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CRITERIA FOR THE DESIGN OF AGRICULTURAL DEVELOPMENT STRATEGIES†

Discussion of the policy issues of agricultural development has been dominated by a polarization of opinion on whether the principal objective of policy should be equity or efficiency. This has been particularly evident in India, where the direction in which policy has moved depended largely on which of those two divergent views was ascendent at the time. Underlying this professional schizophrenia has been the assumption that equity and efficiency are separate and necessarily contradictory goals.

THE NEED FOR CRITERIA

This paper seeks to define criteria for assessing alternative strategies for agriculture. W. D. Hopper's contribution to the Rockefeller Foundation's Symposium on "Strategy for the Conquest of Hunger" provides a particularly emphatic statement of the view that agricultural strategies should be based on single-minded pursuit of the goal of increased output. Thus he argues that for countries that cannot afford "the luxury of mixed goals and of uncertain, unproductive policies ...the production of food must be accepted as *the* priority objective...." (*11*, p. 105.) The thesis of this paper is that agricultural strategies can and should be directed at "mixed goals," or as I prefer to express it, multiple objectives. In the next section of the paper I put forward a concept and a set of criteria which, I believe, are useful for that purpose. In this section attention is given to some of the factors that seem to account for the tendency to emphasize the dichotomy

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between efficiency and equity and also to the principal concepts or techniques that have been offered as guides to decision-making related to the development of agriculture in low-income agrarian societies.

It is not hard to see how the polarization of opinion referred to above has emerged. Considering the magnitude of India's food problem, and the crisis of the mid-1960s which followed two years of serious drought, it is not surprising that many of India's decision-makers as well as foreign advisers were impatient with policies that might jeopardize the success of efforts to expand production. But in reacting against certain measures that involve a clear conflict between the goal of increased output and political goals, Hopper along with many others takes the position that any attempt to influence the "form" or "pattern" of agricultural development is virtually bound to have adverse effects on "*the* priority objective" —increased food production. He declares "that if the pursuit of production is made subordinate to other aims, the dismal record of the past will not be altered." As a final example in a "long and depressing" list, he states that "Policies to discourage the development of mechanized agriculture because of its assumed impact upon rural labor-force employment are incompatible with the need for careful timing and precision in farm operations for multiple cropping in areas where growing conditions and the availability of water would permit the harvest of two or three crops per year" (*11*, p. 105). That criteria other than maximization of output might be relevant is not even considered by Hopper.

In his contribution to the *Asian Agricultural Survey*, Hopper emphasizes that "development programs should aim at the application of the latest in science and technology." And he condemns "the placing of restrictive imposts on farm implements of proven productive performance such as tractors and power tillers because they are thought to be 'labor saving' and might cause serious unemployment in the rural economy" as "a confounding of economic and political ends" (*1*, p. 31). Although it is certainly appropriate to emphasize the importance of basing the modernization of agriculture increasingly on scientific knowledge of productive technologies, it is patently impossible for a developing country to apply "the latest in science and technology" except in a highly selective manner. Since Hopper has only one objective in mind, anything favorable to that objective is deemed desirable, and any consideration of other criteria is a "confounding" of goals.

Economists have not given sufficient attention to the special difficulties involved in the task of designing overall strategies for fostering the development of the agricultural sector in late developing countries. Failure to seriously consider that question has been responsible for an inadequate treatment of the agricultural sector in drawing up national development plans. This has contributed to an undue emphasis on applying a one-dimensional scale, such as the rate of return, to decision-making with respect to specific investment projects, individually considered. In recent years efforts have been made to develop more elaborate sector models using linear programming, recursive programming, simulation systems, and other techniques. Erik Thorbecke, an important contributor to those efforts, has concluded on the basis of a critical evaluation of the sector models that have been evolved that "there is still a large gap between what the models can deliver and what the users need and desire for policy-formulation pur-

poses...." And his final conclusion is that sector analysis applied to agriculture is still "more of an art than a science" (*32*, pp. 23, 27).

In practice national planning exercises have mainly emphasized commodity targets and have been aimed at what Finn Reisegg (*31*, p. 462) terms "planning for action," i.e., a detailed attempt to outline a program to be followed and fulfilled. But this emphasis on demand projections for major agricultural commodities, accompanied by crude attempts to estimate the investment and other measures required to achieve the planned targets, appears to be an inappropriate approach to agricultural planning at the national level. Demand projections can be useful, but major emphasis on achieving target "requirements" is misplaced. Usually there is a wide divergence between the targets and what actually takes place. And that of itself is of no great importance. The advent of technical innovations which improve the input-output relations for certain products, for example, may make it highly desirable to overfulfill some targets and underfulfill others. Even for calories, the income and price elasticities of demand in low-income countries are appreciably above zero, probably especially so for consumption changes in an upward direction. And we know that demand for individual commodities is fairly responsive to changes in relative price. Moreover, the possibility of exports or imports introduces some additional flexibility.

The approach that is appropriate at the national level is, in Reisegg's terminology, "planning for decision-making," i.e., analyses aimed at deciding the right approach for solving problems when several alternatives exist—"giving a direction for development rather than the exact result." More specifically, I will argue that for agriculture the fundamental need is to emphasize the design and implementation of strategies that are efficient in achieving the fundamental objectives of agricultural development. Agricultural planning that concentrates on target-setting diverts attention from that more fundamental task. Concentrating on decisions related to specific, narrowly defined investment projects also has serious disadvantages as applied to agriculture. It encourages giving consideration only to those costs and benefits which are easily quantified. And in placing undue reliance on a narrow concept of efficiency, it contributes to the neglect of the mainsprings of agricultural development, notably the development and widespread use of innovations that enhance the productivity of the "internal" resources of labor and land already committed to the agricultural sector. By focusing on specific projects for which costs and returns can be estimated with comparative ease, it also encourages a partial view of the development options available. The result is a tendency to exaggerate the economic returns to be realized from concentrating investments in atypically large operational units that adopt capital-intensive technologies and a consequent neglect of the measures needed to achieve an expansion path for the agricultural sector suited to the factor proportions of a late developing country.

Rate of return or benefit-cost calculations can be of great value in assessing individual projects and in helping to ensure that scarce resources are allocated in directions that will have high payoffs. This type of analysis is, however, subject to important limitations because of the great difficulty of quantifying the returns to a set of complementary activities such as agricultural research, field demonstrations and farmer training programs, and investments in extending or

improving rural roads and in irrigation facilities. The Puebla Project initiated by the International Maize and Wheat Improvement Center (CIMMYT), although termed a "project," is in fact an interesting attempt to implement a strategy for increasing productivity of smallholders in the Puebla region of Mexico by a program of adaptive research emphasizing field trials to determine optimal rates of fertilizer application and other agronomic practices and promotional activities to secure widespread distribution and use of the new cultivation practices. Sufficient data were available concerning the costs of the program and its effects on crop yields to permit Jairo Cano and D. T. Myren to calculate benefit-cost ratios for 1968 and 1969 (*2*). By the second year the estimated benefit-cost ratio had risen to 1.7, and they project an extremely favorable benefit-cost ratio of 7.8 for the period 1970 to 1975. The well-known study by Zvi Griliches (*8*) of the returns to research for the development of hybrid maize in the U.S. can also be cited as an illustration of the difficulties of making even *ex post* estimates and, more important, the magnitude of the potential returns from altering production functions. An additional danger related to the usual project-oriented approach has been noted by A. O. Hirschman (*10*, p. 180). He argues that emphasis on ranking projects according to a one-dimensional scale such as the rate of return, leaving all other considerations to be introduced later as "political" factors, will increase the reliance on *ad hoc* judgments and actually reduce the extent to which decisions will be based on systematic evaluation of alternative courses of action.

Some attention has been given to public investment decisions involving multiple objectives, especially projects that affect both output and income distribution. The usual view, which is in accord with the compensation principle of modern welfare economics, is to argue for "the efficient choice" and then to supplement that decision with "the necessary distributional adjustment through a tax-transfer mechanism" (*26*, p. 804). But where poverty is widespread and fiscal constraints are severe, distributional adjustments through a tax-transfer mechanism will not and can not be carried out on a significant scale. Perhaps even more important, conclusions with respect to "the efficient choice" that relate to maximizing output relative to cost within the context of a given set of production functions may not only have unfortunate effects on the distribution of income but also may be inappropriate in terms of the broader concept of efficiency that should guide the design of strategies for agricultural development.

A minority view which I believe is especially pertinent to the choice of strategy for agriculture has been put forth by Arthur Maass. He argues that government economic programs intended to attain multiple objectives should be designed for such objectives. He notes that even if it can be safely assumed that the supplementary action to achieve the distributional objective will be carried out, "the means by which a desired distribution of income is achieved may be of great importance to the community" (*22*, pp. 214, 215).

Historical experience and the recent breakthroughs associated with the seed-fertilizer revolution demonstrate that the potential for increasing farm output by improving cost-price relationships through altered production functions is very great. To ignore the opportunities that exist to enhance the agricultural sector's productive capacity through investments in research, extension, and irrigation or other key items of infrastructure is to ignore the most promising means

of expanding farm output at minimum cost. Especially in countries that have experienced little structural transformation and have only begun to exploit the potential for technical change, measures that enable an increasingly large fraction of rural households to raise the productivity of their land and labor resources take on special significance.

In late developing countries, questions relating to the choice and timing of a sequence of innovations that lead to increased farm output are of crucial importance. There is a huge gap between the modes of production on which most of their economic activity is based and the enormously more productive technologies currently available. The average farm worker in the United States produces over 40 tons of grain annually compared with grain output per worker in Indian agriculture of one ton or less. The estimates of total farm output per male worker by Yujiro Hayami and V. W. Ruttan indicate a differential of 40 or 50 to 1 in comparing the U.S. and Australia with India and Pakistan (9, Chap. 4). Such differentials are, of course, related to a whole complex of differences in the structure of an advanced economy as compared to the economic structure of a late developing country. A significant indicator of the difference in economic structure is the fact that less than 5 per cent of the American labor force is engaged in agricultural production compared to some 70 per cent in India and Pakistan.

It is not to be assumed that agricultural development in the contemporary developing countries can or should retrace the slow, evolutionary process represented by economic growth in the United States or the countries in western Europe. The cumulative advance of science and the existence of a wide range of highly productive technologies in the developed countries provides the basis for advantages that are potentially very great. The seed-fertilizer revolution is in large measure a product of the advances that have been made in genetics, plant breeding, and other domains of agricultural and general science. And its significance in making possible large and relatively low-cost increases in agricultural output derives in part from progress in developing increasingly efficient manufacturing and mining technologies that have greatly reduced the real cost of chemical fertilizers. But difficult problems arise in the choice and sequential adoption of innovations.

The constraints imposed by shortages of capital and foreign exchange severely limit the rate of investment and the extent to which "the latest in science and technology" can replace existing modes of production over the next 5, 25, or 50 years. Overcoming those constraints is inevitably a slow process. Not only is the attainable rate of physical capital formation limited by the poverty (and limited saving capacity) of the late developing countries, but development also depends on the progressive accumulation of stocks of "capital" embodied in human knowledge and skills and institutions. Moreover, the rapid growth of the population of working age in these countries compounds the difficulty of expanding nonfarm employment opportunities rapidly enough to alter their occupational structure in a relatively short period of time. In a situation in which the total labor force is increasing at a moderate rate of 1 per cent per year, a 3 per cent rate of growth of nonfarm employment would suffice to achieve a "structural transformation turning point" (i.e., where the absolute size of the farm labor force begins to decline) in only 29 years even though agriculture's share of the

total labor force was initially 80 per cent. But with the farm labor force growing at 3 per cent and under the same initial conditions, even a 4.5 per cent rate of growth of nonfarm employment would only suffice to reduce agriculture's share in the labor force to 60 per cent in 50 years and the farm population of working age would still be increasing at an annual rate of nearly 2 per cent (*14*, p. 310).

The use of a "U.S. model," which underlies much of the current thinking about agricultural strategies in less developed countries, encourages undue preoccupation with a narrow view of technical efficiency. In their approach to the problems involved in devising a successful agricultural development strategy, Hayami and Ruttan avoid that trap by placing major emphasis on the role of relative factor prices. Recognizing that "there are multiple paths of technical change in agriculture available to a society," they point out that the rate and direction of technical change will be influenced by the nature of biological and mechanical processes in agriculture, by factor endowments, and by interactions between factor endowments and a country's economic environment as reflected in relative factor prices (*9*, Chap. 3). In particular, they stress that constraints imposed by an inelastic supply of land can be offset by biological-chemical innovations and that those imposed by an inelastic supply of labor can be offset by mechanical innovations. Their general conclusion is that "The ability of a country to achieve rapid growth in agricultural productivity and output seems to hinge on its ability to make an efficient choice among the alternative paths" (*9*, p. 54).

An "induced development model" is the mechanism put forth by Hayami and Ruttan to explain how relative factor prices will guide the behavior of farmers, public policy and research programs, and institutional innovations in the direction of an optimal choice. It is an intriguing model and coincides well with the pattern of agricultural development in the United States and Japan. The crux of the argument is that relative factor prices—and changes in relative factor prices associated particularly with differences in the rates of expansion of factor availabilities—induce not only farmers and firms supplying inputs but also agricultural administrators and research scientists "to search for technical alternatives which save the increasingly scarce factors of production." Although the model coincides well with the pattern of agricultural development in the United States and Japan, the assumptions required for their induced development hypothesis point up its limitations as a guide to policy formulation in contemporary developing countries. They "hypothesize that technical change is guided along an optimum path by the price signals in the market, provided that the prices sufficiently reflect changes in the demand and supply of products and factors and that there exists effective interaction among farmers, public research institutions and private agricultural supply firms" (*9*, p. 57).

The lack of efficient interaction in contemporary developing countries among farmers, public research institutions, and private firms supplying agricultural inputs is one of the more obvious factors that points up the need to supplement their induced development model with a more conscious and systematic consideration of alternative strategies. Because of price distortions, market prices in developing countries often fail to accurately reflect the scarcity of capital and the relative abundance of labor. Moreover, there are cogent considerations that suggest that even without policy-induced distortions the market wage overstates the

social opportunity cost of unskilled agricultural labor. Finally, the overwhelming importance of agriculture in late developing countries means that alternative strategies for promoting agricultural progress are bound to have important repercussions on overall economic growth and structural transformation; and the nature and significance of those interactions and differential effects cannot be assessed simply on the basis of relative factor prices.

An interesting episode in Japan's economic development, reported by Hayami and Ruttan, provides a good illustration of the need for a probing and more conscious examination of the implications of different patterns of agricultural development (*9*, p. 164):

> In the 1880's, under the depression due to the monetary reform by the Finance Minister Masayoshi Matsukata, there was strong agitation for the reduction of the newly established land tax, an essential revenue source for Japanese industrial development. At that time the *Nogakukai* (Agricultural Science Association) issued the *Konoronsaku* (A Treatise on the Strategy of Agricultural Development) in which they rejected the argument for a land tax reduction and advocated "more positive measures to develop agriculture such as agricultural schools, experiment stations, itinerate lectures and agricultural societies" to reduce the burden of farmers. The establishment of the National Agricultural Experiment Station represented the response to this plea. In retrospect the policies advocated by the Agricultural Science Association were remarkably successful.

The decisions that were taken at that time required impressive foresight to initiate the "positive measures" needed to realize the potential that existed for relatively inexpensive gains in agricultural productivity. Elsewhere I have considered at some length two general questions that are illustrated by this "treatise on the strategy of agricultural development," other documents of the Meiji period, and by the success of this development effort: Why were the leaders in Meiji Japan able to make and effectively implement policy decisions which appear to have been so appropriate to the goal of economic development? And why was the response and performance on the part of the mass of the people so energetic? (*14*, pp. 254–65).

It seems clear that an important influence on Japan's policymakers was an awareness of the importance of economic advance on a broad front which was dependent on the decisions and energy of a large number of entrepreneurs, including some five million farm operators, responding to market-determined prices. Japan's first "development plan," a massive document entitled *Kōgyō Iken* or *Advice for the Encouragement of Industry* that was completed in 1884, recognized the importance of improving the functioning of the market economy. It is certainly significant that, with few exceptions, cost-price relationships were not distorted and acted as a spur to efficiency; and policymakers' perceptions of relative factor prices and of changes in those prices certainly must have influenced the design of development strategies.

Studies of the economic policies and programs of the Meiji period make it clear, however, that the insights and objectives that guided policy formulation were shaped by many other factors. The fascinating description and analysis of the *Kōgyō Iken* by Ichirou Inukai and A. R. Tussing emphasizes that Japan's

development strategy was based on careful study of the strengths and weaknesses of the economy, a recognition of the need "to begin with undertakings which were familiar to the people and small of scale," awareness of the advantages of fostering advances in productivity based on research and diffusion of new technical knowledge and new equipment or inputs among a host of small-scale enterprises, and a realistic appreciation of the role of agriculture in achieving national goals.[1] Inukai and Tussing emphasize that "The planners understood that Japan had to become an industrial and military power by her own resources, and that virtually her only resources were her indigenous industries and abundant labor. If development was to occur, it had to reflect the planning of the governing elite, but it was the people themselves who had to do the practical innovating and the work" (*12*, pp. 34–35). The choice and successful implementation of an agricultural strategy that emphasized widespread increases in productivity within the framework of the existing small-scale, labor-intensive agriculture permitted a satisfactory rate of expansion of output with minimal demands on scarce resources. Hence it was possible for the agricultural sector to shoulder a large part of the burden of financing the industrial development and increase in military strength that were major national goals of the period.

Many of the goals that influenced the leaders of Meiji Japan were determined by a specific constellation of historical, socio-political, and psychological factors, although the "reactive nationalism" that was a powerful motivating force is certainly not unique to Japan. Policy formulation in any country is bound to be influenced by objectives and constraints determined by unique features of its history and resource endowment. There are, however, certain objectives of an agricultural strategy that would appear to be relevant to all late developing countries, and in the next section I single out four objectives that appear to merit explicit consideration in assessing alternative strategies.

THE MULTIPLE OBJECTIVES OF AGRICULTURAL STRATEGIES AND THE CONCEPT OF TOTAL EFFICIENCY

It has long been recognized that in spite of its central position in economic theory the concept of efficiency is subject to theoretical and empirical complications. L. J. Lau and P. A. Yotopoulos have recently emphasized that in spite of its elusiveness, the concept of economic efficiency has important policy implications that apply to both the micro- and macro-economic level (*20*, p. 94). They present a concise review of the conceptual and empirical difficulties that characterize existing approaches, for example, comparisons of the marginal productivity and opportunity cost of various inputs based on production function analysis. Their own approach is to use a profit function for comparisons of relative economic efficiency. On the basis of an empirical analysis, using a profit function specified according to a Cobb-Douglas functional form and data derived from farm management studies carried out in India during the late 1950s, they reach the conclusion that the relative economic efficiency of small farms (less than ten acres) is higher than for large farms. In the context of their analysis, this means that small farms attain higher levels of price efficiency and/or they operate at

[1] The phrase in quotation marks is from a prefectural report of the Meiji period quoted by Inukai and Tussing (*12*, p. 9).

higher levels of technical efficiency. Their results thus confirm the findings of earlier studies based mainly on partial productivity measures.

Although it is clearly desirable to consider the general concept of economic efficiency rather than focusing only on technical or price efficiency, it is essential to consider an even broader concept of efficiency in assessing alternative strategies for agricultural development. The approach set forth in this section is similar to the Hayami-Ruttan induced development model in emphasizing the importance of the dynamic process of technical change that can lead to shifts in production functions resulting in highly significant increases in total factor productivity. In addition to affecting the rate of increase in factor productivity, the choice and timing of agricultural innovations will have significant effects on a number of other important and interrelated objectives.

The historical experience in a number of countries, and the recent technical breakthroughs of the Green Revolution, justify major emphasis on increases in factor productivity. It is, however, the experience of Japan and Taiwan that is especially useful in demonstrating that an *appropriate* sequence of innovations based on modern scientific knowledge and experimental methods makes possible an expansion path for the agricultural sector that is characterized by large increases in factor productivity *throughout* the agricultural sector. Such a strategy enables a widening fraction of the working population in agriculture to be associated with increasingly productive technologies, based mainly on expanded use of purchased inputs that are divisible and neutral to scale. It is because the new inputs of seed and fertilizer, that are the essence of the Green Revolution, are complementary to the large amounts of labor and land already committed to agriculture that these increases in factor productivity can have such a large impact on total farm output. At the same time, by involving an increasingly large fraction of the rural population in the process of technical change, such a strategy means that the fruits of economic progress are widely shared.

The thrust of this argument is that it is possible and desirable to devise and implement agricultural strategies which are efficient in terms of a number of objectives, including but not confined to the objective of achieving desired increases in farm output at low cost. The following objectives, which are examined later in some detail, seem to be especially relevant to the design of strategies for agriculture that are efficient in this broad sense:

(1) Contributing to the overall rate of economic growth and the process of structural transformation,

(2) Achieving a satisfactory rate of increase in farm output at minimum cost by encouraging sequences of innovations which exploit the possibilities for technical change most appropriate to a country's factor endowments,

(3) Achieving a broadly based improvement in the welfare of the rural population, and

(4) Facilitating the process of social modernization (including the lowering of birthrates, the extension and improvement of rural education, and the strengthening of entrepreneurial capacities) by encouraging widespread attitudinal and behavioral changes among farm households.

I believe that it is useful to assess the "total efficiency" of alternative agricultural strategies in terms of their relative success in achieving those four objectives.

The concept of total efficiency is, quite obviously, difficult to define operationally. That is inherent in the nature of the problem. But the problem must be confronted because only when a country's agricultural strategy is efficient in this broad sense is the trade-off between the goal of increased output and other objectives likely to be minimized. Indeed, it is my contention that with an agricultural strategy that is designed with those multiple objectives in view, the trade-off is likely to be small or nonexistent.

A country's overall strategy for agriculture is a composite of substrategies relating to research, education, water resources development, promotion of farmers' organizations, marketing and price policy, credit and the distribution of inputs, agricultural taxation, land tenure, policies affecting the nature and pace of mechanization, and other elements. The total efficiency of the strategy depends on the complementarities among those various activities and the quality of implementation as well as decisions with respect to the allocation of funds and personnel and policies for individual substrategies. Rational decision-making is complicated by insufficient knowledge about a large number of interacting variables, including the response of farmers to changes in the technical and economic environment in which they operate. This lack of knowledge can be reduced, but not eliminated, by research and systematic analysis. Certainly at the present time, it is difficult to quarrel with Erik Thorbecke's conclusion that sector analysis applied to agriculture is more of an art than a science (*32*). This is a disturbing situation because it implies that various practitioners of the art will have different conceptions of a suitable strategy, and there are no generally accepted criteria for choosing among alternatives. It is believed, however, that evaluation of alternative strategies in relation to the four objectives listed earlier offers useful guidance in the unavoidably complex exercise of designing a strategy for agricultural development, including the choice between the polar alternatives of a "unimodal" and "bimodal" approach.

The Choice Between Unimodal and Bimodal Agricultural Strategies

The most fundamental issue of agricultural strategy faced by the late developing countries is to choose between a bimodal strategy whereby resources are concentrated within a subsector of large, capital-intensive units or a unimodal strategy which seeks to encourage a more progressive and wider diffusion of technical innovations adapted to the factor proportions of the sector as a whole. The essential distinction between the two approaches is that the unimodal strategy emphasizes sequences of innovations that are highly divisible and largely scale-neutral. These are innovations that can be used efficiently by small-scale farmers and adopted progressively. A unimodal approach does not mean that all farmers or all agricultural regions would adopt innovations and expand output at uniform rates. Rather it means that the type of innovations emphasized are appropriate to a progressive pattern of adoption in the twofold sense that there will be progressive diffusion of innovations within particular areas and extension of the benefits of technical change to new areas as changes in environmental conditions, notably irrigation facilities, or improved market opportunities or changes in the nature of the innovations available enable farmers in new areas to participate in the process of modernization. Although a bimodal strategy

entails a much more rapid adoption of a wider range of modern technologies, this is necessarily confined to a small fraction of farm units because of the structure of economies in which commercial demand is small in relation to a farm labor force that still represents some 60 to 80 per cent of the working population.

The late developing countries face a wide choice of farm equipment embodying large investments in research and development activity in the economically advanced countries. The performance characteristics of these machines are impressive, and representatives of the major manufacturing firms in the economically advanced countries are experienced and skillful in demonstrating their equipment. And they now have added incentive to promote sales in the developing countries to more fully utilize their plant capacity which is large relative to domestic demand (mainly a replacement demand since the period of rapid expansion of tractors and tractor-drawn equipment in the developed countries has ended). The availability of credit under bilateral and international aid programs temporarily eliminates the foreign exchange constraint to acquiring such equipment; and when such loans are readily available it may even appear to be an attractive means of increasing the availability of resources—in the short run. Within developing countries there is often considerable enthusiasm for the latest in modern technologies. But little attention is given to research and development activity and support services to promote the manufacture and wide use of simple, inexpensive equipment of good design, low import content, and suited to the factor proportions prevailing in countries where labor is relatively abundant and capital scarce.

In most of the contemporary developing countries the measures adopted for the purpose of accelerating industrialization have included highly protective tariffs and import quotas, and also investment licensing and regulation of interest rates that financial institutions are permitted to pay on deposits and charge borrowers. The price distorting effects of these measures have probably been the major factor giving rise to large discrepancies between the private and social profitability of investment decisions. In particular, the underpricing of capital and foreign exchange, and the consequent reliance on administrative rationing of those scarce resources, intensifies the need for systematic assessment of alternative development strategies, perhaps most conspicuously in connection with the choice of policies affecting the agricultural sector. In many developing countries the various interventions have represented a mix of policies for achieving what K. M. Marsden has aptly described as a "crash modernization strategy." Such a strategy is based on the view that "modern advanced technology and organization are synonymous with economic development" and the government therefore "seeks to equip the labour force, or at least part of it, with the most up-to-date tools as quickly as possible" (*23*, p. 391). For the reasons noted earlier, in a country with a large and growing labor force in traditional agriculture and other backward sectors such a strategy means that for many decades the advanced sector with its high capital-labor ratios, high labor productivity, and relatively high wages will comprise only small enclaves of modern industry and agriculture.

For many branches of manufacturing, the technical coefficients for efficient production are fairly rigid. If a developing country chooses, for example, to undertake local manufacture of nitrogen fertilizer, it can ill-afford not to opt for the

large-scale, highly capital-intensive processes that are required for low-cost production. It is sometimes argued, implicitly or explicitly, that in agriculture also efficient production requires the concentration of resources in a subsector of untypically large and capital-intensive enterprises.

A recent monograph by W. F. Owen (*28*) presents an extraordinarily explicit presentation of the case for a "bimodal" agricultural strategy. He argues that "sound development policy, as well as more relevant research in the social sciences, likely needs to be based on an explicit recognition of two quite distinct rural sectors: a 'modernized' or 'commercial farming sector' and a 'transitional' or 'surplus population–supporting sector.'" The commercial farmers, defined rather arbitrarily as those "capable of generating from the production and sale of farm commodities a continuing standard of living comparable to that earned by skilled workers in the modernized urban-industrial sector," would "include only a small proportion of the entire farming population." He goes on to assert that "it may be posited as a basic condition of economic growth in all countries that most of the available land resources should be incorporated in this commercial subsector" (*28*, pp. 3–4).

Farms in the commercial subsector, which in his view should account for virtually all of the marketed surplus, should be of "optimum size" which he defines "as the *maximum amount of land* that a qualified farmer can fully exploit based on the most advanced standards of farm technology compatible with the particular stage of development of the country concerned. Such a standard will normally tend to express itself around a given item of farm power, for example, a donkey, buffalo, small cultivator, or a tractor, and in the form of associated cultivating and harvesting equipment and compatible variable inputs" (*28*, p. 30). In accordance with experience in the United States, he stresses that "an upward adjustment in the area size of commercial farms" is to be expected. "The only question," he suggests, "is whether the transition should be gradual or . . . involve large discrete technological jumps. . . ." He offers no criteria for resolving that question beyond his proposition that there should be "two entirely different optimal conditions with respect to size of farms in the two different rural sectors." But his preference is suggested by the observation that he "personally finds it hard to be convinced that a jump from the donkey to the tractor is any less merited in the *commercial farming sectors* of less developed countries than its more dramatic but more widely accepted equivalent in urban-industrial development" (*28*, pp. 30, 31).

Owen's monograph is unusual for the way in which it faces up to the implications of the bimodal strategy which he advocates. He recognizes that because of rapid growth of population and labor force and the limited absorptive capacity for labor in industry or commercial agriculture "the numbers of people dependent for their survival upon the rural transitional sector will increase in most of these countries for at least several decades to come." He asserts that land assigned to the "surplus population–supporting sector" of agriculture "deserves to be rationed as strictly as funds devoted to other welfare programs. . . ." Later he adds that "for maximum efficiency in its welfare role, the size of farming plots in this sector must be kept small enough to support a considerably higher intensity of labor input per unit of land than that applying in the commercial farm-

ing sector of the same country." Owen even argues that there should be maximum possible distance between the transitional and the commercial sector; and in his view one criticism that could be leveled against a bimodal strategy is that it might "be impossible to prevent cheap labor from the rural transitional sector from flowing into the commercial farming sector and that the availability of this cheap labor destroys the case for any significant degree of mechanization of production in the commercial sector" (*28*, pp. 5, 8, 13, 39). (Thus it appears that Owen has in mind an objective other than cost minimization, although he does not clarify that objective.)

Owen dismisses the idea that the small-scale farm units of the "transitional sector" might pursue a course of progressive modernization based on gradually increasing commercial sales and use of purchased inputs as a "myth." "If the majority of the population concerned is transitional to anything," he declares, "it can only be to potential non-farming employment opportunities, irrespective of how difficult this potential may be to realize" (*28*, p. 7). He suggests that greater emphasis should be given "to the development of cottage and light industries and . . . also to relatively more labor-intensive industrial developments in these countries" (*28*, pp. 24, 41). But agriculture, apart from the commercial subsector, is simply a "surplus population–supporting sector."

The views of Owen have been examined at length because they express explicitly a viewpoint that dominates a great deal of implicit theorizing and a pattern of agricultural development that seems to be emerging in an increasing number of developing countries. The historical experience of Japan and Taiwan demonstrates, however, that a bimodal pattern is not an inevitable outcome.[2] It is a pattern that is being determined to a considerable extent by economic policies that distort price signals and by failure to take the positive measures that would encourage a unimodal strategy of progressive modernization of agriculture.

Considered in the context of the multiple objectives of an agricultural strategy, a unimodal approach appears to have significant advantages with respect to "total efficiency" as well as in its effects on income distribution and equity. But before examining those multiple objectives, and the interrelationships among them, in terms of their relevance to the choice of strategy for agriculture, it will be useful to clarify the differences between the two strategies by means of a unit isoquant diagram. M. J. Farrell used this device to define the concepts of technical, price, and economic efficiency, but it also serves as a useful expositional device for clarifying how the "total efficiency" of the agricultural sector's expansion path is influenced by the new production possibilities that become available (*7*).[3]

Points on the diagrams represent the combinations of inputs used by different firms per unit of output. By joining the points that represent the minimum input

[2] In a recent journal article Owen asserts (*29*, p. 653): "In spite of all the eulogies to peasant farming—and none better has been provided in economic literature than that of John Stuart Mill—no country has yet satisfied both of these developmental imperatives—the support of surplus farm people and the production of surplus farm products—on the same type of farms." It would be interesting to see how he would dismiss the contrary evidence represented by experience in Japan and Taiwan.

[3] I am indebted to John M. Page, Jr. and Peter Warr for the preparation of this section elucidating the concepts of unimodal and bimodal strategies by use of Farrell's concepts and their extension by C. Peter Timmer.

combinations an envelope curve is drawn so that no observation lies between the envelope and the origin. The frontier thus defined represents the least quantities of inputs required per unit of output; firms whose input combinations lie on that frontier isoquant are said to be technically efficient. All other firms are described by points lying within the envelope. A curve fitted to such points can be defined as the "average isoquant" (*33*, Chap. 4). For expositional purposes we imagine that all firms other than frontier firms lie on this average isoquant and employ an "average technology."

In Chart 1 the frontier and average isoquants are labeled F_t and A_t respectively. On both isoquants price efficient firms employ the combination of inputs indicated by the tangency of the relative price line PP with the isoquant.

A bimodal strategy in agriculture involves capital-intensive technical change within a modernized subsector. A unimodal strategy involves progressive technical change which only gradually increases the degree of capital-intensity and which involves the entire agricultural sector. These differences are represented in Charts 2 and 3.

As in Chart 1, A_t and F_t represent the average and frontier isoquants prior

CHART 1

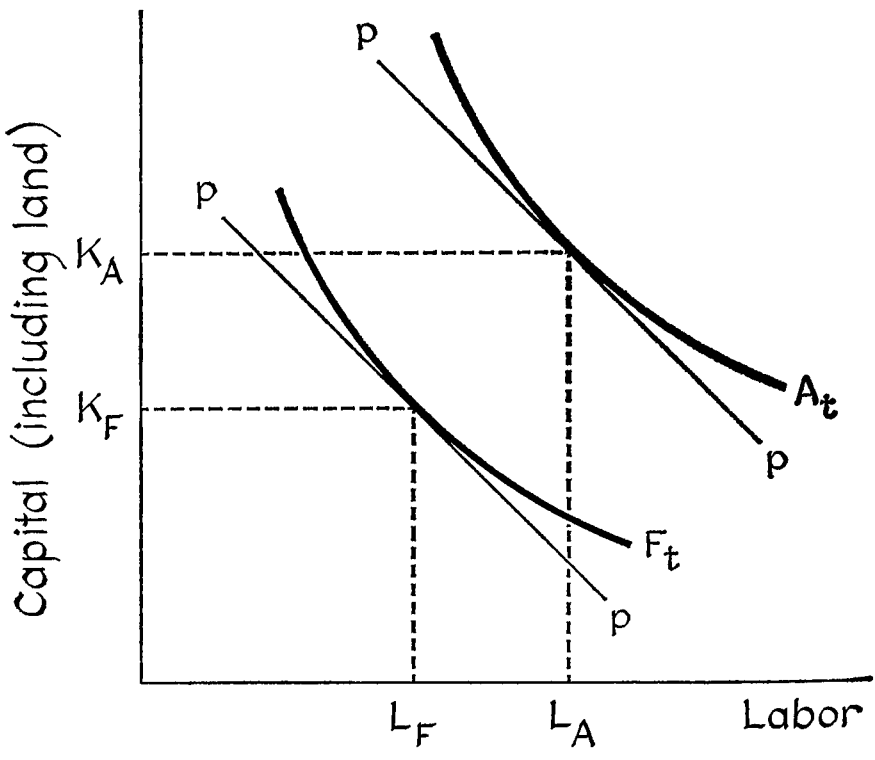


CHART 2

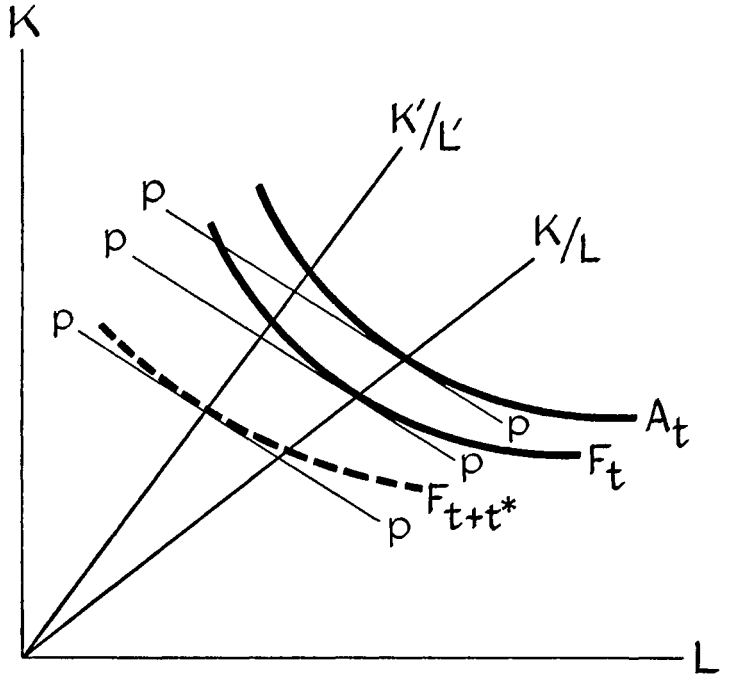
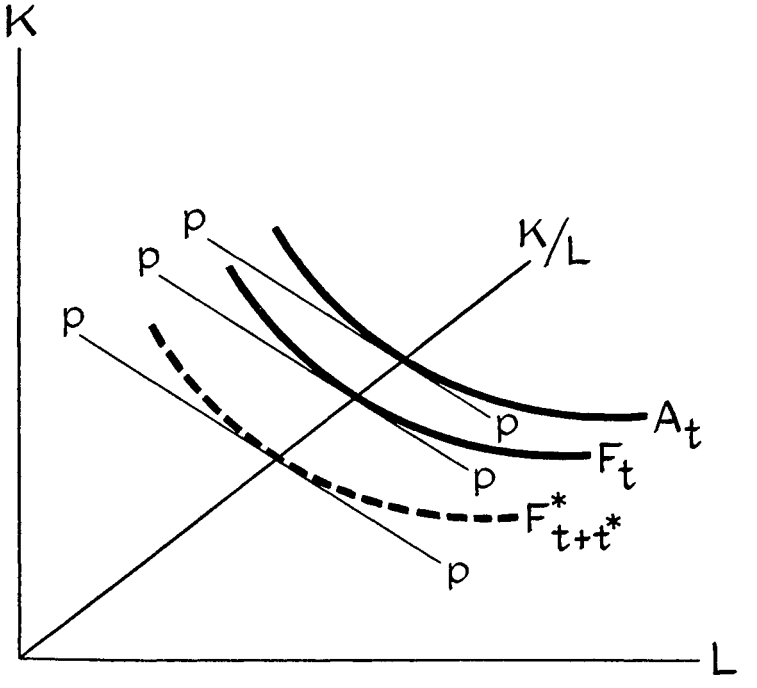


CHART 3



to the technical change. In Chart 2, F_{t+t^*} represents the new frontier isoquant after a capital-using bimodal strategy has been introduced. In Chart 3, $F^*_{t+t^*}$ represents the frontier isoquant associated with widespread introduction of improved seed-fertilizer combinations and the investments in research, training, and infrastructure emphasized by a unimodal strategy. Inasmuch as these are innovations that can be used efficiently by small, labor-intensive farm units using only limited quantities of purchased inputs, there will also be an inward shift of the average isoquant. To simplify the diagram, it is assumed arbitrarily that the new average isoquant, A_{t+t^*}, now corresponds to the position of the old frontier isoquant.

Under identical relative factor prices (represented by the price line PP) the bimodal strategy involves a much higher capital to labor ratio in those firms that have access to the land and capital that makes it possible for them to operate on the frontier isoquant.[4] Consequently, the bimodal strategy results in substantial differences in the factor proportions employed by average and best firms as indicated by the slopes of the K/L and K′/L′ rays in Charts 2 and 3.[5] In fact, it is to be expected that the K/L ratio for the remaining farm units will be considerably less than would be possible under a unimodal strategy because of the concentration of purchased inputs in an atypically capital-intensive subsector if a bimodal strategy is pursued.

The rate at which the agricultural sector as a whole moves from the original average isoquant, A_t, toward the new frontier isoquant, F_{t+t^*} or $F^*_{t+t^*}$, depends on the rate of diffusion of technological change including the use of purchased inputs required by the new technology. The strategy chosen by governments in promoting agricultural development can have a significant influence on the pace and especially on the nature of this diffusion process. As structural change takes place and farm firms make the transition from predominantly subsistence production to commercial farming, there is a progressive increase in their ability and need to use purchased inputs.

Under a bimodal strategy frontier firms with their high capital to labor ratio would account for the bulk of commercial production and would have the cash income required to make extensive use of purchased inputs. Inasmuch as the schedule of aggregate commercial demand for agricultural products is inelastic and its rightward shift over time is essentially a function of the rate of structural transformation, to concentrate resources within a subsector of agriculture inevitably implies a reduction in the ability of farm households outside that subsector to adopt new purchased inputs and technologies. In addition, the high foreign exchange content of many of the capital inputs employed in the frontier sector implies a reduction in the amount of foreign exchange available for imported inputs for other farm firms (or for other sectors). It is, of course, because of these purchasing power and foreign exchange constraints that it is impossible for the

[4] Some of the atypically large and capital-intensive firms will, of course, operate at points within the frontier isoquant.

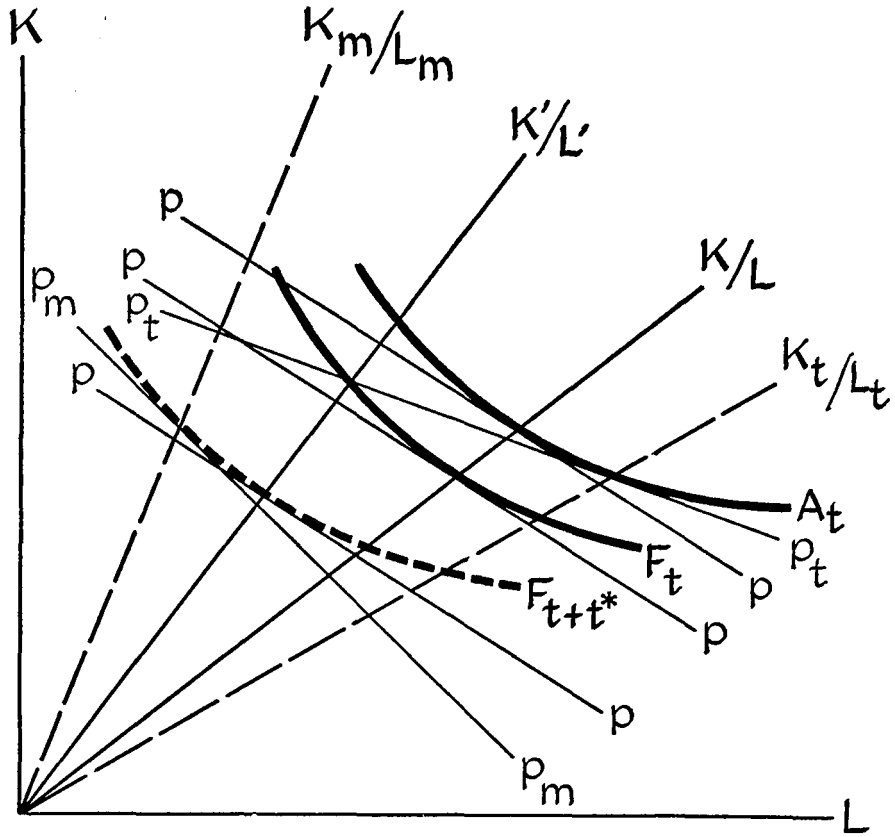
[5] The fact that the unit isoquants in Chart 3 are drawn so that A_t, F_t, and $F^*_{t+t^*}$ have the same K/L ratios is, of course, arbitrary. It is conceivable, however, that the saving in land inputs per unit of output with land-augmenting innovations such as improved seed-fertilizer combinations would leave the K/L ratio more or less unchanged since K is defined to include all forms of capital, including land.

agricultural sector as a whole to pursue a crash modernization strategy. It might be argued that a proper farm credit program could eliminate the purchasing power constraint, but the availability of credit (assuming that repayment takes place) merely alters the shape of the time horizon over which the constraint operates. And capital and government revenue are such scarce resources in a developing country that government subsidy programs are not feasible means of escaping from this constraint. In brief, bimodal and unimodal strategies are to a considerable extent mutually exclusive.

Under the bimodal approach the divergence between the factor intensities and the technical efficiency of "best" and average firms is likely to become progressively greater as agricultural transformation takes place. Moreover, both the initial and subsequent divergences between the technologies used in the two sectors are likely to be accentuated because the factor prices, including the price of imported capital equipment, faced by the modern sector in contemporary developing countries typically diverge from social opportunity cost. This divergence is obvious when subsidized credit is made available on a rationed basis to large farmers and when equipment can be imported with a zero or low tariff at an official exchange rate that is overvalued. In addition, the large-scale farmers depend on hired labor rather than unpaid family labor. The wages paid hired labor may be determined by minimum wage legislation, and even without a statutory minimum the price of hired labor is characteristically higher than the opportunity cost of labor to small farm units. Market wage rates tend to reflect the marginal productivity of labor in peak seasons, and even in those seasons jobs are likely to be rationed to some extent. This underpricing of capital (and foreign exchange) and overpricing of labor means that the relevant price line facing the "modern" subsector will be the steeper line P_mP_m shown in Chart 4. Various factors, including policies which repress instead of foster the healthy growth of financial intermediaries, would tend to raise the price of capital to the traditional sector above the social opportunity cost of capital, resulting in an opposite bias in relative factor prices as represented by the price line P_tP_t. The price distortions would thus accentuate the divergence in capital–labor ratios caused by biased technical change; this greater difference would be represented by the K_m/L_m and and K_t/L_t rays for the modern and traditional sectors respectively.

Under the unimodal strategy with its emphasis on highly divisible and scale-neutral innovations, the best firms in the agrarian sector display essentially the same factor intensities as average firms. Interfarm differences in performance will be large, especially during transitional periods as farmers are learning how to use new inputs efficiently, but this will reflect mainly differences in output per unit of input rather than major differences in factor proportions. Inasmuch as the expansion path for the agricultural sector associated with a unimodal strategy implies a level of capital intensity and foreign exchange requirements that are compatible with a late developing country's economic structure, more firms within the agricultural sector are able to expand their use of fertilizer and the other divisible inputs that dominate purchases under this strategy. Thus, the diffusion of innovations and associated inputs will be more broadly based, and the divergence in factor intensities between frontier firms and average firms will be moderate.

CHART 4



Although the foregoing has emphasized the contrast in the pattern of technical change, it is apparent that the two strategies will have significantly different impacts on many dimensions of economic and social change. Most obvious are the differences in the nature of demand for farm inputs, but the structure of rural demand for consumer goods will also be very different under a unimodal as compared to a bimodal strategy.

A major difference in income distribution is to be expected because of the likelihood that under a bimodal strategy the difficult problem of absorbing a rapidly growing labor force into productive employment would be exacerbated whereas under a unimodal strategy there is a good prospect that the rate of increase in demand for labor would be more rapid than the growth of the labor force. Underemployment and unemployment would thus be reduced as a result of wider participation of the rural population in improved income-earning opportunities. This improvement in income opportunities available to members of the rural work force would result in part from increased earnings as hired labor since rising demand for labor would tend to raise wage rates and the number of days of work available during the year for landless laborers and for very small farmers whose incomes derive to a considerable extent from work on farms that are above average size.

Most important, however, would be the increased incomes earned by farm households cultivating their own or rented land. The extent to which tenants would be able to share in the increased productivity resulting from yield-increasing innovations will be determined by forces considered later in a section discussing land reform as an aspect of broadly based improvement in the welfare of the rural population. Basically, however, it will depend upon the rate of growth of the rural population of working age seeking a livelihood in farming or in nonfarm activities relative to the rate of expansion of income-earning opportunities. The latter will be influenced strongly by the demand on the part of landowners for labor "hired" indirectly through tenancy arrangements, or hired directly as laborers on owner-operated farms.

Much of the discussion of agricultural policy in India and Pakistan has tended to ignore or deny the fact that rapid mechanization of field operations is tantamount to choosing a bimodal strategy and relegating the bulk of the agricultural population to a "surplus population–supporting sector." S. S. Johl, for example, argues that in all likelihood there is no conflict between rapid increase in the use of mechanical power and the expansion of employment and income-earning opportunities (*13*, p. 32):

> In balance there seem to be few arguments, logic or facts that should cast doubts on economic feasibility of substituting totally inefficient animal draft power with mechanical power in agriculture of the developing countries, which will generate positive interaction with other elements of improved production technology, creating more demand for human labor, and also improving its productivity, wage rates as well as productivity and returns to all other factors of production.

Earlier in the paper he concedes that under certain conditions tractor mechanization might lead to a widening of interfarm and interregional income disparities. But in line with the compensation principle, he argues that that "should not create much of a worry" since the increased income "can be distributed equitably through a well structured system of taxation and transfer payments" (*13*, p. 30).

Johl expresses a viewpoint that is widespread and influential in many developing countries and among agricultural specialists in bilateral and international aid-giving agencies. My reading of the relevant evidence is that this viewpoint is based on a misleading, partial view of the "positive interaction" between agricultural strategy and other dimensions of development. Special circumstances in the Punjab and an underlying disequilibrium situation seem to have conditioned Johl's views. Three points can be mentioned briefly.[6] First, the large scope for import substitution, supported by government purchase operations to minimize price declines, has given the illusion that the effective demand for increased agricultural output is essentially unlimited. Secondly, the Punjab and a few other areas have been able to expand agricultural production and commercial sales so rapidly that the direct increase in demand for farm labor, together with the increase outside agriculture due to the secondary and tertiary effects of this expansion of farm cash incomes, have been exceptionally rapid. In fact, it

[6] These are set forth in more detail in *16*, Chaps. IV and VI.

is surprising that there have not been really acute labor shortages and a very large rather than moderate increase in real wages. Thirdly, up to the present time the most important type of investment in mechanization has been in tubewells and other pumps which, together with substantial expansion of the area served by canal irrigation, has permitted a large increase in cultivated area and an even larger increase in planted area because of increased multiple cropping. And these developments have meant increased demand for labor for land development and for crop production additional to the increases in labor requirements associated with the rapid increases in crop yields resulting from the seed-fertilizer revolution.[7]

Decisions with respect to appropriate policies to influence the balance between investments in large-scale farm equipment, as epitomized by tractors and combine harvesters, versus expanded investment to increase the capacity of millions of small-scale, labor-intensive farm units to take advantage of the seed-fertilizer revolution are the key issue of agricultural policy in most of the late developing countries. It was suggested earlier that the "total efficiency" of such alternatives should be assessed in terms of their effects on multiple objectives.

The Multiple Objectives of an Agricultural Strategy

In the paragraphs that follow I comment briefly on some of the reasons why the design of an efficient strategy for agriculture should be guided by explicit consideration of four major objectives of an agricultural strategy and the interrelationships among them. In the monograph cited earlier, Kilby and I have examined these objectives in greater detail, giving particular attention to the interactions between agriculture and the growth of local manufacturing which, we believe, lies at the heart of the structural transformation of a predominantly agrarian economy (*16*).

Contributions to overall economic growth and structural transformation.— It is conventional when considering agriculture's role in economic development to catalog a number of specific "contributions." Several of these contributions imply a net transfer of factors of production out of the agricultural sector as the process of structural transformation takes place. Typically the farm sector provides foreign exchange, public and private investment resources, and labor to the more rapidly expanding sectors of the economy as well as increased supplies of food and raw materials to support a growing urban population and manufacturing sector.

These contributions are, of course, synonymous with the increased sectoral interdependence that characterizes a developing economy. Outward labor migration and increased farm purchasing power are synchronized with the growing importance of commodity flows between agriculture and other sectors: a flow of food and raw materials out of agriculture and a return flow of farm inputs and

[7] In the years between 1950/51 and 1965/66, before the new varieties were a factor, wheat production in the Punjab increased at an annual rate of 5.5 per cent and increases for other important crops—sugarcane, rice, maize, and groundnuts—were even higher (*18*, pp. 3–5). The *annual* increases in wheat production in 1967/68 and 1968/69, the first two years of rapid spread of the high-yielding varieties, were 36 and 35 per cent respectively. Wheat production in 1969/70 was 4.9 million tons, only up 10 per cent from the year before; but that was twice the level in 1966/67 which had been a record crop.

consumer goods from the manufacturing sector. Tertiary activities of government, transport, marketing and other service industries expand to meet the needs of individual sectors and to facilitate the linkages between them.

Agricultural exports have special significance here for two reasons. First, in countries that have experienced little structural transformation there are usually few alternative means of meeting the growing demands for foreign exchange that characterize a developing economy. Secondly, expanded production for export makes it possible to enlarge farm cash incomes when the domestic market for purchased food is still very small, and at the same time it provides a stimulus and the means to establish some of the physical infrastructure and institutions that are necessary for the creation of a national, market-oriented economy.

The structure of rural demand for farm inputs associated with alternative agricultural strategies exerts an important influence on the growth of local manufacturing as well as on the pattern of productivity advance within agriculture. I emphasize the composition of this demand because the capacity of the agricultural sector to purchase inputs from other sectors is powerfully constrained by the proportion of the population living outside agriculture. Pathological growth of population in urban areas only loosely related to the growth of off-farm employment opportunities is a conspicuous and distressing feature of many of the contemporary less developed countries, but basically this growth of urban population depends on the transformation of a country's occupational structure that is a concomitant of economic growth.

The nature of the linkages between agriculture and the local manufacturing sector and the seriousness of foreign exchange and investment constraints on development will be influenced significantly by the structure of rural demand for both inputs and consumer goods. Because of their differential effects on the sequence of innovations and on rural income distribution, a bimodal and a unimodal strategy will differ greatly in their aggregate capital and foreign exchange requirements.

The more capital-intensive bimodal strategy emphasizes rapid adoption of mechanical innovations such as tractors along with chemical fertilizers and other inputs essential for increasing crop yields. Even if that type of machinery is manufactured locally, the foreign exchange requirements for capital equipment and for components are high, and the production processes require a high level of technical sophistication, large plants, and capital-intensive technologies.

The unimodal strategy with its emphasis on mechanical innovations of lower technical sophistication and foreign exchange content, such as improved bullock implements and low-lift pumps, appears to offer greater promise for the development of local manufacturing which is less demanding in its technical requirements and which is characterized by lower capital–labor ratios and lower foreign exchange content. On the basis of experience in Japan and Taiwan as well as an analysis of the nature of the supply response to the two patterns of demand, it seems clear that a unimodal strategy will have a much more favorable impact on the growth of output and especially on the growth of employment in local manufacturing and supporting service industries. The reasons cannot be pursued here except to note the wider diffusion of opportunities to develop entrepreneurial and technical skills through "learning by doing" that leads to increasing compe-

tence in manufacturing. Progress in metalworking and in the domestic manufacture of capital goods are especially significant because they are necessary to the creation of an industrial sector adapted to the factor proportions of a late developing economy. (See *16*, Chap. IV; *19*.)

Increasing farm productivity and output.—The differences in farm productivity between modern and traditional agriculture are, of course, to be attributed mainly to their use of widely different technologies. Those differences in turn are based on large differences in their use of fixed and working capital and associated differences in their investments in human resources that affect the level and efficiency of agricultural research and other supporting services as well as the knowledge, skills, and innovativeness of the farm population.

The importance of distinguishing between inputs and innovations that are mainly instrumental in increasing output per acre and those that make it possible for each farm worker to cultivate a larger area has already been noted. Biological and chemical innovations increase agricultural productivity mainly through increasing yields per acre. In general the effect on yield of farm mechanization *per se* is slight, although certain mechanical innovations, notably tubewells and low-lift pumps may be highly complementary to yield-increasing innovations. Indeed, for some high-yielding varieties, especially rice, an ample and reliable supply of water is a necessary precondition for realizing the genetic potential of the new varieties. This distinction between yield-increasing and labor-saving innovations is significant because the relative emphasis given to these two types of innovations largely determines whether development of agriculture will follow a unimodal or bimodal pattern.

The thrust of a unimodal strategy is to encourage general diffusion of yield-increasing innovations and such mechanical innovations as are complementary with the new seed-fertilizer technology. The bimodal strategy emphasizes simultaneous adoption of innovations that increase substantially the amount of land which individual cultivators can efficiently work in addition to the yield-increasing innovations emphasized in the unimodal approach.

For reasons discussed above, it is not possible for developing countries to pursue the unimodal and bimodal options simultaneously. In placing emphasis on reinforcing success within a subsector of large and capital-intensive farms, a bimodal strategy may have an advantage in maximizing the rate of increase in the short run because it bypasses the problems and costs associated with involving a large fraction of the farm population in the modernization process. In a longer view, however, a unimodal strategy appears to be more efficient, especially in minimizing requirements for the scarce resources of foreign exchange and loanable funds. Because of the scope that exists for obtaining widespread and substantial increases in the productivity of the relatively abundant resources of labor and land, and of other farm-supplied resources such as draft animals that are internal to the agricultural sector and often to the farm unit, the potential impact on aggregate farm production is very large. Calculations which purport to substantiate the view expressed by Johl concerning the substitution of "totally inefficient animal draft power with mechanical power" tend to ignore this potential for enlarging output through fuller and more productive utilization of internal inputs which have low opportunity cost in economies where little structural trans-

TABLE 1.—PERCENTAGE OF AGRICULTURE IN TOTAL LABOR FORCE IN SELECTED YEARS*

	1830	1880	1900	1920	1940	1950	1960	1968
United States	71	51	40	26	17	12	8	5
Japan	...	76	66	52	48	47	31	19
Taiwan	...	...	71	70	62	61	56	49
India	...	...	...	...	...	72	73	...
Pakistan	...	...	...	...	...	76	74	...

* See *16*, Table 2 and Appendix Tables I–V, for data sources.

formation has taken place. The historical experience summarized in Table 1 suggests that change in the occupational structure of a developing country is a slow process, and the rapid growth of the population of working age that now prevails makes it extremely difficult to accelerate the process.

Attempts to quantify the impact of the spread of high-yielding varieties and increased use of fertilizers in West Pakistan and in the Indian Punjab make it clear that the potential increases in grain production are very large indeed (*15*; *30*). The projections for West Pakistan, where environmental conditions for the introduction of the new varieties of wheat and rice are admittedly especially favorable, indicate that even with an essentially bullock-powered agriculture the output of those two crops could expand from about 8 million tons in 1969/70 to 22 million tons in 1984/85 if prices remain at levels that sustain reasonably favorable product to input ratios. But on the basis of the projected increase in domestic demand for wheat and rice, to realize such a level of foodgrain production would only be feasible if exports reach a level of 9 or 10 million tons by 1984/85.

Policies and programs to ensure that the seed-fertilizer revolution is exploited as widely and as fully as possible are clearly of central importance. This emphasizes the importance of adaptive research and of training and extension programs to promote further diffusion of new varieties and to narrow the gap between yields at the farm level and the potential yields obtainable. Investments in infrastructure and in land and water development required to provide environmental conditions favorable to the introduction of more productive technologies are also priority needs. There is a serious lack of knowledge, however, as to the trade-offs between investments to increase the supply of irrigation water from canal systems as compared to pumping underground water and also concerning the trade-offs between increasing the availability of water and measures to increase efficiency in the use of existing supplies. Gilbert Levine and others have stressed the importance of better coordination between the operation of irrigation systems and farmers' use of the water available and also the need for improving on-farm water management practices (*21*). Progress in those areas will require better knowledge and improved institutional arrangements as well as better layout of irrigation and drainage channels, land shaping, and possibly land consolidation as stressed by B. S. Minhas (*24*). And in many agroclimatic regions measures to achieve more efficient use of natural rainfall can be expected to have the highest payoff.

The distribution of land ownership and, more particularly, the size distribution of operational units are highly important factors influencing the choice of technique and the factor proportions that characterize the expansion path of the agricultural sector. Both are influenced by policies and practices affecting land tenure which are discussed in the following section.

Achieving broadly based improvement in the welfare of the rural population. —In a longer term view substantial improvement in the welfare of the rural population depends upon the process of structural change which, inter alia, makes possible a reduction in the absolute size of the rural population, a large increase in commercial demand for farm products, and large increases in the capital-labor ratio in agriculture. There are, however, some more direct relationships between strategies for agriculture and the improvement of rural welfare that need to be considered.

Rural works programs are probably the most frequently discussed measure aimed directly at improving the welfare of the poorest segments of the farm population. There is much to be said for such programs as a means of providing supplemental employment and income to the most disadvantaged members of the rural population and at the same time building infrastructure important to agriculture and other sectors. But because of the organizational problems and particularly the severe fiscal constraints that characterize a developing country, it seems doubtful whether this approach can have a very substantial effect on underemployment and unemployment in rural areas. The rural works program in East Pakistan, one of the more ambitious undertakings and one that received major financial support from P.L. 480 counterpart funds, seems to have made a worthwhile contribution to the welfare of the families affected directly and in providing roads and other infrastructure; but it is estimated that the program represented an annual reduction of rural unemployment of only about 3.5 per cent (*6*, p. 30).

Other programs also merit attention because they offer the promise of substantial benefits relative to their cost, and some of them can also make a substantial contribution to the expansion of output by improving the health and productivity of the rural population. Public health programs such as malaria control are notable examples. The success of such programs is, of course, a major factor underlying the population explosion and the urgent need for policies and programs that will have both direct and indirect effects in encouraging the spread of family planning. Nutritional programs also deserve attention. The effects on well-being of increased farm productivity and incomes can be enhanced considerably if diet changes are informed by practical programs of nutrition education. Encouragement of the manufacture and distribution of products that are especially effective in meeting the needs of vulnerable categories (e.g., Vitasoy, Incaparina, and other low-cost sources of high quality protein) also offer the possibility of large returns at small cost.

Although it is foolhardy to attempt to treat the complex and controversial subject of land tenure in a few paragraphs, the positive and negative effects on rural welfare of land reform programs cannot be ignored. In Asia the land tenure situation is dominated by the fact that the area of arable land is small relative to the large and growing farm population entirely or mainly dependent on agri-

culture for their livelihood. One implication of this, which is distressing but beyond dispute, is that for the agricultural sector as a whole in these countries the average farm size will become even smaller—or at least that the number of agricultural workers per acre of arable land will continue to increase for several decades until a structural transformation turning point is reached.

It is sometimes argued that because of the connection between size of holding and choice of technique, redistributive land reform is a necessary condition for a unimodal strategy. Indeed it is even claimed that the success of unimodal strategies in Japan and Taiwan is attributable to their postwar land reforms, notwithstanding the fact that in both countries the basic pattern of progressive modernization of small-scale, labor-intensive, but technically progressive farm units was established long before World War II.

I am persuaded that an effectively implemented land reform program that brings about a more equal distribution of landed wealth will not only contribute to the goal of equity but will also tend to facilitate low-cost expansion of farm output based primarily on yield-increasing innovations. Although such a program would appear to be desirable, there is reason to believe that for a good many Asian countries it is not a likely outcome. It therefore seems important to emphasize that historical evidence and logic both contradict the view that in the absence of land reform the pattern of agricultural development will inevitably accentuate the problems of rural underemployment and unemployment and the inequality of income distribution.

The critical factor determining the choice of technique and factor proportions in agriculture is the size distribution of operational (management) units rather than ownership units. Past experience, for example in prewar Japan and Taiwan, demonstrates that a highly skewed pattern of land ownership is not incompatible with a unimodal size distribution of operational units. To a considerable extent the widespread condemnation of tenancy, particularly of share tenancy, seems to stem from a tendency to confuse what is really a symptom with the root cause of the miserable existence that is the plight of so many tenant households in underdeveloped economies. The fact that tenants are prepared to accept rental arrangements that leave them such a meager residual income is fundamentally a consequence of the extreme lack of alternative income-earning opportunities.[8] The proposition, briefly stated, is that bargaining between landowners and tenants will tend to result in equilibrium arrangements with respect to the rental share, the amount of land rented to individual tenants, the cropping pattern and other farm practices, and sharing of expenses of inputs. These arrangements will tend to maximize the land owner's rental income subject to the constraint that a tenant and members of his household must obtain residual income that represents a "wage" approximately equal to his best alternative earnings or they will not enter into the agreement. To the extent that the proposition is valid, it means

[8] Neglect of that point is the main reason that economists have commonly condemned share tenancy as inevitably leading to an inefficient allocation of resources, an allegation that the theoretical analysis and empirical evidence presented by S. N. S. Cheung effectively refutes (*3*; *4*). Given his assumptions, including competition among landlords for tenants and among tenants for renting land, the pattern of resource allocation will be the same under share tenancy, fixed rent tenancy, or owner cultivation, although of course the distribution of income will be different if a landlord collects a rental share.

that improvement in the welfare of tenants must depend primarily on improving the income-earning opportunities available, including the possibility of enlarging their own holdings by redistributive land reform as well as the increase in demand for labor within and outside agriculture.[9]

A good deal of the literature on land reform seems to regard redistributive land reform and the imposition of legal ceilings on rental payments as more or less perfect substitutes. But establishment of an arbitrary ceiling on rental shares does not change the underlying situation or the determination of landowners and tenants to strike a bargain that will yield each party the most favorable outcome possible. In general, the establishment of a legal ceiling on rent is accompanied by an attempt to enforce security of tenure so that tenants will be able to benefit from the more favorable terms instead of being evicted. Enforcement of rental ceilings and security of tenure depends, however, on continuing surveillance by local officials in a political environment in which the power of landlords is great and where both landowners and potential tenants have a strong incentive to evade the ceilings. Enforcement is thus considerably more difficult than the implementation of redistributive land reform based on acreage ceilings which is carried out only once. Although tenants would no doubt prefer a regulated situation that yielded an income higher than they could obtain in a bargaining situation, the fact remains that many potential tenants are prepared to pay rents that would leave them a "wage" no better than their alternative earnings rather than join the ranks of landless laborers.

This possibility has been stressed because there is a good deal of evidence which suggests that the attempt to impose rental ceilings, often accompanied by the rhetoric of redistributive land reform without the reality, have been among the important forces that have encouraged a trend toward "self-cultivation." Creation of large operational units encourages landowners to invest in labor-displacing mechanical equipment, resulting in considerably more capital-intensive technologies than would be expected with tenant cultivation. The technical problems of introducing lumpy items of capital equipment are eliminated. More important, there are significant diseconomies in operating large units with labor-intensive techniques because of the difficulty of supervising a large farm labor force, and under those conditions landowners have a strong incentive to increase the degree of mechanization progressively in order to reduce their dependence on large numbers of hired workers. The indirect "hiring" of labor by various types of tenancy arrangements is a much more efficient way of organizing farm production based on labor-intensive technologies because tenants have considerably more incentive to exert themselves to maximize production than hired laborers. The progressive mechanization of agriculture in the Mississippi Delta in the American South, following the initial introduction of tractors and the shift from sharecropping to the use of hired labor, is particularly illuminating

[9] The proposition will, of course, not be valid if tenancy agreements are determined by tradition rather than bargaining or if landlords collude in the renting of land. Descriptions of land use in a number of Latin American countries indicate that large haciendas are often operated in a very extensive manner and smallholders find it difficult to rent land to enlarge their extremely small operational units, presumably because landowners prefer to keep their haciendas intact for reasons of status, power, and perhaps to ensure the availability of abundant and cheap labor for work on the haciendas.

(5). The reduction in the number of workers employed during the first stage was moderate because there were still seasonal peaks in labor requirements, but with the introduction in later stages of cotton pickers, chemical weed killers, and changes in cropping patterns the seasonal peaks in labor demand were eliminated and the reduction in agricultural employment in the region was tremendous.

The advantages of organizing agricultural production primarily on the basis of small-scale units appropriate to the unfavorable man-land ratios that characterize the agricultural sector in late developing countries are enhanced by the new technical possibilities resulting from the seed-fertilizer revolution. Although those advantages are to a considerable extent a function of the size of operational units, there are some specific advantages of owner cultivation related to productivity considerations as well as the more obvious effects on income distribution. Although in principle, investments in land improvement that are profitable will be made by the landowner, by the tenant, or under some joint agreement, the division of responsibility in decision-making is likely to delay or prevent investments even though they would be to the advantage of both parties. Owner cultivation also avoids the difficulties that arise when landlords, responding to higher yields, raise the percentage share of output that they demand as rent. But if redistributive land reform is not a realistic possibility, widespread renting of land seems clearly preferable to the further concentration of land in large operational units and the bimodal pattern which is thereby accentuated.

Agricultural development that depends on fostering economic and technical change among the rural population, buttressed by a network of institutions and in organizing institutions and networks of communication and delivery to provide the supporting services on which a unimodal strategy depends. To the extent that developing countries have a commitment to expand education, however, such activities provide a range of opportunities for worthwhile employment of those leaving school at various educational levels. Moreover, the spread of rural education and other institutions useful in promoting the modernization of agriculture are capable of bringing many other benefits to the countryside.

Facilitating the processes of social modernization by encouraging widespread attitudinal and behavioral changes. — The spread of economic and technical change among the rural population, buttressed by a network of institutions and communication links, undoubtedly has significant effects on the process of social modernization that go beyond their effects on economic growth. It seems likely that the broad impact of a unimodal strategy would have favorable effects in three areas important to this process of social change. First, the wide diffusion of familiarity with the calculation of costs and returns and of opportunities to acquire managerial experience would appear to provide a favorable environment for the training and recruitment of entrepreneurs. The same would apply, of course, to the wider diffusion of learning experiences in manufacturing which is associated with a unimodal strategy.

Secondly, a broadly based approach to agricultural development seems likely to generate strong support for rural education as well as the institutions more directly related to promoting increased agricultural productivity. It is sometimes argued that large-scale, highly commercialized farm enterprises are easier to

tax than millions of small units. Because of the power structure maintained or created by a bimodal strategy, however, the greater administrative convenience may in practice mean very little. The fact that public education, and especially rural education, in most of South America seems to lag behind progress in other developing countries where average incomes are considerably lower seems to provide some support for this generalization.

Thirdly, and most important, the reduction in birthrates in the countryside, resulting from spontaneous changes in attitudes and behavior as well as behavioral changes induced by government population programs, are likely to be more widespread and have a greater effect on the national birthrate under a unimodal than a bimodal strategy. For reasons examined earlier, the bulk of the population in the late developing countries is going to be in the agricultural sector for several decades or more. Under those circumstances rapid reduction in a country's birthrate to bring it into tolerable balance with a sharply reduced death rate cannot be achieved unless family planning spreads in the countryside as well as in towns and cities. It seems probable that reasonably rapid changes in this domain of behavior are more likely to take place if the dynamic processes of economic and technical change affect a large fraction of a rural population involved to an increasing extent in formal and informal education and communication networks (including mass media). It also seems likely that the wider spread of improved income and educational opportunities will affect motivations in ways favorable to the practice of family planning. There also seems to be some evidence that reduction in infant mortality rates to very low levels accelerates the change from pro-natalist attitudes to the attitudes and behavior required for birth control, including a marked reduction in the average family's "ideal" from a goal of five or six or more to two or three children.

CONCLUDING REMARKS

It has been emphasized that the task of designing efficient strategies for agriculture in late developing countries is difficult. Indeed it could be argued that an attempt to devise strategies well suited to attaining multiple objectives is unwise because it may divert attention away from "*the* priority objective" of increasing food production. A. H. Moseman has expressed a viewpoint similar to Hopper's in stating that "The building of a more productive agriculture must no longer be submerged under general concerns about rural social welfare. The latter is an important but equally distinct and special problem." He does emphasize "*the need for more effective programs for family planning and for improved strategies for achieving sustained growth in food production . . .*" but ignores the possibility that those objectives are interrelated (*25*, pp. 11–13).

The thesis of this paper has been that on grounds of efficiency as well as concerns about rural welfare, it is essential to pursue agricultural strategies that are well designed to achieve several interrelated objectives. The complexity of this task, however, underscores the importance of careful study of the relevant evidence and analysis of alternative strategies and a concerted effort to reach a consensus with respect to the objectives and pattern of agricultural development. As an agricultural scientist, Moseman is especially concerned with the difficult, time-consuming, and fairly expensive task of building effective agricultural re-

search systems in developing countries. He is critical of the "extension bias" that has characterized many of the agricultural assistance programs of the past two decades, an approach that had little to offer because it was based on false premises concerning the ready availability of innovations adapted to the agricultural environments of the developing countries and the scope for substantial increases in output by correcting the alleged inefficiency of traditional cultivators by reallocation of their existing resources. Moseman is also critical of the widespread enthusiasm and substantial allocations of resources for community development during the 1950s. He recognizes that such activities were "useful in bringing about a greater cohesiveness in the village or community structure. But, because of the limited attention to improvement of agricultural productivity and the broad scope of attention given to many things by the village level workers and community development specialists they tended to defer and retard the growth of basic agricultural education, research and extension organizations" (*25*, p. 71).

Fortunately, there is now an increasing consensus concerning the fundamental importance of agricultural research, although there is reason for concern that current enthusiasm for international or regional centers may divert attention away from the need for strong national research organizations. But owing to the success of the high-yielding, fertilizer-responsive varieties of wheat and rice, there would now be wide acceptance of the statement that J. W. Mellor and I made a decade ago in assigning first priority to agricultural research as a critical element in an appropriate agricultural strategy (*17*, p. 586):

> Mounting an effective agricultural research program is a long-term project that depends heavily on continuity of personnel. Shortage of qualified agricultural scientists is a critical problem which can be overcome only in part by employment of research workers from abroad. So basic is an effective program of research to the other elements of an agricultural development program that it represents one of the few instances in which plans and budget allocations should err on the side of boldness, provided that this openhandedness applies only within the limits of carefully determined research priorities.

The controversial issues today concern the determination of research priorities. These will be quite different depending on whether a country's agricultural strategy is aimed at a bimodal or unimodal pattern of development. If it is the latter, adaptive research on yield-increasing innovations capable of widespread adoption clearly deserves major emphasis. Protective research to minimize losses from disease, pests, or environmental hazards also becomes increasingly important as farmers enlarge their use of purchased inputs and operate at higher yield levels. Research and pilot projects to determine the most feasible and economic techniques of improving the availability and management of water supplies also merit special attention because of the critical importance of investments in agricultural infrastructure required to create environmental conditions that will enable a larger percentage of farm households to take advantage of the new seed-fertilizer combinations. Another research need, and one that has received relatively little attention, is to promote the development of well-designed but inexpensive items of farm equipment that can be widely used on small-scale farm units to ease labor bottlenecks and permit more timely and more precise per-

formance of various operations. The development of a bullock-drawn disc harrow and a seed-fertilizer drill in India are examples of partial success in that type of operation. But for reasons that Peter Kilby and I have examined in some detail, the impact on agricultural production has been very limited, especially as compared to Japan or Taiwan where a wide range of simple, inexpensive implements of good design are used by virtually all farm households (*16*, Chap. IV).[10] Training programs, carried out in conjunction with efforts to organize irrigation associations and other organizations with the emphasis on accomplishing specific objectives requiring group action rather than on spreading "the principles of cooperation," are another requirement that is essential to all of the major objectives of an agricultural strategy.

Other controversial areas concern price policy, subsidies on inputs and subsidized credit, agricultural taxation, and land reform. It is apparent from the interrelationships between agricultural and industrial development that efforts to hold farm prices above their equilibrium level, justified by simplistic slogans such as "incentive prices," can have effects as detrimental to economic progress as those resulting from urban-oriented policies to hold food prices at artificially low levels (e.g., by restricting sales from surplus to deficit zones).

Decision-making with respect to the complex and controversial issues of agricultural strategy is complicated by the influence of interest groups and political considerations. The welfare of various social groups is affected quite differently by alternative policies. Increasing land taxes and imposing excise taxes on those farm inputs that are mainly labor displacing in their impact appear to be important policy instruments for implementing a unimodal strategy. They can serve the twofold purpose of mitigating extreme inequalities in rural income distribution and enlarging government revenues available for financing agricultural research and training, infrastructure projects, and a host of other development activities needed to promote rapid and widespread economic progress. Large landowners, who would bear a substantial part of the burden of paying such taxes, can be expected to oppose these measures out of self-interest and a conviction that as the most advanced element in the agricultural sector they should be free of disincentives and benefit from positive measures such as the availability of credit at subsidized rates in order to make a maximum contribution to the growth of farm output. Such groups are likely to be unmoved by the sort of argument advanced by the Secretariat of the Economic Commission for Asia and the Far East (as quoted in *27*, p. 55):

> To judge from actual experience, large and growing income disparities have not proved conducive to brisk economic performance and a strong thrust of development. It seems more likely, in fact, that heavy income concentration has often impeded healthy economic expansion by acting as a powerful disincentive (both material and psychological) to public participation in development. It cannot be overlooked that the prevailing *laissez-faire* attitude towards distributional aspects of development policy lends convenient support to maintenance of the political and social *status quo* in Asian countries.

[10] The reference to Japan applies to the decades prior to the 1950s when a structural transformation turning point was reached; the use of power tillers has spread rapidly since the mid-1950s.

Although political forces will clearly have an important influence on the design of agricultural strategies, the theme cannot be pursued here. Recognition of that fact emphasizes, however, the need for specialists in national governments and international agencies and university scholars to face up to the problems of designing agricultural strategies in the light of multiple objectives. Wider agreement on the criteria to apply in assessing alternative strategies is an essential step in arriving at a greater consensus and thereby contributing more constructively to policy formulation.

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