Upgrading Traditional Rural Technologies

by

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Introduction

It is now slightly more than a decade since the publication of Schumacher's Small is Beautiful. And judging by the subsequent spectacular rise to prominence of the appropriate technology concept in the development literature, one would be entitled to conclude that the central message of this work has been at least thoroughly examined, if not necessarily widely accepted. But a closer inspection of the literature shows that such a conclusion is not at all warranted. For what Schumacher advocated was a redirection of the development effort in favor of the non-modern sector, and in particular, for a conscious effort to apply an "intermediate technology" to improving the standard of living of the impoverished inhabitants of this sector.[1/] A major portion of the literature, in contrast, has taken as its primary focus the modern sector, and has addressed in great detail, the technological problems that are posed for this sector by international transfers of technology, multinationals, factor price distortions, etc. With few exceptions, the corresponding problems of the non-modern sector have suffered from considerable neglect. The main aim of this paper, accordingly, is to begin to redress this imbalance in the treatment of the subject, and to argue for a renewed interest in Schumacher's original concern with the non-modern sector as the proper primary focus of policies for appropriate technology.

But whereas many of those who have adopted this perspective have tended to view the solution to the technology problem of the non-modern sector mostly in terms of "making available" more productive alternatives to the target group living in poverty,[2/] our view is that this approach is incomplete. For one thing, it leaves entirely open the important question of whether these alternative techniques should comprise improved versions of traditional methods, downgraded variations of modern methods, or entirely new alternatives. More importantly, by making what goes on in that part of the non-modern sector in which the poor are located, the exclusive focus of attention, the proponents of this approach are led to an inadequate view of the process by which the benefits of more productive techniques are transmitted to these groups, as well as to a tendency to neglect the dynamic linkages with other parts of the economy on which the degree of ultimate success of policy often crucially hinges. By making the adoption of appropriate technology the end result of the process, this method ignores, moreover, the whole question of the efficiency with which the adopted techniques are used over time.

The conceptual part of this paper addresses these essentially mutually reinforcing deficiencies and advocates a more dynamic and "holistic" approach to the technological problems of the non-modern sector. It begins by making a case for upgrading the traditional techniques that are widely employed in this sector, as opposed to a policy of descaling modern technology or generating entirely new alternatives. Thereafter, we argue that an adequate upgrading framework needs to take into account that the adoption of improved technology is only one link in a dynamic process, that what occurs in the non-modern sector is dependent on the relationship of this sector to others (and vice-versa) and that heterogeneous poverty groups are affected in diverse ways, as both consumers and producers, by the particular form of the upgrading process.

Having thus argued that there is a wide range of (often mutually interacting) variables that need to be incorporated into an adequate analysis, we turn in the following section to case-study material, in order to determine the types of circumstances in which these variables interact to produce particular outcomes, both favorable and unfavorable. Taken together, the conceptual and empirical sections of the paper, contain a number of important lessons for those who seek a renewed emphasis on technology policies for the non-modern sector of developing countries as a major instrument in the alleviation of mass poverty.

1. <u>The scope for upgrading traditional rural technologies</u>

The scope that exists for alleviating poverty by these means depends on the extent to which the poor actually depend on traditional technologies, as well as, of course, the definitions of "traditional" and "technology" that are adopted. For the purpose of this paper, by the term traditional we shall refer to any technology that has been in use for a relatively long period of time, such as 25 years. And from our definition of technology we shall exclude all the biological and chemical aspects of production that have been discussed in the literature dealing with the Green Revolution. On the other hand, we shall want to include in our definition, consumption, as well as production technologies.

Because the vast majority of the population of developing countries (and especially the poorest groups in these countries) live in the rural areas, it is essentially there that one needs to focus in order to gain some idea of the extent of traditional technologies in the Third World. Any such estimate is, of course, necessarily highl_' approximate in the absence of immensely detailed survey data, and the most that can probably be provided on the basis of available evidence, is an upper limit on the potential that exists for helping those who rely on these technologies.

A useful starting point is the classification of rural technologies according to whether they are used for farm or non-farm activities. The former, in turn, may be grouped into three broad types, namely, those operated by hand, those which rely on draught animal power and those relying on mechanization in the form of tractors. Table 1 shows the shares of these three forms of technology in the developing as well as the developed world i-- 1975.

Table 1

	Area cultivated - in million hectares - 1975							
					Power sources			
	Total		Hand labour		DAP		Tractors	
	Area	%	Area	%	Area	%	Area	%
Developing countries	470	100	125	26	250	52	104	22
Developed countries	644	100	44	7	63	11	537	82
World	1,123	100	169	15	313	28	641	57

The above excludes China. China cultivates 100 million ha., 50% of which is cultivated by DAP and 50% by tractors. Contribution of hand labour and percentage shares are not known.

Source: N.S. Ramaswamy, Draft Report on Draught Animal Power as a Source of Renewable Energy, FAO, Rome, 1981, p. 21.

The table confirms what one would expect -- that the reliance on non-mechanical forms of technology is substantially greater in the poor than in the rich countries. And, within the former, the same systematic variation appears to hold between countries according to their levels of income per head. Whereas in Taiwan, for example, the share of mechanical power is similar to the average for the developed countries, in India the share is only about one per cent, and in most parts of Africa the figure rarely exceeds 3 per cent.

This tendency for the shares of the two non-mechanical forms of rural farm technology to be positively associated with the "stage of development" appears to offer some basis of a workable concept of "traditional technology." But to what extent would it be valid if one were to rigidly identify these two categories with the term traditional, as it was defined above? In many parts of the world, a close identification would in fact seem to be easily justified. Take first the situation in Africa, about which a recent study has noted that, "In many cases ... Africa's small farmers -- numbering over 300 million if women and children are included -- ... are using virtually the same kind of hoes, knives, scythes, and animal-drawn ploughs as were depicted in Egyptian monuments of 5000 years ago."[3] Much the same description can be applied to many countries of Asia. In India and West Pakistan, for example, "the bulk of farmers utilize a comparatively limited number of implements <u>most of which have remained unchanged for centuries</u>."[4] Or again, in relation to draught-animal power in India (which has the largest supply of this type of power in the world), one commentator has observed that, "the bullock-cart and carts drawn by other animals have undergone little change in design over the past several decades. There has been no systematic effort ... to transmit the benefits of modern science and technology to the bullock-cart, rural transportation and the communication system as a whole."5/

To the extent then that one can, for the above reasons, closely equate non-mechanical with traditional technologies, it is evident that for much of the developing world these technologies dominate the land areas devoted to rural farm production. The same conclusion may be restated in terms of labour, if it is (reasonably) assumed that mechanical technologies are operated on the basis of wage labor and that hand and animal powered methods are conducted on the basis of non-wage modes of production. Then, by subtracting the wage-labor share from the total agricultural labor force, one arrives at an estimate of the proportion of the latter that is dependent upon traditional technologies. In 1970, this proportion amounted to some 70 per cent for the developing countries as a group;6/ a figure that is similar to the share of non-mechanical technologies given in Table 1.

Rural non-farm employment comprises an average of roughly 25 per cent of the rural labor force in those countries for which data are available.7/ It is of course impossible to classify this activity as traditional on the same basis (i.e. source of power) as for the farm sector. All that can be said here is that since much non-farm activity is small-scale and of low productivity,8/ there is a presumption that most of the technology with which this activity is associated has remained substantially unaltered over a relatively long period of time.

<u>Three frames of reference in the improvement of traditional rural technologies</u>

So far, we have suggested that the rural (farm and non-farm) sector of developing economies is frequently dominated by traditional technologies and that there are consequently vast numbers of households that would stand to gain from an improvement in these technologies. But it by no means necessarily follows that upgrading is always, or even generally, the most suitable method by which such improvements ought to be effected. In the presence of other broad approaches to the problem, the case needs, instead, to be spelt out.

Upgrading is an approach that may usefully be characterized as operating from the "bottom-up." For in a very general sense (which is the only sense with which we need be concerned at the present stage of the analysis), its distinguishing feature is the implication that there are intrinsically worthwhile elements of the traditional technology (such as accumulated knowledge, cultural values, skills, designs, etc.) which need to be retained in the process of creating an improved alternative. There are, in contrast, two other approaches with which are associated quite different assumptions as to the appropriate frame of reference, and what characterizes both these approaches (as Table 2 indicates) is a rejection of the need for retention of significant elements of the technologies whose productivity is to be increased.

Table 2

Alternative frames of reference in the improvement of traditional rural techniques

Method	Associated frame of reference	Retention of traditional techniques
Upgrading	"Bottom-up"	Significant
Descaling	"Embodied modern technology"	None
Replacement investment	Existing scientific knowledge	None

The descaling strategy has as its frame of reference the technology shelf that has been built up over time, and which, for the most part, comprises technologies developed in and for the rich countries. It is by the "scaling-down" of these existing technologies to the village level, that advocates of this approach seek to raise the productivity of producers who, formerly, were reliant on traditional methods.

The third approach (that of replacement investment) takes neither traditional nor modern technology as its point of departure. Instead, the existing base of scientific and technical knowledge is applied directly to generating an alternative technology, which, as in the case of descaling, <u>replaces</u> rather than builds upon the elements of traditional technologies. (It is, of course, often difficult to meaningfully distinguish between upgrading and replacement of traditional technologies, since it is unlikely that the latter approach will incorporate <u>none</u> of the elements that comprise such technologies and the distinction, consequently, becomes one of degree. The same arbitrariness applies with respect to the comparison between descaling and replacement investment).

The question that needs then to be addressed is whether there are any compelling reasons to expect upgrading, rather than the two competing approaches, to be the most suitable basis on which to seek an improvement in the kinds of traditional rural technologies with which we are concerned. More accurately, we need to examine the circumstances, or areas, in which each approach is likely to constitute the most effective solution to the problem. To begin with, let us consider the general circumstances in which descaling is likely to constitute an effective approach and then ask if these circumstances have any relevance to the problem at hand.

The method of descaling will generally be most effective when the environment in which it is to be applied is similar in all respects, save only for its scale of production, to that from which the relatively modern technology originates (or, alternatively, where dissimilar elements can easily be adapted to the host environment). One is referring here not merely to economic factors (such as factor prices, organization of work, infrastructure, etc.) but also to the physical environment (climate, soil, etc.). These conditions (at least those of an economic kind) are often approximately satisfied in that small part of the developing country -- the modern industrial sector -- which is based on wage-labor, profit maximization and factor prices that tend to reflect rich, rather than poor countries' factor scarcities. But the effectiveness of descaling is likely to be quite different where, instead of large-scale modern firms in the industrial sector, it is traditional producers in rural areas that the method is designed to serve.

One obvious difference is the sheer extent of the de-scaling that will normally be required to render the technology operational at the village level of traditional technology. Recent attempts in India to descale modern cement and refined sugar technologies well illustrate the nature of the problems involved.

In regard to the construction of small-scale plants for the manufacture of Portland cement it has been argued [9/] that there is a lower limit below which production is uneconomic and although there is insufficient evidence on this point to be able to draw any firm conclusion, the example does raise a more general point about descaling that bears emphasizing. It is that much of the efficiency of modern methods derives from economies of scale; at the level of output that is normally associated with traditional production, this basic advantage will almost certainly be lost.[10/]

In the descaling of crystal sugar in India, an attempt was made to overcome this problem by organizing production on a co-operative rather than a village entrepreneurial basis. But this alteration in the organization of production brought its own considerable problems. Indeed, four of the eight co-operative units that were initially set up were forced to close down and since that time, the growth of new units has been remarkably low.[11/]

Even if the scale difficulties described above could be somehow overcome a host of other problems are likely to beset a strategy of descaling in the context of traditional rural techniques.

The characteristics of the product, for example, may remain more or less invariant to a reduced scale of production (as in the two downgrading cases referred to above) and, being geared to a quite different market, may therefore be poorly suited to the low average incomes and tastes of the rural population. Many of the poorest groups in the rural areas of India, for example, prefer to purchase gur rather than the considerably more expensive refined sugar.

Many other problems can be described in terms similar to what Evenson and Binswanger refer to as "environmental sensitivity."[12/] This term is designed to reflect economic (mainly factor price), as well as noneconomic (such as rainfall, soil quality, etc.) barriers to the transfer of technology between regions. Different technologies may display varying sensitivities to the economic and noneconomic differences between regions, while these differences may themselves be large or small. Transfer of technology may then be difficult (i.e. the "environmental sensitivity index" is high) "either because a technology is very sensitive to economic or noneconomic differences and/or because the environmental differences between which transfer is attempted are very large."13/ Applying this framework to assessing the descaling method with which we are concerned, suggests that the limitations to its widespread applicability may indeed frequently be high. For on the one hand, traditional rural technologies (excepting those of a biological/chemical variety) are fairly sensitive both to factor prices and (as we shall see below) to the noneconomic environment. On the other hand, the differences in these respects (as well as in repairs and maintenance skills and attitudes to risk) between which descaling is attempted are likely to be very considerable.

Despite these apparently cogent arguments against adopting modern technology as a valid general point of departure in the improvement of traditional rural technologies, they do not appear to be universally accepted. A recent review of water supply and sanitation technology in the Third World, for example, found that "the differences in climate, socioeconomic conditions, and the sheer scale of the problem make it difficult to apply technical data from an industrial country directly to conditions in a developing country, even when the data are of a 'scientific' nature. This is particularly true with respect to nonconventional waste-disposal technologies. The influence of conventional Western research in wastewater collection and treatment on attitudes in most developing countries cannot be overestimated. Wastewater research, even when it is going on in a developing country, in many cases follows Western models and turns its back on local traditions and practices. The result is that very little is known about what is actually going on."[14]

If a principal weakness of the descaling approach is the remoteness of the environment of the transferred technology from those aspects of traditional rural technologies that are central to their operation, then the strength of the alternative upgrading approach is precisely its focus on, and attempted integration of, these key elements into an improved method (as we shall see below, being able to identify exactly what these crucial elements are is a distinguishing feature of successful upgrading). This general point is well illustrated in the specific case of an upgraded traditional pit latrine. The new version (the ventilated improved pit latrine) embodies almost all the features of the traditional version, but in addition, it relies on a vent pipe to control the major disadvantages of the latter. Among the reasons for the reliance on the traditional technology as the basis upon which to generate the new latrine were the following. "In rural areas it is best to design the latrine as far as possible in the same way as the local houses are constructed, so that self-help construction and maintenance can be used with only the minimum of external instruction and supervision. Such an approach is not only likely to be the least cost one, but it also ensures that the latrines blend in well with their environment, such aesthetic consideration may well prove to be one of the more important factors affecting local acceptance and sustained use of latrines in rural areas."[15] It is considerations such as these that led the recent survey on water supply and sanitation technologies quoted above, to conclude that, "Any attempt to upgrade or improve the existing situation, and this is surely the only strategy that has any chance of success, will have to be based on sound understanding of existing resources, limitations, and possibilities."16/

Similar arguments have been adduced for other types of traditional rural technologies. Water mills in Nepal for example, are said to have numerous specific advantages deriving directly from their close integration into the local environment. "The people are able to make these mills in their own surroundings. Wood and stones are the materials mainly used. A few iron parts are added. ... As people can use materials from their rural surroundings the cost is almost nil. ... Repairs are no real difficulty."17/

It would be a mistake, however, to confine the relevance of this essential point to only the "hardware" aspects of traditional rural technologies. One needs to pay attention, as well, to traditional craft skills as well as to traditional forms of organizing production, especially in the case of "public goods" such as irrigation and sanitation. With respect to irrigation, for example, Coward points to the existence of a large number of locally constructed and operated systems that exist around the world. "Within this set of experiences are a large number of 'silent successes': traditional, usually small-scale systems, many of which have operated for decades and centuries. ... These traditional irrigation systems offer important insights regarding the solution of organisational problems, particularly at the level of the terminal unit; not that they can simply be duplicated in other situations but that they suggest important principles of organisation which can be applied in other specific settings."18/

The appropriate inference to be drawn from the above examples is that traditional rural technologies will usually contain certain worthwhile elements that, when incorporated in an alternative, more productive technology, have significant instrumental value in promoting its adoption, maintenance and efficient usage. Most of these valuable instrumental elements of traditional technologies derive from their close adaptation over time to the natural and engineered local environment. But because this environment may itself change -- sometimes suddenly and drastically -- the force of the case for upgrading will vary substantially fom one locality to another and in a given region from one period to another. And in circumstances where the relevance of traditional technologies is on this account rendered obsolete, replacement investment, rather than upgrading, will tend to be the appropriate approach to the problem. A good example is to be found in the circumstances that gave rise to the replacement of the water wheel by mechanized irrigation in the Saga Plain Area of Japan. From the middle of the 18th century until the 1920s the water wheel, operated by human labour, was the technology used in this area to raise water. But beginning around 1900, "The equilibrium of the technology was shattered ... by events happening outside the agricultural sector." In particular, rapid industrial expansion resulted in a marked fall in the agricultural labor force and a consequent substantial increase in wage rates. Because there were limits to the extent to which the water wheel could be adapted to the changed economic circumstances, it soon became clear that "the introduction of a mechanized pump to replace the water wheel was essential to further progress in agriculture."[19]

The Economic Framework

In the previous section, a very general notion of upgrading was used for the purpose of comparison with other, equally broadly defined approaches to the problem of alleviating poverty through improving the productivity of traditional rural technologies. It was suggested that there are good general grounds for thinking that the frame of reference associated with upgrading will generally offer the most suitable basis on which to begin the task of designing such a strategy (supplemented, where appropriate, by descaling and replacement investment). The next stage in the argument is to proceed from this general level to the more specific, operational aspects of the problem. One aspect of this is the need for a framework which includes not only the question of the means of dissemination of the upgraded rural technologies, but also a description of the economic mechanism through which the benefits of these technologies are actually to be transmitted to the groups living in poverty in this sector.

We begin with a detailed criticism of the narrow approach, with which, in the introduction, many of Schumacher's followers were associated, and which in our view incorporates only a part of the required economic framework. On the basis of the criticisms that will be advanced against this approach, a more extended framework is formulated, one which will also lay the foundation for an adequate analysis of the lessons of the case-study material in the following section.

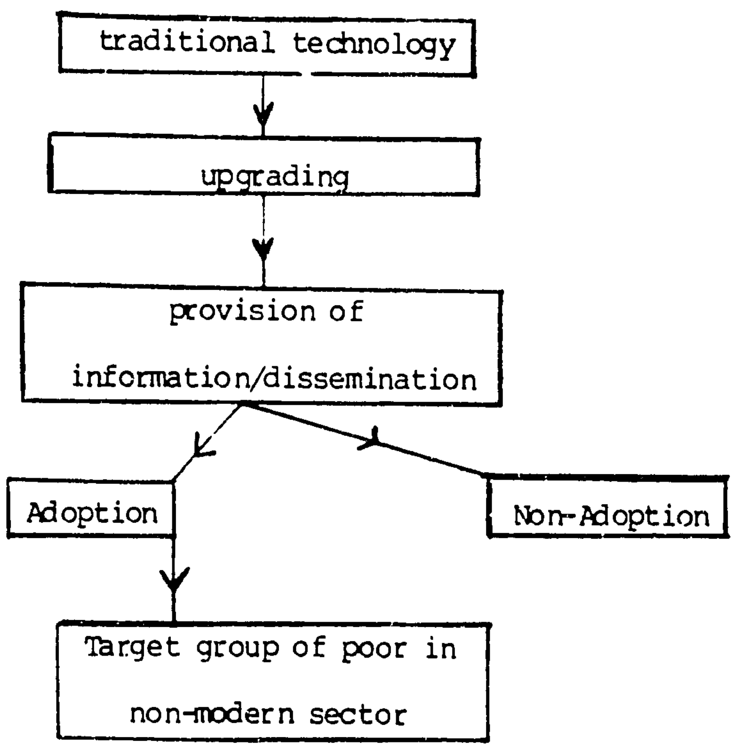
The narrow approach

A schematic presentation of this approach is shown in Figure 1.

This general methodology characterizes the operations of many of the appropriate technology institutions, although particular groups focus differentially on the separate stages that are embodied in the approach. Some of them pay primary attention to the technical problems of upgrading, while others focus more heavily on providing information and other methods of disseminating the improved technologies. But characteristic of all the literature that can be subsumed under the methodology described in Figure 1 is a failure to adequately describe the nature of the economic relationships that link the adoption of improved technology to the supposed beneficiaries among

Figure 1

A Schematic View of the Narrow Approach



the poor. The essential difficulty is that even <u>if adoption is widespread among the target group</u>, the immediate and future impact of this on poverty is a highly complex matter, the underlying variables in which are entirely neglected in the very assumptions that are made by the narrow approach. Some of the most important and restrictive of these assumptions have to do with its characterization of the nature of poverty in the non-modern sector.

<u>The implicit characterization of poverty in the non-modern sector</u>

In the narrow approach, the poor in the non-modern sector tend to be viewed as a relatively homogeneous category (in terms of the mode of production and occupational groups) that is related to technology only through the process of production (i.e. through the incomes that this process generates). The economic impact of upgrading on poverty is consequently viewed in the narrow terms of how the increaed incomes that are thereby generated accrue to the homogeneous category of poor households. In reality, however, the poor are highly heterogeneous in terms of their relationship to technology through the production system, but they are also affected by technology in their capacity as consumers (Table 3 contrasts this view of the poor with that implied by the narrow approach). Recognition of these factors demands a quite different view of how the upgrading of technology in the non-modern sector may impinge on patterns of poverty in this sector.

Let us consider first the production side of the question, and specifically, the issue of how heterogeneous groups among the rural poor, namely, the owners of productive assets, the unemployed, and "the working poor," might be differentially affected by the upgrading of traditional

Table 3

Alternative Characterizations of the Relationship of The Poor to Technology

	System of production	Consumption
Narrow approach	Homogeneous	Ignored
Realistic approach	Heterogeneous	Important

technology. It is at this point that one has to confront the crucial question, thus far ignored, of exactly whose productivity is to be upgraded.

The input (capital, labor or land) whose productivity is upgraded will initially face a decline in demand because the existing level of output can then be produced with less of this input. However, because the rise in productivity is also a decline in costs, output will often tend to expand to a degree that more than offsets this decline in the demand for the input to produce each unit of output. The net impact on demand for the input will then be positive. If then the supply increases sufficiently, the price of the input will remain fixed; at the other extreme is the case in which there is no forthcoming increase in supply, and the entire change in demand is reflected in the increased price of the input (Figure 1 in the appendix sets out these relationships formally).

The general point is that the effect of upgrading on the prices and quantities employed of the various inputs depends on the degree to which it is biased in favor of raising the productivity of one input rather than another, the extent to which output increases in response (which factors together determine the change in the demand for the input), and the change in the input supply that follows the alteration in the demand. And, to complicate matters further, one needs also to take into account the mode of production -- whether it is based on a wage or non-wage family system -- which will determine the manner in which the gains from given increases in the productivity of inputs are distributed (see Figure 2 in the appendix for an elaboration of this last distinction). The outcome of all these relationships, in turn, will determine, as shown in Table 4, the impact of upgrading on the heterogeneous groups comprising the poor. The last column and row of the table are intended to capture the fact that much traditional activity is organized along pre-capitalist (e.g. family) lines and that this activity cannot properly be classified according to the other divisions in the table that are based on capitalist relations. In particular, people working according to pre-capitalist forms of organization cannot be termed 'employed' in the relevant sense, nor can their earnings be classified into the categories of profits and wages.

Table 4
The direct impact of upgrading

	Unemployed	Working poor	Owners of productive assets	Pre-capitalist organization of production
Rise in wages	X	+	X or -	X
Rise in employment	+ or X*	X	X	X
Fall in employment	X	-	X	X
Rise in profits	X	X	+	X
Rise in earnings	X	X	X	+

+ = gain from change
X = position unchanged
- = lose from change

* This depends, of course, on whether or not the unemployed (underemployed) are willing to accept new wage-employment opportunities.

What this table shows is thus not merely that a particular form of upgrading may leave the situation of certain poverty groups unchanged, but that it may even cause a deterioration in their economic welfare. An increase in wages, for example, may be harmful to the interests of those who own productive assets. There may also be interactions between some of the changes shown in the table (i.e. the rows) which lead to the same result (as when a rise in wages reduces the number of jobs available). This type of result derives particular importance in relation to the fact that the proportions of the different groups in poverty vary substantially from one country to another (as Table 5 shows). It means, firstly, that a given policy of upgrading will have a different impact, depending on where it is applied. And secondly, it implies that upgrading policy, if it is not formulated very carefully, may have only a slight impact, in a particular country, on the very problem that it was designed to solve.

Referring to Table 5, it is clear, for example, that upgrading the productivity of traditional technology will do little to solve the poverty problem in Trinidad and Tobago, unless it is associated with a significant increase in employment.[20/] Similarly, unless the working poor in Chile are able to share in the productivity gains of upgrading, the result of this policy will be only a slight impact on poverty. To this extent, technical changes which appear to fall into the category of being appropriate, may not in fact have a significantly greater impact on poverty than those which are more obviously inappropriate because they entirely bypass the groups represented by the columns of Table 4, and instead distribute increases in employment, wages and profits solely to members of the richest groups such as

Table 5

Occupational composition of the poor (percentages)

	Employer	Self-employed	Employee	Housewife	Unemployed
Malaysia, 1970 (poorest 49%)	0.5	51.8	41.8	2.3	3.6
	Employer	Self-employed	Employee, private sector	Employee, public sector	Sharecropper
Brazil, 1960 (poorest 31%)	0.5	51.0	37.0	3.0	8.0
	Employer	Self-employed	Salary earner	Worker	
Chile, 1968 (poorest 46%)	0.0	24.0	5.0	71.0	
	Employer	Self-employed	Employee	Unemployed	Other
Trinidad and Tobago,* 1975/6 (poorest 42%)	0.4	15.1	25.6	18.6	40.3

*The table on which these figures are based classifies households by monthly income and occupation of head of household.

Sources: H. Chenery et al., Redistribution with Growth (Oxford University Press, 1974) p. 23; Trinidad and Tobago, Central Statistical Office, Household Budgetary Survey 1975/6 (1977) Table 22.

labor "aristocracies", and owners of large firms.

If, therefore, it is important to take into account the differential impact of upgrading on the heterogeneous occupational groups comprising the poor in each particular case, it is also necessary to consider the disaggregation of these categories in order to allow for the impact on particular groups (e.g. women) within them. What occurred as a result of the introduction of improved reeling technology in the Indian tasar silk industry demonstrates the importance of heterogeneity within (as well as between) the groups living in poverty. In particular, the improved technology appears to have generated "a definite structural change in the employment relationship in the industry. Most certain, is the decline of silk reeling activity by the women folk and giving the place to a small number of machine employed hands."21/ The significance of this altered structure for poverty derives in part from the fact that "Among low income households such as the tasar weavers, women's earnings contribute significantly to family income. In fact, their total earnings, unlike those of their men who spend a part of their income on liquor and such other items, go down to meet the basic need -- food -- of the family. This underlines the importance of female earnings in these families and hence their crucial need for employment."22/

So far, we have described the various ways in which the heterogeneous groups in poverty may be affected by upgrading, through the medium of the production system, and in particular, through the alteration in the demand for inputs that is wrought by this process. But as noted above, the impact of upgrading on the poor will also be transmitted on these groups qua consumers, and it is to the nature of this aspect of the issue that we now turn.

Compared to the emphasis on the production aspects of the distributional impact of technological change, very little attention has been paid to the role of consumption. As Scobie has recently put it, "The impact of technological change on the distribution of income between producers and consumers is probably the most powerful and compelling aspect of the distribution consequences, although ironically, that which receives the scantest recognition in the debate. The benefits which flow to consumers of agricultural products are more diffuse, less visible and often harder to measure than the immediately apparent impact of the income on producers."23/

It is important to recognize that "the benefits to consumers" described in this quotation are the result of a fall in the prices of the products that they consume. This way in which consumers benefit is to be distinguished from the upgrading of consumption technologies (such as wood-stoves), wherein the gains to consumers arise from an alteration in the nature, or characteristics of the product itself, rather than from a fall in its price. (This distinction is illustrated diagramatically in Figure 3 of the appendix.)

With respect to the former means by which consumers (rather than producers) may gain from upgrading, one major determinant is the type of demand for their output faced by producers. At the one extreme is the situation in which demand is such that producers are able to sell as much as they desire without any reduction in the price (so-called "elastic demand"). "Such has been the case for export crops, and where the new technology, through lack of regional uniformity, favored only a small part of the total producing sector." At the other extreme, the market demand is such that prices will fall in response to even a slight increase in production (which is referred to as an "inelastic demand"). This type of demand is thought to characterize much of agricultural production especially foodgrains.

In the first case, where there is little or no fall in prices, it is producers rather than consumers who would benefit from upgrading, while the converse applies to the other polar case (producers and consumers both benefit, of course, from intermediate situations). For a given reduction in price, low-income consumers will benefit in proportion to the amount of their budgets that is devoted to the item whose price has fallen. Consequently, a given percentage reduction in the price of say, rice, will yield a substantially greater benefit to the poor than in the case of a less essential item.

Reversal of means and ends -- the characterization of the upgrading process

The second major restrictive assumption of the narrow approach which is summarized in Figure 1, is that adoption of the improved technology is the ultimate goal of the process. This assumption, unfortunately, by effectively reversing the proper way in which means and ends should be viewed in the upgrading process, excludes some of the most important factors that bear upon the impact of this process on the target group of beneficiaries.

The main point to be made here is that adoption is a necessary, but not sufficient condition, for realizing the gains from an upgraded technology. As Figure 2 shows, there is, for one thing, an important intermediary stage, the outcome of which is often central to an understanding of the effect of technological change.

Figure 2

adoption ——→—— efficiency with which new technology is used ——→—— gains from upgrading

The narrow approach implicitly assumes that new technology is efficiently used in production (or consumption, if this is the technology that is upgraded). But this assumption is most unlikely to be generally true, and will be perhaps most severely violated in relation to changes in traditional technology which demand new and unfamiliar methods of production. The resistance to the new methods that is often imposed by the forces of habit and tradition will tend to imply some degree (which may on occasion be considerable) of inefficiency in the way that the new technology is actually used. This point is very well illustrated by the way in which the moldboard plow has been used in India and Pakistan, as described by Johnston and Kilby. "Being a specialized implement, the moldboard plow cannot be used for harrowing and intercultivation. Many farmers who have bought a moldboard have not acquired the knowledge, technical skill, and associated implements to use it effectively. In fact, they have not infrequently employed it as a wedge in the manner of a local (desi) plow. In some areas the techniques used to control bullocks are not very satisfactory so that plowing is not done in a straight line with parallel rows, and the adjustments of the moldboard to reap its benefit are not carried out properly at all."24/

Because of inefficience is such as these, it may even sometimes be the case that the actual benefits derived from upgraded technology fall short (at least temporarily) of those obtained from the traditional method (although the potential benefits from the former may far exceed those available from the latter).

A second reason why mere adoption cannot properly be considered as the desirable end-product of upgrading, has to do with time, and in particular, the fact that short-run benefits may not be maintained in the longer run.

Precisely the problems posed by this distinction have been encountered by those concerned with policies for family planning. For a time, it seemed reasonable to these people that initial acceptance of family planning methods would be closely associated with long-term use. Subsequent findings, however, belied this view, since it was found that continuation rates were frequently very low.[25/] The same difficulty is described by "The widespread failure of community water supply and latrine programs, when measured by long-term successful operation or usage."[26/] Indeed, some authors have noted that in some countries, village water systems are breaking down faster than they are being built.[27/]

Similar problems have been reported in cases where farm machinery has been introduced at the village level. Several such attempts in Tanzania, for example, "had required the constant attendance of government workers such as agricultural engineers, with their relatively sophisticated management of, and accounting for, supplies of fuel and spare parts, regular maintenance, and the proper use of machinery. When the government workers were withdrawn, the machinery tended to fall into disuse for lack of one or a combination of these."[28/]

The discussion thus far has drawn attention to the efficiency and durability of the use that is made of upgraded technologies, and to the importance of these factors in determining the gains, both static and dynamic, that are realized by a <u>given</u> upgraded technology. But what may be equally as important, if not more so, is the degree to which the recipients of this technology are able, through changes and adaptations, to <u>improve</u> continually its productivity. For without this "evolutionary" quality (as Jequier has called it [29/]), any gains from appropriate technology will be merely "once-for-all" and even these may be negated over time by the technological changes that are occurring in the competing non-modern sector of the economy. This last consideration leads us to a discussion of the dynamic, intersectoral aspects of upgrading.

The neglect of dynamic, intersectoral linkages

We have seen in an earlier section, that what economists refer to as a "general equilibrium" approach is important to understanding how the benefits of upgrading will be distributed among and between producers and consumers in the economy. What is important to this question, that is to say, is not merely what occurs in one sector of the economy, but rather the interactions between the different sectors. These interactions, which, as we have seen, are ignored in the narrow approach, also occur over time (i.e. dynamically), and these dynamic interactions are equally important to understanding the ultimate success with which policies for upgrading are applied.

What is mainly at issue here is the nature of the relationship over time between the non-modern and the modern sectors. Because it is reliant essentially on technological change occurring in the rich countries, the latter tends to grow rapidly, but given its typically small initial size and rapid rates of population growth, cannot normally grow sufficiently rapidly to absorb the labor force that accumulates in the former (as occurred in many of the now developed countries). If, on the one hand, the modern sector is thus incapable of rapidly solving the problems of mass poverty and unemployment, on the other, it appears in many ways as a formidable obstacle to an alternative path to development based on the non-modern sector. In few areas, is this essential problem more apparent than that of technology.

Reference has already been made to the dynamic character of the technology that is adopted by the modern sector. Insofar as this sector competes with the products of the non-modern sector (and on occasion, the relationship may of course be complementary as under certain subcontracting arrangements, or non-existent, as with, for example, local housebuilding, local latrines, etc.), and to the degree that the competitiveness between the two is determined by differential rates of technological change, then the challenge that is thereby posed to the successful upgrading of traditional technology is a formidable one indeed. For the difficulty is then that upgrading needs to have not merely an ongoing, continuous quality, but also one that is sufficiently dynamic to keep more or less in step with the rate of change in the modern sector.

This demanding requirement, in turn, forces us to consider the type of circumstances in which it is likely to occur. Much has been made, in this regard, of the importance of the role played historically by a small-scale, dispersed rural capital-goods industry (i.e. backward linkage). Thus, in countries as diverse as Taiwan and China, "widely dispersed rural workshops manufacturing farm equipment have performed a crucial role as a technological training ground in developing the capacity to build machine tools and other capital goods. This steady upgrading of the processes and products of rural industry encourages the development and spread of technologies adapted to a country's factor endowment and thus stimulates continuing growth in the size and competence of its local manufacturing industry."[30]

Pointing again to historical experience (especially of the now industrialized countries), some economists argue that this symbiosis can be achieved without substantial direct intervention by government. For given the existence of a patent system, which enables the gains from innovation to be appropriated, "the location-specificity of many of the adaptive solutions give farmers, blacksmith repair shops, or small firms an important advantage over public research institutes or large corporations."31/ Moreover, "mechnaical innovation, unlike biological or chemical ones, does not usually depend on university-acquired skills of chemistry, genetics or statistics. Mechanically minded individuals with little formal education are thus not at a disadvantage."32/

In many of the poorest developing countries, however, neither the existence of a reasonably well developed patent system nor (and more importantly) even a relatively basic level of mechanical skills can be taken for granted. In much of Central and East Africa, for example, the small foundry and casting knowledge and moulding, patternmaking and machining skills required for the manufacture of simple hand-operated machines or agricultural implements, such as water pumps, appear to be largely absent.33/ Here, therefore, a far more active role for the government in promoting the development of this sector (through, for example, training schemes and protection), and in temporarily assuming some of the intersectoral functions that it would otherwise perform, may be necessary.

Even from this cursory statement of the intersectoral requirements of a sustained process of upgrading, it should be apparent that the political economy aspects of this process cannot be ignored (as proponents of the narrow approach are sometimes wont to do). The essence of a dynamic sequence of technological upgradings is to convert a situation in which rapid technological change occurs in only a narrow segment of the economy, to one in which this change is far more widely diffused. And relative to the status quo, this implies an increase in the proportion of the economy's total resources that are controlled by units in the non-modern sector; an alteration in the composition of units (to use Stewart's phrase[34/]), that will occur, not only in the markets for final goods, but almost certainly also, as we have seen, in the markets for capital goods (such as for rural farm and non-farm equipment and tools). Within these markets, the challenge to existing interests that is posed thereby, occurs in relation both to the size of units (with large firms, both private and public, losing relatively to small) and also to their location (with the rural sector tending to gain relative to the urban).

If wishing to alleviate poverty through the continuous upgrading of traditional technologies therefore also means to some extent being against certain other interests, it is often precisely because of the influence of the latter with governments that the outcome of upgrading efforts diverges from the appearance of enthusiasm with which they are pursued. In the case of India, for example, partly because of the "conflicting pulls and pushes of interest groups, implementation of various policy measures favouring decentralized rural industries has been tardy, half-hearted, and at best counterproductive."[35/] Tanzania's failure to promote the widespread use of animal-drawn implements is especially noteworthy, for "it might be assumed that as a socialist country with a strong commitment to an egalitarian approach to development, the political pressures which have elsewhere contributed to the encouragement of inappropriately capital-intensive technologies would have been almost nonexistent. However, the gap between policy pronouncements and actual implementation has been wide."36/

Important though the political economy aspects of upgrading undoubtedly are, we shall see in the following section that these forces do not account for all instances of failure, nor do they always seem capable of totally undermining the chances of a successful outcome.

The lessons of experience

In the previous section it was argued that upgrading is a much more complex process than is often depicted, particularly by exponents of what was referred to as the "narrow approach." To this incomplete approach several additional dimensions were added in order to derive a more adequate conceptual framework. This extended framework is now applied to an analysis of case-study material, with the aim of isolating the main factors that seem to account for the cases of success, as well as of failure, in this area.

It needs to be emphasized that the results of this endeavor are based on a data set which suffers from numerous (and in some cases severe) limitations. Firstly, many of the cases are rather fragmentary, dealing with only a few of the variables in the upgrading process that were described in the previous section. Secondly, the number of cases which qualify even on this count (many are mere technical/engineering descriptions of the new technology), is relatively small -- certainly a long way from what is required for statistical significance. Thirdly, there is a quite pronounced regional bias in the distribution of the case-studies, with a preponderance of the material coming from Asia. Finally, the data set does not purport to be even approximately inclusive of all relevant experience. Rather, it should be viewed as the outcome of a brief, but intensive survey of the English-language literature.

The problem of dissemination

In the discussion above, our analysis focused mainly on the determinants of the success of upgrading efforts that occur after the dissemination process has occurred, because it is these less obvious aspects that have been neglected in the literature. But the problem of disseminating the new technologies is obviously itself also critical to the success of any upgrading efforts and it is to the light that can be thrown on this problem from the case-studies that we turn first.

One of the principal conclusions that emerges from a study of these cases is that, though there are some general lessons to be drawn, the choice of a suitable approach to dissemination needs to reflect the variation in the nature of the technology that is upgraded. There are, in particular, three distinctions that need to be made, namely, between (a) technologies for production and those for consumption, (b) technologies that can be disseminated on an individualistic basis as opposed to those that require some communal form of organization, and (c) technologies that are located "on the farm" in rural areas and those that are associated with non-farm activities. Taken together, these distinctions enable us to draw up a typology of cases, in the form of the matrix shown in Figure 3.[37] (Some of the cases which we shall analyze are contained in the matrix for illustrative purposes).

Each of the cases shown in the six cells in the matrix is defined by a set of characteristics, and by showing how these bear on the choice of a suitable method of dissemination, we ought thus to be able to offer a set of guidelines

Figure 3

A typology of cases

	Individual	Communal
Consumption	Wood-stoves, rain collectors	Sanitation, water supply
Production		
Farm	Tools, animal carts	Pumps
Non-Farm	Food-processing, crafts (e.g. pottery)	Crafts (e.g. communal kilns)

for the successful dissemination of any particular type of technological improvement (representing a particular combination of characteristics).

Farm versus non-farm production technologies

One of the most significant features of peasant farming in many countries is the presence of a marked seasonal shortage of labor.[38/] This feature of the farming system has a crucial bearing on the question of whose productivity needs to be raised if upgrading is to result in the kind of expansion of farm output that will promote widespread adoption of the new technology (expressed formally, the concern here is with the appropriateness of the bias in factor-saving). For unless the improvement in traditional technology makes some contribution to reducing the peak labor requirements (by raising the productivity of this input and therefore, effectively increasing its supply), it is unlikely to meet the needs of the farm sector, however much it may raise the productivity of other inputs. The converse of this proposition is that the ease with which innovations can be disseminated may be substantially increased if they are expressly designed to reduce the seasonal labor bottleneck. The experience of the ILO/UNDP Tanzania project on appropriate agricultural implements clearly illustrates this important point.

In seeking to define the characteristics of a set of improved farm implements that would be widely acceptable to the villagers, those concerned with the the project came to the conclusion that this required "careful attention to the constraints under which farmers live, because such constraints determine the limits of what is feasible. The project ... was developed within the limits of such constraints, and it is from this initial awareness that its success resulted."39/ One of the most important of these constraints was a seasonal shortage of labor for weeding which the new technique, because of its reduced labor requirements, was able to break. And even though this method did not represent a substantial reduction in total costs compared to the traditional technique, it was nevertheless "a gain of great significance to the farmer."40/

A second major feature of farming systems which warrants special consideration is the marked variation in environmental conditions between and often within regions, a degree of variation that was described above in terms of a high index of environmental sensitivity. What this sensitivity implies for the requirements of a successful upgrading effort, is that improved technologies need to be designed (or adapted) in a manner that is closely reflective of the features of a particular geographical area. For instance, "An outstanding feature of Taiwanese agriculture implements is the degree to which each tool has been designed for its special task and specific environment. An example is the harrow, one of the eight types of tools used in secondary tillage. There were nine kinds of harrows reported in 1952 ... Since 1952 the animal-drawn typed tiller and the disk harrow have been introduced. A single one of these harrows, the standard knife tooth, has twelve regional variants. Width, length, material and number of teeth, shape of tooth blade, and method of affixing teeth are adapted according to local typography, field size, soil structure and available construction materials."41/

If adaptation to specific environmental circumstances were a major feature of the successful Taiwanese case, the failure to effect these types of adaptations is said to have been an important reason for the disappointing experience of the Chilalo Agricultural Development Unit (CADU) in Ethiopia. Initiated under the Third Five Year Plan (1968-1974), CADU was given the task (among other things) of conducting "adaptive research in the major ecological zones of Chilalo." Included in this research program was to be the design of ox-drawn plows, harrows and carts, and other improved farm implements. "But acceptance of the prototypes by small farmers to date has been very disappointing with the exception of the ox-drawn harrow. One reason for the rather slow acceptance of most of the improved farm tools seems to be that sufficient consideration was not given to environmental variations between localities and farmers' preferences as to, for example, the shape and weight of certain tools. For example, the ox-drawn plow was rejected by many farmers primarily because they found it too heavy to be carried on their shoulders from their homes to the farm, and too heavy to be pulled by their oxen."42/

The two features of peasant farming systems that were described above, are not peculiar to this component of the rural sector; they apply in varying degrees also to certain non-farm activities. Traditional open pan sugar technology, for example, is said to suffer from a pronounced labor shortage during the crushing season[43/] and many non-farm activities are characterized by a degree of environmental sensitivity, which, though not as high as is usual in the farm sector, is still of a magnitude that is uncommon by the standards of the urban sector. But what mainly distinguishes rural non-farm activities from those that take place on the farm are the dimensions of the upgrading process.

Firstly, the upgrading process in the non-farm sector has to pay particular attention to skills, since it is the level of these (especially in crafts production) that is a major determinant of earnings in the sector.[44/]

Secondly, whereas farms produce mostly undifferentiated products, the output of the non-farm sector is often significantly differentiated from competing goods, and this fact has a major bearing on what is required for successful upgrading. It means, in particular, that in addition to the production technology, the product itself may often need to be upgraded, a dual requirement that is attested by several case studies.

Early efforts to upgrade the village pottery industry in India, for example, were confronted with the problem that the traditional product, a non-porous red-coloured variety made from local clays, had lost ground over time to whiteware articles made from China clay. As a result, upgrading the village potters' technology on the basis of the former proved to be inadequate. "The only alternative which appeared to stand a good chance of success was to initiate the manufacturing of whiteware at the village potters' level."45/

Upgrading of traditional products need not, however, require such a major alteration; what may be required instead, is a reduction in the variation in the quality of a given product. Any attempt to replace cement with a village-produced alternative, such as lime-pozzolana, for example, will have to confront the problem that "Unfamiliarity of the product will initially make users suspicious of it, and unwilling to make the risk of using it in preference to the well-known and reliable existing product. The fact that it is made in the village with less quality control than can be expected in a factory, and not subject to any recognised standard or specification, will increse the lack of confidence. ... Any sub-standard material which finds its way on to the market particularly in the early stages of production when users are unfamiliar with the product, will increae the potential users' lack of confidence in the material."46/

Much the same problem appears to have had a lot to do with the failure of the attempt by the Khadi and Village Industries Commission (KVIC) in India to upgrade the technology of the cottage match industry. Lack of uniformity in the quality of the matches associated with this project made it difficult to market the goods through the existing network of wholesalers and retailers, even though these agents were offered margins that were higher than conventional rates. And when the KVIC "lost the hold over the market function -- the crucial rein -- all other development measures failed to push the programme to success."47/

Up to this point, we have stressed the essential differences in the required form of the dissemination process between the farm and rural non-farm sectors. But the case-study evidence indicates that there are also numerous common requirements in the two sectors. The most important of these common dimensions of appropriateness in the design of improved technologies are listed below.

a) Costs

In relation to the farm sector, we took note earlier that, if they are to be widely disseminated, new technologies will often need to break the production bottleneck that is imposed by the seasonal shortage of labor. Though there are in principle many forms of new technology that are capable of meeting this requirement, it is generally only those that can do so at a sufficiently low cost in relation to farm incomes that will be spread successfully. In the cse of traditional producers in the poorest developing countries, this requirement places highly stringent limits on the capital costs of improved technologies. And to meet these, all available means of reducing costs have normally to be employed.

In Taiwan the importance of this point had been grasped even by the early nineteen fifties, as the following description of the period clearly reveals. "Farm implements in Taiwan are comparatively cheap and this is due to the farmers' low purchasing power. Manufacturers often have to sacrifice quality in order to maintain a low price. If sturdy and highly efficient farm implements were to be made, their prices will have to be raised; farmers because of their financial stringency, will not be able to buy these implements even if they are aware of their good performance. In other words, the farmers in Taiwan should be temporarily satisfied with the minimum serviceability of implements available."48/ Exactly how cheap most of these implements were, can be gauged from the fact that the average price of half of the total stock in existence in 1952 (i.e. 160 items) was less than five United States dollars at 1970 prices (and the majority of animal drawn implements fell in the 10 to 40 dollar range).49/

The same type of concern with methods of cost reduction as a key determinant of widespread dissemination has recently been expressed in the advocacy of "village technology". This concept, which arose out of the ILO/UNDP Tanzania project mentioned above, is meant to describe a technology that "takes the fullest possible account of the cash constraint on subsistence farmers, while at the same time permitting great reductions in labour input per unit of output, as well as lightening much of the physical arduousness of agricultural work -- no mean consideration for the malnourished."50/ Those concerned with the project sought to distinguish this concept from "intermediate technologies" (such as cultivators, harrows, etc.) that are manufactured mainly from metal and which, partly on this account, are often beyond the means of subsistence farmers. Village technologies, in contrast, are made chiefly from wood and other cheap local materials and are shown to represent, on average, a savings in cost of some 60 per cent over the intermediate alternatives.

The difficulty, of course, lies in creating pressures/incentives/attitudes that are favorable to the concerted and creative efforts to reduce the costs of improved technologies that have been described above. In the Taiwanese case, these propitious circumstances were provided on the demand side by gradually rising cash sales per farm unit together with a high degree of competition between a very large number of producers, and, on the supply side, by the absence of significant economies of scale in the production of farm tools.[51] In the Tanzania project, the favorable outcome arose mainly from a close interaction between the officials involved and the villagers for whom the new technologies were designed. Frequently, however, neither economic circumstances nor the attitudes/behavior of researchers are conducive to achieving the level of costs that produce widespread dissemination.

In the upgrading of traditional Indian ox carts, for example, a contrasting set of economic circumstances from those that obtained in Taiwan led to a very different outcome. Among the deficiencies of these carts are rough and loose bearings and iron-rimmed tyres on wooden or iron wheels that lead to low carrying and earnings capacity, damage to animals and to roads.[52] An improved vehicle, introduced by Dunlop, has a steel axle, steel wheels, roller bearings and pneumatic tyres. But this vehicle, though it is considerably more efficient than the traditional cart, has had only a very limited impact on traditional producers. One reason for this is said to be its relatively high cost -- approximately double that of the traditional alternative. And the reason for the inappropriately high costs (relative to the incomes of traditional producers) has been stated as follows. "Because of the low volume of tyres required, tyre companies have no incentive to manufacture specifically designed tyres for ADVs [animal drawn vehicles]. The same points hold good for ball bearing or taper roller bearings. Now ADVs are using truck bearings which are costly as they are meant for high speed, high precision, heavy loads, etc. ADVs need slow speed and cheap bearings."[53]

On occasion, the cost of improved technologies fails to match the resources available to traditional producers, even when they are designed specifically for this group. Consider, for example, what occurred when the Central Tasar Research and Training Institute in Ranchi, India, operating under the aegis of the Central Silk Board, attempted to effect an improvement in the traditional method of cooking cocoons. For this purpose, a new cooking chamber was designed which allowed a faster and more efficient process. But the new cooker, at a cost of 300 rupees, proved too expensive to be widely adopted by the target group of low-income households.[54/]

b) Scale

The costs and scale of technologies are often closely related, so that innovations which are excessively costly in relation to the resources of target groups among the poor tend also to be of too large a scale. Thus, intermediate technologies in the Tanzanian example referred to above, are mostly both more expensive and of larger size than the village technologies and in the case of the cocoon-cooking equipment in India, the scale, as well as the cost, was inappropriate to the objective of securing widespread adoption of the new equipment among the poor.

But the appropriateness of the costs and scale of upgraded technologies has to be defined not merely in relation to the size of holding (in the farm sector) or the unit of production (in the non-farm sector), but also to the institutional capability of organizing the ownership or use of these technologies on a communal basis. In the case of the improved cocoon-cooking equipment, this capacity was apparently absent, for the technology demanded a change in the "method and organization of production apart from market arrangements which could not be possible with the target beneficiaries."[55/]

In other cases, however, the required capability does exist, and this substantially alters the definition of the appropriate scale (and costs) of production.

One example is the upgrading of traditional pottery technology in India, that was referred to earlier in another context. In some of the locations in which the production of whiteware was organized, the firing of the pottery was carried out in a centralized workshop that had been established by the local government, but other components of the process were performed at the level of the village potters' own workshops. It was only after the initially satisfactory experience with this form of organizing production, during which the potters had acquired experience in producing whiteware, that they were encouraged to build kilns in their own workshops. Taken together, these and other efforts to upgrade the traditional technology created additional employment for some 10,000 people in Uttar Pradesh, an experience that led M.K. Garg to observe that "the most critical factor [in scaling-up village technology] is the type of organisational set-up required to initiate, expand and support such a programme for at least a dozen years or so."[56/]

The Japanese experience is an especially noteworthy illustration of how the appropriate scale for upgrading (and replacement investment) can be separated from the individual unit by various forms of co-operative arrangements. After the First World War in that country, "There were many kinds of farm machines whose prices were too high for individual households to be able to buy and for which the minimum required scale of operation was too large for individual farm households to be able to use them efficiently. Therefore, there was scope for a minor cooperative to perform the function of the agent for the joint investment of these individual farm households."57/ Indeed, Ishikawa has demonstrated that, in the 1930s, the proportion of listed farm machines that were jointly owned was between 10 and 25% of the total ownership.

One needs to be extremely cautious, however, in drawing policy conclusions from the successful Japanese experience with co-operatives. For this experience was very largely the product of an organizational capacity among the rural population that had been inherited from the feudal period. And as Hayami has pointed out, (in A Century of Agricultural Growth in Japan), in this respect, "The conditions of agricultural development surrounding the countries in South and Southeast Asia today are certainly very different from those prevailing in Japan at the Meiji Restoration." But one needs also to stress the policy aspects of the Japanese experience, and in particular the attention that was paid to the need for technological adaptations and innovations.

c) Simplicity

In addition to being appropriate with respect to cost and scale, many of the instances of widely diffused improvements to traditional technologies are characterized by simple manufacture, maintenance and repair requirements in relation to levels of available skills. Table 6 shows a number of such illustrative cases (including two consumption technologies, in the area of sanitation).

b) Consumption versus production technologies

The second main distinction on which our typology is based, is between consumption and production technologies (though in some cases, of course,

Table 6

	Cost	Scale	Simplicity
ILO/UNDP improved farm implements in Tanzania	60% lower than intermediate technology	village level	"enables the villagers to construct and keep in working order a whole variety of agricultural equipment."
Water pump in Saga Plain, Japan	Capital cost of installation per hectare of land equal to annual wages of one hired worker	village cooperative level	"easy to operate and fitted into the existing layout of water channels."
Handpump in Bangladesh	700 takas in 1979	Individually owned and operated	"easy to install and maintain and the necessary skills are available locally"
Ventilated improved pit latrines in Zimbabwe	often the least-cost technically feasible sanitation "technology" in rural areas	Family or village community level	"since the architectural style of these latrines is essentially the same as that of their houses, the householders have the necessary skills to do regular maintenance work"
PRAI improved latrine in India	"Within the financial means of the villager"	Village household level	"can be made locally, and the skills required for manufacturing the parts, erecting the latrine ad operating it can be easily acquired by the villagers"

Table 6 (cont'd.)

Sources:

For Tanzania, G. Macpherson and D. Jackson, "Village Technology for Rural Development," International Labour Review, Feb. 1975.

For Japan, P. Francks, "The Development of New Techniques in Agriculture: The Case of the Mechanization of Irrigation in the Saga Plain Area of Japan," World Development, April/May, 1979.

For Bangladesh, M. Howes, "The Social and Economic Implications of Alternative Approaches to Small Scale Irrigation in Bangladesh," IDS, Sussex, mimeo.

For Zimbabwe, P. Morgan and D. Mara, "Ventilated Improved Pit Latrines: Recent Developments in Zimbabwe," World Bank Technical Paper No. 3, 1982.

For India, M.K. Garg, "The Upgrading of Traditional Technologies in India: Whiteware Manufacturing and the Development of Home Living Technologies," in N. Jequier (ed.) Appropriate Technology-Problems and Promises, OECD, 1976.

elements of both types may be involved, as when, for example, rain collectors are used to store water for domestic needs and also for watering livestock).

The importance of the distinction here, turns, principally on the fact that whereas production technologies relate to the producing unit (be it a farm or non-farm activity), consumption technologies are normally used in the household. And within this unit, the key person involved is often rural women. The consequences of this fact for the dissemination of improved wood-burning stoves, an important example of upgrading a consumption technology, have been described by Agarwal as follows. "The status of women wihin the household could be a significant factor in wood-stove adoption, especially where adoption requires cash expenditure, by virtue of the fact that although women are the potential users of the innovation, and therefore in the best position to assess its advantages and disadvantages, it is men who usually handle the household cash and make decisions on how it is spent. ... Where men make the decisions, the purchase of an improved stove may not get priority, especially where the only advantage perceived is greater leisure or convenience in cooking for the women. This is also one significant reason why attempts to promote wood-stoves in the same way as watches and radios (whose primary users and main beneficiaries in the rural areas are men) are likely to be ineffective. ... Likewise, the status of women within the community enters as an influencing factor in a number of significant ways. ... rural women usually have no direct access to institutional credit or to independently disposable cash income to purchase new innovations/technologies; and they seldom have access to information on new innovations. Also, there is a strong ideological bias in extension services which is likely to work against the direct involvement of, or consultation with, village women in the experimental designing of wood-stoves for their use -- an involvement which the Guatemala and Ghana case studies indicated as being a significant feature in effective diffusion."58/

What distinguishes the dissemination of this, and other similar types of consumption technologies (such as for water supply and health-care), is therefore the extent to which the process is embedded in, and hindered by, a complex set of social relationships. And, as Agarwal points out, the more inhibiting are these relationships, the less appropriate is a "top-down" approach to dissemination i.e. one in which problems of diffusion are basically viewed as problems of information/communication and persuasion. Instead, it is the nature of the social relationships themselves that more urgently need to be altered. Where this has, in isolated cases, proved possible, the results have been encouraging. The Jamkhed rural health project in Maharashtra illustrates the possibilities.59/

Initiated by two doctors in 1970, it sought to train and use local women in the delivery of curative and preventive health care. And although "the majority of these women are illiterate, they are quick to learn, and their ability to communicate with and gain the confidence of the other village women (helped by commonality of diction, tradition and values) has been one of the strengths of the programme. There is a conscious attempt to overcome caste barriers ... and to maintain a relationship of equality between the professionals and the non-professionals."60/ The success of the project can be gauged from the fact that its operation has spread from an initial 8 villages to a current figure of over 70.

In another, similar example, the Dian Desa organization was able to introduce and successfully disseminate rain collectors made of bamboo and cement, to a village in Indonesia.[61/] One of the most interesting aspects of this project, and indeed the work of Dian Desa in general, is that its point of departure represents an inversion of the "top-down" approach. That is, "Traditional communities' perceptions, values, ways of thinking, natural resources, etc. are first determined before any innovations are pursued. And this process's point of entry is local technologies that at least reflect local perceptions."[62/]

In the context of the bamboo-cement rain-water collectors, the design of the new technology originated directly from three elements of traditional practice, namely, the plaiting of bamboo, the catching of rain water and the local availability of bamboo. And in the dissemination of the rain-water collectors, involvement of the local community was again actively sought. First, "Dian Desa started a 'dialogue' with 20 local people and together made a decision to build some bamboo-cement rain-water collectors. ... Before building more collectors, a village seminar was held. In this seminar/meeting each person who received and used a rain-water collector explained about its advantages and disadvantages."[63/] What appears to have been especially important to the villagers was that "they were pleased and proud about being able to build the rain-water collectors themselves."

c) Individual versus communal levels of adoption

Our third and final variable is concerned with the implications of the level at which adoption decisions are taken in the use of different types of technologies. In particular, we shall consider the implications for the dissemination process of decisions that are taken at the level of the community, rather than the household or individual.

According to some authors, the importance of this distinction has to do solely with the question of group consensus, and the difficulty of achieving this in the case of a large and heterogeneous groups of individuals. Jequier, for example, makes this point in the following way. "The purchase of a transistor radio, a sewing machine or a tin roof for instance is a decision which is taken by the individual or his family on the basis of his own resources and ability to pay. ... When it comes to something like a village water distribution system, a sewage system or a new type of crop, the decision to innovate is no longer in the hands of the individual, however directly he may be involved. Decisions of this type require some form of consensus which is much more difficult to achieve than consensus in the family."[64/] Various techniques for overcoming this problem in decision-making for small communities have been proposed.[65/] However, these techniques are as yet neither well-known nor widely used.

While there is, of course, no question that the difficulties of obtaining consensus are inimical to the adoption of new technologies at the communal level, it does not follow that perfect consensus will always achieve this result. The reason -- indeed, the more fundamental problem of group action -- is that when the group is large, no single individual has any incentive to join a communal scheme. For by definition, he cannot make a perceptible contribution to the group scheme, and since no one in the scheme will react if he fails to contribute, there is no economic incentive for him to do so.[66/] And the resulting inherent tendency for the large group to fail to act in accordance with its common interests applies not merely to decisions regarding the adoption of new technologies, but also to their operation and maintenance once installed. (It is, in fact, often mainly for this reason that poor maintenance is one of the most frequently encountered problems of providing communal facilities, such as improved sanitation technologies.67/)

The case-study evidence suggests two ways in which this intrinsic difficulty of group action may be lessened. The first is to use social pressure as a substitute for the above-mentioned absence of an economic incentive. In this way, the economic gain from leaving the burden of securing the benefits of commmunal technology to others can be offset by the loss in social status that would result from such uncooperative individual action. A very good example of how social pressure can be made to serve the common interests of the community is to be found in the introduction of a new sanitation technology into the village of Yalcuc in Mexico.68/

The decision to install the latrines in this village, comprising forty-three households, "was made within the context of a community project; all the aura of the leadership and the pressures of social control were brought to bear on the villagers. Gradually, all the men in the community signed an agreement in a village meeting signifying their commitment to the collective decision to install latrines."69/ Equally significant, is the observation by two students of the dissemination of the new technology, that, "The costs (in money and time) of installing a latrine were perceived by many as minor compared to the costs (in social pressure, loss of good will, and deterioration of solidarity) of <u>not</u> installing one."70/

It should be apparent from this example, that for the effective use of social pressure a relatively small group is needed, one in which the members can have direct contact with one another. In a larger group, the members do not know each other and it is accordingly more difficult to exercise social pressure on individuals who fail to contribute to the objectives of the group. From this observation it follows (and this is a second lesson from the case-studies) that, insofar as it is possible to maintain a relatively small group as the relevant organizational unit, the problem of group inaction may be consdierably ameliorated. Nowhere is this lesson more evident than in the experience of irrigation technology.

A common feature of traditional irrigation systems is that they are small in size; these small systems, moreover, are invariably further divided into smaller sub-units.[71] This sub-division into mini-units can be interpreted in terms of the discussion above as an attempt to overcome the problems of co-ordination, conflict and co-operation that are inherent in the operation of an irrigation system. In relation to Laos, for example, one observer has noted that the small size of the irrigation association is rooted in the elements of village sociology. In particular, "Lao society is founded on reciprocal solidarity bonds connecting the members of a group; in order for these bonds to function satisfactorily the group must not have more than 70 or 80 members."[72] More generally, Coward has suggested that "Small groups (especially if differences of social status and social class are relatively minor) are able to employ special mechanisms of reciprocity to achieve relative order and conformity. While this can also be achieved with large-scale organizations such as bureaucracies, these organisational arrangements are often dependent upon technologies and infrastructures (for example, roads and telephones to facilitate mobility nad communication) not available in developing countries."73/

It does not seem unreasonable, therefore, to propose that maximum use of these indigeneous, small-scale units should be made in attempts to upgrade traditional irrigation systems. Otherwise, the advantages of cohesiveness that are associated with these small groups will be lost and the new system will tend towards inefficiency. This is precisely what occurred, for example, in Java and Bali, as described by Ishikawa.74/ He points out that the traditional patterns of organisation in these regions (based on strong village communal ties), "worked well for developing, operating and maintaining local irrigation systems."75/ Recently, however, the size of the organisational unit for these systems has apparently become significantly greater, and at the same time, the extent of government involvement has increaed considerably. The result, according to Ishikawa, has been that "The autonomy and responsibility of the traditional irrigation groups have been correspondingly reduced. Side by side with this, a number of inefficiencies have arisen relating to construction and water management."76/

However, as Coward points out, there may be a solution to this dilemma. Large-scale, modern irrigation systems may be designed in a manner that combines the technical and economic requirements of large size with elements of traditional social systems. The Chinese "melons-on-a-vine" design illustrates this approach. It uses a main canal system to supply a series of small reservoirs or ponds, which, in turn serve a smaller command area. "Thus, while part of a larger system, each pond group has some independence of action regarding water allocation."77/

Some general lessons

In the previous section, we tried to show how the characteristics of (traditional) technologies give rise to differences in the way that innovations should be promoted; differences that, in our view, were shown to fully justify a typologically sensitive approach to the problem. But at the same time, there is a need to recognize any lessons that are common to the cases referred to above.

One such lesson is that an appropriately upgraded technology (that is capable of widespread dissemination) should be viewed as a multi-dimensional concept, although, as suggested above, the dimensions of appropriateness and their relative importance will vary with the characteristics of each type of technology (products, for example, will be a highly relevant dimension in the dissemination of some technologies, but not in others). But whatever these dimensions of appropriateness happen to be, it is the ability to determine and satisfy the user requirements with which they are associated that is crucial to the outcome of policies for dissemination. Indeed, it is what may be termed the criterion of "user needs understood" that best discriminates between the cases that appeared to be successful, and those that may be designated as failures, regardless of whether the technologies involved were for production (farm or non-farm) or consumption, individuals or communities. Table 7 provides some support for this general conclusion by showing the role attributed to this factor (by the relevant authors) in the outcome of selected case-studies, drawn from those considered above, and representing each dimension of the typology matrix (in Figure 3).

If understanding user needs does (on this very limited evidence) seem to

Table 7

The role of "user needs understood"

Case	Outcome	Author's observations
ILO/UNDP improved farm implements project in Tanzania (MacPherson & Jackson)	Successful	"The project was devised within the limits of such constraints [under which farmers live], and it is from this initial awareness that its success resulted."
Wood-stoves - a summary of case experience (Agarwal)	Mixed	"The familiarity of the stove designer with the cultural milieu of the community where the stoves are to be promoted, and the adaptation of the stoves to suit specific users' needs, is a crucial factor in adoption."
Rain-water collector (Indonesia) (Soedjarwo)	Successful	"Understanding a community's perception takes a lot of time. Though physically the result of this process has not yet been seen, the utilization of this process itself has to be worth as much as other activities. ... Using the community's participation to fuse the community's perception into the development process gives much better results than the 'top down' process."
Water supply and sanitation technologies - review of LDC experience (Rybczynski _et al._; Kalbermatten _et al._)	Generally unfavorable	"It is becoming accepted that the optimal solution and often the only possible solution, is the one that takes into account local and circumstantial resources. ... The amount of interaction with the eventual users must be greatly increased. ... The diffusion of the new technologies and their acceptance is related to the involvement of the communities in the planning as well as implementation of the projects."

Table 7 (cont'd)

Case	Outcome	Author's observations
Improved farm implements in Ethiopia (Tecle)	Failure	"Distribution of improved farm implements to farmers was not possible because the prototypes developed by CADU were found to be unacceptable to farmers."
Irrigation pumps, Saga Plain, Japan (Francks)	Successful	"Selection of appropriate characteristics in areas such as scale, mobility and complexity was the crucial element making for a successful choice. ... it involved particularly close contact between farmers and officials for reasons which were in, part, peculiar to the environment of the Saga Plain."
Improved technologies for rural industry in India - a review of the evidence (Moulik)	In most cases a failure	"The failure to understand user needs was in a number of cases the critical factor explaining the poor rate of adopton of upgraded technologies."
Improved farm implements in Taiwan (Johnston)	Successful	"Dispersed manufacture of such equipment facilitates feedback between farmers and manufacturers and thereby helps to insure that the implements that are produced are adapted to the needs of the local farming systems."

be a crucial variable determining success or failure in the dissemination of innovations, a high degree of local involvement at the design stage is invariably the only means by which this can be achieved. The generation and dissemination of improved technology, that is to say, ought to be seen as closely related, rather than as entirely distinct stages of a sequential process. From a policy point of view, however, a focus on local involvement still leaves one with the problem of how such involvement is to be achieved at the macro level, rather than at the level of merely isolated instances of success. The point is that it is one thing occasionally to be able to successfully involve the target group of beneficiaries in projects, often with the assistance of outside agencies, but it is quite another to be able to do so as a matter of routine functioning at the macro level of the economy. For it is precisely at this level that success in fostering local participation in the design of new technologies has been the most elusive, as even a cursory review of the experience of most countries in Asia and Africa will indicate.[78/]

According to Coombs and Ahmed,[79/] the problem at this level has to be tackled through policies for training additional researchers and for bringing about a basic change in their attitudes to the dissemination process. Thus, "it should be standard practice (though it rarely is now) for researchers to leave their laboratories for frequent visits with sample farmers in their own fields, to listen to the farmers' questions and hypotheses, to observe production problems and results under normal (nonlaboratory) conditions, to take the farmers into their confidence -- in short, to become direct parties to the extension and feedback process. For this to happen on a sufficient scale however, there must be many more well-trained researchers and a new attitude on their part toward contact with farmers."80/

In part, attitude reform would seem to be a question of altering the narrow, single-disciplinary focus that is characteristic of most research activities in agriculture. Many observers now recognize that "the usual approach which has concentrated on the development and testing equipment by agricultural engineers is simply not effective."81/ Largely in response to the inadequacy of this narrow approach, "farming systems research", embracing a wider, more inter-disciplinary perspective, has been developed and its use in a number of developing countries is reported to have met with some degree of success in achieving closer contact with, and enhanced understanding of, the technological needs of small farmers.82/

A reform of attitudes will often also have to be sought in the restructuring of the systems of incentives and other aspects of the way in which research is organized. In India, for example, institutes that were set up explicitly to upgrade traditional rural non-farm technologies are organized as mere extensions of the central government administration, and as such, have assumed many of the same attitudes and rigidities that are inimical to a close and effective relationship with the target groups. More specifically, a recent study has drawn attention to the fact that the rules according to which research is initiated and approved, credit is granted for the diffusion of innovations, and promotion of staff is given, all seem to be highly unsuitable for the flexible and imaginative type of operation that the generation and dissemination of new technologies in the rural areas often requires.83/

If for the above reasons, change in the method and organisation of research seems essential, it is not at all clear how much even substantial improvement in these areas can bring about the kind of macro-level reform that is needed, for the problem may, as Agarwal has pointed out, be more fundamentally rooted in circumstances where economic and social inequalities are high, and where interpersonal relationships are, partly on this account, extremely hierarchical.[84/] To this extent, an improvement in the interpersonal relationships on which a close understanding of user needs fundamentally depends, will require "basic structural changes to promote equality of material assets and of attitudes between households, between the genders, and between people of different professions and work backgrounds."[85/]

The ability of a developing country routinely to involve traditional producers in the upgrading of the technologies on which they rely -- that is, in an ongoing manner at the macro level -- depends, however, not only on the functioning of the formal R&D system in the respects just described, but also on the extent to which a dispersed rural capital goods sector has become established and on the circumstances in which it operates. Whereas in the former, the absence of market pricing for its output does not exist and the outcome depends on the strength of the links between researchers and farmers, in the case of manufacturers it is the nature of market relationships that are crucial. Reference has already been made in this respect to the Taiwanese experience in which small farm equipment manufacturers proved highly receptive to the diverse needs of farmers located in different regions of the country. And in the United States as well, "a conspicuous feature of the historical development of mechanical innovations has been the critical role played by local blacksmiths, tinkerers, and inventors working closely with innovative farmers. Frequently, it has been a local farmer who has defined 'the problem' and has turned to a local workshop to translate an idea into a new or modified piece of equipment in a process that often involves much trial and error."86/ We shall, however, defer to the next section discussion of the evidence that bears on the policy question of how this important sector can most effectively be promoted in a context where it exists only in relatively rudimentary form.

Beyond the Narrow Approach: the Lessons of Experience

If adoption were the sole criterion of successful upgrading -- as is posited in the narrow approach -- there would be no need to proceed beyond the lessons of the case-study material that have already been drawn. Much of the conceptual part of the paper, however, was concerned to stress that the impact of upgrading on poverty depends on far more than whether or not the improved technologies are actually adopted by the target group of producers. Accordingly, the remainder of the empirical part of the paper will attempt to use the case-study approach to further validate this position, and to discern the lessons for policy that are associated with this (post-adoption) stage of the upgrading process.

The impact of upgrading on heterogeneous poverty groups

One of the central themes of the earlier conceptual analysis was that heterogeneous groups among the rural poor will be differentially affected by the upgrading of traditional technologies, not only in their role as producers of output, but also in their capacity as its consumers. It is thus unfortunate that none of the case-studies to which we referred above, have sought to throw any direct light on this question. Only in the context of the much more thoroughly documented experience of the Green Revolution has evidence on the distributional impact of new technology been systematically gathered. To what extent can this experience usefully serve as a basis on which to predict the probable consequences for rural poverty of upgrading traditional non-biological/chemical technologies?

As Binswanger has correctly observed in this regard, even for the same kind of technical change as occurred in the Green Revolution, there are dangers inherent in simple extrapolations of this historical distributional pattern to other contexts. In particular, "The regionally regressive impact of the green revolution stems from its limitation to the already richer regions. If it had occurred in the disadvantaged areas, the regional distributive impact would, on the contrary, have been progressive. The limitation of the technical change to certain areas also accounts for the regressive impact among factors of producion. It it had been more widespread, landlords might not have gained as much because they would have faced inelastic commodity demand. If export markets had prevented inelastic commodity demand, the effects on labor demand would have been more vigorous. In considering future technical changes one thus must know the characteristics of the technology, the characteristics of the region where it occurs, and the characteristics of the factor supply and output markets."87/

In most of the respects mentioned in the last sentence of this quotation, it is clearly difficult, at a general level, to specify whether (and in which direction) improvements to technologies other than those comprising the Green Revolution will differ from the latter (and it is consequently hazardous to predict any systematic differences in the composition of beneficiaries). It is perhaps only in regard to the characteristics of the output produced by the two types of technologies that any distinction can be drawn at this level. Thus, whereas it is a distinguishing feature of the biological and chemical innovations that they produce foodgrains with a highly inelastic demand, this is not at all true of many of the commodities of rural industry with which we have been concerned. Specifically, whereas the price elasticity of demand for maize and wheat in developing countries is frequently not more than 0.3, the products of rural industry (such as processed sugar, pottery, soap, cement, etc.) are characterized by a relatively elastic demand (i.e. greater than 1).[88/] The major implications of this distinction for the distribution of the gains from technical change between consumers and producers and between those involved in the productive process are described in Table 8.

Table 8

The distributional implications of alternative price elasticities of demand

	Biological and chemical innovations (inelastic demand)	Innovations in rural industry (elastic demand)
Distribution of gains between producers and consumers	High proportion of gains to consumers	High proportion of gains to producers
Distribution of gains between those involved in the production process	Relatively modest gains to labor (direct employment and wages)	More substantial gains to labor (direct employment and wages)

One of the most striking aspects of the Green Revolution is the extent to which consumers, rather than producers, benefited from the innovations that occurred. For example, "With the introduction and rapid diffusion of dwarf rices in Colombia, the real price of rice to consumers fell. In the three years prior to the introduction of the high-yielding varieties, the retail price of rice was $(Col.)3.6 per kg. (in 1964 pesos), while in the three years ending 1974 the price was $(Col.)3.0 per kg. Rice is a major staple food in Colombia, being the principal source of calories in the Colombian diet. The lowest income consumers were the principal beneficiaries, capturing a larger relative as well as absolute share of the gains to the investment in rice research. The lowest income stratum captures annual average net benefits equivalent to over 10 percent of household income, while for those in he highest stratum, the benefits were less than 0.1 percent. ... The Colombian results are vivid testimony to the power of agricultural technology to effect a favorable change (both relative and absolute) in the distribution of income among consumers."[89/] Similarly, with respect to rice-breeding research in Japan, Hayami found that "the major gains from the research were captured by the consumers in the form of an increase in consumers' surplus."[90/]

In the case of improvements in the method of producing goods with a relatively elastic demand, in contrast, it is producers to whom the gains will tend to accrue. Whether this is likely to be more or less favorable to the alleviation of poverty and a reduction in inequality is difficult to assess, since it will depend, among other things, on which particular groups among those who are concerned with the production of goods and services are relatively favored in the distribution of gains. And in this respect, all that can be predicted is that (with other things the same) upgrading of (the method of producing) goods with a relatively elastic demand will tend (as Table 8 indicates) to benefit labor -- through increased employment or higher wages -- to a greater extent than has occurred in the case of the improvements in the production of foodgrains associated with the Green Revolution. In fact, one commentator has gone so far as to argue on this basis that, "agricultural technical change cannot be expected to solve the unemployment problem of many less developed countries ... for most countries, the solution to the employment problem will have to be found in nonagricultural sectors with high demand elasticities."91/

The role of dynamic, intersectoral linkages

The earlier discussion suggested that particular emphasis ought to be paid to the role of intersectoral linkages in conceptualizing the process of upgrading traditional technologies. Much of the case-study evidence validates this focus and points to the special importance of government macro policies in determining whether these linkages will tend to undermine or promote the likelihood of a successful outcome.

Macro policies influence not merely the immediate competitive relationships confronting the newly upgraded technologies but also those of an ongoing, continuous kind that govern the sustainability of any such improvements. With respect to the latter, the influence of these policies will be felt, as suggested above, principally through their impact on the viability of a dispersed, small-scale capital goods sector that is capable of providing a steady series of improvements to the products and processes of rural industry. In several countries, both the direct and intertemporal impact of macro policies has often been to thwart, rather than assist, such efforts to upgrade traditional rural technologies as have been made.

India's policies, for example, by discriminating against the small-scale rural industrial sector, have effectively subverted the efficacy of several attempts to upgrade traditional technologies in this sector. Thus, according to Moulik and Purushotham, "Some DS [decentralized sector] technologies, though improved, are not able to stand the competition from the highly mechanized, capital intensive sector in terms of productivity and unit costs. ... there seemed to be little rationale on the part of the government in not regulating a competing technology and at the same time expressing a strong desire to promote the DS."[92/] Similarly, in the context of the development of small-scale cement plants in India, Spence concludes that, "Even when technical problems have been overcome, the establishment of an alternative technology will be difficult if certain types of support continue to be given to manufacturers of the conventional technology.[93/] These biases in favor of the large-scale cement industry are said to derive from national pricing policy (which makes it difficult for alternative technologies to expand), distribution and freight equalisation charges (which reduce the economic advantage of setting up small-scale plants near their markets) and policy towards standard setting (which prevents an adequate but slightly below standard material from being sold).

One should not, however, conclude that it is only on the basis of these policy-induced advantages that the large-scale sector has been able to undermine certain of India's upgrading efforts. Such a conclusion would obscure the challenge that has been posed to the success of these efforts by the inherently dynamic pattern of technological change in this sector and would thereby understate the extent of the difficulties that policy for upgrading is likely to confront. Consider, for example, what occurred in the efforts to upgrade technology in the Indian oilseed processing industry. In particular, "by the time the technology (power ghani) was improved, the organized sector with its high technology base (baby expellers) moved into the village economy and gained roots. The DS [decentralized sector] found it extremely difficult to sustain itself."94/ More generally it has been observed that, "any time lag in the development of technology factor relating to a certain sector, particularly the DS, could place it in a highly disadvantageous position vis-a-vis its counterparts. ... paying mere equal R & D emphasis toward the technologies of different scale oriented sectors does not ensure a uniform pace in their growth pari passu. A bit of time lag could turn out to be indefinite drag for the disadvantaged sector."95/ The Indian experience with upgrading that gives rise to these sorts of observations would appear to heavily underscore the need for a small-scale, flexible capital-goods sector that is able to produce a continuous countervailing stream of inovations for the sector whose traditional technology has been upgraded. Unfortunately, in this area too, macro-policies have often run counter to the interests of the small-scale sector and this policy bias can be illustrated with particular clarity in relation to small-scale, rural industry in the Pakistan Punjab.

According to Child and Kaneda, the Green Revolution in this area gave rise to a series of producion bottlenecks that could easily and appropriately have been met by the products of an indigenous, small-scale engineering industry. "The threshing machine, which would eliminate the temporary labor shortage at harvest time and permit earlier planting of the next crop, is but the most obvious example. An inexpensive reaper and on-farm storage equipment would make further contributions to productivity. Bottlenecks in land preparation could be reduced by a more efficient plow, and the sowing process improved by a seed drill. ... In short, there could be substantial backward linkage from agricultural to domestic industry if Pakistan would emphasize a technology based on improved agricultural implements and specific, bottleneck-removing machinery which can be produced by the indigenous, small-scale engineering industry. Both the small independent farmer and the small engineering firm could survive and thrive."96/ Instead, however, the government chose to adopt a set of macro policies (e.g. heavy public subsidies to capital and import-intensive equipment) which, by favouring the large-scale sector, "portends not only the demise of the small farmer in the Punjab; it will erode or even erase the market of the small-scale domestic industry supplying capital goods to the agricultural sector."97/

Similar observations have been made in relation to India by Johnston and Kilby. They point, on the one hand, to "rationing policies which deny scarce inputs to small-scale producers of farm equipment and inexpensive consumer goods which have the greatest potential for reaching the bulk of the farm population."98/ On the other hand, the policy of underpricing both capital and foreign exchange, which concentrates the agricultural sector's demand for new farm equipment on tractors, threatens to undermine the growth prospects of "even the more progressive implement manufacturers." Yet, the Indian experience also contains an instance of the successful creation of a backward linkage to rural industry that appears to have supported, rather than hindered, the sustainability of the upgrading effort. Kaplinsky's study of the upgrading of the OPS sugar technology shows how, during the past decade, this process was accompanied by the emergence of a specialized set of OPS machinery suppliers. "This has led to their introducing improvements autonomously, and then marketing these to OPS plants."[99/] Depending upon the rate of these improvements relative to those that occur in the competing VPS sector, the creation of this backward linkage may, therefore, enable a sustainable process of upgrading OPS technology to be achieved. But before any lessons for policy can be drawn from this case, much more needs to be known about the particular factors that contributed to its success, in an economic environment that seems generally to discourage this type of favourable interaction.

What evidence is available for Africa, also confirms the contribution of government policies to the widespread failure to effect the beneficial kind of backward linkage that was described in the previous paragraph. Thus, in seeking to explain the "large gap between the potential contribution of expanded use and local manufacture of simple and inexpensive farm equipment and the actual situation in East Africa," Bruce Johnston has argued that "Perhaps the most fundamental problem has been a common failure to consider the structural and demographic characteristics of these economies which pose a fundamental choice between a broadly based strategy aimed at the progressive modernization of the great majority of a country's farm households and a 'crash modernization' strategy which concentrates resources in atypically large and capital-intensive farm units."[100] As in the other countries examined above, that is to say, a widespread and continuous process of technological upgrading seems to be incompatible with a set of macro policies that have the effect of concentrating available resources among the large-scale units in the agricultural and capital-goods producing sectors of the economy.

Efficiency in the use of upgraded technologies

We took note earlier in the paper that adoption *per se* should not be considered as the ultimate *desideratum* of upgrading since a new technology may be used inefficiently, may be poorly maintained or may even be discontinued altogether. It was suggested, therefore, that a distinction needs to be drawn between the benefits that are *potentially* available to the user of an innovation and those that are *actually* realized therefrom. The recent experience of wood-stoves in Guatemala is a good practical illustration of this distinction.

Though there was a high level of adoption of the stove in the deforested highland areas of that country, "the effectiveness of the diffusion programme *vis-a-vis* one of its primary purposes, namely saving firewood, has been limited. This is because the users, while perceiving that the stove has a number of advantages, also see in it several disadvantages which they have sought to overcome by 'adapting' the stove to their particular needs, thereby reducing its efficiency in terms of the wood-saving potential inherent in the original design."[101] The need for the adaptations, and the resulting loss in efficiency, were due, in turn (among other factors), to the failure to take adequately into account the specific nature of users' needs. "If the local methods of cooking had been better understood, appropriate modifications could have been made without a loss of technical efficiency."102/

Examples drawn from the introduction of other types of new technologies lend support to the conclusion of the Guatemalan case-study that a high degree of local involvement is critical to continued, efficient usage. For instance, the explanation of the alarming prevalence of breakdowns and discontinued usage in community well projects, is said to reside in the facts that "the community or village has not been adequately involved in the project in the first place, and has not accepted the social responsibility for the task of maintaining the pump."103/ Similarly, with respect to sanitation technologies, Kalbermatten et al. conclude that "To result in a successful project, the community's participation should extend from the initial collection of baseline data and identification of user preferences, through the design and construction stage, to the continued operation and maintenance of the facilities. ... Rural communities ... need to develop a system they can operate and maintain with a minimum of external inputs."104/

Summary and Conclusions

The point of departure of this paper was the view that because there are vast numbers of poor people who are dependent upon traditional technologies in farm and non-farm activities in rural areas, considerable scope would appear to exist for alleviating mass poverty through the upgrading of the productivity of these technologies.

So far, the predominant response to this potential has been to focus on the technical (engineering) problems of generating improved technologies and, to a somewhat lesser degree, on the problem of disseminating information about the new technologies to the target groups of recipients. Much of the conceptual part of the paper, however, was concerned to show that this is an inadequate response. For while it does undoubtedly highlight several of the most important aspects of the problem, it ignores many other economic issues that are crucial to determining the outcome of upgrading efforts. It is for this reason that we described it as a "narrow approach."

This paper, accordingly, has advocated that an alternative and broader concept of upgrading be adopted, one that is capable of adequately incorporating these additional dimensions of the problem. In particular, the broader concept seeks to locate upgrading in a context of heterogeneous poverty groups and complex intersectoral linkages and in which the adoption of improved technology is only a necessary condition of a successful outcome.

Much of the import of this expanded focus is to shift the policy emphasis towards consideration of the factors that contribute to the sustainability of a process of continued improvements in the productivity of traditional technologies. This, in turn, requires those concerned with the formation of policy to consider the nature of the numerous interdependencies between traditional producers and other economic agents in the economy (Economists refer to this as a "general equilibrium" approach). And the analysis of these interdependencies has necessarily to be conducted within the framework of a dynamic, as well as a static methodology.

Within the general framework of the altered focus that is advocated, the following were shown, on the basis of the available case-study evidence, to constitute the specific conditioning factors on which policy ought to focus.

a) Dissemination: there are several characteristics of traditional technologies that give rise to differences in the way that new technologies should be promoted. Among the most important of these typological differences were thought to be between technologies for production and those for consumption, between those that can be disseminated on an individualistic basis as opposed to those requiring some communal form of organization and, finally, between those that are located on the farm and those that are associated with non-farm activities. One of the clearest lessons of the study, however, is that whatever the combination of these characteristics that any particular technology comprises, it is the ability to determine the user requirements with which they are associated, that primarily determines the success or failure of policies for dissemination. What is much less clear, on the other hand, is how the close involvement of users at the design stage that this condition demands, is to be achieved in environments where interpersonal relationships between the relevant groups are, from this standpoint, highly unfavorable.

b) Heterogeneity: perhaps because it is thought to be self-evidently favorable, very little is known about the impact of upgrading on rural poverty. What we do know, however, is that the poor are often highly heterogeneous occupationally and spatially, and that new technologies are likely to have a differential impact on these groups, benefitting some at the expense of others, while leaving the position of yet other groups essentially unchanged. It was shown that only very limited predictions about the composition of these groups could be made on the basis of the (much more thoroughly documented) experience with the biological-chemical innovations of the Green Revolution. Research that directly addresses the question should focus not only on the impact of upgrading on the heterogeneous groups comprising the poor in each particular case, but should also examine the effects on specific categories of poor people (e.g. women) <u>within</u> the groups. A matrix approach (such as the one used for illustrative purposes in the paper) may be a useful basis on which such empirical work could be initiated.

c) <u>Efficiency in use</u>: unlike the narrow approach, the framework used in this paper makes the impact of upgrading on the poor depend on the use that is made of new technologies <u>after</u> they have been adopted. In this area, as well, however (and again partly because of its neglect under the narrow approach), empirical evidence (on the extent of inefficiencies) is scant. But what data are available suggest that these inefficiencies can be substantial and that they can be avoided or reduced if a high degree of involvement of local users is elicited in the design and implementation of the new technology.

d) <u>Products</u>: most of the case-studies refer to improvements in processes and pay relatively little attention to products. But with respect to the non-farm component of the rural sector, where traditional producers have frequently to compete with the products of the modern sector, the <u>simultaneous</u> upgrading of products and processes seems often to be necessary to the success of the latter (quite apart from, and in addition to, the fact that improved products <u>themselves</u> confer welfare gains on poor consumers). The competitive relationships between sectors also give rise to further necessary conditions for the viability of upgrading and these are described immediately below.

e) Linkages: a major theme of the study is that technologies improved by upgrading must be viable in the long term if they are significantly to contribute to economic development. Accordingly, the potential of the upgrading approach to the alleviation of poverty must be judged against this intertemporal criterion as well as its immediate impact on the incomes of traditional producers and consumers. Clearly, the long-term condition will be met by neither a merely once-for-all improvement nor by one whose viability over time depends on continual government subsidization.

The requirement that new technologies be competitive over time at market prices immediately confronts the difficulty that in important respects traditional producers compete with the products of the technologically dynamic modern sector (or with imports). The outcome of upgrading then depends not only on the intrinsic characteristics of the improved technology but also on policies that determine the context (eg. prices) in which the competition takes place. It also appears to depend to an important degree on the nature of the backward linkages that are established with a dispersed rural capital goods sector, since it is on the innovatory possibilities that are forged by these linkages that the continuity of the upgrading process crucially depends.

The evidence points to the role of the overall rural development strategy in determining the extent to which the outcome of the relationships described in the previous paragraph is conducive to the long-term viability of upgrading. Where a "bimodal" strategy is followed (i.e. one that is based on a highly dualistic size structure of farm and non-farm units), policies and resources are geared to the dominance of large-scale units and the resulting economic environment appears to "choke off" the evolution of the upgrading process. Where, in contrast, a "unimodal" strategy -- emphasizing the progressive modernization of the entire rural sector -- is pursued, the macro-environment is far more favorable to the long-term viability of improvements in traditional technology. It is surely at least partly for this reason that whereas many of the unsuccessful cases in our survey were found in India (which has followed a bimodal pattern), numerous of the successful outcomes were drawn from Taiwan (which is a very good example of the workings of a unimodal pattern).

One seems entitled to conclude, therefore, that the innovatory potential of an upgrading approach depends perhaps less on any intrinsic aspects of the approach as on the overall policy context in which it is attempted (and the manner of its implementation).

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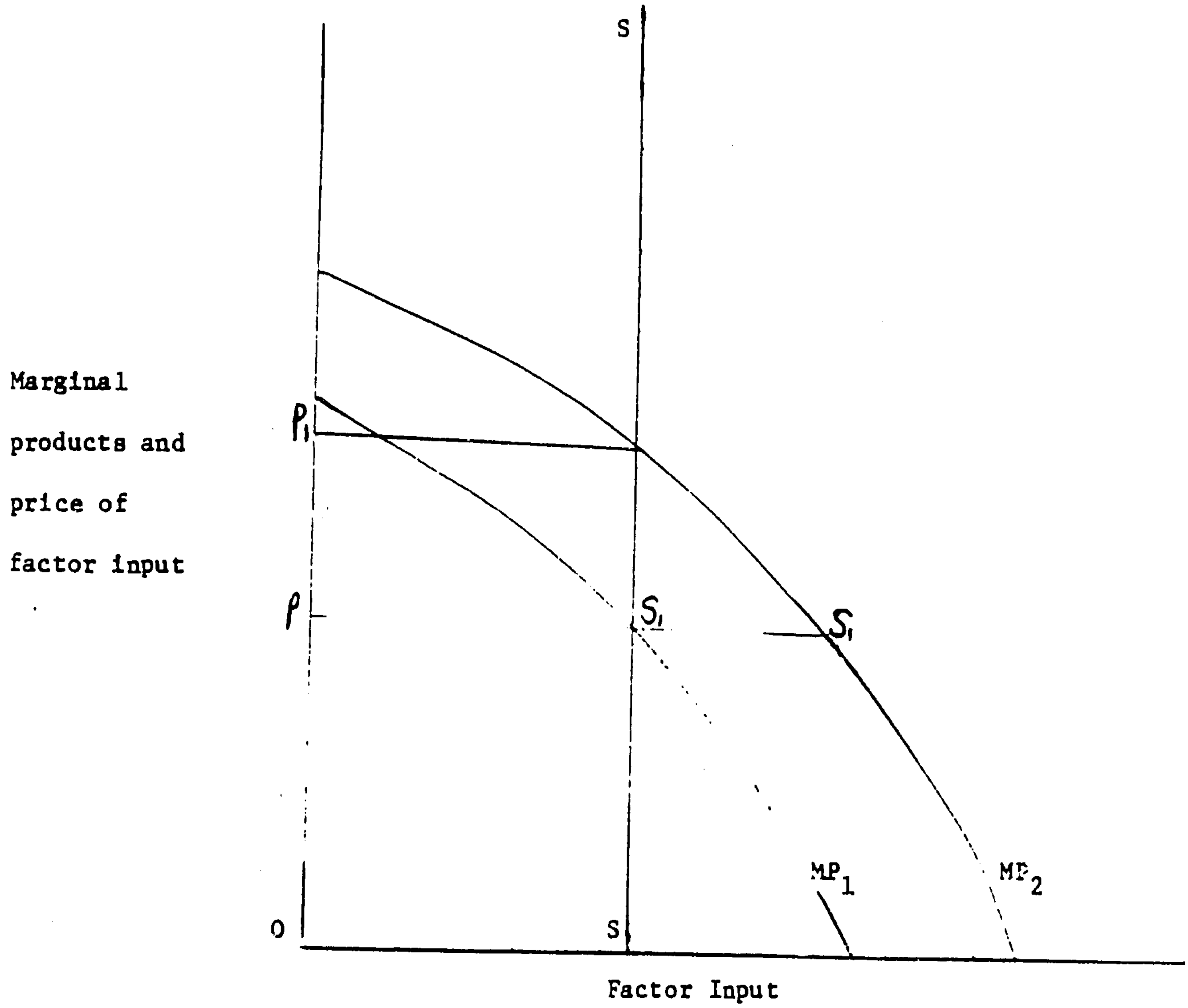
Technical Appendix

Figure 1

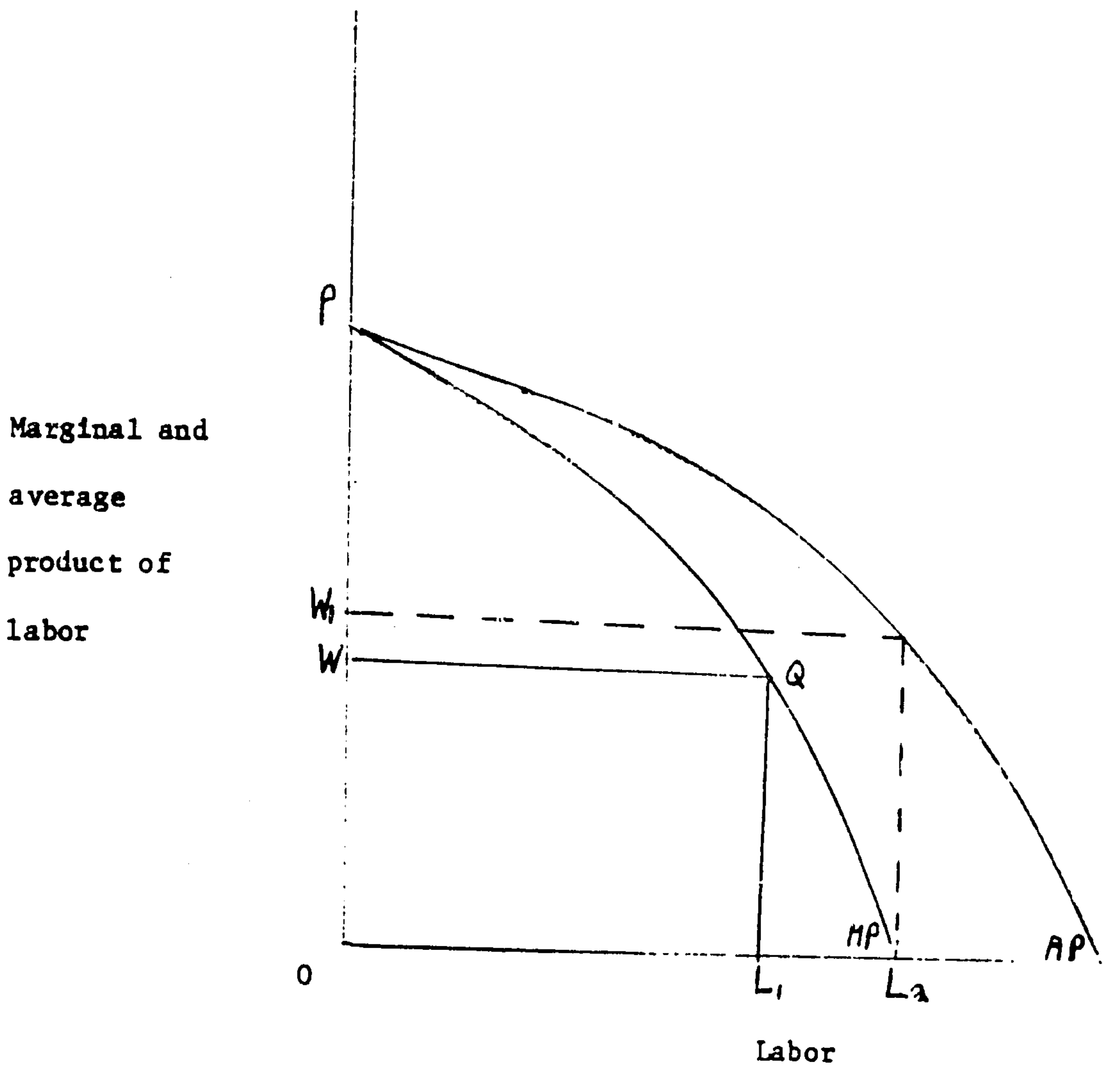
Changes in the demand and supply of factor inputs



MP_1 is the initial demand curve for the factor and SS the supply curve. The intersection of the two curves yields the price OP. If, after an increase in the demand (and a resultant shift in the curve to MP_2), supply remains constant, the price rises to OP_1. However, if the supply increases along the perfectly elastic curve S_1S_1, the price of the factor will remain constant at OP.

Figure 2

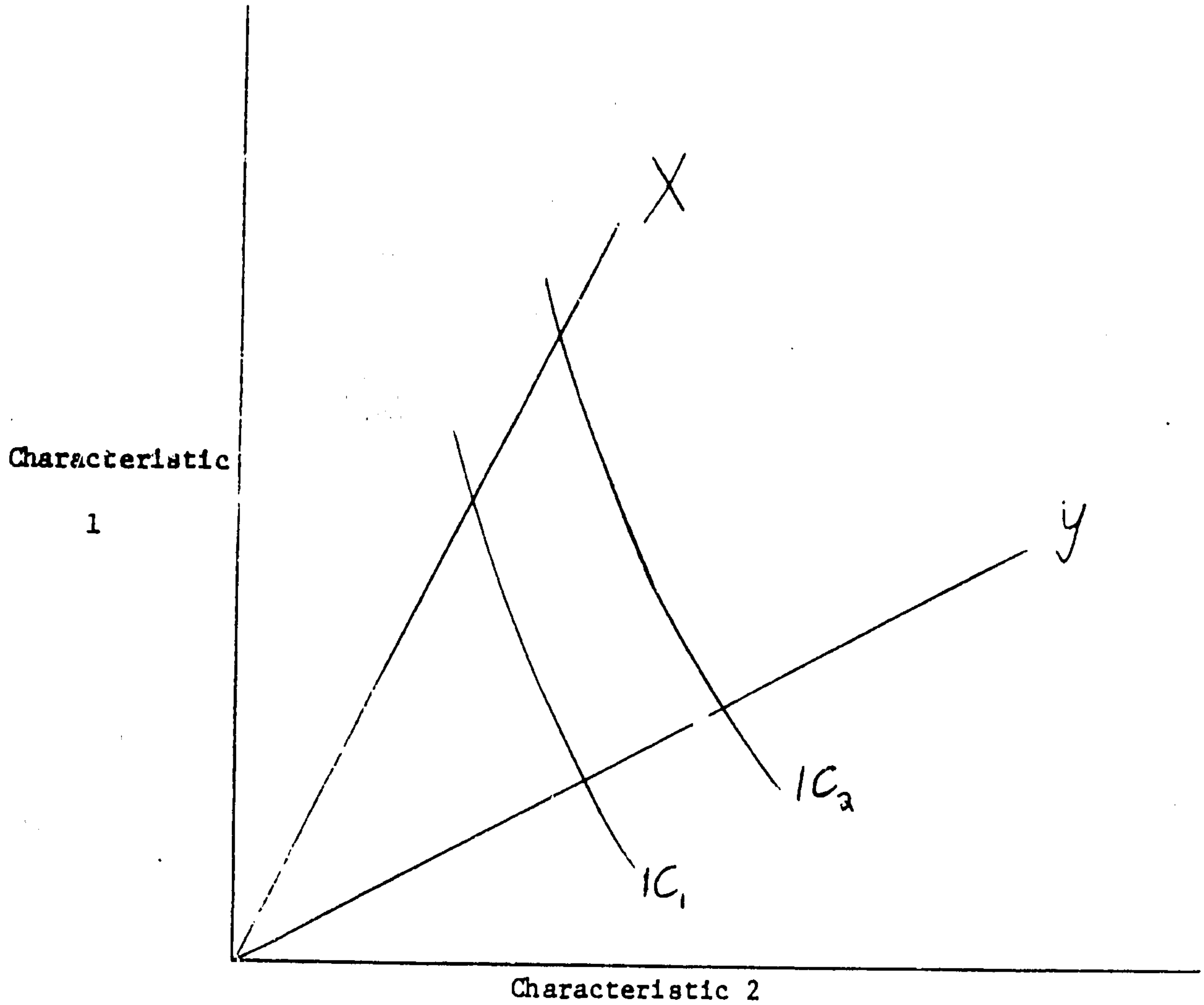
Distribution of income under alternative modes of production



Under a capitalist (wage) mode of production, with wage OW, OL_1 workers are hired and the total product, OPL_1 is shared between workers (who receive $OWQL_1$) and capitalists who receive PQW). Under a non-wage mode of production (e.g. family farms) output will be pushed to the point where the marginal product of labor is zero i.e. at OL_2. Each worker will receive OW_1 (and OW_1 multiplied by OL_2 is equal to the total product OPL_2).

Figure 3

Upgrading of consumer goods versus a reduction in price of an existing good



A fall in the price of a given good, X, enables the consumer to buy more of this product, and hence move to the higher indifference curve IC_2. But the movement to IC_2 can also be achieved by the introduction of good Y, which embodies the two characteristics in a different (and preferred) combination from that embodied in good X (i.e. good X is in this sense upgraded to form the new good Y).

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This paper makes a case for upgrading traditional techniques that are widely employed in the non-modern sector, as opposed to a policy of descaling modern technology or generating entirely new alternatives. Thereafter it argues that an adequate upgrading framework needs to take into account that the adoption of improved technology is only one link in a dynamic process, that what occurs in the non-modern sector is dependent on the relationship of this sector to others (and vice-versa) and that heterogeneous poverty groups are affected in diverse ways, as both consumers and producers, by the particular form of the upgrading process. Case studies are presented to determine the types of circumstances in which certain variables interact to produce particular outcomes, both favorable and unfavorable.

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