INCREASING AGRICULTURAL PRODUCTION IN EARLY STAGES OF ECONOMIC DEVELOPMENT*
RELATIONSHIPS, PROBLEMS AND PROSPECTS

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INTRODUCTION

Rapid population growth and relatively high income elasticities of demand for agricultural products require that large increases in the supply of agricultural commodities accompany economic development in low income countries. Meeting this demand with increased commercial imports of agricultural commodities conflicts with the need to utilize limited foreign exchange to import capital goods for industrialization. Indeed, these same pressures in regard to foreign exchange argue for strenuous efforts to develop or enlarge exports of agricultural commodities.

Thus, for most low income countries an essential condition of economic development is a major increase in domestic production of farm products. The inflationary effect of failure to meet this need is large because of the heavy weighting of food in consumption expenditure. In low income countries, 50 to 60 per cent of total consumption expenditure is devoted to food compared with 20 to 30 per cent in high income countries.

Choice of the means by which increased agricultural production is achieved is made within an environment in which the opportunity cost is high for all forms of capital which can be turned to industrial development. Rural welfare as well as overall economic growth demand a transformation of the economic structure involving relative decline of the agricultural sector and large absolute and relative growth in the industrial sector of the economy. The capital requirements for such a transformation are formidable. Agriculture, as the only major existing industry, is looked to as a major source of capital for this crucial aspect of the growth process.

Policies which facilitate agriculture's contribution to the economic transformation are in the long-run interests of agriculturists as well as the country as a whole. Rural population growth will lead to or aggravate a condition of too small farms, underemployment of labour and resultant low farm incomes. Even Japan, with a large capital contribution from agriculture and unusually rapid industrial growth, has required well over half a century to reach a point at which growth in non-farm jobs can more than absorb all increments of total population and thereby allow an absolute decline in the farm labour force. These conditions provide a clear need for capital conserving techniques of agricultural development.

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Planning of agricultural development programmes which meet these important demands continues to be handicapped by lack of knowledge of the effect on production of particular economic forces and governmental policies. The relevant forces and the environment within which they operate are often quite different from those of high income countries. Thus, even the scant knowledge we have of agricultural supply mechanisms in high income countries must be applied to low income countries only after careful testing and modification.

The principal objective of this paper is to present an analytical framework to study changes in the level and techniques of production of agricultural commodities in low income countries. Fundamental factors affecting production will be indicated and their normal impact suggested. Where possible, empirical substantiation will be provided. In most cases, however, lack of data will limit the presentation to indicating the specific points subject to empirical testing and to suggesting hypotheses to be tested. The rudimentary nature of knowledge of agricultural supply mechanisms will make this paper speculative in approach.

The paper will be divided into three main sections—one presenting the analytical framework chosen, and the remaining two dealing with each of two specific phases of agricultural development. The discussion is divided into two distinct developmental phases because of the quite different character of the processes of increasing production in those two phases. These differences sharply limit the extent to which observation in one phase can be generalized to another and require that development policies be modified as an agricultural economy makes the transition from one phase to another.

AGRICULTURAL DEVELOPMENT PHASES

The nature of the agricultural development process and the identity of the key factors influencing output change considerably over time. Moreover, they change in a manner from which a broad pattern of development can be distinguished. Division of this continuum of development into specific phases is useful in clarifying the contrasting features of the agricultural development process in different time periods. The three phases delineated for the purposes of this discussion are:

Phase I — Providing Agricultural Development — Pre-Conditions

Phase II — Rising Agricultural Production — Low Capital, Intensive Technology

Phase III — Rising Agricultural Production — High Capital, Labor-Saving Technology.

The delineation of these phases and their ordering contain an element of the diagnostic as distinct from pure historical analogy. It appears, for example, that in the United States a number of conditions created a phase of high capital,
using labour-saving agricultural technology in early stages of agricultural development. These forces included (a) the presence of vast quantities of unexploited land, (b) large supplies of foreign capital, (c) rapidly growing urban industry, and (d) the relatively low level of development of basic aspects of the biological sciences. It is only in recent years that the United States has achieved major increase in yields per acre through use of low capital technology.

However, in the case of contemporary low income countries the optimal path for growth will normally involve taking these phases roughly in the form and order suggested here. The nature of indigenous resource potentials, the limited availability of capital, including foreign sources, and the currently high state of knowledge of the biological and physical sciences relevant to yield increasing innovation all provide pressures in this direction.

The statistical evidence from relatively recent agricultural development in Japan and Taiwan gives historical testimony to the feasibility and efficacy of this sequence and approach.  

*Phase I—Providing Agricultural Development Pre-Conditions*

Phase I is a technologically stagnant phase in which production is increased largely through increased application of traditional forms of inputs. In this phase changes in attitudes and institutions necessary to later technological advance may commence. Such changes will not be sufficiently complete or well integrated to do more than provide rudimentary pre-conditions for agricultural development. Of particular note in this regard are changes in the land tenure system and related changes in the political power structure. Although such changes do not provide a sufficient condition for technological advance, they do help develop a decision-making environment in which farmers accept the possibility of personal gain from improved farming.

Despite technological backwardness, an increase in total agricultural production may occur in phase I. Likewise, while agriculture is still in phase I, other sectors of the economy may push ahead, causing rising demand for food through an increased rate of population growth and rising per capita incomes. It is important to know the extent to which needed agricultural production increases can be achieved in phase I and the likely effect of various public policy measures on production.

*Phase II—Rising Agricultural Production — Low Capital Technology*

It is in phase II that agriculture plays a crucial role in overall economic development. In this phase, (a) agriculture still represents a large proportion of the total economy, (b) demand for agricultural products is rising rapidly due to both demographic and income effects, (c) capital for industrial development is particularly scarce and returns are rising, (d) labour-capital supply relationships preclude enlargement of the average acreage per farm, and (e) use of labou-

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saving agricultural machinery is largely precluded by unfavourable labour-capital cost relationships.

At the beginning of this phase traditional forms of agricultural labour, land and capital are abundant relative to the level of production and are used to the point of very low average and marginal productivity. In this environment, technological advance can provide the basis for rapid increase in agricultural production.

It is important to know the specifics of technological advances which may increase production in phase II, the institutional developments needed to facilitate application of relevant technology, the role of public policy in generating the desired changes, and the rate of production increase which may be achieved.

Phase III—Rising Agricultural Production — Capital Intensive, Labour-Saving Technology

Phase III is also a period of agricultural production expansion based on technological advance. But, this phase is noteworthy for the increasing importance of capital-using, labour-saving technology. The farm mechanization of phase III typically represents a late stage of development, especially for countries with high population density. Japan, for example, is apparently only now entering this stage. In this phase, farm labour has become scarce, capital is more abundant, demand for food is rising slowly and agriculture no longer occupies a dominant place in the total economy. The rapid development of a highly mechanized agriculture, which is appropriate to this phase, is generally not appropriate to phase II.

The discussion in this paper will be confined entirely to phases I and II.

A FRAMEWORK FOR ANALYSIS OF CHANGES IN AGRICULTURAL PRODUCTION

Economic analysis of change in agricultural production requires a framework which (a) reflects all influences on production, and (b) categorizes those influences in a manner which is conducive to quantitative measurement. If measurement of influence is more difficult for some inputs than others, it is useful to categorize them so as to isolate those for which reliability is likely to be low or highly uncertain. For this latter reason, the analysis in this paper arbitrarily divides output influencing factors into two major categories: (1) changes in the quantity of inputs of conventional forms, used in a traditional production process, and (2) changes in production processes resulting from introduction of new technology that alters input-output relationships.

5. Conceptually the first category of production influences is represented by conventional production functions within which the level of technology is held constant. Output change is then due to changes in the level of use of the traditional inputs included in the function. The second category of production influences covers factors which facilitate development and acceptance of new production processes which are technically superior to the old methods of production. This can be represented by shifts to new production functions.

Both categories of influences can be conceptualized within a single complex production function including both conventional and unconventional inputs. It is, however, convenient to clearly separate for consideration relatively conventional forms of inputs on one hand from the unconventional, more difficult to measure influences on the other.
Conventional inputs are pragmatically defined as those forms of land, labour and capital which can with relative ease be measured both in regard to input quantity and to effect on output. They lend themselves to simple cost-benefit and marginal analysis. Examples are land, capital improvements on land such as irrigation, clearing and drainage schemes, labour with the skills traditional to its own society, and capital in such forms as tools, machinery, and fertilizer.

Changes in production processes result from introduction and increased application of difficult to measure "unconventional" inputs. These inputs are largely of an institutional sort. They include research programmes, administrative structures for administering supply programmes for new forms of inputs, and education in its various forms. Provision of these institutions and facilities requires allocational decisions concerning scarce resources. The impact on the level of production is potentially very large. Although joint relationships preclude precise separation of effect, it can be argued that these process shifters are considerably more important in explaining major increases in production than increased use of the conventional forms of inputs. 6

*Increased Quantity of Conventional Forms of Inputs*

With the production process given, changes in output are determined by changes in the level of actual use of the conventional inputs. Particularly in phase I, but also carrying well into phase II, agriculture is characterized by large quantities of underutilized resources. This statement is particularly true of labour but has some degree of validity for other inputs as well. Thus, it is conceptually useful to view the level of use of inputs as a function in turn of (a) the total stock of inputs available, and (b) the percentage utilization of that total stock. The distinction is in essence between factors beyond the control of individual farmers and factors which are in significant part subject to farmer control.

*Factors Influencing the Total Stock of Inputs Available*

Change in the total quantity of conventional inputs available is determined largely by factors outside the individual farm business. For example, the total supply of agricultural labour in early stages of development is almost entirely controlled by population factors. Further, in low income countries a change in the aggregate supply of conventional inputs which is not directly related to available labour is largely limited by government budget policy. Budget policy is in turn affected by a host of other factors including comparative marginal returns from expenditure on various types of facilities. These factors are not under the control of individual farmers.

*Factors Influencing Utilization of the Stock of Conventional Inputs*

The extent to which the stock of conventional inputs is actually used in the production process is, in the final analysis, subject to decision of the individual farmer. To understand changes in agricultural production one must understand

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the environment within which these decisions are made. Analysis of these factors will be covered primarily in discussion of phase I. Of particular importance in this regard are (a) the physical productivity of the inputs in question, (b) the relative utility of using inputs from the farmer's household for production as compared with other uses, (c) the level of purchased input prices, (d) the level of output prices, and (e) the degree of risk and uncertainty felt by farmers in regard to the preceding factors.

**Development of New Production Processes**

Development of new production processes is a consequence of the introduction and increased application of unconventional inputs. Particularly important examples of such inputs are specific types of trained manpower for performing technical and administrative tasks. Such resources create research, training, supplying and other institutions crucial to creation and application of new production processes.

These categories of inputs or institutional changes have two important, mutually reinforcing influences on the level of production. Firstly, they have the potential substantially to raise the productivity of the existing set of conventional inputs of agricultural production. This potential stems from the relatively complementary relationship which they bear to the conventional inputs. Secondly, with the marginal productivity of the traditional inputs raised there is incentive for increased application of the existing stock of traditional inputs. The second influence is of special importance in phase II because of the availability at low opportunity cost of large quantities of the conventional forms of inputs.\(^7\)

Although this discussion has reference primarily to changes in production technology, changes in output composition including introduction of entirely new crops may have a similar effect. Such changes may increase the value of production markedly and may serve to mobilize the existing stock of conventional inputs. Johnston, in regard to Africa notes the striking case of the introduction of certain export crops serving to mobilize previously unused male labour for agricultural production.\(^8\) Changes in output composition like technological change, are normally not spontaneous but require a host of institutional changes in marketing, transportation, and other services.

**PRODUCTION INCREASE IN PHASE I**

Since it is assumed that the nature of the production process is largely fixed during phase I, changes in production will be examined from the point of view of changes in input quantity within the confines of the traditional production process. In this section observations will be made concerning the effect of (1) increasing labour input, (2) increasing the input of capital in the form of land

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7. The economic effect of raising the marginal productivity of the traditional inputs is of course very similar to a reduction in input price or an increase in output price. As will be pointed out later, in early stages of development, response to price changes tends to be relatively small. Heider's shifts in the production function induced by technological change may be sufficiently radical to overcome the factors which reduce response to moderate changes in price.

reclamation projects, (3) increasing the input of capital in the form of inorganic fertilizer, and (4) price changes and price uncertainty.

It will be argued that although its marginal productivity is in absolute terms low, increased labour input is a major source of increased production during phase I. In phase I, increased capital input in the form of large scale land reclamation and inorganic fertilizers both represent a possible means of increasing production, but because of the small base of existing input and the low marginal productivity of these resources in this phase, the total impact will tend to be small. In regard to responsiveness to price, it will be argued that contrary to the generally accepted view, farmers in phase I tend to be highly price responsive in substituting one crop for another but that aggregate production is not greatly affected by price. Within the bounds of what is politically and economically feasible, neither increasing price nor reducing risk and uncertainty will significantly increase the aggregate of agricultural production during phase I.

With these assumptions, agricultural production may, in phase I, be expected to keep up with population growth if the rate of urbanization is low. But meeting the needs of a growing population at the same time that urbanization is proceeding rapidly is less likely. This problem is compounded by increased per capita demand for food resulting from income growth and high income elasticities of demand.

**Increased Labour Input**

The effect of Malthusian population pressures is to drive the marginal product of labour to very low levels, perhaps even to zero. Once the marginal product of labour input has been reduced to zero, increase in the labour force through population growth or other causes cannot in itself provide an increase in production. However, in most parts of the world population pressures have not yet reached this point. Although, in many areas a significant proportion of the stock of agricultural labour is idle, it is becoming increasingly clear that the marginal productivity of the labour flow is in fact positive, and very likely close in level to the wage rate. In most areas of the world current wage levels provide for more than simply food subsistence. Thus, marginal productivity at the wage rate would mean that added farm population can provide more than their own food subsistence. Marginal productivity of slightly less than the wage rate may still provide sufficient extra food to support the added labour. By this means population growth in low income, agrarian societies can be matched by a nearly proportionate increase in agricultural production.

A reasonable, although hypothetical, set of figures illustrates this effect. Assume that a population is 80 per cent rural, that the marginal productivity of the labour actually used is 75 per cent of the wage rate, and that the wage rate

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allows for a level of living comprised 75 per cent of agricultural commodities and 25 per cent of non-agricultural commodities. With this set of assumptions, workers added to the farm labour force provide their own food subsistence. A rate of population growth of 2 per cent (assuming the same rate in rural and urban areas) would provide a rate of growth of agricultural production of 1.6 per cent. If, to vary the example, the marginal productivity of labour was on all farms equal to the standard wage rate and other factors were as stated here, agricultural production growth would be slightly more rapid than population growth.

This set of hypotheses is consistent with the significant rate of increase in agricultural production in countries which appear to be largely in phase I. This is in contrast to the standard stereotypes concerning agriculture in phase I, which are apt to lead to the erroneous conclusion that agricultural production cannot increase during that phase. In India, for example, agricultural production has probably been expanding at a rate of between 2 and 3½ per cent per year for the past decade.\textsuperscript{11} A preliminary examination of the extent of technological progress and the increase in the traditional inputs and marginal productivities of these inputs suggests that a substantial proportion of the agricultural production increase in India is directly attributable to continuous population growth and consequent enlargement of the farm labour force.

There are two primary reasons why the empirical evidence on marginal productivity of labour often appears to be inconsistent with the above argument.

Firstly, the contention that the marginal productivity of labour is positive and near the wage rate will rarely receive significant statistical support. The standard problems of definition and measurement will normally introduce variability into the data which is large compared to the difference between the hypothesized level of marginal productivity of labour and zero. Thus even if the marginal productivity of labour in low income countries is actually at the wage rate, we can expect that most empirical studies will show that such marginal productivity is not significantly different from zero at the usually chosen levels of statistical significance. The wage level is, however, positive and significant in an economic sense, as is a level of labour productivity at the wage rate.

Secondly, there has been a tendency to measure not the flow of labour but the stock of labour when measuring marginal productivities. It is common to generalize from the clearly observed substantial stock of idle labour to a conclusion that its marginal productivity must be zero. For the purposes of the argument presented here, the productivity of increments to actual labour utilization is the relevant consideration not the effect of stocks of labour available.

The anomaly of a substantial proportion of the labour stock going unutilized at a time when the marginal productivity is close to the wage rate is explained by a complex of incentive factors.\textsuperscript{12} Probably the chief factor is a substantial discontinuity in the schedule of marginal utility of material goods income. Put in

\textsuperscript{11} Standard statistical series depict a 3½ per cent increase in Indian foodgrain production during the past decade.

\textsuperscript{12} This argument and its supporting evidence is the subject of a paper still in process of preparation.
a somewhat oversimplified form, labourers are willing to work for extremely low
wages to the extent necessary to claim minimum subsistence. Beyond that point,
a substantially higher return is required to stimulate them to do more work. It
will be a common case for countries in phase I to have the rural wage rate lying
within this area of discontinuity. As a result, the actual input of labour will be
relatively unresponsive to price. However, increments to the population will
provide additional pressure to provide minimal subsistence and thereby force
increased labour input.

It should be made clear that this argument depends for its applicability on
a discontinuity in the utility schedule and a low level of wages and marginal pro-
ductivities. It is not based on the assumption of a value orientation in low
income countries which is radically different from that in high income countries.

This explanation of phase I production increase has relatively clear validity
in the case of nations which have unutilized land resources. As long as land
that is not currently cultivated is only slightly less productive than that which is cultivated,
an increment to the population can provide roughly proportional increases in
agricultural production. This probably explains much of the increase in pro-
duction of subsistence crops in tropical Africa during the last several decades.13

This paper also argues that the same process is possible through further
intensification of production on existing land through such processes as better
seed bed preparation, better weeding, and more timely operation. These pro-
cesses form the base of population-responsive increases in output in high popula-
tion density areas of the world.

These hypotheses should be tested. This can be done through further deve-
lopment and refinement of our knowledge of farm labour productivity schedules
in low income countries. In particular, we need to study whether or not the
marginal productivity of labour declines only slightly even with substantially
increased inputs of labour. Insufficient data are currently available to give
conclusive evidence on this point.

Careful historical study is also needed to determine the extent to which past
increases in production in various parts of the world can in fact be attributed to
further intensification in labour use within the traditional production pattern.

*Increased Input of Traditional Forms of Capital*

Capital in the form of the simple tools and implements of a technologically
stagnant agriculture are in large part created directly from traditional forms of
labour. Their output effect can therefore be conveniently described as an indirect
influence of the labour input rather than as a separate input. The same applies
even more clearly to minor irrigation, land levelling, and conservation measures
carried out largely with local labour.

But let us consider the important forms of traditional capital which may
usefully be differentiated from labour as an input. These include the various

13. B. F. Johnston, "Changes in Agricultural Productivity and Patterns of Production in
large scale efforts to increase the land area through major land clearing and irrigation schemes, efforts to increase yields on existing land through large scale irrigation projects, and commercial fertilizer. The latter is of course frequently thought of as a non-traditional form of capital. It seems preferable for this discussion to separate consideration of the fertilizer input itself, which can be handled and measured by traditional methods, from the difficult to measure inputs and influences which allow changes in production processes and greatly alter the production response to increased application of fertilizer. In phase I, we assume that the conditions necessary for major shifts in the production processes are not present.

**Fertilizer**

In phase I, there is but small scope for a significant percentage increase in aggregate production through increased use of inorganic fertilizer.

Firstly, the marginal productivity of increments of inorganic fertilizer tends to be low in phase I. High returns to fertilizer are normal only when combined with that complex of changes which allow a radical shift in the production process. For example, uneven application of fertilizer because of lack of knowledge may result in burning of crops; or, the wrong types of fertilizer may be applied; or, native crop varieties may make excessive vegetative growth and grain crops thus lodge; or, poor timing of application of fertilizer may result in only a small fraction of the fertilizer being available for plant use. These problems are alleviated only by introduction of new production processes through research, education and other institutional changes of phase II.

Secondly, in phase I the actual additional input of fertilizer will tend to be small. This may be in part due to the low marginal productivity of fertilizer in phase I, marginal returns dropping to the level of marginal costs with relatively small total input. In any case, in phase I the initial level of application is so small that even very large percentage increases in fertilizer use will not have a substantial effect on total production. The striking effect from fertilizer comes only when (a) the level of use has been raised to a substantial absolute amount, (b) the rate of growth from that substantial base is rapid, and most important, (c) the productivity of fertilizer application is being rapidly raised by introduction of new production processes through technological and managerial advance. These are the occurrences of phase II of development.

These considerations suggest that in phase I the effect on output of increased fertilizer input will tend to be very small. The intent is not to disparage the long-term importance of increased fertilizer input; neither is the intent to suggest that expansion of fertilizer capacity and availability is inadvisable in phase I. The advances of phase II are largely dependent on a huge complement of inorganic fertilizer. Developing the production and distribution facilities may be a function that can usefully be performed in phase I. It may even be well in phase I to subsidize fertilizer sales to farmers in order to continue such a build-up prior to the technological changes which sharply increase the response to fertilizer.\(^{14}\)

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14. See for example "Some Aspects of the Current Fertilizer Situation in India," V. G. Panse, *The Agricultural Situation in India*, May, 1961, in which it is pointed out that prices of major forms of inorganic fertilizer in India currently run some 40 per cent higher than in Japan.
**Major Irrigation and Land Reclamation Schemes**

As in the case of inorganic fertilizers, the marginal productivity of direct investment in increased irrigation and land reclamation is often low. Unless associated with technological advance in the production sciences, the capital investment per acre in such schemes is often very large—even to the point at which major production innovation is not sufficient to make the rate of return on investment competitive with alternatives.

The Gezira scheme in the Sudan indicates the tremendous productive potential for large scale schemes if unusually favourable physical conditions are at hand and if the complementary technological advance is assured. Far more frequent are those of the type of the East African groundnut schemes, the Office du Niger project in the former French Sudan, and the Niger Agricultural project in Nigeria. The risks for such schemes appear to be such as to counsel moving slowly on expenditure of scarce capital on them in phase I, even in anticipation of the productivity increasing advances of phase II. In any case their aggregate influence on production will tend to be small compared to the total volume of production.

**Price Response**

In phase I of agricultural development a relatively high proportion of agricultural production is for direct home consumption. Since a large fraction of production does not enter the exchange part of the economy, changes in price relationships may appear to have no relevance in production planning. However, practically all farmers in low income countries produce at least a part of their produce for the market, and in turn draw a portion of their consumption and production goods from the market. Such activity connects farmers with the market, makes the relative price levels of goods sold and bought of significance and thereby provides potential for a price effect on the volume of production.

There is little or no evidence that farmers in low income countries operate according to a different set of guiding principles in making their management decisions than do farmers in high income countries. They do apply these principles in a different operating context. Consequently they may often reach decisions quite different to those reached by farmers in high income societies.

Clearly, if under existing land tenure arrangement the farmer-decision-maker does not receive an added net return from a changed operation, he will not respond to price changes. But if the incentive system works passably well, a change in price relationships among products which use essentially the same bundle of resources should result in a change in the production pattern.

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evidence for low income countries indicates relatively high supply elasticities for
individual commodities. In some cases, farmers in low income countries appear
more responsive to relative price changes than those in high income coun-
tries. This may be explained by the low level of technical knowledge specific
to individual crops and little or no use of specialized machinery. Both these
characteristics favour marginal rates of substitution of various competing outputs
which are conducive to a high level of response to price changes.

Aggregate production response to price may however react quite differently
to the response for individual commodities. Aggregate changes in production in
response to price changes are achieved through a change in the aggregate quantity
of inputs placed in the production process. In phase I, the mechanism must
operate largely through change in the labour input. For aggregate production
to be increased labour input must be increased; for it to decline the converse
must occur. The critical determination is the relative utility of the money income
or other fruits of productive use of labour compared to leisure. Earlier in this
paper it was indicated that a major discontinuity tends to exist in this relationship.
Material goods are valued extremely highly up to the point at which the minimum
socially defined subsistence level is reached. The value of material goods drops
sharply after that point.

If farmers are operating near this discontinuity, a price decline may even have
the effect of encouraging farmers to increase their labour input of family labour
and hence to increase production. The converse may well hold for a price in-
crease. In any case, the price elasticity of the aggregate supply schedule will
tend to be very low.

Price Uncertainty

For essentially similar reasons to those stated above for price changes, a
change in the certainty that given price relationships will prevail will tend to have
only slight effect on the aggregate supply of agricultural commodities in phase I.
Likewise, of course, relative changes in uncertainty for different products may
have a strongly stimulatory effect on substitution of commodities in production.

In regard to the aggregate effect, again in phase I the response will have to
occur largely from changes in the labour input. Thus, the question is to what

19. See, for example, L. S. Venkataraman's work on Jute in India: A Statistical Study of
Indian Jute Production and Marketing with special reference to Foreign Demand, A dissertation
submitted to the Department of Economics for the Ph.D. degree, University of Chicago, June,
1958 (unpublished); Raj Krishna's work on Cotton in India: Farm Supply Response in the
Punjab (India-Pakistan)—A Case Study of Cotton, A dissertation submitted to the Faculty of the
Division of the Social Sciences for the Ph.E. degree, University of Chicago, September, 1961;
B. R. Chauhan's discussion of change in tobacco production in a small sub-region of India: "Rise
and Decline of a Cash Crop in an Indian Village," Journal of Farm Economics, August, 1960;
P. T. Bauer and B. S. Yarney, "A Case Study of Response to Price in an Underdeveloped Eco-

omy," Economic Journal, December, 1959; also see W. O. Jones' examination of African data on
this point, "Economic Man in Africa," Food Research Institute Studies, May, 1960. For discussion
based on a contrary assumption, see, B. K. Madan, "Presidential Address," Proceedings of the
Eighteenth Conference of the Indian Society of Agricultural Economics, Indian Journal of Agricul-
tural Economics, Vol. XIII, No. 1, Jan.-March, 1958; W. C. Neale, "Economic Accounting and
Family Earning in India," Economic Development and Cultural Change, Part I, April 1959; and
R. O. Olson, "Discussion: Impact and Implications of Foreign Surplus Disposal on Underdeveloped

extent will more or less labour input be encouraged in phase I by increased certainty or uncertainty concerning a given set of price or exchange relationships. For many farmers, there will be a large incentive to achieve a given subsistence level, but little incentive to achieve much more. In such circumstances it is possible that uncertainty will encourage farmers to play it safe by planning to produce more than the subsistence amount required. In such circumstances, increased certainty could have a production decreasing influence.

PRODUCTION INCREASE IN PHASE II

Characteistics of Phase II

Phase II of agricultural development is by definition the phase in which substantial change in production processes is not only possible but becomes a basic tool of agricultural development policy. The low marginal productivity of land, labour, and capital which characterized phase I is due to a lack of certain complementary inputs of a technical, educational and institutional nature. In phase II these complementary inputs are identified, decisions are made concerning the proportions in which they should be combined, priorities are set for programmes to increase them and the programmes are pushed forward.

The effect of a carefully executed increase in the unconventional inputs is to provide new production possibilities. As a result, the marginal productivities of the various traditional inputs rise substantially. In response we find large changes in the whole structure of agricultural production. The substantial increase in the marginal productivity of labour encourages a large increase in the flow of labour per unit of land. This provides scope for absorption of a portion of the accompanying population increase, or of increased percentage utilization of the existing stock of labour. Increased returns to irrigation favour an increase in both major and minor irrigation works. Increased returns to fertilizer provide an environment favourable to a truly extraordinary increase in the inorganic fertilizer input.

The potential for production increase implicit in this set of changes is large. Viewed from the perspective of presently known basic technology, total output increases of from four to eight-fold seem in order for favoured areas. Averaged over large areas an increase of two to four-fold seems conservative. The continued advance of basic science will further enlarge this potential.

21. This argument emphasizes shift of the fertilizer production function in explaining increased fertilizer use. Griliche’s studies of fertilizer consumption in the United States are somewhat in conflict with this view. See Z. Griliches, “The Demand for Fertilizer: An Economic Interpretation of Technical Change,” Journal of Farm Economics, August, 1959. He suggests that in the United States nearly all of the changes in fertilizer consumption of the last three decades can be explained by technological advance in the fertilizer production industry and the consequent relative decline in the price of fertilizer. However, in the period studied there was close correlation between the relative price of fertilizer production and factors shifting the fertilizer production function. In Griliches’ study, separate attention was not given to the 1950’s, a period when the relative price of fertilizer was stable, fertilizer consumption was rising, and a shifting of the production function was occurring. In addition, it is increasingly recognized that the distributed lag model used has a built-in bias towards high correlation coefficients.

22. For data on yields and cropping ratios which form the base for such projections, see for example D. M. Etherington: Structural Changes in Peasant Agriculture, A Comparative Study of Indian and Japanese Farm Data, A thesis presented to the Faculty of the Graduate School of Cornell University for the Degree of Master of Science, February, 1962; Reports on Studies in the Economics of Farm Management in Madras, Punjab, Uttar Pradesh and West Bengal, Department of Agriculture, Government of India, Albion Press, Delhi, 1958; J. W. Mellor and R. D. Stevens, Op. cit.
The important caution in regard to these figures is that they refer to the total increase obtainable under an assumed technology. They can only be realized after extremely complex changes have been executed. The crucial question concerns the rate at which these presently seen potentials will be realized. A doubling of production is impressive if reached in ten years (a seven per cent rate of growth); it is not impressive if achieved in 35 years (approximately two per cent rate of growth).

**Structural Comparison of Japanese and Indian Agriculture**

Comparison of selected farms in present-day Japan with Indian data from a similar type of farming area provides striking confirmation of the tendencies suggested above.23

In a farm accounting sample, rice farms of Kinki District, Japan average about the same acreage as a set of farms in a farm management survey for rice farms of West Bengal, India (Table I). The labour force (stock) on the Japanese farms is 50 per cent larger than on the Indian farms. Strikingly, the labour flow or utilization on the Japanese farms is 3.8 times as large as on the Indian farms. This results in twice as high a utilization percentage on the Japanese farms despite 50 per cent more labour available per acre of land. This contrast is apparently accounted for by the complementary relationship between input of various forms of capital, technological change and labour.

**Table I—Comparisons of Farm Input Structure, West Bengal, India, and Kinki District, Japan**

<table>
<thead>
<tr>
<th>Region</th>
<th>Average size of holding</th>
<th>Labour per holding available for farm work (man equivalent)</th>
<th>Labour available for farm work per acre (man equivalent)</th>
<th>Labour utilization per acre (man equivalent)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(acres)</td>
<td>(months)</td>
<td>(months)</td>
<td>(months)</td>
</tr>
<tr>
<td>India</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>West Bengal</td>
<td>2.9</td>
<td>24.0</td>
<td>8.0</td>
<td>1.9</td>
</tr>
<tr>
<td>Japan</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kinki</td>
<td>3.0</td>
<td>37.0</td>
<td>12.0</td>
<td>7.2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Region</th>
<th>Labour utilization as percentage of availability</th>
<th>Operating expenses per acre</th>
<th>Value of fertilizer per acre</th>
<th>Gross output per acre</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(per cent)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>India</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>West Bengal</td>
<td>23</td>
<td>$17.30</td>
<td>$2.70</td>
<td>$45.80</td>
</tr>
<tr>
<td>Japan</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kinki</td>
<td>58</td>
<td>$132.00</td>
<td>$34.90</td>
<td>$448.30</td>
</tr>
</tbody>
</table>


23. The following data and comment are adapted from D. M. Etherington, *Op. cit.*
AGRICULTURE AND ECONOMIC DEVELOPMENT

As expected in direction if not in degree, operating expenses per acre are nearly eight times as high on the Japanese farms as compared to the Indian farms. The value of fertilizer is over 16 times as high per acre on the Japanese farms. Most of the input of fertilizer on the Japanese farms is of inorganic types while that on the Indian farms is primarily animal manures.

The contrast of a nearly ten-fold difference in gross output per acre is superficially accounted for by the sharply higher yields per acre and cropping ratios on the Japanese farms. Behind this explanation lies, as the figures in part reveal, an advanced technology and a much higher level of input.

REQUISITES FOR DEVELOPMENT OF NEW PRODUCTION PROCESSES

Agricultural development appears in this treatment as a process of mobilizing a vast quantity of already existing resources and raising their productivity. The distinguishing characteristic of a high productivity agriculture is not simply more of the traditional forms of land, labour, and capital. Rather it is the set of institutions and facilities which complement these existing resources and raise their productivity.

These institutions and facilities—the scarce resources of agricultural development—fall conveniently into five comprehensive categories:

(a) **Institutions to provide incentives**: In many low income countries small farmers have little incentives to increase production because they have found through experience that little if any of an increment to production will fall to their personal benefit. Changing institutions, such as those of land tenure, require not only the drafting of new legal codes but also institutions for administering such change. Much of the change of this type occurs in phase I.

(b) **Research to develop improved production possibilities**: In agriculture the research results which are applicable to one geographic area can rarely be applied directly to another. This is particularly true of innovations which increase yields per acre as distinct from labour-saving mechanization. Thus, applied research in the plant and animal sciences is vital if farmers are to have the opportunity to increase their productivity. Put bluntly, we find at the present time that relatively few of the low income areas of the world have a stock of proven research results which offer significant increases in production under local-farm operating conditions.

(c) **Production facilities for inputs of new and improved forms**: Traditional agricultural economies depend largely upon inputs produced on the farm. A modern progressive agriculture uses many inputs purchased from outside. Seed of improved varieties and fertilizer are prime examples. Improved seed requires seed multiplication farms, inspection and certification systems and complex distribution channels. The complexity of the task of seed multiplication stands as a key barrier to agricultural progress in a number of areas of the world. In the same manner the complex problems of fertilizer production and distribution may also stand in the way of technological advances by farmers.
(d) **Institutions to service agricultural production**: Effective use of new inputs once produced requires a whole host of servicing facilities. They include facilities for distributing new inputs, the marketing and processing of increased output, extending credit to finance purchase of new inputs, and rural governmental bodies for fostering roads, schools, and other services. Nearly all of these services are either entirely new to a traditional economy or represent a substantial change in the form of old services.

(e) **Education to help farmers make choices**: A progressive agriculture is characterized by the constant appearance of new alternatives, the acceptance of some of these, and just as important, the rejection of others. A high degree of variability within agriculture due to differences in physical resources, past practices and current management makes it impossible to make blanket recommendations concerning new alternatives. Thus the final success of a programme to develop agriculture depends upon training tradition-bound farmers to make economically sound decisions regarding new alternatives.

The inputs categorized above have a number of characteristics important to the agricultural development process:

First, they come from outside traditional agriculture. The individual farm operator makes the decision, for example, whether to use fertilizer or improved seed if those inputs are available. But, whether the fertilizer or seed is available in a time, place and form conducive to increased production is in large part determined by influences beyond the control of the individual farmer.

Secondly, all of these unconventional inputs or developmental services depend very largely on government initiative and programmes. Agricultural research and extension-education programmes are normally performed by government. Under the conditions existing in low income countries, it is also frequently necessary for government to provide the institutional facilities required to supply new production inputs and credit and to process and market agricultural products.

Third, and most important, the complementarities among these inputs require that a number of developments occur simultaneously. Leave out one crucial change and the whole process fails.

The rate of growth of agricultural production is largely dependent upon the speed and efficiency of development of this set of institutions and conditions. Development is retarded by (1) lack of sufficient knowledge and understanding of the specific composition and requirements of a development programme, (2) lack of sufficient knowledge of the precise form which individual inputs and institutions should take on, and (3) shortcomings in the size and competence of the administrative staff and structures necessary to implement the vast and dispersed programmes once begun.

**Price Response in Phase II**

Presumably in phase II aggregate production should be considerably more responsive to price than in phase I. Firstly, the use of purchased inputs will.
have risen considerably. These inputs, fertilizer in particular, will have production functions which are conducive to a positive price response. Secondly, the marginal productivity of labour will have been raised sufficiently so that operation is well away from the considerable discontinuity in supply price which occurs near the point of provision of minimum subsistence. Thirdly, the tendency for labour input to be more fully responsive to price will be enhanced by greater familiarity with and availability of a wide range of consumer goods.

Thus, on the surface, price policies in phase II might appear to be an important tool in the kit of policy instruments for increasing production. However, the usefulness of this tool is severely limited. Firstly, capital formation considerations will make it desirable to hold the terms of trade as they are or even turn them against agriculture in this phase. Secondly, the factors allowing new production processes have a vastly greater potential for increasing production than the modest effects of price in favouring increased inputs within an old production process.

An analysis of the effect of changes in input prices leads one to similar conclusions. However, it is possible that for certain inputs the best level of use will differ between the individual farmer and society as a whole. For example farmers may weight risk and uncertainty more heavily and they may require a higher rate of return on capital than society as a whole. In such cases, input subsidization might bring about an optimum input use from society’s viewpoint.

Uncertainty

With an increase in purchased inputs, increased incomes, and increasing price responsiveness, a reduction in price risk and uncertainty may also become a positive devise for inducing a production increase.

Again however qualifications are in order. First as indicated above, the effect of the introduction of radically improved production processes in this phase vastly overweights the effect of changes in input quantity induced by changes in prices and price uncertainty. Secondly, a net capital transfer from agriculture is required. Thus it is desirable to avoid programmes which result in a net transfer of income towards agriculture. Price stabilization schemes are apt to include stabilization at a level which results in income transfers toward agriculture.

There is also uncertainty concerning the technical applicability of innovations. This form of uncertainty is best combatted by extensive field testing of innovations. Such testing should be an integral part of all programmes of production increase in phase II.

Lags in Achieving Production Increase

Although the absolute potential is clearly very large, there is considerable difficulty in achieving a rate of increase in agricultural production sufficient to meet the needs generated by population and income growth.

The first problem is the clear one of lags in the development and application of new production processes. Even if we are correct in our hypotheses concerning
the nature of the institutions which must be developed, we still know little of the lags from conception of ideas until the time when they have their effect on output. In the case of a research programme, for example, we do not know how long it will take to develop workable institutions; or once those institutions are developed how long it will take for them to provide tangible, workable results; or once such research results are provided, at what rate they will be applied to farm operations and what their effect on output will be. We know very little about this last question even though considerable work has been done on the problem. We know practically nothing in regard to the first two questions. It is likely that the lags are substantial and that diffusion is slow. The result is a substantial dampening of the growth process.

A second major difficulty arises from the nature of the output increase in phase I. In that phase, output increases largely because the pressure of population growth against the subsistence level forces additional labour into productive employment. The technological advance of phase II raises incomes and hence reduces the pressure to add labour. Thus it may be difficult to add the production increasing effect of technological advance onto the production increases already occurring in phase I. The contrast between phase I and phase II may only be in regard to the means by which production is increased and not in regard to the rate of increase.

It follows from the argument of this paper that if production is to be increased more rapidly in phase II than in phase I, a sharp increase in the productivity of the labour resources will be needed. It is assumed that such an increase would allow a bridging of the discontinuity in utility functions which occurs at very low levels of wages and productivities. That is, sharply increased productivity would stimulate labour to work beyond the level required to provide merely bare subsistence. If this were accomplished, the level of labour inputs might be increased as compared to phase I. This would provide potential for a more rapid rate of production increase in phase II than in phase I.

It is because of this necessity of sharply raising the marginal productivity of labour that simple, low capital cost labour-saving devices may play an important role in combination with yields increasing technological advance. The process may also be aided by increasing the attractiveness and the range of consumer goods available to rural people thereby increasing the desire for money income. Particularly useful in this regard are low-unit-cost types of consumer goods. These developments become particularly important if the major forms of yield increasing innovation are heavily labour using—as illustrated by the Japanese data cited previously. Agricultural development then requires major inducements for drawing the necessary added flow of labour into the production process.