Production Problems and Issues in Agricultural Development

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The Context of Agricultural Development

THE prime economic objective of agricultural development is to contribute to increased per capita incomes. In most low-income countries, this objective is sought in an environment in which (a) the relative price of agricultural commodities tends to rise, and (b) capital forms drawn from the nonagricultural sector of the economy have a high opportunity cost.

Upward pressure is placed on agricultural prices by the unprecedented rate of increase in population. In addition, the relatively high income elasticities of demand for agricultural commodities, characteristic of low-income nations, make growth in per capita incomes highly effective in increasing the demand for food. Such demand conditions provide a favorable environment for raising national income by increasing the supply of domestically consumed agricultural commodities. Demand conditions may be less favorable for nations oriented to production of commodities exported to high-income nations, with their low rates of population growth and highly inelastic demand schedules for most agricultural commodities.

The high opportunity cost of capital drawn from the nonagricultural sectors of the economy derives from the low ability to save consequent to low incomes and from the rapidly growing demand for capital. The demand for capital arises not only from intense effort towards capital deepening as a means of raising per capital incomes, but also from the requirements of maintaining capital-labor ratios in the face of rapid population growth.

Capital forms which are essentially a direct embodiment of labor, using little of nonlabor resources and with short time for creation, have a low opportunity cost. Farm-to-village roads, leveling of land for irrigation, and hand-dug wells are examples of such capital. At the other extreme, capital forms which require foreign exchange are normally exceedingly scarce and have particularly high opportunity costs.

Agriculture must extract a high rate of return if it is to justify use of the scarce forms of capital. A high rate of return may be provided by rising prices consequent to failure to increase production apace with increasing demand. In that case, agriculture does not contribute to the economic objective of rising national income. For that objective to be met, agriculture

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must provide high rates of return to scarce capital by increasing efficiency in resource use.

Most low-income countries are deeply concerned with political integration and the distribution of income. Agriculture, as the dominant sector, occupying most of the geography and half to three-quarters of the population, is of particular concern from these points of view, and agricultural development policy is substantially conditioned by such considerations.

Concern with political integration and nation building presses for agricultural development programs which emphasize governmental presence in the countryside and the participation of rural people in the institutions of development. Thus, extension services and other forms of education may receive added priority over research, and cooperatives may receive added priority over the private sector in distribution of inputs and the marketing of output. Such weighting of programs may be in conflict with that which gives maximum contribution to growth in per capita income.

Concern with income distribution emphasizes agricultural development because it can provide wide dispersion of benefits. However, the tendency for response to new technology to be greater in regions which already have higher incomes, due to favorable physical, economic, and cultural factors, may foster a widening of income gaps. This circumstance may argue for a regional allocation of inputs for agricultural development other than that dictated by maximum returns to scarce forms of capital. In addition, the extent to which agricultural development programs help landless laborers or those with extremely small holdings who depend on wage labor for much of their income depends on the extent to which expanded agricultural production creates a demand for more labor. Government policy may well call for influencing agricultural development programs so as to have more impact on the demand for labor. That there is potential for an approach to agricultural development which increases the demand for labor is well illustrated by Japan.\textsuperscript{1} Concern for income distribution also places added emphasis on industrialization as a means of increasing the demand for the labor of rural people who may not benefit from technological change—a people who are among the most economically disadvantaged in society.

The Process of Agricultural Development in Historical Perspective

Agriculture has provided the classical case of diminishing incremental returns to increased resource input. Historically, this has traced from the limited supply of land and its importance in agricultural production processes. With a limited land base and constant technology, increased input

of labor is accompanied by decreasing returns and hence decreased incomes of rural people. Likewise, increased input of capital is accompanied by decreasing returns to capital and hence reduced inducement to save and invest.

As population has grown in the rural sector of low-income countries, additional labor has been applied to the fields in an effort to maintain incomes. But these processes of intensification give smaller and smaller increments in production for each unit of labor applied, and average incomes decline. Alternatively, new land is brought into cultivation. At best, the new land is of equal productivity with the old land and just allows per capita incomes to be maintained if capital formation is sufficient to prevent decline in the per capita stock of capital.

Under conditions of declining per capita incomes, an attempt is made to arrest the decline through increased capital investment. This places severe pressure on already low levels of consumption. It also drives down the returns to capital. Thus, under conditions of technological stagnation, land reclamation schemes, irrigation, and even increased use of organic and inorganic fertilizers will pay less and less well as their input increases.

Under such circumstances, there is strong economic logic in concentrating the economic development effort on the nonagricultural sector of the economy. In the industrial sector, the land resource does not provide rapidly diminishing returns to labor and capital. Indeed, in industry various external economies tend to provide increasing returns to resources and hence a natural basis for raising per capita income.

Thus, in the first stages of the industrial revolution, economists concerned with increasing national income advocated creating a favorable environment for industrialization through importing cheap corn from overseas (in important respects analogous to P.L. 480 shipments) so that industrial wage rates could be kept low and investment in industry encouraged. The Soviet Union emphasized drawing produce from agriculture to support the urban labor force and to export in trade for industrial capital. And modern India, like so many developing nations, has in the early plan periods placed major emphasis on creation of an industrial base. Given a state of declining incremental returns to resources in the agricultural sector, such policies make sense. Japan and Taiwan, the latter being Japan's protégé in agricultural development, are two of the few nations which invested in agriculture so as to contribute to increased resource productivity and rising incomes. Japan was unusual in the early date at which technological change, particularly of the yield-increasing sort, managed to appear on the scene. Rice yields in Japan have been steadily increasing ever since the turn of the century, whereas crop yields in the United States did not increase at all for the first four decades of the 20th century.
The Nature and Conditions of Technological Change in Agriculture

It is technological change which makes it economically sound to emphasize agriculture in pursuing economic development.

New technology changes the shape and position of the production function—shifting and extending it upwards and to the right. Two important and related results follow: (a) existing resources are made more productive, providing a direct increase in production; and (b) it becomes profitable to use more resources, providing a further indirect increase in production. The latter effect is quantitatively the most important. However, to realize this potential there must be a major increase in complementary inputs of water, fertilizer, and even labor. This relationship between technological change and increased input is particularly striking in the case of fertilizer. Improved seed varieties and new agronomic practices may increase the level of yield somewhat at low levels of fertility, but their big effect on production is in conjunction with large increases in the input of fertilizer.

Shifting the production function for traditional inputs would be of little use in economic development if the supply schedules for those inputs were highly inelastic. In that case, technological change would not increase the use of resources or result in increased production and the benefits would go largely as rent to the owners of the fixed resources. This points to another important facet of technological change. It not only increases the productivity of resources but also provides new sources of inputs which have the potential for highly elastic supply schedules. Examples are inorganic fertilizers, chemical pesticides, farm machinery, and mechanical and electrical power. For some inputs, technological change not only increases the elasticity of supply but also shifts the supply schedule sharply downwards.

Thus, technological change shifts production functions up and to the right and input schedules down and to the left. The result is a sharp increase in production. Since demand schedules for agricultural commodities in low-income countries are shifting up to the right, agricultural prices may actually increase, even as technological change increases resource efficiency. The result is a substantial rise in the real incomes of farmers. Indeed, as long as the agricultural sector is dominant, greater agricultural production will itself significantly increase the demand for agricultural commodities through the income effect experienced by farmers.

It is the sequence of major discoveries in the biological and physical sciences since the mid-18th century which has made possible rapid advance in the applied agricultural sciences, which in turn provides the base for technological change in agriculture. In general, however, it has been only during the past few decades that the applied sciences have successfully exploited these opportunities. Hence, the potential for agricultural development is much greater now than it was when Western Europe initiated the industrial revolution. Policy for economic development should be in tune with these new circumstances.

The profitability of technological change to farmers, and hence the extent and rate of application, depend on (a) the division of income between the farmer and landlords or owners of other resources used by farmers in production, (b) the physical productivity of inputs used by farmers, such as fertilizer, water, hired labor, and tools, and (c) the relationships among prices of things farmers buy and things they sell. The root of technological change lies with item (b)—changes in physical productivity of inputs. However, unfavorable conditions in regard to either distribution of benefits or price relationships may remove the profitability to farmers and prevent the application of technological change. Institutions mold these aspects of environment and hence the development and modification of institutions are the keys to agricultural development.

Three Policy Issues

In theory, a whole host of inputs, institutions, and policies interact in agricultural development so that primacy cannot be given to any one. In practice, disproportions occur which attach special weight to a few changes. At the moment, substantial interest centers on the relative weights to be given (a) price policy and technological change, (b) capital input and technological change, and (c) research and education. In practice, these policies are highly complementary. The critical policy questions are ones of timing, developing the precisely correct institutional forms and balance at the margin.

Price policy and technological change

The preceding discussion dramatizes the general ineffectiveness of agricultural price policy in increasing the aggregate of agricultural production unless it is combined with an effective program of technological change. As long as the production function is such that the marginal return to increased input is already low and declining sharply and the supply of in-  

3 As an occasional exception, major transportation breakthroughs may cause sufficiently radical changes in prices to sharply influence the aggregate level of production.
puts is relatively inelastic, increased prices of output will induce relatively little further input of resources. Likewise, subsidization of inputs will have only a modest effect on production.

In contrast, in conjunction with technological change, price policy can play a major positive role in effecting increased agricultural production. First, new technology causes the input response curve to continue much further up to the right, so that a favorable net marginal return may continue for a much larger input, encouraging a larger input and hence a large increase in production. Second, inputs which have elastic supply schedules, such as fertilizer, become more important, so that it becomes possible to increase input quantity sharply. Third, the marginal return to inputs is higher, so that a given increase in input quantity will bring about a larger increase in production. A less defensible but still possibly valid argument is that there may be thresholds to acceptance of technological change which price policy can help to cross.

It is important in setting price policy to know the nature of the response schedule to various inputs and from that to know to what extent particular price policies will be effective in influencing production. All too often it is incorrectly assumed that purchased inputs are profitable to farmers and that new technology which interacts with more inputs is at hand and profitable. Very rarely is policy made with clear quantitative information available on these important matters.

**Capital input and technological change**

Although, in practice, capital input is often undertaken as a substitute for technological change—witness many large-scale irrigation projects and even some fertilizer programs carried out without new supporting technology—the two should in fact be seen as complements. Without technological change, increased input of capital in the form of land reclamation, water, and sometimes even fertilizer, tend to be ineffective in achieving a significant aggregate increase in production, and what increase they do achieve is at low returns to capital and hence is in conflict with other objectives of economic development. Given lack of technological change, the industry-first planners have the economic logic on their side.

However, technological change has as one of its most important influences an increase in the returns for a large additional input of resources which have potentially elastic supply schedules and which come from outside the agricultural sector. If technological change is to be effective, these resources must flow into the agricultural sector in large quantity. With technological change, such a flow of resources is consistent with other objectives, since they will receive a high rate of return and thereby contribute substantially to increased per capita national income. Of course, a flow of resources into agriculture need not be a net flow. While
agriculture is taking fertilizer, irrigation facilities, and other resources from the nonagricultural sector, it may be paying for these with a reverse flow of agricultural commodities which feed an urban labor force, substitute for other consumer goods, and earn foreign exchange. The net of these counterflows must be determined in the light of relative savings and investment capabilities in the two sectors, as well as by incentive, welfare, and political considerations.

Creating knowledge and diffusing knowledge (research and extension)

During the past decade or two, much of the approach to agricultural development has been based on the assumption that profitable new technology was available to farmers but that they refused to adopt it because of traditional behavior, ignorance, and lack of profit motivation. It is now clear that farmers the world over do respond directly to monetary profitability. It is also clear that much of the technology recommended to farmers in the past has been rejected because it was not profitable under their conditions.

The necessity of research to develop new technology has in the past been underestimated because of (a) failure to recognize that the conditions of farming differ substantially over relatively small areas, thereby greatly limiting the applicability of innovation developed in one place to the conditions of another, (b) a tendency to compare experiment station results with the average of farmers rather than with the farmers in the upper deciles, and (c) failure to recognize that the distribution of yields amongst farmers is caused in substantial part by varied physical, economic, and institutional factors which it is difficult and often unprofitable to change. The extent of error in these regards is perhaps particularly great with foreign consultants, who observe a few contrasts in practice with their home situation and then assume that simply changing those few factors will bring about major increases in production. In fact, all too often the recommended practices are not followed because other, perhaps unknown deficiencies make them unprofitable.

W. David Hopper makes these points dramatically for India by pointing out that the maximum rice-yield trials at the premier rice research institute in India average no better than the average obtained by the second-best decile of farmers in important rice-producing districts;

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likewise, in the 1960–64 period, the second-best decile of farmers in a major wheat district had 30 percent higher yields than the premier wheat breeding station.\(^5\) This lesson has probably now been learned. The new danger is that the pendulum may swing to the opposite extreme, with the argument that if the research job is done properly, the resultant innovation will essentially sell itself to economically minded farmers of the world. What is not understood is that the profitability of innovation depends in large measure upon the care with which it is applied and that much innovation involves a complex set of changes. A careful educational program run by competent technicians is needed to impart the necessary knowledge. Further, although innovators may make careful economic decisions regarding profitability of innovation, many farmers are followers who do not calculate carefully. The processes by which innovation spreads to such farmers and the means which could speed the spread of such innovation are not understood in most parts of the world, and hence the diffusion of complex innovation will occur less rapidly than is now expected. We have, in fact, little experience with improving extension programs because in the past we have had very little complex, profitable innovation to spread. As research programs improve, as they now are doing, the present failings of the systems for diffusing knowledge will begin to show clearly.

Research is a necessary condition of technological change in agriculture. An educational program competent in the technical aspects of production and the social processes of communication and emulation can buy time. And time, which is a prime determinant of rates of growth, is of the essence in both the technical sense of economists and the emotional sense of the politicians.


Discussion: Institutional Aspects of Agricultural Development Policy

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Integration of the economic and technical aspects of transition agriculture creates, in each case, an economic system having unique institutional characteristics. This is so because of the interdependence and interrelationship of the “blend” of will, incentives, skill, and decision competence

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