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The Strategic Details of Development Traditional Agriculture*

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THE STRATEGIC DETAILS OF DEVELOPMENT

IN

TRADITIONAL AGRICULTURE

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1. INTRODUCTION.

The appreciation of the importance of agriculture in the process of development has been greatly enhanced by the "green revolutions" that have begun to transform the economies of such diverse countries as Costa Rica, Israel, Nigeria, Philippines, Thailand, Tanganyika and Yugoslavia, U.S.D.A. (1965). Even for countries with high population densities such as India and Pakistan, which as late as half a decade ago, were cited as evidence of the Malthusian theses by as perceptive an observer as Myrdal,[1] the recent advances in agricultural output have infused their economies with new hope. In some quarters there is now talk of the ability of the agricultural sectors in these economies not only to feed the growing populations, but also the possibility of producing agricultural surpluses for export. In view of the accumulating evidence of vast agricultural transformations under way in these countries, a detailed analysis of the economic and technological environment in which development is proceeding in the third world would greatly enhance our understanding of the development process in agriculture. The purpose of this paper is to outline some of the factors that should be ideally included in any regional study of production response in agriculture in the LDC's.

While agricultural development remains at the center of development theory and policy, and while its importance in overall development is fully appreciated, only recently has attention been devoted to the empirical examination of its role in the LDC's. These recent empirical investigations have been conducted on two broad fronts: one stressing and determining the role of agricultural exports in development and the other stressing the more fundamental problem of increasing domestic output. Though a case has

been made for emphasizing the importance of agricultural exports as a point of departure in the development process of certain underdeveloped economies MYINT (1958), CAVES (1959), LEWIS (1955), there is a growing realization that the more fundamental problems are those associated with agricultural production response; that is, the factors determining the production of agricultural commodities HELOR (1965, 1966), SCHULTZ (1964). Even when agricultural exports provide funds for development, an increase in agricultural exports requires an increase in the domestic agricultural output. Consequently, whether or not agricultural exports can or cannot play a critical role, the problem of increasing domestic production is fundamental. This accounts for the growing interest in production responses in the LDC's.

A large part of the empirical work done so far on production response in the LDC's has concentrated on estimates of price responsiveness of single crop acreages and this work is steadily on the increase.[2] This concern touches on a very important aspect of the possibilities of the transformation and modernization of traditional agriculture: the question of whether or not peasants in traditional or near traditional agriculture respond to opportunities which are made available by changes in market conditions. These studies have shown that agricultural production of specific commodities in specific LDC's is price responsive, especially when adjustment lags due to uncertainty and quasi-fixity of capital stocks are accounted for. Moreover, they suggest that the general form and direction of this response is consistent with price theory and that peasants in traditional agriculture respond quickly, normally, and efficiently to market incentives, which can therefore be expected to play an important role in the transformation of traditional agriculture. In fact, it is fair

to say that the view of BOEKE (1953), DABASI-SCHWENG (1965), DALTON (1962), FUSFIELD (1957), LEWIS (1964), MYRDAL (1968), NAIR (1965), NEAL (1959), OLSON (1960) and WHARTON (1962), and others that the people of LDC's are tradition bound, and that cultural and institutional restraint limit to insignificance, any responsiveness to market incentives, and that the developed countries have a monoply on "economic man" has been pretty thoroughly discredited. These initial econometric studies seem acceptable as first order approximations to the quantification of production response.

A related area of inquiry has been concerned with a study of rural institutions and their effects upon agricultural productivity and economic incentives, with a special concern for tenancy rights, land tenure and the structure of rural credit and rents. These studies have emphasized the importance of institutional constraints of one form or another that operate upon the economic environment. The first two approaches have concentrated upon the questions of the way in which decisions are made in agriculture and the last has been concerned mainly with the enviornment in which these decisions are made.

Aside from matters of emphasis,it is reasonable to accept that institutional arrangements modify response to economic opportunity, often change the goals of economic activity and the means of production adopted to carry it out, and yet allow for a major concern with economic decision making in the study of agricultural transformations. Whereas both the study of the institutional framework and the study of economic responsiveness are involved, there are two additional factors that should be included in any study, if the analysis of agricultural transformation in the LDC's is to be complete, and which hitherto have not been incorporated in the quantitative study of production

response. The first and the most important is the nature of subsistence production in traditional agriculture and the related phenomenon of the interdependence of the household and the firm that defines this subsistence, and the second is the problem of technological change. Indeed these two factors - the interdependence of household-firm units and the existence of new technological opportunities - are in matter of fact the elements that define the point of departure in the study of production response in traditional agriculture from similar studies of modernized agriculture. Both these factors are fundamental to any study of transformation; the former because large sections of agriculture in the LDC's operate under conditions of subsistence production and the latter because the questions of technological change and choice are at the very heart of the transformation process.

An accepted characterization of traditional agriculture is a state of economic equlibrium in which the state of the arts is constant, the set of preferences and motivations for acquiring incomes have been fully adjusted to the costs at the margin,and the marginal productivities of the factors of production have been adjusted to their returns. SCHULTZ (1964) This equilibrium is stable because given the state of the arts,the rates of investment in traditional inputs are so low that little or no investment takes place and, furthermore,"there are comparitively few significant inefficiencies in the allocation of the factors of production." As a result,small changes in either the relative prices of inputs or outputs or in the quantities of inputs unchanged in quality are unlikely to bring about any long run departure from this equilibrium. As a result, only the application of "new inputs" in the production of "new outputs" and the use of "new means of production" and "new knowledge" are required in order to shift agriculture from this traditional state. Generalizations of this nature, however, without reference to the details

of the environment, the relationship of the various factors in the environment, and their interaction are more likely to mislead than to bring about agreement with regards to specific policies required to transform traditional agriculture.

In the practice of development, as distinct from the mere theorizing about it, few if any generalizations suffice. This only reflects the vast differences in the experience of development as well as the vast variety that becomes evident if we proceed to examine the details of the development process. The details of development have not been neglected, but have become the special concern of the administrator, and in the case of agriculture the concern of the agronomists, plant pathologists and breeders, soil scientists, farm management experts, and the extension specialists - because these people have been concerned with the details, without a knowledge of which, the practice of development would become impossible. It is evident that changes that consitute a permanent departure from the equilibrium in traditional agriculture require the application of the detailed findings of many disciplines, and any analysis of its transformation should try as far as possible to incorporate these details. What is needed is an analysis that bridges the gap between the theory and the practice of development, between the administrator, the economist and eventually the farmers who make decisions on the farm. Such an analysis would be an instrument that could be used both as a research tool for the purposes of theorizing about economic behavior as well as a manual of agricultural practice, one that could view the agricultural sector as a whole without neglecting the details required for it transformation.

Most of the detailed research has been conducted at the farm level in the form of budget studies for particular farms or representative farm types through the use of partial crop budgets or linear programming studies to determine the most profitable allocation of resources on the farm. This approach

to the allocation problem, however, does not take account of the region as a whole, but does give attention to the detailed microeconomic information that determines decisions at the farm level. The focus of this approach is correct for it concerns itself with the classical problems of development - the problem of the reallocation of scarce resources, of the changing pattern of resource use, the role of technology and investment and the changing pattern of market demand. What is required is to make this approach available at the regional or sectoral level so that the level at which policies are made can be integrated with the level at which decisions are made in response to these policies. In this manner it would become possible to trace not only the path of regional development, but perhaps also to isolate the details that are "strategic" to the development process in any given region, and to the extent that these are influenced by policy actions to trace the effects of policy.

In emphasizing the importance of strategic details in the study of agricultural development at the regional level, it is not suggested here that no attention has been given to them. There are many elements of production response at a regional level that were recognized by DAY (1962) in his study of agricultural transformation in the Mississippi delta. Among those he considered necessary and meaningful are:

1) The interdependence of outputs using common inputs (i.e. the multi-product nature of the agricultural production firm);
2) Technological change;
3) Changes in both acreage and yield components in field crop production;
4) Uncertainty;
5) Adjustments over time;
6) The aggregate regional supply of production inputs;
7) The relative interaction of input and output prices;

8) The rate of investment in factors fixed in the short run;

9) Planned or programmed policy actions.

These interrelated categories have been incorporated in the empirical studies of production response in developed agriculture DAY (1963), HEIDHUES (1965), SCHALLER (1963), but their relevance to the study of production response in the LDC's has not been fully appreciated. These categories are not only relevant but crucial to the analysis of production response in traditional and near traditional agriculture. Besides these important categories there are some special features of traditional agriculture alluded to earlier that have yet to be incorporated in an empirical study of production response in the LDC's. Among these the most important mentioned earlier - the nature of subsistence production - leads to the examination of some of the details of development we wish to incorporate.

In broad terms, we can think of four sets of details: 1) the details of the firm-household interdependence in traditional agriculture, 2) the details of technological change, 3) the details of decision making and the details of regional interdependence. The rest of this paper is devoted to a discussion of these details, and a paper that follows will try to incorporate some of these for analysis into a regional model of production response in traditional agriculture, by using activity analysis.

2. THE DETAILS OF FIRM-HOUSEHOLD INTERDEPENDENCE.

It has long been recognized that the farm combines two fundamental units of microeconomic activity--the household and the firm. Some attention has been given to the resulting interdependence in the economic analysis of developed agriculture. HEADY (1953), DAY (1962) and DAY and HEIDHUES (1967). But while this interdependence is clearly of the essence in the analysis of traditional agriculture, scant attention has been paid to its implications. The exceptions

are NAKAJIMA (1957, 1963, and 1965) and MELLOR (1963, 1965), who have both contributed to a clearer theoretical understanding of this interdependence. It is now time to incorporate this feature in an empirical model of production response in traditional agriculture.

NAKAJIMA (1965) classifies all farms according to: 1) the degree of subsistence production (commercialization)-- that is the proportion of production consumed (or sold) by the farmer; and 2) the degrees to which a farm is a family farm--that is the proportion of family (or hired labor) in the total labor input on the farm. A subsistence production family farm is a farm with a high degree of these characteristics. Subsistence production is then due to the predominance of such farms in the agricultural sector.[3] Traditional agriculture is, therefore, distinguished mainly by a) the overwhelming dependence of the household upon the output of the farm for its consumption requirements for food and other outputs and b) the overwhelming dependence of the farm upon the household for its labor requirements. The resulting firm-household interdependence has several important implications for the analysis of production response.

2.1 The Interdependence of Consumption and Production.

The first implication is that consumption and production decisions cannot be separated and must be analyzed simultaneously. There are several ways in which these two interact. First, the dependence of the household upon the farm to meet its consumption requirements modify the cropping pattern on the farm since land has to be set aside to produce for consumption. To the extent that this is done, it modifies the response of the farm to the market profitability of alternate crops. The extent to which traditional farmers respond to market incentives depends upon factors such as the availability of markets, their structure, transportation costs and seasonal price fluctuations for their outputs, and their ability to store and process food, since these factors determine the extent to which the household has to rely upon the farm to meet its consumption

needs. Secondly, consumption needs often lead to a very diverse cropping pattern since a variety of needs have to be met, and as a result specialization and any economies that accrue from it are lost. The change from traditional to modernized agriculture, therefore, often requires a substantial reorganization of the agricultural institutions for marketing and substantial investments in infrastructure to improve transport and communications. Thirdly, and more directly, consumption requirements determine the extent to which farmers commercialize their production, since the amount and the composition of the marketable surplus is the outcome of two sets of interdependent decisions - the decision to produce and the decision to consume produced output - and not the outcome of production decisions alone. What is perhaps even more important is that the decision to consume depends upon the actual amount produced on the farm, and less upon such factors as income and market prices. SINGH (1969) Lastly, since consumption decisions determine the marketable surplus, they in effect determine the flow of cash income which is the principal means for the purchase of inputs not available on the farm.

2.2 The Interdependence of Consumption and Investment.

The second implication is that production and investment decisions cannot be separated and should be analyzed together. There are several ways in which consumption and investment interact. First, since the most significant input into the traditional agricultural production function is labor, and a large proportion of this is supplied by the household, the amount of family labor available on the farm depends upon the choice between leisure and income. It has been suggested that traditional farmers attach substantial value to leisure* and a relatively low value to additional incomes beyond the requirements of subsistence consumption. The outcome of this limited aspiration on the part of

* Leisure is best defined in terms of activities that consume time but do not produce any material (as distinct from psychic) income.

peasants is after a certain target income has been achieved the supply curve of family labor tends to bend backwards. If this is so,one has to know at what point to expect this. However, this is unlikely as MELLOR (1965) has pointed out, since in many low income economies, the very low incomes may have actually pushed the marginal utility of the last increment of income to such a high level that additional family labor is introduced into production even when marginal returns are low. The "reluctance to work" is not a condition of tightly limited aspirations as much as it is an unwillingness to work for extremely low marginal returns, so that we can expect supplies of family labor to be limited more by its availability then by limited aspirations. NAKAJIMA (1957) The supply of family labor maybe expected to rise with both the introduction of new consumer goods during transformation.

Secondly and more directly, investment is limited by the ability of the household to save, since in traditional agriculture a large part of the capital accumulation is done either through a direct expenditure of labor on farm improvements or through unconsumed income. The rates of saving and investment may be low because of the low rates of returns expected from investments in traditional inputs, or they may be low because of the high rates of discount for future incomes due to the larger uncertainty and risk in traditional agriculture. A preference for current and assured but admittedly low incomes over highly variable increments to future incomes expected from investments is very rational, given the large uncertainty where the physical environment upon which agricultural production depends is beyond the control of the traditional state of the arts. SCHULTZ (1964) has correctly suggested that the way to raise investments in such conditions is to substantially increase and stabilize the rates of returns by the introduction of "non-traditional" inputs and outputs. Thus saving may be available but opportunities for investment may be so limited that actual investments remain at a low level

On the other hand, it is also likely that savings may not be available, since levels of output are so low that after consumption requirements have been accounted for there may be nothing left for investment. At the micro-economic level the ability to invest is very much determined by the surplus of production over consumption for each farmer. To the extent that production just covers "subsistence consumption" (in the sense of the minimum required to maintain family labor), there may be no hope of raising the existing levels of investments unless significant changes in the production function occur first. In this regard, it should be borne in mind that at such low levels of consumption, consumption and investment cannot be entirely separated even as concepts, since food requirements are essential for maintaining the main production input - family labor - and can be regarded as an investment in a very durable and versatile asset. In this sense it is correct to say that there is no way in which decisions to consume, produce and invest can be separated except as useful descriptions of various types of activities one observes in the firm-household and labels for convenience.

2.3 Interdependence of Marketable Surplus, Investment and Consumption.

It has already been pointed out that the amount and the composition of the marketable surplus depend upon both decisions to retain outputs for consumption as well as decisions to produce these outputs. In its own turn the marketable surplus is the most important determinant of the cash available to the subsistence farmer, and hence the extent to which he can purchase both variable and quasi-fixed inputs that are not provided by the household. The choice between consumption and sales is, therefore, a very important determinant of the production function and traditional farmer uses. If we believe Schultz that there are comparatively few inefficiencies in the allocation of traditional resources, then an increase in the cash flows becomes a necessary condition for the transformation of traditional agriculture. Not only does current production compete

for these cash flows since 'new inputs' can only be purchased, but investments in new technologies are not possible without this cash flow. This is the reason underlying the importance given to the institutions of credit, the availability and terms of credit and the sources and the uses to which credit is applied, since it is felt that unless credit is made available to allow the farmers to move to new production functions, they may not be able to take advantage of opportunities even when they are available, since initially they can only generate a small marketable surplus.

Not only do variable inputs and investment purchases compete for available cash flows, but the purchase of consumer goods and services also require cash. As the traditional farmer is integrated with local markets for outputs he is also integrated with local markets for consumer goods, and hence he can forgo his total reliance upon the farm to provide all his needs, and he begins to substitute purchased goods for produced goods in his consumption bundle, thus increasing his needs for cash. In addition as his income increases, given a positive income elasticities for most consumer goods, his cash consumption is bound to increase. Of special significance is the introduction of new consumer goods into rural areas and the resultant 'domonstration effect' upon consumption, which may increase the supply of family labor forthcoming for production at the expense of leisure, may increase the amount of the marketable surplus, with a resultant increase in cash flows, only to find them being used for consumption.

Consideration of the details of the firm-household interdependence suggests that there are great similarities between the traditional farm and the traditional 'household' of economic analysis. Both the household and the traditional farmer obtain income by utilizing their labor, both aim at a maximization of their utilities which are a function of income (and all goods) and the quantity of labor (or leisure). The essential difference is in their

income equations; the income equation of the traditional farmer contains the production function, while that of the household does not.

3. THE DETAILS OF TECHNOLOGICAL CHANGE.

The most strategic role in the transformation of traditional agriculture is assigned to technological change. Studies of the growth of output in the United States has reinforced the idea that quantitatively, technological change has been the major causal influence SOLOW (1957), ABRAMOVITZ (1956), KENDRICKS (1956) and is expected to be so in the LDC's also ECKAUS (1962). Although there is agreement about the role of technological change there is little agreement with regard to what constitutes technical change and how it is to be measured.

There are deceptively easy ways of discussing technology, but most do not provide a quantitative measure of what is involved. It is necessary to measure technology in order to arrive at an appreciation of its significance for the transformation of traditional agriculture. Aggregate terms such as land, labor and capital do not sufficiently discriminate between alternate types of resources involved. What is required is a breakdown of the notion of technology into its various components in order to measure them. Fortunately, such a definitic does exist which breaks down technology by identifying and measuring the various inputs that are required to product a given output - an activity in linear programmir terms. DAY (1964) Usually activity analysis is associated with technologies with fixed factor proportions; and this is one of the criticisms of its use; but it is possible, as is shown later to define activities that allow us to approximate variable factor proportions through linear combinations of several activities.

The concept of technological change as applied to traditional agriculture involves three broad components that can be quantitatively analyzed in terms of activity analysis: 1) New Materials, 2) New Implements and Power Sources and 3) New Cultural Practices.

3.1 New Materials.

Technological change often implies the use of new materials not familiar to the traditional farmer. These new materials may be inputs used in the production of traditional outputs, or they may be new outputs produced by traditional inputs or a combination of both. New materials usually involve a change in quality as distinct from changes in quantity alone, but can be easily represented by activity analysis, since the use of a new input is a change in the resource used and a new output is an addition to the traditional activity set, while a new output using new inputs is a combination of both. New inputs and outputs are usually associated with a substantial increase in the per acre productivity, and are of special significance in countries with high population to cultivable land ratios.

Examples of inputs that are new and strategic to the development of traditional agriculture are : a) Water in the form of irrigation which allows the planting of crops that could not be grown previously, increases yields and reduces their variability by reducing the dependence on weather, and allows the development of multiple-cropping where climate and other factors permit. Water is also a most important complementary input with several other new inputs; b) Inorganic fertilizers which are either a far superior substitute for traditional organic manures or are totally new inputs. Fertilizers allow a substantial increase in yields per acre when used in combination with water and other practices. Their successful use, however depends upon i) a body of research in soil sciences to determine crop yield responses, without which farmers could not use them without substantial risks;[4] ii) an industrial base to produce them or imports and a good distribution network after their initial acceptance, iii) prices that would make their use profitable and iv) a system of extension education to provide information about their use to demonstrate their effectiveness, and assure their wide acceptanc and c) herbicides, pesticides and fungicides which assure increased yields by

reducing crop disease and destroying pests, and require conditions similar to those for fertilizers to assure their success.

Examples of outputs that are new and strategic to traditional agriculture are: a) crops not grown previously, in the sense that they do not belong to the traditional cropping pattern. The introduction of new crops often takes the form of production for the market, either foreign (cocoa in Ghana) or domestic (kenaf in Thailand), of cash crops as distinct from subsistence crops; b) new seeds and crop varities often in the form of hybrid strains developed to increase yields, resist disease and pests and grow better under certain climatic conditions, and which are currently credited for bringing about the "green revolution" and c) new non-crop activities such as livestock production, poultry and food processing which can be easily integrated into farm activities and which increase incomes and take up the seasonal slack in agricultural employment.

3.2 New Implements and Power Sources.

In agriculture production is carried out through the performance of a combination of tasks. A task can be described as a general type of action required in the production transformation. Land preparation, planting, cultivation, irrigation, harvesting and transportation are examples of agricultural tasks. Certain crops are basic to every method of crop production while others are unique to the crops for which they are performed. Not all tasks are performed for a given crop nor are they always performed a given number of times. A task intensity specified the number of times a task is performed for a specific crop. The production of final crop outputs requires the performance of a sequence of tasks at specific intensities. The "output' of each task can be viewed as an intermediate output which is then considered as an input into the next task in the sequence. The production of final crop outputs can then be viewed as the production resulting from a sequence of intermediate outputs. A standard intermediate output

is the output of a certain standard task with a fixed input output structure associated with it. It is then possible to combine various standard intermediate outputs at varying intensity levels to give final crop outputs. (For a more detailed examination of these concepts see SINGH, RAY and JOHL (1968).

The purpose of all this is that each standard task and the level of inputs used to produce intermediate outputs by its performance embodies a given technology, since each task can be performed by an implement-power combination we call an operation. Each operation is a distinct way of performing a standard task. Thus the task of land preparation can be performed with either a wooden plow or an iron plow powered by animal draft (a change of implements), or it could be performed with a disk harrow powered either by animal draft or by a tractor of given horse power (a change in the power source). Generally, it is not possible to consider the power source and the implement separately since implements are usually designed for given power sources. Thus an operation consisting of a given machine-power-implement combination has a quantitatively well defined input output structure.

With regard to this component of technological change there are a number of important observations. Firstly, even in traditional agriculture there is a vast availability of choice even when investments are confined to known implement-power sources. Traditional agriculture is a complex phenomenon with hundreds of tasks being performed, in many possible combinations, requiring detailed knowledge of soils, climate, topography, with scarce resources being distributed over time and crop use. These choices are enlarged when both old and new implements and power sources have to be considered.

Secondly- partly due to this complexity, the process of technological change cannot be viewed as the replacement of an entire set A of traditional operations by a new set B of modern operations. For example, the transition from a bullock operated farm to a modernized farm using machinery for all its tasks

requires an element by element examination of such choices as the use of bullocks versus tractors to prepare the land, a bullock or camel operated persian-wheel well versus an electric tubewell for irrigation, bullock threshing and hand winnowing versus the use of a power operated thresher and winnower, hand harvesting versus the use of a mechanical harvester. An entire bullock technology is never replaced by a tractor technology even if the capital were available. An analysis of only the "before" and "after" states militates against the examination of the detailed changes in this component of technology. What is needed is a task by task analysis of the profitability, availability and application and adoption of different machine power combinations. When a farmer is faced with a choice of technology, it is usually with regard to a change of technology for a given task and for the production of given intermediate output. Thus a choice of changing technology here is a choice of changing operations. Since outputs are produced through a sequence of such operations, each possible combination of operations represents a separate sequence.[5] No aggregate concept of technology allows us to understand this microeconomic choice unless one breaks down the components of technology.

Thirdly, a consideration of all possible operations, for all possible crop outputs would give a very large structure to analyze. In practice, however, it is possible to reduce the number of alternatives by 1) combining several tasks in a sequence and considering them as a single task, ii) combining sequences of operations to represent distinct discrete processes or "stages" of technology, iii) considering only those operations that are most frequently used in a region and including only those new operations that are likely to be significant and iv) considering only the most important crop outputs in a given region in the analysis of production activities

Lastly, and most important of all, the seasonal aspect of the performance of agricultural tasks should be explicitly accounted for. Every operation that is performed is performed at a given time in the crop year, and this timeliness is crucial in agricultural production because i) unless operations are timely agricultural production is not possible and ii) this imposes a time distribution on the use of all inputs, and the availability of inputs has also to be timely. This latter is a crucial determinant in the adoption of certain operations where there may be seasonal labor shortages for the performance of certain tasks like harvesting (thus one finds the use of labor saving devices in a so-called labor surplus sector!) and where seasonal demands for labor requires the maintenance of a larger labor force than justified by the availability of year round employment.

Examples of important implements and power sources that significantly effect traditional agriculture are: i) new implements which cost little but may effect yields such as deep furrow plows and tine cultivators; ii) tractors and diesel engines which replace animal and human labor and about which few factors should be kept in mind. Firstly, the arguments about capital lumpiness does not apply to them with with such vigor since the development of small units. Secondly, due to the time inelasticity of agricultural operations, not only their costs but their availability and reliability have to be considered. Given seasonal peak demands for labor the mechanization of given agricultural tasks may be observed alongside other labor intensive techniques. The choice depends not on relative factor proportions in the aggregative sense but of relative factor scarcity at a given time to a given farming unit which explains the vast hybrid of technologies that one observes in developing agriculture. Thirdly, their rate of adoption depends, among other factors, upon the availabilit of other complementary inputs such as fuel and lubricants and maintenence services with an adequate supply of parts, without which their adoption becomes a highly

risky venture - a risk against which farmers often hedge by keeping spare draft animals even when they have begun to mechanize; iii) electricity, a power source requiring vast public expenditures, but which once made available, can drastically reduce the cost of many agricultural operations and provide other secondary effects such as replacing animal manure as a fuel in some parts of the world and making this available as an organic manure.

3.3 New Cultural Practices

A third set of technological changes are more difficult to classify and are here lumped under cultural practices - that is, those changes that are not embodied in either materials or in implements and power sources. Difficult though it is to measure disembodied technical change, we can define a change in cultural practices as either i) a change in the number of times as task is performed (task intensity defined earlier) or ii) the inclusion (or exclusion) of tasks in the production of final outputs. An example of the first case is increasing the frequency of irrigation or land preparation tasks, and of the second is the inclusion of the task of applying fertilizers where none were before. A change of either type requires an increased (decrease) in the level of inputs, and it is possible to give a quantitative dimension to the notion of "cultural practice". Thus for example, the often recommended Japanese method of rice cultivation implies both the performance of new set of tasks (raising seedlings in a nursery and transplanting) and an increase in the task intensity for certain tasks (like more frequent irrigation). Cultural innovations such as deep plowing, terracing, contour planting may be viewed as new tasks not usually performed in traditional agriculture, while changes in crop rotations and intercropping can be considered as entire sequences of tasks not performed before. Even though the input structure may not be, unless explicit attempts are made to relate changes in cultural practices with changes in yields or yield variabilities.

3.4 The Accumulation of Capital

In view of the above breakdown of technological change, the accumulation of capital during transofrmation can be viewed as involving technological choices and the subsequent change in the structure of assets in the region. More fully, the accumulation of capital, whatever form it takes, involves the additions to capacities of fixed and quasi-fixed inputs - addition to total productive capacity. We can then distinguish two types of changes in capacities: i) an increase in the capacities of traditional fixed and quasi-fixed inputs and ii) an increase in the capacities of "non-traditional" inputs available for production. An analysis of capital accumulation involves not only an analysis of the quantitative increase in the two types of capacities but also a change in their relative composition over time. Thus it involves in a fundamental way the factor-product, factor-factor and product-product relationships in agricultural production, and when we analyze their components it involves technological choice with regard to different technologies for the performance of agricultural tasks.

This choice depends not only on relative costs and operational efficiencies of various operations, but also upon the availability of factor inputs and the cost and availability of credit, since credit supplements the cash flows generated within the farming household. An analysis of capital formation must account for both the details of technological choice as well as for the role of the availability of capital - that is both the demand for and supply of investment capital.

To view technological change in either a static of comparitive static sense is misleading since we view only the before and after - the before in which aggregative technology is called traditional and the after when it is referred to as modern. Rather technological change is a dynamic process involving microeconomic decisions, the cumulative effect of which is for

technology to slowly evolve until the modern set has replaced the traditional set.

4. THE DETAILS OF DECISION MAKING

The real difference in the economic behavior of farmers in traditional agriculture from farmers in modern agriculture arises from the way in which they make their decisions and the environment in which these decisions are made. This section describes some of the elements that would be useful in settin- up a framework of decision making in traditional agricultre.

4.1 Risk and Uncertainty.

All economic decisions are made under uncertainty and involve some element of risk, so that their inclusion into the analysis is not a new concept. However, with regard to traditional agriculture, several aspects of this problem should be kept in mind. Firstly, the element of risk cannot be easily separated, since based upon a knowledge of the probabilities of uncertain outcomes, it should be possible to insure against it, but in traditional agriculture where no institutional framework exsits to market this insurance, typically the distinction is not meaningful; and there is no way for the farmers to evaluate risk. Secondly, a part of underdevelopment is the availability of information that does exist with regard to probable outcomes, but which due to the lack of communications, education or markets is not available to the farmer to include in his decisions. Thus farmers in traditional agriculture have a greater area of uncertainty in arriving at their decisions. Thirdly, in traditional agriculture there is greater dependence upon the environment and fewer means to curcumvent it. Thus,for example, the dependence upon weather and the inability to prevent crop disease and pests leave the farmer at the mercy of a variable environment over which he has little control or predictability. Lastly and most significantly, often there is very little margin for error where farms are subsistence farms since the outcome of pro-

duction decisions determine survival. The farmers unwillingness to innovate may be related to the fact that he cannot afford to be wrong, for the opportunity cost of an unfavorable outcome is very high, even when its probability is small. He is, therefore, more likely to stay with the tried and true specially when his information about its outcome is derived from a long run sample and is based upon an intimate knowledge about his environment. Since he knows with a high degree of certainty the outcome of the traditional event, the trade off between this and a new event has to be very large in order for him to consider it, and it is only when real events diverge significantly from his predictions do traditional rules of behavior become inefficient and force a change.

A concern with uncertainty is a concern not only for the payoffs of certain events but also their probabilities. In this regard it should be understood that uncertainty is best viewed from the vantage point of the farmer and his environment, not from an outside vantage point and that a high cost has to be attached to "setbacks" - events that did not turn out to be what they were expected to be, since this reinforces the farmers reluctance to change and his faith in traditional outcomes. What is required is to learn from the farmers what choices and outcomes they feel they face and how they evaluate them rather than to assume these from "objective" criteria. The researcher has a great deal to learn from the farmer about his decision rules and there is no necessity for the farmers decisions to conform to research concepts. This has an important implication for analysis, since research should focus upon explaining what farmers actually did and why rather than on what they ought to do -- a positive rather than a normative research approach as a focus to model building.

4.2 Feedback and Expectation.

All current economic decisions which have possible future outcomes are based

upon expectations. Expectations have two elements, one based upon knowledge of the past behavior of events and the other based upon expected changes in past behavior. Expectations, therefore, depend upon the availability of information about past events, and this information is available and accurate when change is small, and events repetitive - as in traditional agriculture - but information breaks down when large structural changes begin to occur, as is typically the case in transformation. (As a result it is very difficult during transformation) to find suitable ways of including expectations when the only objective information is based on past events. Secondly, the greater the extent of the change the more variable the expectations and the greater the reliability on some mechanism to "feedback" information about events in relation to their expectation. feedback mechanism that allows the evaluation of changing expectations against actual outcomes makes it possible to adjust expectations in the right direction. Thus, a feedback mechanism should be considered an essential element in the analysis of decision behavior of traditional agriculture in transition to allow for the adjustment of expectations in a changing environment.

4.3 Learning Behavior

A special case of feedback is the effect upon performance of repeated trials - learning. In traditional agriculture, the lack of familiarity with new elements of technology introduced into the environment retards its adoption. Thus, even though a given technology may have provable high returns, the very fact that it is new is retarded by learning behavior. Such learning behavior is not unique, but considering the large number of simultaneous changes introduced in a relatively short period of time during transition, its constraint may be very important; or alternatively, as some have argued, that one can "learn to learn" so that each successive change becomes easier to adapt to and is less of a constraint. However, our analysis of new profitable choices must reflect this learning principle, and a study of adoption patterns should be included in any analysis of production response in traditional agriculture.

4.4 Ordering of Preferences.

There is a growing realization that economic decision making has a multiplicity of goals CYERT and MARCH (1965), and that all goals do not have equal priorities, and that they are often ranked according to a set of preferences, ENCARNACION (1964) This has a very special application to traditional subsistence agriculture, because farmers are observed to order their objectives according to some criteria. The most important example is the case of the farmer who desires to maximize short run profits but only as a second order goal; his first priority is to meet the food requirements for his personal consumption, especially when these are not available from any other source. Sucl an ordering is basic to his survival and the existence of such orderings may be basic to our understanding of decision behavior in traditional agriculture.

5. THE DETAILS OF REGIONAL INTERDEPENDENCE.

Besides the above details, there are details of intra-farm, inter-farm and farm-non-farm interdependence that should be considered.

5.1 Intra-Farm Interactions.

Intra-farm interactions include: i) the multiproduct nature of the farm where there is the interdependence of several outputs using given inputs. Production analysis that does not account for this interdependence and competition for available resources gives misleading results; ii) land used for fodder crops since traditional farms often rely upon animal draft which requires large land resources (15-20 per cent in India) to maintain it. If proper account is not taken of this opportunity cost, the cost of animal draft powered operations is underestimated, typically leading to an underestimation of their replacement by other power sources. Both these intra-farm interactions suggest that traditional agriculture has many closely interdependent activities which complement or compete with each other, so that a change in one inevitably places the other out of "equilibrium" so that they have to be simultaneously analyzed.

An example of this extreme interdependence is the fact that draft animals are also sources of manure and fuel in some traditional agricultures. As a result, a shift towards mechanization may raise the productivity per man-hour, but at the same time may imply a downward shift in the production function for field crops unless commercial fertilizers replace the loss of manure reducing productivity. At the same time, costs of obtaining fuel from alternati sources may have to be considered since manure (dung) is often used as a fuel source.* Such interdependencies explain the reluctance with which farmers make a change in the traditional activity set since a change in one activity often involves several interrelated changes in other activities.

5.2 Inter-Farm Differences

In a given region, there are several differences between farms that account for their different economic behavior, differences that have to be kept in mind for regional analysis. These include factors such as i) specialization where different farms due to their different soil, climate and topography are differently suited to the production of different crops. The resulting specialization may be enhanced due to the nearness to markets and the availabilit of transportation. Such regional specialization means that only relatively homogeneous farms as regard to location can be analyzed together; ii) farm size which may be important in determining the resource availability on the farm and may effect decisions due to economies of scale in machine use, greater degree of commercialization and larger potential for savings and capital accumulation. Even though it has been shown that small farms are often more efficient with regard to their resource use (E.S.O. PUNJAB (1956)) farm size may have important implications for learning behavior and the rate of adoption. To the extent that there are vast differences in farm size regional analysis should treat these explicity; iii) tenure where large differences in the terms of tenure effect production decisions at the farm level and hence between farms.

* It is estimated that in India some 80 percent of all energy is obtained from animal manure

As a result of these inter-farm differences in a given region only a region that is relatively homogeneous with regard to soil, climate, farm size and conditions of tenure can be analyzed without explicitly taking account of these differences and their impact.

5.3 Farm-Non-Farm Interactions.

The interaction between the agricultural and other sectors is of great importance in the analysis of the transformation of the traditional sector. The most important interactions include. i) the demand for farm outputs which effect the prices offered for farm outputs, and which may be especially favorable in countries with high rates of population growth; a high rate of employment growth in the non-farm sector with resulting high incomes and in creased demand for far output; ii) the demand for industrial inputs in the form of fertilizers and other non-farm inputs, whose supply, prices and availability are essential features of transformation; iii) the demand for industrial goods on the part of an agricultural sector with rising incomes and increasing commercialization during transition and iv) opportunities of non-farm employment that both competes for agricultural labor making it more costly for farm use as well as supplementing farm cash flows through the availability of seasonal employment. All these interactions with the non-farm sectors play a major role in transforming traditional agriculture and should be explicitly examined for their impact where necessary.

5.4 Agricultural Infrastructure and Farm Policies.

The importance of public investment in infrastructure - transportation, communications, irrigation, power, markets and credit institutions has already been mentioned, and to the extent that their effects are measurable should be explicitly accounted for in any analysis.

Farm policies on the other hand often have a more direct and measurable effect since they effect either i) the opportunities offered to farmers in te

of the activities made available to them and the payoffs of these activities (here we include pricing policies for both inputs and outputs, quotas, restriction and farm subsidies through government purchases); and ii) the constraints placed upon farmers through the availability of specific resources with which to carry out his decisions (here we include policies affecting the supply of non-farm inputs, credit, and regional resources through a change in the infrastructure.) Thus, it becomes possible to analyze both changes in the farm infrastructure as well as farm policies at the regional level by measuring their efeect upon opportunities,, payoffs to the opportunities and constraints placed on the availability of resources.

It is clear that in the analysis of the transformation of traditional agriculture attention has to be paid to many details that may turn out to be strategic in understanding its development. A case must, therefore, be made for including explicitly, as far as possible, as many of these details that seem significant in the regional analysis of production response. It may be impossible to include all these details, but before excluding any, the research worker should carefully examine the significance of the detail and the possible error resulting from its exclusion.

FOOTNOTES.

1. See MYRDAL (1968).

2. See BAUER and YAMEY (1959), BERRMAN (1967, 1967, 1968), BROWN (1963), DEAN (1965), FALCON (1964)KAUL (1967), KRISHNA (1963), MANGAHAS (1966). MUBYARTO (1965) and STERN (1962.

3. The notion of subsistence production should be distinguished from the notion of subsistence consumption or subsistence standard of living. As used here the word subsistence is used to apply to production only. For a clarification of the notion of "subsistence" see WHARTON (1963).

4. The basic research in soil sciences in order to classify soil types and determine the effect of various inorganic nutrients upon crops grown in various soil types requires about 10-15 years before the results become available for use by the farmers. The gestation period and the cost of such a research program should be kept in mind when we consider a vast program of fertilizer use, even if we assume that supplies are forthcoming, either through the development of a chemical industry or the allocation of scarce foreign resources. Thus, fertilizers and new crop varieties are no "quick" solutions as is often implied.

5. In activity analysis such sequences of operations are often called processes (hence process analysis) and technology is often defined as a complete set of processes available for production, and regional technology as all processes available in the region for production. DAY (1965).

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