JOHN W. MELLOR

Agricultural Growth – Structures and Patterns

INTRODUCTION

It is now nearly a quarter of a century since Bruce Johnston and I published our paper, 'The Role of Agriculture in Economic Development' (Johnston and Mellor, 1961). In that paper we recognized explicitly that the means by which agriculture is to be developed is closely related to the functions it is to perform. Hence we delineated an appropriate role for agriculture and in that context proceeded to expose the means by which agriculture could be developed to play that role efficiently. Both Johnston and I have further developed those basic ideas in several subsequent books and papers, (for example Mellor, 1966, Mellor et al., 1968, Johnston and Kilby, 1975, Mellor, 1976).

In our early paper we stated five classes of contribution by agriculture: (a) meet a rapidly growing demand for agricultural products associated with economic development (essentially a wage goods argument); (b) increase foreign exchange earnings by expanding agricultural exports; (c) supply labour to the non-agricultural sector; (d) supply capital, particularly for its own growth, for overheads and for secondary industry; and (e) serve as a market for industrial output. The agricultural development strategy follows from these objectives; the initial dominance of agriculture in the economy; the inevitable relative decline of agriculture with economic development; and the restraint imposed by diminishing returns given the relatively fixed land area on which most agricultures operate.

The basic prescription for agricultural development under the circumstances was 'expansion of agricultural production based on labour-intensive, capital-saving techniques relying heavily on technological innovations'. We also recognized a substantial period for 'establishing the preconditions for such growth' and a much later period, emphasizing 'expansion of agricultural production based on capital-intensive, labor-saving techniques'. Because the key intervening period 'requires an environment in which the possibility of change is recognized and accepted, and in which individual farmers see the possibility of personal gain, from technological improvement', it followed that in the preconditions phase

'improvements in land tenure are likely to be the most essential requirement'. In agricultural development, emphasis was given to 'nonconventional inputs' to complement the existing land, labour and capital resources. Explicitly noted are the large numbers of trained people needed by institutions for agricultural research, extension, supply of purchased inputs, particularly seed and fertilizer, and other institutional facilities. In the latter context, the principles for allocating this scarce personnel resource are discussed and major emphasis is placed on large expenditure for education.

These may now appear as rather widely accepted and even practical views. The agricultural development of Japan subsequent to the Mejie restoration (Ohkawa, 1964); of Taiwan (China) (and to a perhaps somewhat lesser extent Korea) (T.H. Lee, 1971); of the Punjab in India (Mellor et al., 1968); and, more broadly, much of contemporary Asia has followed this pattern at least in broad outline. In view of this we must ask why this has not been the pattern in much of Africa and why it has not been pushed more vigorously in significant parts of Asia. Further, after a quarter century of espousal of these views, what further lacunae can we find in the knowledge as then put forth.

Reticence in pursuit of this agricultural based strategy can be explained by three sets of factors. First, there has been explicit rejection of the basic premises with respect to the role of agriculture and a consequent very different set of alternative approaches to agriculture, with important structural implications. Second, a number of diversions have occurred arising from equity and ecological concerns which have been based substantially on ignorance of the context, the process and the results of technology based development – a point of view which although based on incorrect analysis served to reinforce the conclusions of those starting from very different premises. Third, Johnston and I drew insufficient attention to the requirements for conventional infrastructure and hence to the size of investment required in agriculture and the implications to the structure of both agriculture and industry. The latter represents an important lacuna in knowledge. Concurrently the alternative development strategy has suffered from an underestimate of food requirements, with a consequent and unexpected constraint on growth. It is important to sort out these forces because the next few decades are likely to be a period when food demand shifts more rapidly than supply and in which broad participation in growth will be essential to the political stability which is itself important to growth and development.

DEVELOPMENT STRATEGY AND THE STRUCTURE AND PATTERN OF AGRICULTURAL GROWTH

All economic development strategies are intended to achieve transformation of the economy from one that is dominantly agricultural to one that is dominantly non-agricultural. This may be justified on the non-intellectual

grounds of a sense of modernity arising from non-agricultural activities that cannot be ascribed to agricultural activities; to a geopolitical view that largely agricultural societies are militarily weak; or, on the economic grounds argued by Johnston and myself – that is, as incomes rise, people demand a consumption basket weighted increasingly towards non-agricultural goods and services while labour productivity is efficiently increased so as to produce the demanded quantity of agricultural commodities with a rapidly declining proportion of the labour force.

The difference between the strategy espoused by Johnston and myself and that of others is thus not in the objective, but rather it is in the role of agriculture in that process and the structure of agriculture and of industry as that objective is achieved.

The Johnston-Mellor structure

The Johnston-Mellor strategy is sharply different to the alternatives in the following three respects. Firstly, it emphasized consumer goods, both in the agricultural and non-agricultural sectors. Second, it emphasized increased employment both with respect to labour supply and to labour demand. Third, it emphasized international trade and comparative advantage and hence is not concerned with growth balanced to meet the domestic structure of demand as distinct from balance among complementary production processes. Each of the three features has important implications to agriculture's structure and development pattern. Each is complementary to the others. And, each represents a sharp contradiction to the alternative strategy.

Emphasis on consumer goods is of course central to an agricultural strategy, since agriculture is basically a consumer goods providing industry. But two other features should be noted. Low income labourers spend some 60 to 80 per cent of increments to income on food. Hence a high employment strategy must be a strategy of high rates of mobilization of food marketing. This point is spelled out explicitly in a recent paper (Lele and Mellor, 1981) which analyses the interacting food and labour markets and shows the importance of influences such as factor bias in technological change on the rate of labour mobilization. Because of the low elasticity of agricultural employment with respect to output, and the inelastic demand for food except among the labouring classes, growth in non-agricultural employment is important to creating adequate increases in income and markets for food.

Conversely, Johnston and I point out equally clearly that incentives to produce in agriculture require availability of non-agricultural consumer goods to provide an incentive to farm producers – while of course concurrently that farm market provides the incentive to the non-agricultural consumer goods industries.

As is clear from the above, an agricultural production orientation is an employment orientation (Lele and Mellor, 1972). This follows from the key role of wage goods in employment. W. Arthur Lewis made an important contribution in underlining this role, but was misleading in giving the impression that underemployed labour could be readily mobilized for non-

agricultural employment, with its food supply automatically following (Lewis, 1954). In practice, increased employment requires increased food supplies, whatever the initial amount of underemployment (Lele and Mellor, 1981).

The interaction of agriculture, employment and trade is an important aspect of the agriculture based development model. It is the supply of wage goods (agricultural) which allows mobilization of labour and hence specialization in labour intensive goods and services for export (Mellor and Lele, 1975). Similarly, agricultural exports may themselves pay for import of capital intensive goods necessary as complements to otherwise labour intensive production.

The emphasis on consumer goods, on employment and on trade represent major points of departure of the Johnston-Mellor strategy from the alternative strategy. I will return to the implications of these departures to the structure of agricultural growth after a brief exposition of the alternative strategy.

The Fel'dman-Mahalanobis structure

It is most convenient to typify the alternative, non-agriculture based strategy by reference to Fel'dman, the Russian economist and intellectual father of the Soviet Union's development strategy, and P.C. Mahalanobis' strategy for the Indian Second Five Year Plan (for a full exposition see Mellor 1974). But the Harrod-Domar family of growth models is based on the same precepts and leads to the same conclusions. The Maoist strategy in China followed single-mindedly prior to, during, and subsequent to the Great Leap Forward and the Cultural Revolution is in the same genre (Tang and Stone, 1980).

For the purposes of this discussion three points need to be made about this class of development models (Mellor 1974).

First, these models focus single-mindedly on capital goods production. The rate of growth is a function of capital formation. Use of resources in consumer goods production is simply a diversion from growth which may give higher welfare in the short run, but at the expense of long-run growth and hence of long-run welfare. Since agriculture is a consumer goods industry, this strategy has no role for agriculture except as a provider of present welfare at the expense of future growth.

Secondly in these models it is capital that is limiting to employment not marketable surplus of wage (agricultural) goods and hence diversion of resources to agricultural production detracts from employment growth by reducing the rate of growth of the capital stock which is the key complement to labour. It is the assumption that capital-labour ratios are fixed that enforces this element. Since in practice in these models, the average capital intensity of production is high, these are in effect slow employment growth models, which, even granting a wage goods argument, which they do not, places only a small burden on agriculture.

Third, these are basically closed economy models. This reduces scope

for decreasing capital-labour ratios through trade and hence increasing demand for food as a wage good. Similarly, the role of agricultural exports is largely ignored, a theoretical argument buttressed by arguing highly inelastic demand for agricultural exports.

Thus we see none of the roles for agriculture delineated by Johnston and myself playing a major role in this approach. Because employment grows slowly due to high capital labour ratios, demand for food grows slowly (and in any case it is assumed that food consumption can be regulated by fiat). Trade is downplayed and hence agricultural exports are downplayed. Employment grows slowly so there is little need to emphasize agriculture as a source of labour. Capital is not created in a consumer goods sector. And, demand for industrial consumer goods arising from a prospering agriculture serves to divert resources from capital goods production and therefore slows rather than accelerates growth.

Implications for the structure of agriculture

The Johnston-Mellor approach leads in practice to a vigorous, privately-operated smallholder agriculture which is technologically dynamic, commercializing rapidly, and, because of variation in control of resources and in enterprise, experiencing widening income disparities within the peasant farming sector.

Economies of scale in management of agricultural labour are such that it is unlikely that such an agriculture will be economically organized in large scale units, whether it be co-operative, collective, state farm or plantation. If public services are available, a small-scale sector will be highly competitive. If those supporting institutions are lacking, then a large-scale agricultural sector will not only result in an even more inequitous development pattern, but it will fail in at least two of the roles delineated for agriculture. It will be relatively more capital intensive, because of the diseconomies of scale in labour management, and hence its net contribution of capital to other sectors will be less. Similarly because of greater concentration of wealth, the demand stimulus from expenditure will tend to leak out of the country much more than will be the case for smaller farmers (Mellor and Lele, 1973). There is of course little role for a feudal agriculture in this strategy; it suffers from the same disabilities as a large-scale agriculture, plus lacking the incentive systems for rapid application of efficiency increasing technological change.

The alternative development strategy conversely calls for an entirely different approach to agriculture. That approach may take one of two quite divergent tracks. It cannot provide a rigorous, efficiency increasing peasant small-holder agriculture because it does not structure its industry to provide the consumer goods essential to farm producer incentives; nor can it generate export surpluses to import either consumer goods for incentive nor the agricultural producer goods needed for a high productivity agriculture.

On the one hand, the approach may attempt to maintain a peasant agriculture on as much of a self-sufficient basis as possible, with little growth in modern inputs, in consumer incomes or in consumption of urban

goods. Production and consumption of locally produced consumer goods through labour intensive cottage industries is of course consistent with this approach – as long as there is no drain on the urban sector. Agriculture and the rural sector generally are seen as a holding area for labour, with little positive contribution to development, but with an important role of preventing labour from streaming into urban areas to create social discontent that would interfere with urban capital formation. This approach requires minimal training of people or building of expensive institutional and physical infrastructure.

On the other hand, the capital orientated approach may emphasize extracting a food surplus from agriculture – either for export as in the Soviet Union in the 1920s and 1930s, or for domestic urban consumption as in The People's Republic of China in the 1950s and 1960s. In this context large farms or conglomerations of farms may be attractive.

In this approach the strategy runs a grave risk of not mobilizing adequate food marketings even for the low level of urban consumption expenditure planned. Given that the strategy tends in practice to consistently underestimate food consumption, this is a serious shortcoming. It tends to result in large diversion of foreign exchange to food imports, for example, India in the early 1960s and the People's Republic of China in the 1970s. This is the basic rationale of the collective and state farm. They lend themselves to extracting a surplus for the urban areas.

Inconsistent variants of the two models

The Johnston-Mellor and the Fel'dman-Mahalanobis approaches are both rigorous, internally consistent models of growth. They work in practice and in theory. Each however has variants which are not internally consistent and which may lead to considerable grief.

In the case of Johnston-Mellor, which is after all an agriculture based model, the incorrect variant ignores the role of industry not only as an objective in itself, but as a necessary condition to agricultural growth. Thus inadequate investment is made in rural infrastructure which facilitates the transfer of capital either through taxes, prices, or direct investment from agriculture to industry and in foreign exchange allocations for rural based consumer goods.

In the case of the capital-based strategy the errors nascent in its variants are even more serious. The model is of course basically a closed economy model and hence difficulty is likely to arise in application to any small country.

A serious problem arises if the growth of the urban sector is in effect highly labour intensive, for example through rapid growth of a government bureaucracy as is now frequent in Africa. This swells the demand for consumer goods, particularly from agriculture, at the same time agriculture is not receiving the resources needed to respond; nor is the capital base being laid for rapid industrial growth. The result is bound to be the rapid growth in food imports we observe in Africa. That phenomenon is reinforced by the diversions to be discussed in the next section. Africa is the

particular victim of the inconsistent versions of the non-agriculture based strategy and the currently fashionable diversions. The result has been large increases in externally financed food imports and slow growth.

Equity implications of the two models

Equity is a separate topic at the next plenary session, so I will only briefly sketch the equity implications of the alternative strategies.

The Mahalanobis-Fel'dman model makes no pretence of the production process contributing to the short-run reduction of poverty. The poverty reductions are strictly seen as long-term/short-term trade-offs. The more poverty alleviation now, the less later and vice versa. That is because poverty alleviation requires more consumption, and therefore diverts resources from the build up of capital. In the short run, poverty can only be reduced by redistribution.

The Johnston-Mellor model has powerful poverty alleviation forces. It is a high employment and a high food production model – both features essential to poverty alleviation. It is of course relaxation of the food supply/wage goods constraint on the one hand and the demand stimulation to high employment production processes which explain this poverty alleviation effect in a growth rather than a redistributional process. Of course within the peasant agriculture income disparities may increase. But, these will not be in favour of large-scale land owners nor against the landless.

Thus, there is a consistent economic logic to a development strategy that fails to invest in agricultural development. It should also be apparent that the industrial capital oriented strategy lends itself to a high level of government intervention since the points of development will be relatively few and concentrated. Conversely, the agriculture oriented strategy emphasizes sectors in both agriculture and non-agriculture with economics of scale that reach their maximum at a low output, calling for large numbers of firms and hence inevitably a major call on market forces for enforcing efficiency. Public sector intervention except for support services and broad influence on 'the rules of the game' will be uneconomic. Hence we find a close interaction between choice of development strategy and choice of political strategy.

DIVERSIONS FROM AN AGRICULTURE BASED STRATEGY

Having made the intellectual case for sharply divergent strategies, with respect to the structure and pattern of agricultural development, it is important to point out diversions from the agricultural oriented strategy which are based on quite incorrect and logically inconsistent arguments. The three sources of this diversion relate to an agriculture based on new biological technology and high input levels. There is a concern for (a) the equity implications of commercialization of agriculture; (b) the energy consumption in a high input agriculture; and (c) the ecological effects of high input agricultures.

In addition, a hotch potch of other concerns reinforce these major sources of diversion: fears that commercialization of agriculture results in lower nutritional status, due to the increased relative attractiveness of non-food consumer goods; life style preference for small self-sufficient communities; and desire to reduce foreign assistance and hence preference for less capital oriented and less commercial rural development.

In the anti-commercialization approach to agriculture, five factors have been ignored. First, we seem to have little prospect of rapidly raising yields per unit area of land without crop varieties which require high input levels. Second, population growth alone requires expansion in production that no longer can be achieved primarily by increased land area under cultivation. Third, for decades into the future availability of energy for agriculture and most clearly nitrogen fertilizer from natural gas, does not face a major natural resource constraint as distinguished from capital and foreign exchange (export) constraints. Fourth, pollution levels from agricultural inputs are still low in developing countries and the need for more food very high. Fifth, the success of institutional approaches to equalizing access to inputs has been understated (for example the Taiwan area of China, Punjab of India and so on).

All of these diversions focus on opposition to biologically based high input agriculture. Such an agriculture is of course the core of any agriculture based strategy of development (Mellor and Herdt, 1964).

Equity and agricultural modernization

The equity and poverty alleviation of an agriculture based strategy has been stated above in terms of the employment and food consumption implications. The equity oriented opposition is based largely on the argument that the new agricultural technology is not scale neutral – that is, it works better on the larger farms than the smaller farms and thus tends to further skew income distribution away from the poor. The latter increased concentration of income would then result in a purchasing of land by the more well-to-do and further concentration of asset ownership. The unfortunate distribution effects were seen as particularly associated with high input levels and unequal access to those inputs. The empirical evidence to support this view is weak and depends heavily on (a) situations with poor input supplies, in which case political power allocates the scarce resources rather than economics; (b) observations documented by the misery making influence of population growth; and of course, (c) already exploitive land distribution systems. The alternatives for dealing with those situations are two: turn to the non-agriculture oriented strategy or emphasize equal access to inputs and other objectives which require even more trained personnel. Unfortunately, this diversion tends to be associated with a form of populism that shuns training of people for national level institutional development on the basis that such development is élitist, so the key to more egalitarian development is abjured. It is perhaps this element of anti-élitism which destroys the basis of agricultural development as clearly recognized in the early Johnston-Mellor paper and demonstrated so successfully in Japan, Taiwan (China) and the Punjab of India.

Energy and ecology

The energy and ecology arguments against an agriculture based strategy are more easily disposed of. The energy shocks of the mid and late 1970s raised concern about increasing agricultural production based on energy intensive use of fertilizers, water and pesticides. Similarly, the rising levels of pollution in developed countries brought a reaction against high input levels in developing countries.

It is sensible to spend on research to increase production efficiency including the productivity of inputs, as part of an agricultural based strategy. And, significant success has been achieved on the pest control side. However, it is crucial to understand that agriculture's key role arises from a process of commercialization and exchange which requires transport, low cost power and complex institutions. The alternatives are development without agriculture or no development at all.

FUTURE MODELS FOR AN AGRICULTURAL STRATEGY

If one opts for an agriculture-based strategy of development, what oversights and errors might one note from the early writing of Johnston and myself. I note two major lacunae. We understated the capital requirements essential to moving agriculture and we understated the role of agriculture as a market for non-agricultural capital goods and services and the key mechanisms for it to play that role.

Our understating of capital requirements probably derived from observation of Japan and the Taiwan area where much of that infrastructure was in place before major yield increasing technologies occurred. Where the infrastructure of irrigation, transport, and power are lacking, very large investment is called for. We did not err in the view that this capital would have to come largely from agriculture. However, the burden cannot be carried by agricultural production alone. Rural consumer expenditure and rural based industries need to share in carrying these overheads. Thus one needs information on the size of these overheads, the optimal pattern of their provision, and the policies needed for their full and effective use. In this context, the timing and placement of rural services requires explicit attention. Since the investment requirements are large, a decision is forced as to the extent to which the development plan is to be based on agriculture or not. If the strategy is to be agriculture based, a commitment is required in financial allocations and in policy. Our early emphasis on low cost development of agriculture left room for equivocation on commitment to this strategy.

Closely related to this, Johnston and I emphasized agriculture's capital contribution coming in the form of taxes or low relative agricultural prices. Although we noted agriculture's role as a market, we saw this more as in conflict with the capital contribution and hence with a careful balance to be struck. This also resulted in a too restrictive attitude on agricultural prices. By emphasizing the market side more and recognizing the possibility of cost

reducing technological change in industry, one can then depict agriculture as a sector providing a growing demand at constant prices for industrial goods produced at decreasing cost and hence with rising profits. It is the highly elastic and upward shifting demand arising from rising rural incomes that can provide the basis for a high rate of capital formation in the non-agricultural sector. These processes, the interaction with price policy, investment and rural policy generally need to be elaborated more fully.

Johnston and I specifically noted that in an agriculture based strategy, recognition would have to be given to the variability in agricultural resources and concentration on those regions most responsive to new technology. There is however a serious interregional problem, which I noted more fully later (Mellor, 1966). This is perhaps the most intractable structural problem we face in an agriculture based strategy of growth.

REFERENCES

Bachman, Kenneth L. and Paulino, Leonardo A., *Rapid Food Production Growth in Selected Developing Countries: A Comparative Analysis of Underlying Trends, 1961–76*, International Food Policy Research Institute, Research Report No. 11, Washington, DC, October 1979.

Herdt, Robert W. and Mellor, John W., 'The Contrasting Response of Rice to Nitrogen: India and the United States', *Journal of Farm Economics,* Vol. XLVI, No. 1, Feb. 1964.

Johnston, Bruce F. and Mellor, John W., 'The Role of Agriculture in Economic Development', *American Economic Review,* Vol. 51, No. 4, Sept. 1961.

Johnston, Bruce F. and Kilby, Peter, *Agriculture and Structure Transformation Economic Strategies in Late-Developing Countries,* Oxford University Press, New York, 1975.

Lee, Teng-hui, *Intersectoral Capital Flows in the Economic Development of Taiwan,* Cornell University Press, Ithaca, 1971.

Lele, Uma, *The Design of Rural Development – Lessons from Africa,* Johns Hopkins University Press, Baltimore and London, 1975.

Lele, and Mellor, John W., 'Technological Change, Distributive Bias and Labour Transfer in a Two Sector Economy', *Oxford Economic Papers,* Vol. 33, No. 3, Nov., 1981.

Lele, and Mellor, John W., 'Jobs, Poverty and the "Green Revolution"', *International Affairs,* Vol. 48, No. 1, Jan. 1972.

Lewis, W. Arthur, 'Economic Development with Unlimited Supplies of Labour', *Manchester School,* May 1954.

Mellor, John W., *The New Economics of Growth – A Strategy for India and the Developing World,* A Twentieth Century Fund Study, Cornell University Press, 1976.

Mellor, *The Economics of Agricultural Development,* Cornell University Press, 1966.

Mellor, 'Food Price Policy and Income Distribution in Low Income Countries', *Economic Development and Cultural Change,* Vol. 27, No. 1, Oct., 1978.

Mellor, 'Models of Economic Growth and Land – Augmenting Technological Change in Foodgrain Production', in Islam, Nurul (ed.), *Agricultural Policy in Developing Countries,* Macmillan Press, London, 1974.

Mellor, 'Accelerated Growth in Agricultural Production and the Intersectoral Transfer of Resources', *Economic Development and Cultural Change,* Vol. 22, No. 1, Oct., 1973.

Mellor, 'The Functions of Agricultural Prices in Economic Development', *Indian Journal of Agricultural Economics,* Vol. XXIII, No. 1, Jan. – Mar. 1968.

Mellor, 'Towards a Theory of Agricultural Development' in Southworth, Herman M. and Johnston, Bruce F., *Agricultural Development and Economic Growth,* Cornell University Press, 1967.

Mellor, and Lele, Uma, 'The Interaction of Growth Strategy, Agriculture and Foreign Trade:

The Case of India', in Tolley, George S. and Zadrozny, Peter A. (eds), *Trade Agriculture and Development,* Ballinger Publishing Company, Cambridge, 1975.
Mellor, and Lele, Uma, 'Growth Linkages of the New Foodgrain Technologies', *Indian Journal of Agricultural Economics,* Vol. XXVIII, No. 1, Jan. – Mar. 1973.
Mellor, Weaver, Thomas F., Lele, Uma J., and Simon, Sheldon, R., *Developing Rural India: Plan and Practice,* Cornell University Press, 1968.
Ohkawa, K., and Rosovsky, H., 'The Role of Agriculture in Modern Japanese Economic Development', in Eicher, C., and Witt, L. (eds.), *Agriculture in Economic Development,* McGraw-Hill, New York, 1964.
Tang, Anthony M. and Stone, Bruce, *Food Production in the People's Republic of China,* International Food Policy Research Institute, Research Report No. 15, Washington, DC, May, 1980.

DISCUSSION OPENING – H. S. KEHAL

Professor Mellor's very distinguished paper raises many important issues. It is interesting to note how he now looks back to interpret the substance of the Johnston-Mellor model (1961). In particular, he draws attention to agriculture's contribution to economic development under the following five categories: wage goods, foreign exchange, agricultural manpower for non-agricultural sector, capital flow and market contribution. He also elaborates his further contributions towards the theory of agricultural development in the post-1961 period. Then he makes a comparative study of the Johnston-Mellor strategy with an alternative strategy for development propounded by G. A. Fel'dman in the 1920s (which became the basis of Soviet planned development) and the strategy for India's development evolved by P. C. Mahalanobis in the early 1950s.

As is well known, Professor Mahalanobis was the architect of the development strategy of India's Second Five Year Plan. The strategy involved: (a) developing heavy industries as the key to long-run economic development; and (b) continuing production of consumer goods in small and labour-intensive industries to generate employment opportunities. The Mahalanobis model did not neglect agriculture but relied on increasing agricultural output by means of institutional measures such as land reforms, fixing of ceilings on holdings and distribution of land among the landless. Professor Mahalanobis maintained that these institutional changes would stimulate agricultural production, provide a large market for industrial output and serve equity objectives by transferring a part of national income away from those who largely spend on luxuries.

Professor Mahalanobis was convinced that industrial development would not be possible without 'an increasing supply of cheap food and raw materials'. Similarly, he expected that the long-run progress in agriculture would depend on large-scale industrial development catering to agricultural inputs like fertilizer, irrigation equipment and other capital goods. But in the short run, the approach to increases in agricultural production must be through institutional changes. Professor Mahalanobis suggested labour-intensive cultivation supported by community projects, village co-operatives, consolidation of holdings and other land reforms.

The discussion of the paper could logically centre around various inferences drawn by Professor Mellor and the policy implications of the Johnston-Mellor and the Fel'dman-Mahalanobis models. All this involves careful comparison of growth models with agriculture and industry orientations.

The actual growth experience of the past two-three decades, especially after the mid-1960s in Asia and Africa, offers the hindsight to look at the relative merits of the two alternative development strategies, viz the Johnston-Mellor and the Fel'dman-Mahalanobis models.

The underlying conceptual framework of the future growth strategy should meet the growth and equity objectives. Professor Mellor rightly refers to the need for poverty alleviation in the developing countries. And although the equity aspect of agricultural growth will be discussed in the next Plenary Session, the structure and patterns of agricultural growth have a bearing on the equity objectives.

Another problem which attracts attention is intersectoral balances and linkages. With the closing of the cultivation frontier, the future growth in agricultural output in developing countries will largely depend on more intensive use of inputs of industrial origin. This indicates the increase in sectoral interdependence and linkage effects of growth in the agricultural sector. This Session may discuss intersectoral relations especially in regard to prices, wages, incomes and technology in different sectors. The Session may also discuss various ways to realise the prospects of integration within and between sectors to achieve an effective use of resource endowments in various sectors.

The rapid growth of agriculture needs basic inputs like high-yielding seeds, fertilizers and water. However, their effective use requires suitable physical and institutional infrastructures. Professor Mellor has specifically mentioned the important role played by infrastructure in the agricultural development of the Punjab in his paper. Infrastructure development and external economies are closely related. Marshall (*Principles of Economics*) maintained that in the long-term development process, the external economies played a key role. External economies accrued to farm-firms in the Punjab with the expansion of infrastructural facilities like irrigation structures, regulated markets, co-operative credit, agricultural research and extension, consolidation of holdings and a network of village and market roads. By the mid-1960s, the Punjab had an infrastructure, both physical and institutional, which could support the introduction of the Green Revolution technology. A salient feature of agricultural growth in the Punjab in the post 1966 years has been the large-scale additions to and strengthening of existing infrastructural facilities as well as the creation of new types of infrastructure, thus generating further external economies.

Keeping in view that agricultural growth strategies have not been successful in some developing countries in Asia and large parts of Africa, as pointed out by Professor Mellor, this session may discuss the factors causing inadequate investments in rural infrastructure and ways and means of accelerating such investment to reap the external economies.

Among three E's, that is equity, energy and ecology, discussed by Professor Mellor in his paper, the line of discussion on the equity aspect of growth has been mentioned above. The introduction of 'new' technologies disrupt the existing ecological balance. It is suggested that fertilizers and pesticides contribute to environmental pollution. Increased use of non-conventional inputs has implications for the energy sector. Similarly, the success of the Green Revolution in certain regions of countries like India has disrupted the interregional balance. Professor Mellor refers to the interregional problems as the 'most intractable structural problem we face'. This Session may also deliberate on these success-related problems while discussing various aspects of structure and patterns of growth.

In conclusion, I may state that the paper presented by Professor Mellor is a fine exposition of the development of the theory and experience of agricultural growth since the 1950s. Professor Mellor is eminently suitable for enlightening this Plenary Session on structure and patterns of agricultural growth because of his long and outstanding contributions towards the theory of agricultural development, evolution of strategy for agricultural and economic development for the developing world, his high professional standing and the recent involvement in directing research from his position as director of the International Food Policy Research Institute. I deem it an honour that I have been asked to comment on a paper by such a distinguished man and I am highly grateful to Professor Kazushi Ohkawa for inviting me to open the discussion.