be to increase welfare where human misery is greatest. Some parts of the tropics constitute such areas.

A sound agricultural policy, correctly articulated with the national development policy as a whole, is essential if the national goals are to: increase food output, improve nutrition and cope with the interaction between food supply and growth of population. Eventually the place where additional food can be produced and the place where food is needed will not be the same. The commercial demand for agricultural and food products will continue to be closely tied to world economic conditions. A food crisis in the world poverty belt will not create effective demand. This is because impoverished and malnourished people cannot get their foodstuffs in the market. Since the market cannot indicate actual need, the situation may require a new way of sensing how research should react in response to food scarcity. Centralised planning of food production research by each country and the coordination of their efforts on an international level may be the best solution to this world crisis. It is hoped that the Brazilian model described in this paper is a correct step in this direction.

Today's world food production system was built mainly by and for the people of temperate climates. The people who live in the tropical climates can use this experience to build one for themselves.

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