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AGRICULTURAL TECHNOLOGY AND THE ISSUE OF UNEQUAL DISTRIBUTION OF REWARDS: AN INDIAN CASE STUDY[1]

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ABSTRACT

A sample of 228 Indian farmers were interviewed at two points in time in order to determine the effects of differential acceptance of improved agricultural technology on changes in equality of reward distribution over time. Analysis shows that inequality increases over time with respect to gross agricultural production, but differences in adoption of improved technology are not clearly implicated in that shift. Conversely, inequalities in both level and standard of living are reduced over time. Early failure to adopt agricultural technology does not seem to lead to enduring and self-reinforcing disadvantage in the context studied. Whether such a pattern is typical in the agriculture of developing countries, or whether Indian development policy is responsible for achieving a degree of distributive equity in conjunction with technological change, are among the topics for further research.

INTRODUCTION

The purpose of this paper is to explore the long-run effects of the diffusion of agricultural innovations. In particular, we wish to address one of the key questions in adoption, and more broadly, development research: does a higher level of adoption of improved technology contribute to greater or lesser equality in distribution of social and economic "rewards" over time? Our data stem from interviews with 228 farm operators in the western state of Maharashtra, India, in 1967. These farmers, who varied considerably in their use of improved agricultural technology, were re-interviewed in 1973, and our analysis is focused on changes in equality of reward distribution among them over the six year time span.

Development and equity perspectives

Adelman (1975) recently summarized development policy issues, and research perspectives, in terms of two broad options. Either one can foster economic growth first, and take up questions of distribution of rewards and improvement of human capital later. Or, alternatively, one can take up the questions of resource distribution and human capital improvement first, and work on economic growth later (see also Schaller, 1978: 200). Each perspective involves the assumption, implicit or explicit, that both economic growth and a degree of equity in reward distribution can be achieved; they are not mutually exclusive goals, it is assumed.

The assorted technological developments which are collectively subsumed under the general heading of the Green Revolution have, on the one hand, brought about a resurgence of interest in the "growth first, equity later" perspective. Substantially improved technology has made for much greater optimism with respect to significant growth, thus reinforcing the position of those who look to technology for the answer to agricultural development problems (cf. Schultz, 1964). On the other hand, however, there has also emerged a considerably more pronounced interest in equity questions, in part as a "second generation" type of issue. That is, as increases in production and productivity have taken place in some parts of the world's agriculture, it is argued that the time has come to pay serious attention to the distribution of benefits (Saint and Coward, 1977; Frankel, 1971). As growth occurs, the expectation that the benefits of growth will be distributed in some reasonably equitable manner has also grown, and it is less than obvious in many situations that the rewards of growth are equitably distributed (see, e.g., Havens and Flinn, 1975). At an even more fundamental level, the often assumed causal linkage between growth and distributive justice itself is being questioned (Weaver, et al., 1978).

Focus of the present study

This study cannot begin to cope with the many questions involved with the distributive implications of economic growth. The literature on the topic ranges across economics and the social sciences, and also ranges from the over-the-centuries world perspective of Wallerstein (1974), to microscopic and highly localized studies of the impact of, say, tractorization on income shares among farmers in different size classes in one Indian district (Jhunjhunwalla and McPherson, 1972). Our study is definitely on the micro side of the macro-micro continuum, and deals with a single question: does adoption of improved agricultural technology, which is a standard part of growth oriented agricultural development strategy, contribute to greater or lesser equality in distribution of economic and social rewards over time?

The distinctive aspect of our study is that we can follow the same individuals over time. Most of the research on equity questions has had to rely on aggregate rather than individual data, or on cross-sectional data on individuals at one point in time, and neither of these approaches can be described as ideal (Fields, 1977:572). Greater or lesser equality in distribution of rewards in a population over time is of interest in its own right. The major shortcoming with regard to equity questions, however, is that entry into and exit from the system in question are unknowns. Thus the key question, which typically cannot be addressed with secondary data, is whether those individuals at, say, the bottom of the income ladder move up over time or fall even farther behind.[2] Do the rich indeed get richer and the poor, poorer, or is the payoff from development equitably distributed? Are the benefits of improved agricultural technology shared equitably, or do some individuals gain substantially while others lose?

The classical supply-demand models of economics indicate that early and/or more complete adoption of productivity enhancing technology should increase income, other things being equal. As supply increases, prices should trend downward, and the stereotypical "laggard" of diffusion theory might not only fail to improve income but actually fall farther behind if his output remains constant and prices fall. The real world is more complex than a theoretical model can ordinarily reflect, however. For example, demand for agricultural products may well be sufficiently elastic in a developing economy to offset the pressure of increased supply on prices. Furthermore Indian agricultural development has to some extent been designed to offset pure market forces. Agricultural development in India has historically been part of a broader rural development emphasis with strong income redistribution overtones (Taylor, et al., 1965). In addition, concerted efforts have been made to involve all segments of the rural population in planning as well as carrying out development programs (Jacob, 1967). Again, the real world is more complex than an abstract model, in this case a design for rural development, can reflect. The Indian policy goal of income redistribution may or may not be achieved in a given situation. Thus the stage is set for empirical studies, such as this one, to determine what actually happens to particular actors in the development drama.

In view of the above discussion one would expect, on the one hand, that modern agricultural technology, which is demonstrably not adopted at the same time by all farmers, might tend to increase inequality of reward distribution in the Indian context. Innovators and early adopters might reap a disproportionate share of the fruits of development. On the other hand, however, it could be the case that institutional forces, plus perhaps human failure to reap the full benefits of improved technology, would tend to offset market forces and mitigate the tendency toward greater distributive inequity. The research literature on equity questions in Indian agriculture, summarized in the following section, is consistent with just such a mixed set of expectations. Some studies point in one direction, some in the other.

Related studies in the Indian context

Perhaps the most comprehensive study of the equity issue in rural India is that of Das Gupta (1978), who analyzes data from a national sample of over 4,000 rural households at two points in time. He concludes that the incremental income from development over a three year span goes disproportionately to those who were better off to begin with, though all income levels benefit to some extent. Das Gupta's data do not permit him to link distribution questions specifically to agricultural technology, however. In contrast, Swenson (1976) focuses explicitly on the impact of improved rice technology in a truly prime rice growing district, Tanjore, and concludes that gains from rice production alone had very little impact on income distribution among farmers. He further finds that inequality in total family incomes of both farmers and agricultural laborers actually decreased over a six-year span. Swenson, however, did not have panel data to trace out effects on individuals.

Other studies report a variety of conclusions which complicate the picture. Mencher (1978) uses ethnographic data to argue that inequality has increased and that development strategy has favored such an increase. Singh (1973) uses aggregate data for two time points, both preceding the Green Revolution era, to demonstrate that income inequality decreases over time in a northern district. The previously mentioned tractorization study (Jhunjhunwalla and McPherson, 1972) demonstrates that income shares increased for both larger farmers and landless laborers, while the share for small and middle-sized farmers decreased as a function of tractorization in another northern district. Tractorization apparently permitted sufficient change in farming systems among larger farmers to permit them to benefit directly as well as hire more labor, while smaller farmers continued to operate as they had before. Another study, in a tribal area (Khaund, 1970), finds decreased inequality in family incomes over time as slash-and-burn farming techniques are replaced by settled agriculture and other sources of employment. Finally, a quite recent study at only one point in time (Narayanan, 1978), demonstrates that the per capita income share for, say, farm laborers is not greatly different from their numerical strength in the population of the study village. The greatest contrast is between per capita shares for farm and nonfarm families (Narayanan, 1978:20), with nonfarm families enjoying an advantage.

The results of research on equity questions do not lend themselves to definitive conclusions for a variety of reasons. The bases for making comparisons regarding changes in equality and inequality are not the same in different studies. Farmers of various size classes have been compared, or farmers have been compared with agricultural laborers or nonfarm workers. In addition, agricultural technology may have been singled out for special attention as a factor influencing income distribution, or it may be submerged in the broad context of developmental change. It can be argued that, at best, there is enough "noise" in a socio-economic system to make it very difficult to detect the impacts of agricultural technology, or any other single exogenous factor, for that matter. Sample selection also, in one geographic area or another, at one time period or another, must affect one's inferences from the data, in view of the location-specificity and time of introduction of particular items of technology. Measurement techniques vary across studies and there exists a sizable literature on just the technical aspects of assessing change in equality/inequality (see, for example, Paglin, 1975 and 1977; Allison, 1978). Finally, we previously mentioned that there were complications involved in using aggregate and/or cross-sectional versus panel data. In short, considerable ground work has been done but firm conclusions are not possible. And given the complexity of the research context, it should be apparent that any one study, such as ours, can only hope to address a few of the unresolved questions, a task to which we now turn.

SAMPLING AND MEASUREMENT

Two hundred and forty-six cultivators in two villages of Yeotmal District, Maharashtra, were interviewed in 1967 as part of a larger diffusion study (Roy, et al., 1968). Ninety three per cent of these farmers (N=228) were asked the same questions a second time in 1973. Comparisons of the distributions of responses from the 228 cultivators at two points in time, and the relationship between these distributions and farmers' 1967 levels of adoption of improved practices, constitute our research design.

The 1967 sample consisted of farm operators, both owners and tenants, no more than 50 years of age. This age restriction undoubtedly contributed to our good fortune in finding almost all of the sample still active in agriculture at the later time point. Our 1967 sample was also restricted to operators of farms of 2.5 acres or more, a size restriction which eliminates very small farms from the comparisons. The district is characterized by rain fed agriculture, however, and farms are consequently larger than national averages would suggest Roy, et al., 1968:8-11). We estimate that perhaps 15 per cent of the farm operators in the study area were excluded by the size restriction. This is a small proportion of the total, relative to some other areas, reflecting the comparatively extensive use of land in an area of uncerta rainfall. Nevertheless, in interpreting the results of our analysis one must keep in mind that operators of very small farms as well as agricultu: laborers, categories which overlap substantially and are typically at the bottom of the economic ladder, are not included in the comparisons.

Soils in the study area, known as black-cotton soils, are good, but rainfall can be a problem and very little land in the area has assured irrigation water. Moisture problems must be stressed here because 1973 was a drought year in this area (Subramanian, 1975) and some of our results reflect the drought conditions. The major crops in the district are cotton and grain sorghum (jowar). Improved plant materials and other improved practices have been extensively promoted in the area but it is important to note that neither of the area's major crops have figured centrally in the "miraculous" yield improvement of the so-called Green Revolution. We are dealing herewith a segment of India's more or less average agriculutre, neither impoverished nor dramatically improving, subjected to introduction of more or less average new technology, better than the old but not "miraculous" in its potential.

Farmers' adoption of improved agricultural practices was a major focus of the 1967 study. In this analysis we capitalize on the observed differences in 1967 adoption levels, in order to determine whether those differences are implicated in changes of equality in reward distribution over time. The 1967 adoption levels were measured via a reliable 10-item index (Roy, et al., 1968: 13-24), which included an array of soil improvement, pest control, animal breeding, and cultivation practices appropriate to the area's agriculture. In general, the levels of adoption which had been achieved in the area in 1967 were low. Over one-third of the 228 cultivators had adopted none of the 10 recommended practices at that time, and another 30 per cent had adopted no more than two, as shown in the second column of Table 1. The balance of the sample ranged upward to a high of 7 out of the possible 10 practices.[3] Our concern is whether these gross differences in adoption levels have social and economic consequences over time.

Our key measure of consequences is an economic variable, gross value of farm product. The 228 cultivators were asked detailed questions about the total amounts of all crops produced in the 12 months preceding the survey, in both 1967 and 1973. This included production for home consumption as well as sale, barter, or payment in kind. Amounts produced were then converted to a common, monetary base by applying published 1966 prices appropriate to that product in that region (Roy, et al., 1968: 30-32). The resultant amounts were then summed across all products to yield a single figure for production volume. These totals are an approximation of gross farm income figures. For purposes of this study, 1973 production volume was also computed on the basis of 1966 prices, thus product price changes and prices actually realized by individual cultivators do not enter into our analysis.[4]

The monetary values given (in Rupees) for the two time points are directly comparable, and permit us to compare distributions for the two time points to determine whether differences among the farmers have increased or decreased.

Level of living indexes and several other measures used in the analysis will be briefly described in the context of presenting the results in the following section (for details see Roy, et al., 1968). In all cases the analysis is concerned with whether the degree of inequality among farmers which was observed in 1967 increases or decreases by 1973, and whether any change over time can be attributed to differential adoption of agricultural technology.

FINDINGS

Inequality in production volume and input usage

Table 1 contains the results of the first portion of our analysis, that concerned directly with the agricultural production process. The first segment of the table shows that average value of product was lower in 1973 than in 1967 for each of the three levels of adoption, with the greatest proportional reduction in the middle and lower adoption categories. Rainfall was inadequate in the 1972-73 crop year and crop losses were severe (Subramanian, 1975: 382-386). It is to be expected, however, that farmers who had been relatively high in adoption in 1967, and also tended to have larger farms, were best able to withstand the negative impact of drought (Table 1).

We became aware, at an early stage of our analysis, that lower production volume in 1973 was complicated by the fact that the amount of land cultivated and labor input had also been reduced. Farmers had reduced their agricultural activities as a result of dry weather. For that reason we computed value of product per acre, and value per day of labor input (i.e., actual input, not labor available) for each cultivator, thereby putting the several trend patterns into a more readily interpretable form. Changes in acreage and labor input (which includes all family and hired labor) are shown in the second and third segments of Table 1, and the figures for value of product per unit of input follow.

That data show that acreage reductions were general, with most substantial reductions for the "high" and "medium" adopters. Some rented lands may have been released for use by others, but rented land is not common in this area and, in any case the prospects for productive use were not favorable in absence of rain.[5] Most of the reduction in acreage farmed in 1973 undoubtedly reflects the practice of allowing less productive land to lie fallow in times of drought. Labor inputs were even more sharply reduced than acres farmed for all adopter categories, Table 1. In this connection it is crucial to note that the absolute levels of labor input for both low and intermediate practice adoption levels are, in 1973, below what would be considered reasonable full employment levels for the farm operator alone, to say nothing of family and hired labor. Low adopters used only 112 days of labor input in 1973 for all production activities, and the farmers in the middle adoption category used 151 days of labor, on average, as shown in Table 1. A likely inference here, but one which we cannot document, is that the use of hired labor was sharply reduced and that the brunt of the drought, therefore, may have been most acutely felt by landless laborers. Drought relief measures in the form of public works employment (e.g. in road building) will have provided some relief for the unemployed landless (Economic and Political Weekly, 1972: 2479-2481; Subramanian, 1975: 384-385), but at the very least they will have had to do without the payment in kind which typically constitutes a substantial fraction of farm workers' compensation. Skotchy data on off-farm employment of farm operators show that fewer farmers worked off-farm in 1973 as compared with 1967. Detailed comparisons on off-farm employment, by level of adoption, were not undertaken because relatively few individuals reported off-farm work in both years. We can infer, however, that farmers at lower 1967 adoption levels were themselves probably under-employed in 1973.

As expected, value of product per acre cultivated is also lower in 1973, though the (1967) high adopters show a slight increase. Value of product per day of labor input is higher for all adoption levels, however, reflecting the sharp reductions in labor input shown in the third segment of Table 1. Product per day of labor input is most substantially increased for low and medium adopters but this is tempered by the absolutely low levels of employment for these cultivators, and their families, which we noted earlier.

Does income inequality increase over time and can such a change be attributed to utilization of improved technology at the earlier point in time? To answer the first part of this question we have computed Gini coefficients and coefficients of variation, V, both of which are measures of dispersion.[6] These results are shown in the two right hand columns of Table 1. Then, to answer the second part of the question, we have prepared Lorenz curves which display 1967 and 1973 production distributions in terms of cultivators' 1967 adoption scores on the 10 item index. The Lorenz curves permit us to locate changes in the spread of the two distributions over time relative to 1967 adoption scores, information which coefficients such as the Gini cannot convey. To save space, we have included here the curves for value of all products raised, Figure 1, but not the product per unit of input curves, which are very similar.

Generally speaking our results show an increase in inequality over time, Table 1 and Figure 1. Referring first to the total value of product results, in the first segment of Table 1, both the Gini index and the coefficient of variation show increased dispersion of production volume in 1973 as compared with 1967. The 1973 coefficients are higher than those for 1967, which means that the 1973 distribution is more widely spread out than the 1967 distribution, and thus we conclude that inequality in production volume has increased over time.

The Lorenz curves, which tie these results directly to 1967 adoption of technology, also suggest an increase in inequality by 1973 (see Figure 1). The 1973 curve is largely farther from the diagonal than that for 1967, but the curves cross. Those ranking lowest in adoption in 1967, the non-adopters, fall slightly closer to the line of equality (the diagonal) in 1973 than they did in 1967. Their proportionate share of total farm production is slightly higher in 1973 than it had been earlier, not lower. Then, for adoption scores of 1 through 7, which was the highest score achieved on the 10-item index, the 1973 curve shifts to the right of the 1967 curve, more distant from the diagonal, thus indicating an increase in inequality for the bulk of the sample. Applying the rather strict "Lorenz dominance" criterion (Allison, 1978:878), the curves cannot be ranked, i.e. the 1973 curve is not fully below and to the right of the other. Thus we cannot unequivocally say that inequality in production volume has increased from 1967 to 1973, but the combined evidence is strongly in this direction. On the other hand, the role of agricultural technology in the increased inequality is not clear. We noted that the 1973 curve for production volume was closer to the "line of equality" at the lowest adoption level, not more distant, thus we cannot argue that adoption "laggards" are falling farther behind.

Results for the acreage and labor input variables are somewhat mixed but we believe that they are consistent with the pattern of results described thus far. Both acres cultivated and days of labor input show a small reduction in inequality over time (see Table 1). These results should probably be interpreted as simply documenting the general constriction of production because of dry weather which we have been discussing. The "value of product per acre" variable, like "value of all products raised," shows increases on both dispersion measures.

indicating an increase in inequality. Value of product per day of labor input, on the other hand, shows a reduction in inequality, but this has to be viewed in the context of the absolutely low levels of employment discussed above.[7] The Lorenz curves for all of these variables (not shown) cross each other and cannot be ranked. The pattern of the several curves is similar to that described for Figure 1, however, indicating a decrease in inequality for farmers with low 1967 adoption scores and an increase in inequality for those with high scores. Thus we conclude that our several production volume and production input measures document increases in inequality over time, but the role of agricultural technology in that change remains unclear.

Our last production-related variable is "kilograms of fertilizer purchased" in the 12 months preceding the survey. Results are shown at the bottom of Table 1 and in Figure 2, and they provide some insight into the role of technology with respect to income distribution. Fertilizer adoption (yes or no) was part of our adoption index, but the amount purchased was not, and is used here as a semi-independent measure of "catching up or falling behind." Fertilizer purchases, which stood at close to zero for the low adopters of 1967, are proportionally much higher in 1973, though rates of application are still absolutely low as a comparison of fertilizer purchases with the acreage figures, also in Table 1, will verify. Nevertheless, fertilizer usage increased over time and the dispersion measures document a decrease in inequality on this variable. Figure 2 shows clearly that fertilizer purchases in 1973 are more equal than in 1967 when arrayed in terms of 1967 scores on the adoption index. One can conclude that the "laggards" are catching up, or conversely, that the "innovators" are not forging ahead.[8] The "innovators" may well be close to their desired optimum levels of fertilizer application. If that were the case, the question of maintaining a leadership position, or forging ahead, would hinge on the availability of a steady stream of new technology. In any case, it is clear that inequality in fertilizer purchases decreases over time for these cultivators. Moreover, we infer that early failure to adopt improved technology may not represent a lasting and self-reinforcing disadvantage under the conditions studied here.

Inequality in socioeconomic and communication terms

Research on inequality in distribution of the benefits of development must centrally include other than purely economic variables because people presumably work in order to improve their living conditions, life chances for their children, and so on. In addition, the volatility of some of our production variables due to weather conditions, increased our interest in analyzing changes in inequality on some more stable measures, such as level of living.

Table 2 displays mean values in 1967 and 1973, for each of the three adoption categories, for an 8-item housing index, an 8-item material possession index, and the sum of these two indexes, which we have called a level of living index.[9] The table also displays dispersion measures for these three indexes. Lorenz curves are included for the level of living index only (Figure 3) because the patterns are virtually identical for all three measures.

<u>Does socioeconomic inequality increase over time?</u> Results for housing, material possessions, and their combination into a comprehensive level of living index, all indicate an increase over time in material well-being for low and intermediate adopters. Mean values for the 1967 high adopters are essentially stable over time, though those mean values do not even approach the highest values possible on the measures. The dispersion measures, in the two right hand columns of Table 2, show a clear and consistent decrease in inequality. In addition, the Lorenz curves for the 1967 and 1973 level of living distributions leave no doubt that inequality in level of living had decreased by 1973. The 1973 curve is fully above and to the left of the curve for 1967 (Figure 3).

Our guiding research question asked whether differential acceptance of improved agricultural technology in 1967 would contribute to increased inequality by 1973. Inequality in material well-being has in fact decreased, not increased. Those who ranked lowest on adoption in 1967 show substantial improvement, and those who ranked highest in 1967 have remained stable. The net result is a definite decrease in inequality. Early failure to adopt improved technology does not seem to represent a lasting disadvantage in terms of material wellbeing. On the contrary, there is evidence here of "catching up."

Why have the high adopters of 1967 levelled off in material well-being when, as demonstrated earlier, their lead in volume of agricultural production seems to have increased? It would seem prudent, at this point, to underscore the fact that our production data involve an estimate of gross rather than net farm income. We have no data on net income. We can speculate, however, that an innovative farmer could have invested in, say, improved cattle breeding, one of the items in our adoption index. The time lag involved in recovering such costs would presumably be greater than for, say, chemical fertilizers, and the realization of a net increase in disposable income could be both distant in time and rather uncertain. Our general point here is that one cannot simply assume that a higher volume of production signifies a higher net return and thus more disposable income for investment in either consumer goods or additional high payoff production inputs. We lack data on both net income and the payoff on specific items of technology (though the case for chemical fertilizer is fairly clear).

The next item listed in Table 2 is more nearly a measure of standard of living than level of living. All respondents were asked the following question: How much money (including food) does your family need per month to live comfortably in this village? The pattern of means, shown in Table 2, indicates that respondents' definition of what is "needed" increased between 1967 and 1973, and increased most markedly for the lower and middle 1967 adopter categories. Results for the dispersion measures are consistent with the pattern of means; inequality has decreased rather than increased.

Low adopter respondents, who in 1967 indicated that they could live comfortably at about half the level of expenditure that their high adopter neighbors felt was necessary, had sharply raised their sights by 1973, whereas the standard for high adopters had increased more moderately. Lorenz curves for the 1967 and 1973 distributions, Figure 4, again show a clear separation, with the 1973 curve fully above and to the left of the curve for 1967, confirming our inference that inequality in standard of living has decreased over time. A further inference that seems warranted by this finding is that those cultivators who ranked low in adoption in 1967 are becoming more fully integrated into the cash economy as time passes. Their stated monetary needs have increased over time and have substantially caught up with those of their more innovative neighbors. If this is the case, one would expect an increase in the use of purchased inputs over time, as was demonstrated for fertilizer in the preceding section. One would further expect an increase in productivity and, possibly, utilization of such an increment to improve material well-being, as suggested by the finding for level of living. Such a speculative picture may be overly optimistic, but our data do show that the "laggards" are not falling farther behind.

Our last two measures are intended to address still another type of "reward" question — access to information via Extension contact and the mass media. We deal with these variables in the context of "rewards" for the following reasons. First, information contacts are logically treated as antecedents of adoption of innovations and thus are also logically part of the distributive implications of adoption of technology. And second, information contact frequencies are positively associated with measures of socio-economic status (see Roy, et al., 1968:93). To the extent that inequality in socioeconomic status increases, one would expect inequality in contact with information sources to increase as well, with the distinct possibility of an interactive effect further increasing inequality in the long run. The tie to "rewards" is a bit tenuous but one might say that an increase in inequality of contact for information represents a negative "reward", or more directly, a negative impact.

Contact with information sources was demonstrably not equal across adoption levels in 1967 (see Table 2).[10] High adopters had 2 to 3 times more contact with information sources, on average, than low adopters. Does that disparity increase or decrease over time?

Table 2 shows small mean increases in Extension contact over time for the two lower 1967 adopter categories, and increases in mass media contact for all three adopter categories. Results for the information contact dispersion measures, Table 2, are somewhat mixed. The Gini index shows a decrease in inequality for both information contact variables, but the coefficient of variation for the Extension contact measure is higher in 1973 and for mass media contact it is lower.[11] We conclude that inequality in frequency of contacts with Extension personnel may have increased from 1967 to 1973, while inequality in mass media contact may have decreased.

Figure 5 shows the Lorenz curves for the Extension contact va and it is apparent that the curves cross and thus cannot be ranked. The 1973 curve is closer to the diagonal for those at low and medium 1967 adoption levels, however, suggesting that inequality in Extensic contact has decreased for the low adopters. The apparent increase in inequality, indicated by the 1973 coefficient of variation for Extensi contact, is seemingly restricted to farmers who were relatively high adopters of improved technology in 1967. Lorenz curves for the mass media contact index are not shown, but are largely parallel and, again, cannot be ranked. At low and medium levels of adoption the two curves coincide, and at higher levels of adoption the 1973 curve is slightly closer to the diagonal, suggesting a moderate decrease in inequality for farmers at the higher adoption levels. This is consistent with the inference based on the dispersion measures, which also showed a moderate decrease in inequality for mass media contact (see Table 2).

Substantively, we infer that inequality in contact with Extension personnel may have increased over time, but not to the disadvantage of those ranking low in 1967 level of adoption. Extension agents do not contact all types of clients equally, but our data do not permit the conclusion that "laggards" are increasingly ignored. Conversely, mass media contact is possibly becoming more equally distributed over time, and again, we cannot conclude that low adopters in 1967 are penalized as time passes. On the contrary, if we treat mass media contact as a consumption or quality of life variable, we would conclude that the laggards of 1967 are holding their own, or possibly catching up on this variable, which is consistent with our data showing clear catching up for level of living in general.

CONCLUSIONS

Our panel data for 228 Indian cultivators indicate that inequality in volume of agricultural production increased over a six-year span. This increase in inequality may be related to differences in utilization of improved production technology, but our data do not support the notion that adoption "laggards" are left behind. Other disparities, such as those in size of farming operations, are probably responsible for the fact that some cultivators were able to survive the effects of dry weather in 1973 much better than others (cf. Swenson, 1976), and may have more impact on changes in reward distribution over time than seems to be the case for technology. Our only measure of change in input use, purchase of chemical fertilizers, showed a clear pattern of decrease in inequality, supporting our inference that adoption "laggards" are in fact catching up with their neighbors.

The data on level and standard of living are consistent with the general conclusion that early failure to adopt modern technology does not result in an overall increase in inequality over time for these respondents. Early disparities in level of living showed a clear pattern of decrease from 1967 to 1973; inequality decreased. We conclude from these results that, for this sample, and in absence of radically improved production technology, the impact of induced change in production inputs and practices is such as to decrease inequality in rewards over time. We can speculate, further, that the avowed welfare emphasis of agricultural development policy in the Indian context may well be having the desired effect of permitting all to share in the benefits of development to an increasing extent.

Many reservations could be expressed about the optimistic flavour of the inferences we have made from the data at hand. Much more research, in different settings and focusing on other parts of the total technological package is obviously needed. Much more work on net incomes and actual expenditures and the income enhancing potential of particular items of technology is needed. A major qualification, directly applicable to this study, is that we were unable to trace out the effects of technological change on very small farmers and agricultural laborers. Our data suggest that under drought conditions these segments of the agricultural labor force are highly vulnerable. We have noted the compensatory potential of another institutional factor, drought relief works, but what actually happens, and how the landless or nearly landless fare in long run terms, is simply not known at this point. Speculation is a poor substitute for empirical research.

Table 1: Agricultural Production and Production Inputs for 1967 and 1973, 228 Indian Cultivators, arrayed by 1967 level of adoption

Variable	No. of cases*	Adoption score in 1967 (range 0–10)	Mean 1967	Mean 1973	Dispersion of entire distribution, N = 228*: Gini index 1967	Gini index 1973	Coefficient of Variation, V 1967	Coefficient of Variation, V 1973
Value of all products raised in preceding year (in Rupees)	80	0	1391	1087				
	69	1–2	2864	1443	.32	.37	1.02	1.67
		3 or more	5229	4237				
Number of acres cultivated	82	0	9.9	9.4				
	69	1–2	14.5	11.9	.22	.20	.94	.85
	68	3 or more	26.2	20.9				
Total labor input in preceding year (days)	79	0	225	112				
	69	1–2	416	151	.27	.20	1.04	.95
	63	3 or more	765	260				
Value of product (in Rupees) per acre	80	0	142	124				
	69	1–2	219	128	.13	.19	.97	1.66
	67	3 or more						
Value of product (in Rupees) per day of labor input	77	0	5.5	14.5				
	68	1–2	7.3	15.9	.22	.21	4.16	1.80
	62	3 or more	18.2	30.7				
Kilograms of fertilizers purchased	88	0	2	35				
	70	1–2	33	80	.70	.50	2.23	2.11
	68	3 or more	234	298				

* Some variation in number of cases due to missing data.

Table 2: Socioeconomic and communication variables for 1967 and 1973, 228 Indian cultivators, arrayed by 1967 levels of adoption

Variable	No. of cases*	Adoption score in 1967 (range 0–10)	Mean 1967	Mean 1973	Dispersion of entire distribution, N = 228*: Gini index 1967	Gini index 1973	Coefficients of variation, V 1967	Coefficients of variation, V 1973
Housing index (range 0–8)	86	0	2.0	2.8				
	68	1–2	2.9	3.4	.18	.10	.74	.55
	70	3 or more	4.1	4.1				
Material possession index (range 0–8)	86	0	1.2	2.0				
	69	1–2	2.7	3.0	.29	.19	.94	.87
	70	3 or more	4.4	4.3				
Level of living index (range 0–16)	86	0	3.2	4.7				
	69	1–2	5.6	6.4	.23	.15	.77	.61
	70	3 or more	8.5	8.4				
Rupees required per month for family living	81	0	154	307				
	64	1–2	216	350	.16	.06	.70	.68
	67	3 or more	317	386				
Extension contact index (range 0–8)	88	0	1.7	1.8				
	68	1–2	3.2	3.4	.28	.26	1.04	1.57
	70	3 or more	5.6	5.2				
Mass media contact index (range 0–8)	88	0	2.4	2.9				
	70	1–2	3.8	4.6	.17	.15	.60	.56
	70	3 or more	4.8	5.6				

* Some variation in number of cases due to missing data.

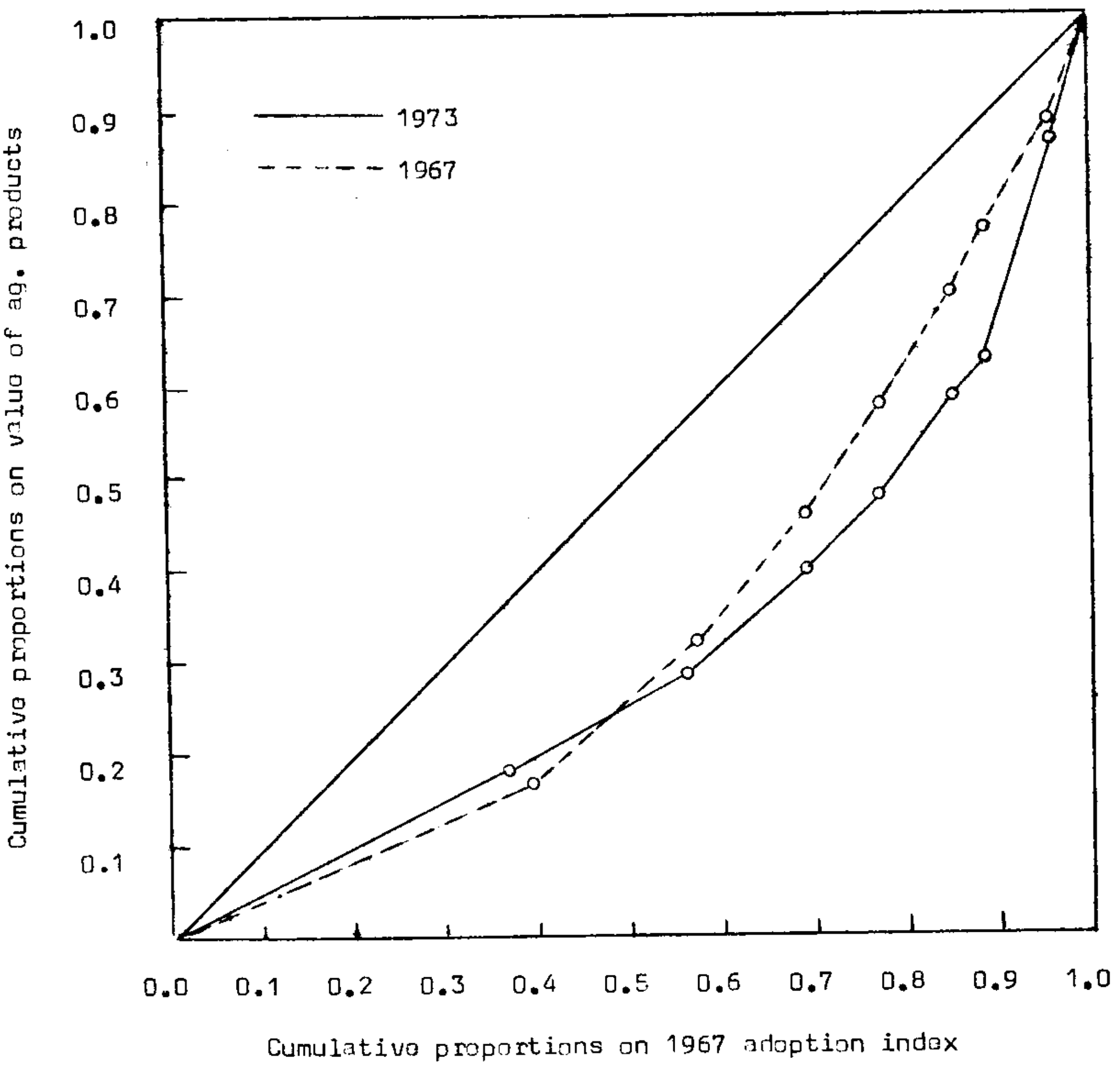

Figure 1. Lorenz curves for value of agricultural production by 1967 adoption scores.

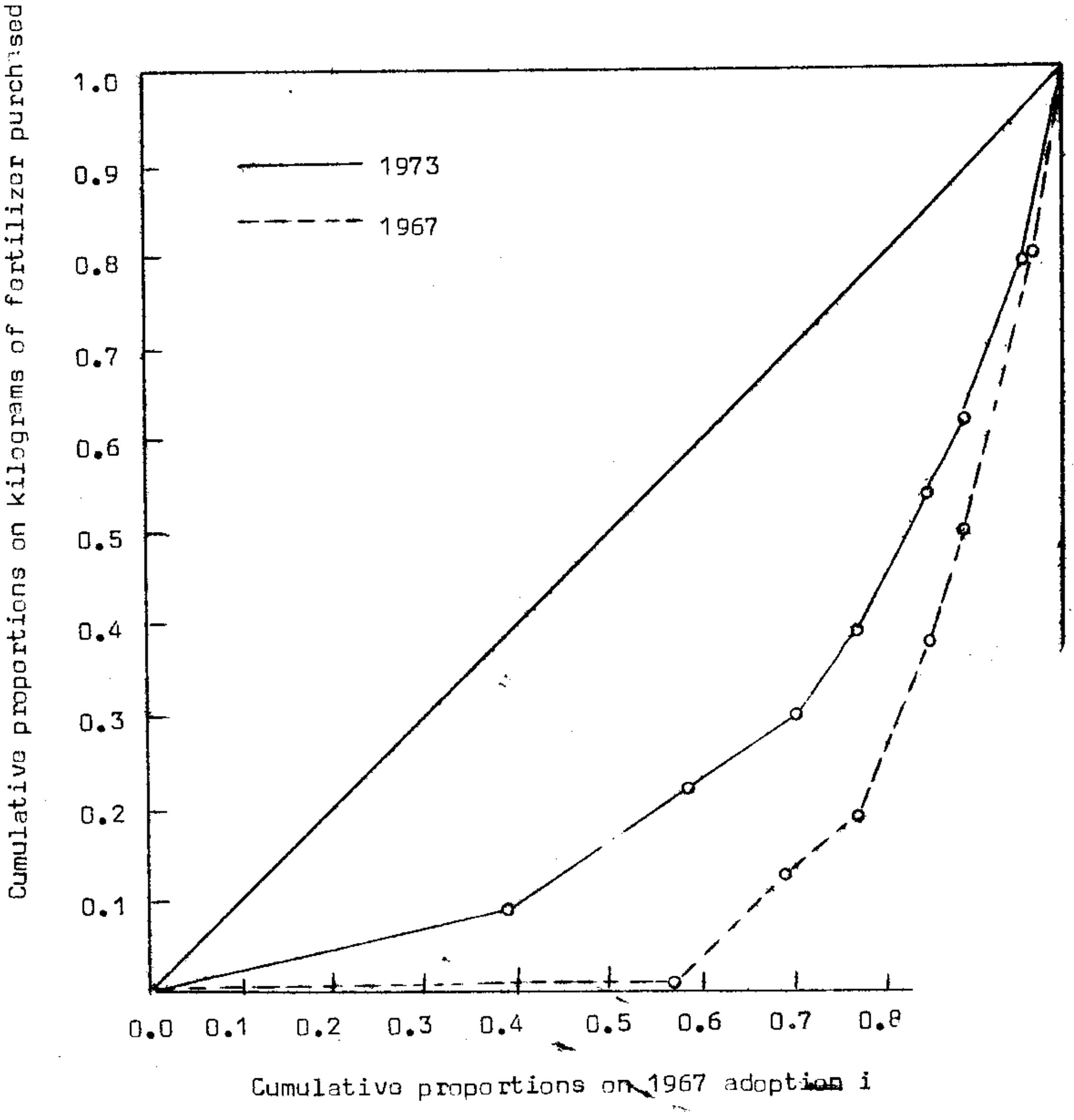

Figure 2. Lorenz curves for fertilizer purchas adoption scores.

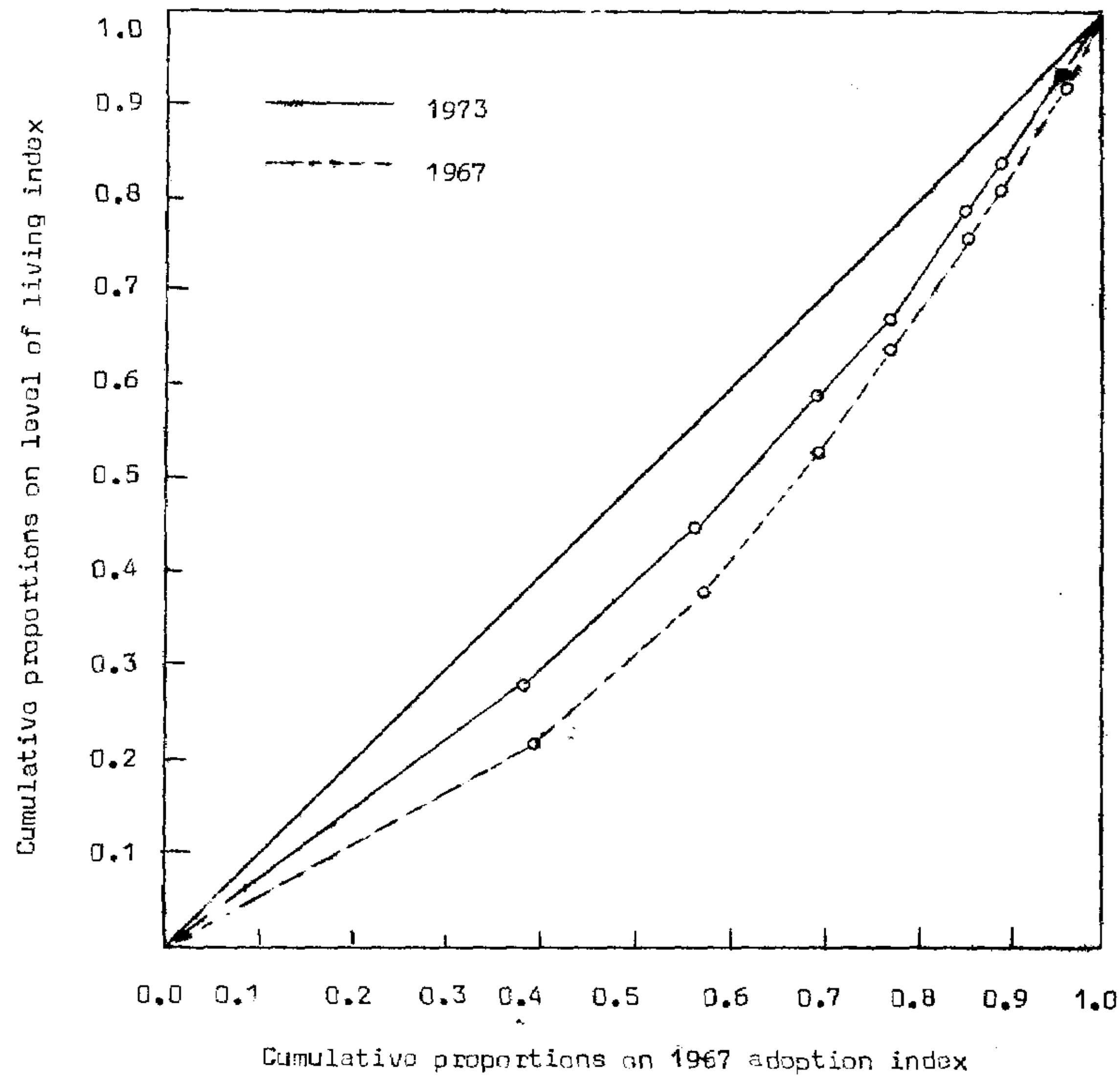

Figure 3. Lorenz curves for level of living by 1967 adoption scores.

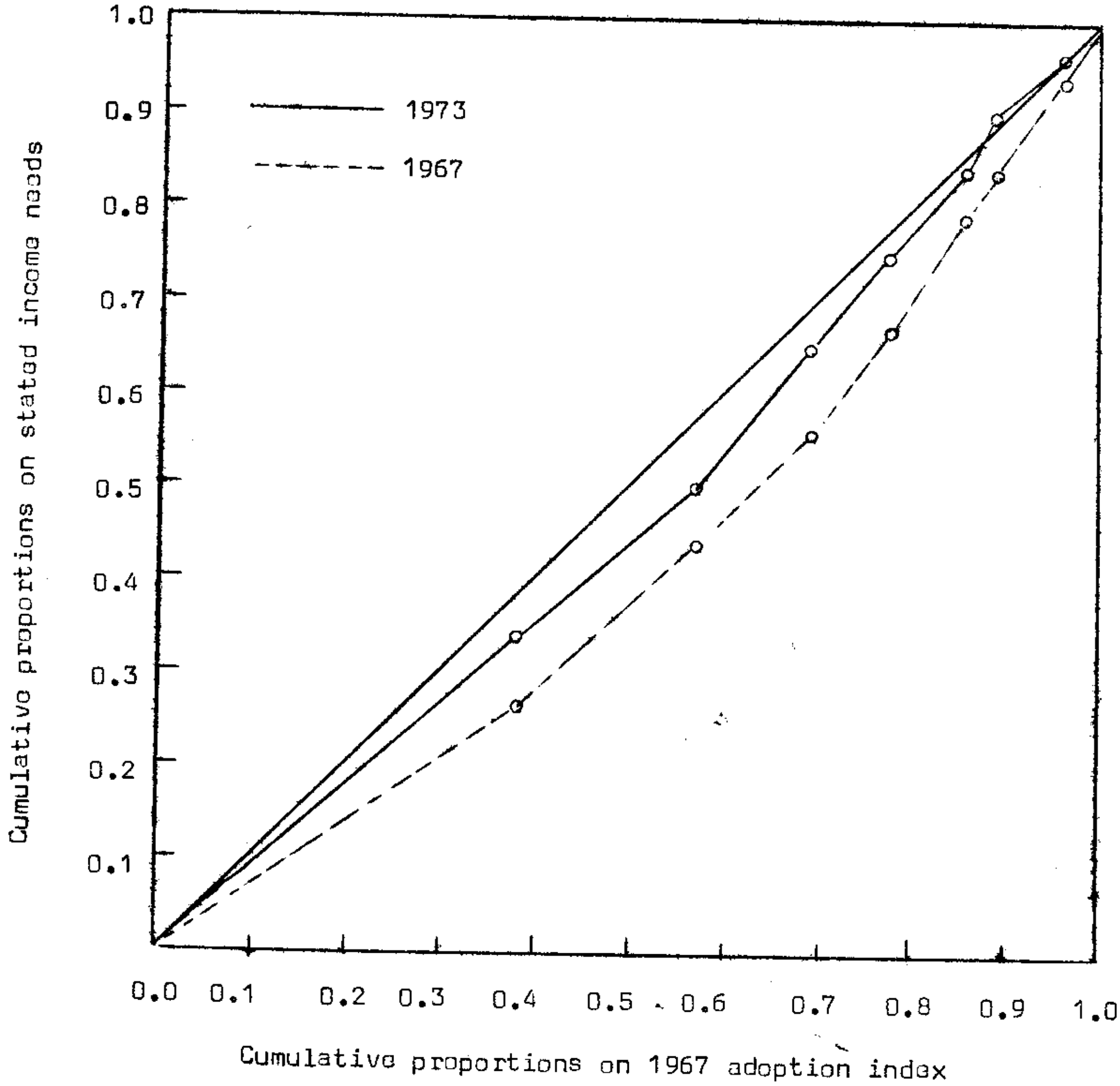

Figure 4. Lorenz curves for stated income needs by 1967 adoption scores

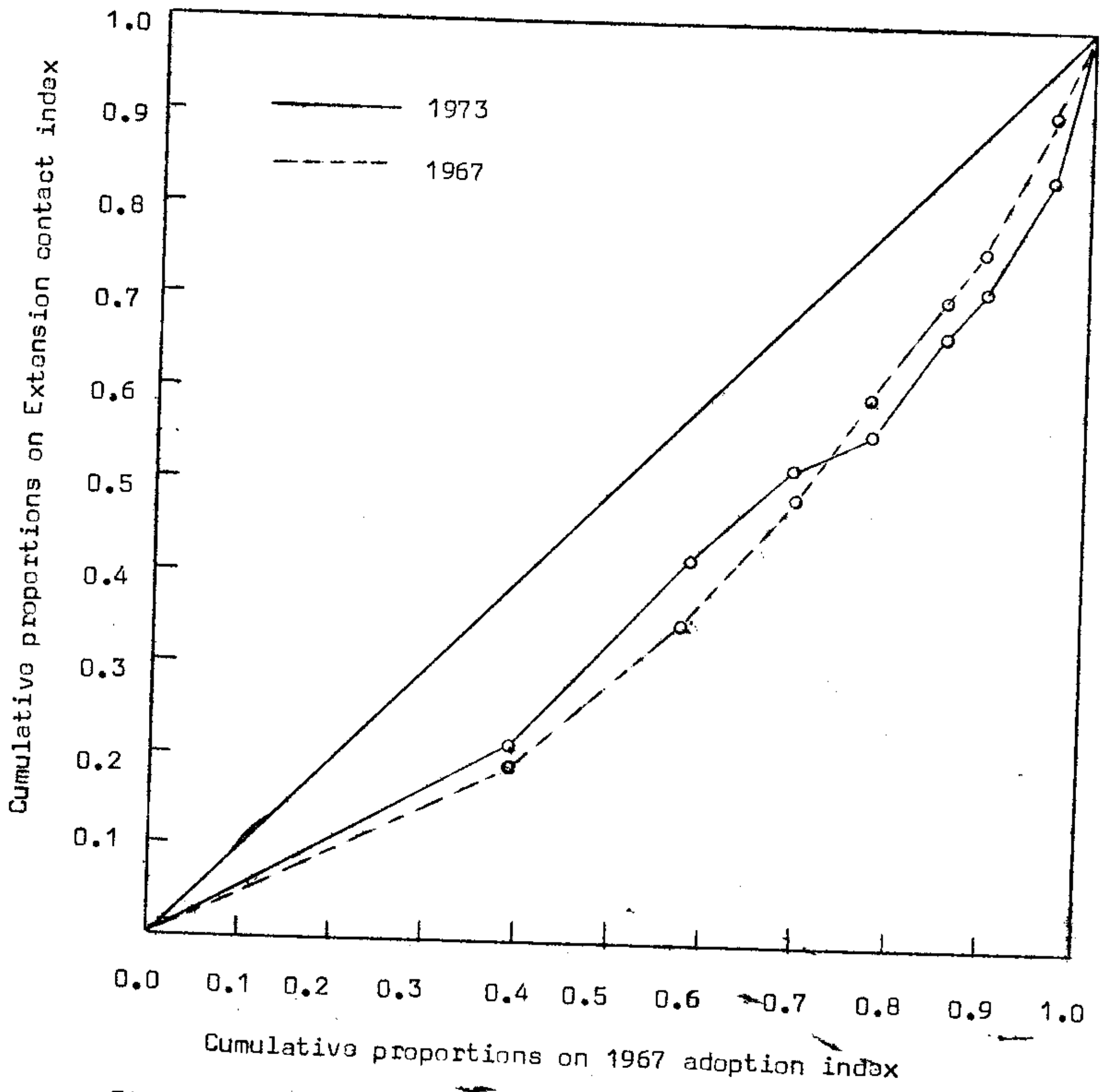

Figure 5. Lorenz curves for Extension contact by 1967 adoption scores.

FOOTNOTES

2. The recent study by Morley (1978), who tempers some of the extant generalizations about increasing inequality in the widely-discussed Brazilian case by introducing age controls, is highly relevant in this context. The point made is that rapid labor force expansion may involve a disproportion of young people at the entry level, thus tending to bias the average wage downward.

3. The adoption index was designed to array cultivators from three states, not just Maharashtra. The total 1967 distribution (N=680) was also skewed, but not as markedly as in the case here (Roy et al., 1968: 22).

4. Swenson (1976) makes the important point that except for the ability of large farmers in his Tanjore sample to hold their paddy for higher prices, inequality in receipts from rice production alone would also have decreased.

5. Our sample of farm operators with 2.5 acres of rented or owned holdings in these two villages is in fact a census of operators in that size class. Changes in control of rented land would therefore most likely have involved exchanges between one respondent in the sample and another, also in the sample, for no net reduction in total acreage, unless the land went out of production.

6. Following Allison (1978) we have also computed the, to us, less familiar Theil's T, which offsets some of the distribution problems with data such as these by converting raw scores to logarithms. The T coefficients are not included in the table to save space, but they generally confirm the results reported; any exceptions will be noted.

7. Given that the coefficient of variation for this variable, for 1967, is strikingly high (the standard deviation is 4.16 times greater than its mean), it is worth noting that Theil's T also shows a decrease in dispersion (see Footnote 6).

8. This finding is relevant to the lively discussion on status inequality as a determinant of adoption, though our analytic framework does not lend itself to making a direct connection. The most recent paper on the topic is Gartrell (1977), and the antecedent of this line of research is the trenchant and provocative paper by Cancian (1967). See also Morrison et al., (1976), which is based in part on the data used here.

9. Material possessions include such items as a wrist watch, shoes, and flashlight. Housing items include cement or stone flooring, shutters on windows, and a private latrine. Details are given in Roy et al., (1968: 49–51).

10. Both of these measures are composites, and the patterns of differences on an item-by-item basis are somewhat erratic. The several items do combine into reasonably reliable indexes, however. The Extension contact index includes viewing of instructional films and frequency of contact with the village level worker in its four item total. The mass media index also contains four items, including print media and radio contact. Details are given in Roy et al., (1968: 62–68).

11. Theil's T is higher in 1973 for both indexes; .59 versus 1.03 for Extension contact, and .25 versus .26 for mass media contact.

REFERENCES

Adelman, Irma

1975 "Development Economics - A Reassessment of Goals." The American Economic Review 65 (May): 302-309.

Allison, Paul D.

1978 "Measures of Inequality." American Sociological Review 43 (December): 865-880.

Cancian, Frank

1967 "Stratification and Risk Taking: A Theory Tested on Agricultural Innovations." American Sociological Review 32 (December): 912-927.

Das Gupta, Malabika

1978 "Distribution of Benefits from Growth in Rural India." Margin 10 (July): 34-43.

Economic and Political Weekly

1972 "For Most, Metal-Breaking." Economic and Political Weekly 7 (No.52, December 23): 2479-2481.

Fields, Gary S

1977 "Who Benefits from Economic Development? -- A Reexamination of Brazilian Growth in the 1960's." The American Economic Review 67 (September): 570-582.

Frankel, Francine

1971 India's Green Revolution: Economic Gains and Political Costs. Princeton, N.J.: Princeton University Press.

Gartrell, John W.

1977 "Status, Inequality and Innovation: The Green Revolution in Andhra Pradesh, India." American Sociological Review 42 (April): 318-337.

Havens, A. Eugene, and William L. Flinn

1975 "Green Revolution Technology and Community Development: The Limits of Action Programs." Economic Development and Cultural Change 23 (April): 469-481.

Jacob, George (Ed.)

1967 Readings on Panchayati Raj. Hyderabad, India: National Institute of Community Development.

Jhunjhunwalla, Bharat, and W.W. McPherson

1972 "Agricultural Mechanization and Income Distribution in Faizabad District, East Uttar Pradesh." Indian Journal of Agricultural Economics 27 (October-December): 56:63.

Khaund, H.P.

1970 "Changes in Income Distribution and Their Significance in a Society in Transition." Indian Journal of Agricultural Economics 25 (July-September): 75-81.

Mencher, Joan P.

1978 Agriculture and Social Structure in Tamil Nadu. Durham, North Carolina: Carolina Academic Press.

Morley, Samuel A.

1978 "Growth and Inequality in Brazil." Luso-Brazilian Review 15 (Winter): 244-271.

Morrison, Denton E., Kishna Kumar, Everett M. Rogers and Frederick C. Fliegel

1976 "Stratification and Risk Taking: A Further Negative Replication of Cancian's Theory." American Sociological Review 41 (December): 1083-93.

Narayanan, S.

1978 "Pattern of Income Distribution and Poverty in a Village in Orissa: An Analysis." Behavioural Sciences and Rural Development 1 (January): 11-24.

Paglin, Morton

1975 "The Measurement and Trend of Inequality: A Basic Revision." The American Economic Review 65 (September): 598-609.

1977 "The Measurement and Trend of Inequality: Reply." The American Economic Review 67 (June): 520-531.

Roy, P., F.C. Fliegel, J.E. Kivlin, and L.K. Sen

1968 Agricultural Innovation Among Indian Farmers. Hyderabad, India: National Institute of Community Development.

Saint, William S., and E. Walter Coward, Jr.

1977 "Agriculture and Behavioral Science: Emerging Orientations." Science 197 (19 August): 733-37.

Schaller, W. Neill

1978 "Public Policy and Rural Social Change." Pp.149-210 in Thomas R. Ford (ed.), Rural USA: Persistence and Change. Ames, Iowa: Iowa State University Press.

Schultz, Theodore W.

1964 Transforming Traditional Agriculture. New Haven, Conn.: Yale University Press.

Singh, Katar

1973 "The Impact of Agricultural Technology on Farm Income Distribution in the Aligarh District of Uttar Pradesh." Indian Journal of Agricultural Economics 28 (April-June): 1-11.

Subramanian, V.

1975 Parched Earth: The Maharashtra Drought 1970-73. Bombay: Orient Longmans.

Swanson, C. Geoffrey

1976 "The Distribution of Benefits from Increased Rice Production in Thanjavur District, South India." Indian Journal of Agricultural Economics 31 (January-March): 1-12.

Taylor, C.E., Douglas Ensminger, H.W. Johnson, and Joan Joyce

1965 India's Roots of Democracy. Bombay: Orient Longmans.

Wallerstein, Immanuel.

1974 The Modern World-System. New York: Academic Press.

Weaver, James H., Kenneth P. Jameson, and Richard N. Blue

1978 "Growth and Equity: Can They Be Happy Together?" International Development Review 20 (No.1): 20-27.