JIMMYE S. HILLMAN AND ERIC A. MONKE

International Transfer of Agricultural Technology

INTRODUCTION

Few would argue with the proposition that technological innovation lies at the heart of successful agricultural development. Yet the transformation of traditional agriculture remains largely incomplete, as more than half of the world's agricultural producers operate under technological constraints that have changed little during the twentieth century. This situation is not a consequence of lack of effort to find new technology – almost all less developed countries (LDCs) have attempted to introduce new intermediate inputs (seeds and fertilizer) or new capital inputs (animal or mechanical devices). Government policies related to land improvement investment, credit availability and controls over importation of inputs such as fertilizer are partly to blame for the slow rate of generation and diffusion of new technology. But more important, market and subsistence orientated farmers alike have shunned new technologies because they offer lower profits or productivity than the traditional technology. Thus the problem of technological change lies primarily with the 'appropriateness' of the new technology for the biological and economic environments of the technology-seeking country.

This essay reviews the substantial literature on agricultural technology transfer, with a focus on the key economic and institutional constraints which account for the stagnation of agricultural technology in LDCs. The principal components of the arguments presented here are drawn from Schultz (1964), Hayami and Ruttan (1971) and Binswanger and Ruttan (1978). The failure of local institutions to develop new technologies has forced a reliance on international sources of both the private and public type. But profit constraints and differences in resource scarcity provide fundamental economic barriers to the development of new technology by foreign private interests, particularly with respect to staple food production. The international research institutes, with the exception of the rice and wheat centres, have also experienced difficulty in the development of widely-adapted and economically efficient technologies. The lack of an effective profit motive or other form of accountability to producers and consumers, and difficulties in the identification of relative resource scarcities of a particular region, again provide a rationale for the failure to develop new technologies. A further difficulty arises because international centres depend primarily on developed countries (DCs) for investment funds. Since DCs see little direct benefit from these investments, high rates of return from successful research do not guarantee increases in financial support. These circumstances imply that the future development of efficient new technologies is likely to require the investment of additional resources at the local level.

CONCEPTS AND DEFINITIONS

Hazell (1982) provides a useful definition of new technologies:

> If a production function $Y = f(X_1, \ldots, X_n)$ relates the maximum crop yield per acre (Y) attainable with different but permissible combinations of inputs (X_i), such as seed, fertilizer and weeding labor, then I shall take the function f() to define a technology. Changes in the combinations of inputs represent movements along the production function, e.g. using more or less fertilizer, and are better described as alternative 'techniques'. However, a change in the quality of seed which leads to a structural shift in the production function, and increases the per acre yield with the same level of inputs, is clearly a 'new technology'.

The distinction by Hazell between techniques and technologies is useful because the barriers to the adoption of each are likely to be different. For example, the availability of credit and fertilizer supplies are likely to have a much greater impact on the level of nitrogen applications per acre than on the variety of seed chosen by the farmer. The introduction of a new technology by local innovation or transfer from outside requires advances in knowledge *and* changed availability of inputs. Schultz (1964) points out that the two elements are inextricably linked. Increased agricultural productivity results from sequential advances in knowledge, changes in the supply of new material inputs, and advances in producers' know-how. Advances in knowledge are differentiated into two categories. One set consists of material things which have come from basic discoveries in the sciences and engineering. The advance in knowledge in this case becomes inextricably associated with the material substance. For example, knowledge with respect to genetic engineering becomes part of the genes. The other set consists of changes in farm practices.

The former set is of principal interest in this paper. This focus is not meant to imply that changes in management practice cannot create increased productivity. Production functions can be modified without introducing new material inputs. Illustrations of this phenomenon are commonplace: changes in rotation, tillage, cultivation practices, seeding rates, irrigation techniques, and the timing of all these.[1] In all cases total resource availabilities are unvaried. Nor are scale economies involved.

Skills, however, become perfected. The key point is that the changes in farm management practices involve improvements in the use of modern technologies. As Schultz has argued, much of the potential for improved management practices within the confines of traditional agricultural technologies has already been exhausted. Thus changes in management practices may be regarded as a second source of productivity increase, but dependent on the initial introduction of a new collection of inputs.

Where can the new input packages and cost-reducing technologies be found? If existing agricultural technologies are not sufficiently productive, then a new technology must be developed locally or transferred from developed countries. If reliance on the international community becomes the principal alternative, a second dichotomy is created by the choice between private, profit-orientated organizations (particularly, multinational corporations – MNCs) and public, internationally-financed sources. The ultimate course followed in the transfer of technology is likely to be a mixture of all alternatives.

TECHNOLOGY: PROBLEMS IN PRODUCING ONE'S OWN

The theory of induced innovation, introduced by Hayami and Ruttan (1971), focuses on those cases where technologies are produced and diffused indigenously. Factor scarcities or factor prices influence the direction of technical change for the production of a particular commodity. Technical change is directed toward saving the scarce or more expensive factors; that is, saving proportionally more of the scarce factor than of the abundant factor per unit of output measured at constant factor prices. Hayami and Ruttan examined and compared the experiences of Japan and the United States, countries with highly productive agricultural systems which represent the extremes in terms of resource endowment. Japan has little land and much labour, and the United States has abundant land but expensive labour. The agricultural development pattern of the two countries proceeded along radically different paths. Japanese development emphasized yield-increasing innovations, while United States agriculture became increasing land-extensive.

The theory of induced innovation suggests, with some qualifications, that technical change can be treated as endogenous to the development process. The theory has subsequently been elaborated by Binswanger and Ruttan (1978) to develop a theory of induced institutional innovation analogous to the theory of induced technical innovation. While these treatments emphasize economic factors, these researchers remain aware of other forces that could also affect the transfer of technology, such as 'an autonomous thrust toward the accumulation of knowledge', '(natural) constraints on what can be discovered', and 'changes in the evolution of ideas in the general cultures' (Binswanger and Ruttan, p. 4).

The key element of the induced innovation process is the presence of a response by researchers to local resource scarcity and an information dissemination network. Research scientists are aware of local resource constraints and are responsive to these constraints if their salary and job security are somehow dependent on their contributions to the development of new technologies. An extension service or news information service provides a conduit through which producer perceptions about resource scarcity can be transmitted to scientists. This network appears lacking in most LDCs. The LDCs account for only 4 per cent of world agricultural research and development expenditures. A similar pattern persists with respect to expenditures in other research and development (R and D) efforts – only one per cent of global research and development expenditures in health, agriculture, housing and industrial technology are made by developing countries (Paarlberg, 1982). As a result, LDCs lack national agricultural research systems comparable to those which exist in any of the major advanced agricultural countries. Even in the middle-income countries, which have some long-established research institutes, there are inadequate means to keep abreast of advances in the biological sciences, laboratory and field methods and equipment.

It is difficult to explain why, in light of current information about the payoff to knowledge and to investment in physical and institutional infrastructures, developing countries have not moved more rapidly to increase R and D activities. A century ago there were few places in the world where grain yields were significantly greater than one metric ton per hectare. Since then, as shown by Yamada and Ruttan (1975), differences in output per hectare per worker have widened considerably. Differences such as these have not been due to changes in resource endowments; nor, necessarily, to inherent differences in endowments between regions. They have been due principally, instead, to technical and institutional innovation and to investments that have improved the capacity of land and labour to respond to output-increasing opportunities. Additional evidence of the importance of local R and D is provided by Jennings and Cock (1975) in their argument that a technology that is productive in the centre of origin can be more successfully introduced where there is less biological stress on the new cultivar. If the R and D institute is located outside the centre of origin, local development may be rapid, but the transferability of the technology and its impact on productivity will be limited.

Part of the explanation for lagging investment may lie with the constancy of real prices for grains on the international markets over the past two decades. Expanded imports of grain have played an important role in the maintenance of domestic consumer subsidy programmes, as net imports grew by over 100 million metric tons over the past three decades. Technological advances in both the DCs and LDCs have enabled the fulfilment of these increasing demands at constant real prices. This constancy meant that government expenditure on subsidy programmes needed to increase only in so far as domestic income and population increased. Since government revenues are commonly related to these variables, lags in domestic grain production did not provoke the sense of urgency so often necessary to induce changes in government policy.

Investment in agricultural research and development retained a low priority in the allocation of government expenditure.

In addition to lagging investments, a second set of reasons for the absence of local innovation in agricultural technology revolves around the lack of economic incentives for LDC scientists. Rewards in the form of promotion and salary are not necessarily tied to contributions to the development of new technology. Educational institutions of the developed countries (DCs) may also be partially responsible for existing circumstances. As a consequence of low investment in educational facilities, most research scientists necessarily receive their training in DC institutions. They may study with scientists who are responsive to factor scarcity, but the type of factor scarcity in the developed country is likely to be entirely different from that which prevails in the home country. Thus, it is not unusual to find Ph.D. candidates in agricultural sciences from LDCs engaged in the study of biological and production problems which are of no relevance to their home country.[2]

TECHNOLOGY TRANSFER

Failure to develop new technologies *via* an indigenous process forces a reliance on foreign sources, particularly the developed countries. A number of historical examples suggest that imported technologies can provide benefits to the importing country. Many European practices were directly transferred to the United States in the nineteenth and twentieth centuries. Early Japanese international collaboration with Germany and the Indian-British colonial relationship also proved conducive to the building of national research and extension systems and the spread of technologies (Hanrahan, 1981). A common property of these successful transfers is neutrality of the technology with respect to the factor endowments of the exporting and importing country. For agricultural technology the list of directly transferable technologies is short, due to differences in climate and factor scarcity. Improved seeds and other genetic modifications may be an exception to the above generalization; but even in these cases yield performance is often dependent on a number of complementary inputs, such as fertilizer, irrigation, and land development. For some LDC-LDC transfers, the climatic and factor endowment differences may be less severe problems. But low investment in R and D by the LDCs has done little to expand the shelf of potential new technologies.

Problems arise with the international technology transfer process when the imported technology does not represent a minimum social cost method of production. If the new technology is not a minimum cost method of production only government tax and subsidy policies can sustain it. Otherwise, the new technology will quickly disappear. Producers with traditional technologies will not adopt higher cost/lower profit methods of production, regardless of the vintage of the technology.[3] An illustration of this circumstance involves the attempt to introduce irrigated rice technologies to Liberia and the Ivory Coast (Pearson et al., 1981). Labour is a relatively scarce factor in both countries while land is abundant. Upland rice cultivation is the dominant type of traditional technology. The new Asian technologies, however, are labour intensive and under West African factor prices were less profitable than the traditional technologies. Government subsidy programmes necessary to sustain the new technology were of a limited magnitude in Liberia and of a limited duration in the Ivory Coast. As a result, the new technology was not adopted on a significant scale. In addition to factor price differences, cross-country differences in institutional structures (such as communications networks and equipment repair facilities) or policy objectives of employment and income distribution can result in the imposition of an inappropriate technology.

Where governments are more determined to adopt new technologies, subsidies on input use and protection against imports of the final product can be used to make new technologies more profitable than traditional technologies. A problem arises because technologies appear appropriate from a private perspective but inappropriate from a social perspective. Inefficiency of resource allocation is the result, with negative implications for real income levels. If the new technologies are capital and/or skilled-labour intensive relative to their traditional counterparts, adoption may have a deleterious impact on employment of unskilled labour and income distribution. Gotsch (1971) provides an illustration of these consequences in which adoption of 'Green Revolution' wheat technologies in the Punjab of Pakistan utilized mechanical rather than labour intensive methods of production. One reason for this adoption pattern was the significant subsidization of tractor usage.

If a country relies on the international community for an economically appropriate agricultural technology, it can obtain that technology from either the private sector – particularly the MNCs – or from the bilateral and multilateral public agencies. The potential for development of appropriate technology by MNCs appears greatest for two classes of products: those goods produced in the host country but not in the home country, such as coffee, cocoa, or bananas, and those products or processes which are not traded on international markets and thus must be produced in the host country, such as fresh milk. In the case of export crops, the only alternative technologies are those developed in the host countries, and profit maximization will dictate maximum usage of relatively abundant factors of production. In the case of non-traded products and processes, prices for outputs can increase to cover production costs, and thus positive profits to the MNC are possible from the onset of MNC involvement. Incentives to develop and adapt new technologies are present as well, since the firm will realize additional profit from cost-reducing innovations. Government policies to encourage competition can be utilized to ensure that non-traded goods prices will decline and tax policies can be used to guard against 'excessive' profits by the MNC.

When outputs are traded internationally or produced in the home country, the interest of MNCs in technological innovation and adaptation is likely to be more limited. Grains represent the most prominent outputs of this type. A private firm which utilizes a profitable, capital-intensive technology for production in developed countries, for example, is unlikely to have the incentive to invent labour-intensive technologies for the LDC. Prices for outputs are fixed rather than adjustable to costs of production and thus profits are not guaranteed for introduction of a 'new' technology into the LDC environment. High start-up costs, due in part to a lack of experience and understanding of LDC climatic and soil conditions, will not necessarily be recovered by subsequent increases in efficiency. Further, since these outputs are widely produced, the probability of capturing rents from successful R and D appears limited. Thus socially profitable investments need not result in private profit and investments of private capital in technological innovation will not occur. Government investment in R and D is essential for the realization of these potential gains.

If a LDC cannot obtain an appropriate technology from the private international sector, the public and semi-public sectors represent a final source of new technology. Assistance has been primarily from bilateral programmes, such as the USAID programme and the thirteen international agricultural research institutes (the Consultative Group for International Agricultural Research).[4]

Since World War II many developed countries have extended bilateral agricultural development assistance to low income countries. Notable among these are Belgium, Canada, France, Great Britain, the Netherlands, the United States, and West Germany. The United States has had the largest and most intense involvement in terms of personnel numbers, scope of locally based technology development and transfer, and the number of government institutions involved. One reason for the large US involvement was its own success with the USDA-Land Grant system. President Truman's Point IV statement that 'we now possess the knowledge to alleviate hunger...' implied that the US success story could simply be grafted on to the agricultural systems of the LDCs. Four decades later it is clear that the technology transfer programmes have not met earlier expectations. The AID Project Impact Evaluation Reports provide ample evidence to support this view.[5] The striking feature of these reports is the uniformly limited success that the bilateral assistance programme has had in creating an indigenous, sustainable research-generating and research-diffusing capacity. Substantial numbers of poor farmers have not been able to participate on a sustained basis in the results which the technology allows. Further, policies and institutions of government have not usually changed enough to allow the full benefits of the technology to filter through existing marketing systems.

Considerable analysis has been made of the technological developments of the international research institutes. Evenson and Ruttan (1978) conclude that the programming of most of the centres for research is somewhat misplaced at present, and that not more than half of the new international centres are optimally located to respond to supply and demand linkages for the transfer of knowledge and input materials.

Dalrymple (1978) enumerates several supply and demand factors that have constrained the adoption of high yielding varieties (HYVs) of rice and wheat in developing countries:

> On the supply side, (1) the present HYVs are not suitable for all soil and climate conditions, (2) they require seeds and inputs which are either not available or not fully utilized by every farmer (seed supply is still a problem in many areas), and (3) in some regions there is a strong demand for the longer straw of traditional varieties. On the demand side, (1) consumers may not prefer the HYVs over the traditional varieties, and (2) government price policies may not encourage the production of HYVs. Although increased attention has been given to developing HYVs which meet local tasks and preferences, they still may not meet all consumer requirements.

The induced innovation theory of Hayami and Ruttan allows identification of two problems which hamper the development of locally adapted technologies by international research institutes. First, the linkage between scientist performance and technological innovations may be weaker for the international institutes than for the national research systems. High turnover rates among expatriate research scientists, for example, may hamper the sequential process of problem identification and resolution inherent in the invention of new technology. Second, fundamental conflicts may arise between a crop-specific research focus and the development of technologies suitable for particular resource scarcities. Rice production, for example, occurs under both land-scarce (Asia) and labour-scarce (Africa) conditions. The principal technological advances of the International Rice Research Institute have involved responses to the former rather than the latter constraints. Technological changes in African production methods appear to hinge on mechanical innovations which would increase arable acreage per farm and on the development of improved upland rice production methods. The ability of research institutes to develop these innovations in surroundings of totally different factor proportions remains uncertain. In response to this problem, a dual system of organization employing both disciplinary and problem orientation has been introduced in several of the institutions to prevent an entrenched focus on particular disciplinary or problem sets (Ruttan, in Schultz (ed.) 1964, p. 252).

The difficulties in responding to the diverse environments in which a particular commodity is grown are confounded by the limitations on available investment resources. Numerous programmes of the international centres, such as the development of wheat and rice seed varieties, have demonstrated substantial returns to R and D investments. These rates of return are well above returns to private investment in most economic sectors and in perfect capital markets international research successes would attract increasing amounts of capital investment. While donor countries have responded to some degree to successful research, the allocation of investment remains less than optimal. Where donor countries do not directly experience the benefits of high return investment, high rates of return on R and D will have a limited impact on the resource allocation process. The receipt of investment funds by the international institutes becomes determined by political decisions of donor countries rather than by economic returns. As a result, the international institutes are forced to choose among multiple attractive investments. In the process of investment rationing certain ecological and factor-price environments are necessarily excluded.

CONCLUSION

Economic development implies the ability to adapt technology to local conditions. Since most developing countries have lagged behind in producing their own new technologies for agricultural production, they have opted for borrowed or imported technology. Private interests, primarily MNCs, have focused efforts on areas where returns from innovation can be captured by the firm, such as export crops or products specific to the host country market. Public agencies have focused on widely traded products, in particular grains and staple starches. Private, public and semi-public attempts to transfer have had their greatest successes with technologies which are neutral with respect to the economic, biological and institutional environment into which they are transferred. Specifically, inputs such as fertilizer and pesticides which can be applied effectively along with farmer knowledge have disturbed the economic equilibrium in traditional societies. Having done so, considerable economic progress has resulted.

In numerous other cases, however, the imported technology has not been cost effective, particularly with respect to small farmers and staple food crops. The tremendous variation in the economic and ecological environments for grain production implies that wide-ranging technological change requires a large number of R and D projects. Given the politically-determined constraints on investment funds from DC donors, local adaptation and the development of appropriate technologies is likely to require an increase in indigenous research and knowledge-disseminating capacity. The focus of domestic investment should exploit regional and commodity complementarities with the efforts of the international research institute. Thus domestic programme design must be predicated on difficult judgements about the future orientation of the international institutes. Research laboratories, experiment stations, and extension organizations in themselves are no guarantee of generating and diffusing appropriate technologies, but they are critically important in linking scientists and institutions to agricultural producers and farming communities. Failure to develop these linkages via changes in national investment policies can only help perpetuate the dominance of traditional technology in agricultural production.

NOTES

[1]Arizona farmers, for example, at one time applied 6 inches of water per irrigation in daylight hours; they now apply 2 or 3 inches at night, at times after midnight.

[2]These comments are speculative. To our knowledge the importance of initial research orientation for subsequent research performance has not been empirically demonstrated.

[3]This comment is not intended to imply that profitability is the only consideration relevant to the adoption rate of new technologies. Hazell (1982) discusses a number of additional barriers to technology transfer. Nor does the comment imply that cost minimization is the sole criterion for a choice of technology; there are other criteria such as maximization of output and full employment with which a country must contend.

[4]Other international agencies, such as the Food and Agriculture Organization, have also participated in the technology innovation effort.

[5]There have been more than thirty of these specific evaluation reports in the last two years. Examples of these are AID Project Impact Evaluation Reports, No. 2, *Kitale Maize: The Limits of Success,* May 1980; No. 27, *Korean Agricultural Research: The Integration of Research and Extension,* January, 1982; and No. 30, *Guatemala: Development of the Institute of Agricultural Science and Technology (ICTA) and its impact on Agricultural Research and Farm Productivity,* February, 1982.

REFERENCES

Binswanger, Hans P., Ruttan, Vernon W. et al., *Induced Innovation – Technology, Institutions, and Development,* Johns Hopkins University Press, 1978.

Dalrymple, Dana G., 'Development and Spread of High-Yielding Varieties of Wheat and Rice in the Less-Developed Nations', Foreign Agricultural Economic Report No. 95, Sixth Ed, USDA, Washington, DC, 1978.

Evenson, Robert E., (Ruttan, Vernon W., Comment), 'The Organization of Research to Improve Crops and Annuals in Low-Income Countries', in T.W. Schultz, (ed.) *Distortions of Agricultural Incentives,* Indiana University Press, 1978.

Gotsch, Carl H., 'Technical Change and the Distribution of Income in Rural Areas', *American Journal of Agricultural Economics,* Vol. 54: No. 2, pp. 326–41, 1972.

Hanrahan, Charles E., 'Concentrating AID Assistance on Agricultural Research Technology Development and Institutions', paper prepared for the Joint Research Committee of AID-BIFAD, Washington, DC, 1981.

Hayami, Yujiro and Ruttan, Vernon W., *Agricultural Development; An International Perspective,* Johns Hopkins Press, 1971.

Hazell, Peter B., 'Barriers to Adoption of New Technologies at the Farm Level', paper prepared for a conference on Technological Change and Rural Development in Developing Countries, University of Delaware, 1982.

Jennings, Peter and Cock, James H., 'Centers of Origin of Crops and Their Productivity', *Economic Botany,* Vol. 31: No. 1, pp. 51–4, 1977.

Paarlberg, Robert, 'A Food Security Approach for the 1980s: Righting the Balance', *Agenda 1982,* Overseas Development Council, Washington, DC, pp. 90–3, 1982.

Pearson, S.R., Stryker, J.D. and Humphreys, C.P., *Rice in West Africa,* Stanford University Press, 1981.

Ruttan, Vernon W., in T.W. Schultz, (ed.) *Transforming Traditional Agriculture,* p. 252.

Schultz, Theodore W., *Transforming Traditional Agriculture,* Yale University Press, 1964.

Yamada, Saburo and Ruttan, Vernon W., 'International Comparisons of Productivity in Agriculture', paper presented at National Bureau of Economic Research Conference on Productivity Measurement, Williamsburg, Virginia, 1975.

GENERAL DISCUSSION* – RAPPORTEUR: ULRICH KOESTER

It was pointed out that Dr Buchholz's evaluation of the effects of national price policies on international trade depended very much on the reference system chosen. It was questioned whether the underlying reference system of the Buchholz paper, namely free trade, was realistic. A preferable system would be where alternative instruments to price policy measures were applied, in order to achieve agriculture's income objectives. However, Dr Buchholz did not agree with this approach. He did not have an optimistic view of the suitability of direct income payments for the purpose of supporting income at a high level. He considered this instrument as supplementary to price policy and to be used in very special circumstances only. Another speaker argued that the statement 'It would not be realistic to simply call for a return to liberalized international trade' did not follow from arguments in the paper. He thought that the performance of developed countries' agricultural policies revealed little success in achieving stated agricultural policy objectives. Hence, he found it logical to argue for a substantial reduction in levels of price protection and for simplification of policies with respect to instruments and their application. Dr Buchholz, in response, felt that there might be some misunderstanding. He was not in disfavour of trade liberalization but saw many obstacles in making progress in this direction.

It was suggested that not only should the impact of restrictions in commodities be evaluated but also restrictions in movement of labour and capital. It was also pointed out that some recent research findings in international trade had been neglected. If uncertainty were taken into consideration, free trade was not the best strategy in order to maximize national welfare. The same held true if a country can affect the terms of trade. It was suggested that the author had overlooked the fact that neoclassicial trade theory does analyse distributional effects of trade policies.

Regarding the Hillman/Monke paper one participant recommended that future research activities with respect to developing new technologies should be based on quantitative models, such as those set up by the International Institute for Applied Systems Analysis. This could help to quantify the consequences of alternative technologies. Another speaker felt that behind the talk about new technology was the assumption that traditional inputs were used optionally in underdeveloped countries. He thought that this was not true. Hence, exclusive emphasis on new technologies was not warranted. It was also suggested that the quality demands of international commodity markets impose constraints upon production technology. It was regretted that many African countries had neglected their agricultural research stations since independence and had looked for other people's technologies, whose resource endowments were different. This opinion was not shared by all participants and it was pointed out that LDCs have been able to generate their own technology but still not

*Papers by Buchholz and Hillman and Monke.

proceed to implement the innovations. Therefore, it was not the agro-biological researcher who should be blamed but the agricultural economist and the agricultural extension specialists. A better education of the farming population should be the aim.

Another participant questioned whether the appropriateness of agricultural economic theory for the social and economic environments of the country should be included in the discussion of technology transfer problems. Another wondered whether the Hillman/Monke statement about labour scarcity in Africa was true. According to his knowledge there was only a shortage of labour in peak seasons and in general there was an abundance of labour. Furthermore, he wanted to know whether the recorded high turnover of expatriate staff in national research institutes was actually higher than that for international research institutes.

Dr Monke responded in his closing statement that the concept of scarcity of labour was a relative concept, labour being considered in relation to land. Therefore, labour was less scarce in Africa than in Asia. Concerning the strategy which developing countries should select, he pointed out that it would be helpful if international institutes had long-range planning. This would help to avoid duplication of international research efforts and would allow individual countries to develop their own research strategy.

Participants in the discussion included S. Tarditi, D. Colman, D. H. Penny, R. Thomsen, K. Parikh, S. H. Destipande, G. Gwyer, M. G. Chandrakanth, Yong Boo Choe and A. Weber.