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Poor Rural Households, Technical Change, & Income Distribution in Less Developed Countries

A SUMMARY REPORT OF FINDINGS FROM WEST AFRICA, SOUTHEAST ASIA AND BRAZIL

The United States Agency for International Development provided support for this research under contracts:

AID/ta-C-1328	Michigan State University
AID/ta-C-1327	Cornell University
AID/ta-C-1326	Purdue University

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INTRODUCTION

Those searching for a better understanding of economic development and committed to improving the level of living in low-income nations are becoming increasingly aware of a paradox. In many poor nations, total agricultural production has been increasing, while a significant proportion of the rural poor continue to live with poverty, unemployment and malnourishment. Why is it that improved farming practices have added to aggregate food production, while large numbers of families continue to live in the backwater of technical change? In several countries it can be demonstrated that the relative and, in some cases, absolute well-being of many have worsened while measures of agricultural output have risen steadily.

The greatest disparity appears to exist between households which control an adequate area of land and families who are landless or live on miniscule plots. Undoubtedly, the size of land holdings is an important determinant of well-being, but the observation is overly simplistic for many other factors contribute to the failure of large numbers to enjoy the benefits of improved agricultural technology. Limited access to credit, improved seeds, agricultural chemicals and irrigation facilities contribute to the complex forces perpetuating low incomes and misery.

The research reported here was originated to gain an improved understanding of the factors which constrain poor rural households from participating fully in technical changes in the agricultural sector. The research was meant to be more than an adventure in scholarship; it was initiated to provide guidelines for policy makers charged with the task of improving the lot of the rural poor. Biological and physical scientists have made remarkable progress in increasing the productive capacity of agriculture. Social scientists have been less successful in comprehending problems of maldistribution of the benefits flowing from these scientific advances.

In 1973, the United States Agency for International Development received contract proposals from three universities: Michigan State, Cornell and Purdue. There was considerable similarity in the broad objectives of the three proposals; each concentrated on an examination of how technical changes in agriculture influence income distribution, each had as its centerpiece an improved understanding of the low-income problem and each suggested that research focus on decision making at the household and individual farm level.

The proposals differed in their geographical orientation. Based on previous research and expertise, agricultural economists from Michigan State University wished to focus on problems of West Africa, while economists from Cornell and Purdue wished to explore the same issues in Southeast Asia and Brazil, respectively. In reviewing the separate proposals, US/AID personnel sensed that a single research effort with common objectives would provide greater continuity than if the three studies proceeded independently. Representatives of US/AID and the three universities met and agreed on a common set of objectives and plan of work.

This then was the genesis of the contract: "Poor Rural Households, Technical Change and Income Distribution in Developing Countries." The three universities owe much to US/AID. Not only did the agency fund the research, but members of the Technical Assistance Bureau had the vision and insight to amalgamate the effort.

Objectives of the Study

Although area-specific conditions and the interests of involved researchers indicated a slightly different emphasis, eight common objectives were agreed upon:

1) To compare and contrast production systems, use of time by household members, participation in the nonfarm labor market and the level of family income under the differing ecological and institutional environments prevailing at the selected study sites,

2) To analyze sources and variability in the income level of three classes of poor rural households: landowners, tenant farmers and landless workers,

3) To conduct an analysis of the rural labor market with respect to its efficiency, migration and the demand for and supply of labor,

4) To analyze barriers to increased participation of landless workers in the development process,

5) To analyze the constraints to adoption of new agricultural technology,

6) To develop models which test the impact of technical change in agriculture on output, income and employment of poor rural households,

7) To develop and test models which analyze the impact of national policies relating to international trade, taxation and agricultural price supports, and, finally

8) To identify policy and institutional changes which benefit and involve the rural poor in the development process.

The three research teams gave these objectives slightly different emphasis. However, in all settings there was a concerted effort to conduct research at the individual household and farm level. It is the reactions and adjustment decisions of individual households which influence the adoption of technology and functioning of the labor market. With this philosophy in mind, primary data were collected at the farm level in all study regions. Research teams concentrated on the poorest segment of rural families. Here, "poor" is defined as a household with an annual income from farm and nonfarm sources totaling approximately $100 (US).

The study sites were purposefully selected to encompass a wide range of environmental conditions, size of land holdings and levels of agricultural technology. In West Africa, two study locales were selected: Kano State in northern Nigeria and Sierra Leone. West Africa may be characterized as having relatively low labor-land ratios. Production is organized around family farms of two to three hectares. In sharp contrast to Southeast Asia and Brazil, landlessness and sharecropping were not major problems. It was assumed that adoption of agricultural technology would be lower in West Africa than in Brazil or Asia. The two West African study sites exhibited considerable variability in climate, particularly the level and seasonal distribution of rainfall. The Nigerian site is typical of the semiarid savannah. The dominant subsistance crops are millet and sorghum while groundnuts are the most important cash crop. The sampled study areas of Sierra Leone had medium to high levels of rainfall with rainfed rice the most important

crop. The Sierra Leone case represented a considerably more land-extensive, bush-fallow system of cultivation compared with continuous cultivation in Nigeria.

In Southeast Asia, four study locations were identified. In the Philippines paddy rice production prevailed, and because of the influence of the International Rice Research Institute it was assumed that a high proportion of farmers would have adopted modern varieties of rice and a significant level of fertilizer and other agricultural chemicals. In Indonesia a Javanese village was selected as typical of very small land holdings, a high level of landlessness and virtually complete dependence on traditional paddy-rice technology. A region of India was identified as having mixed farming with rice dominate. In this location a significant number of farmers either owned or hired tractors, offering an opportunity to study factors associated with mechanization. The fourth Asian site was in the middle hills of Nepal and contrasted sharply with the other areas because of its steep topography, lack of infrastructure, mixed farming and the moderate level of adopted technology that prevailed.

The Brazilian sites represented a wide spectrum of environmental conditions. Ceara was chosen because it typified the severe natural resource constraints of the northeast. The states of Sao Paulo and Minas Gerais were selected for their wide variations in climate, soil, farm size and access to off-farm employment opportunities. In all regions subsistance crops of corn and beans occupied a significant proportion of arable acetarage. Cash crops included coffee, tea, sugar, cotton and horticultural products. It is recognized that no sample can capture the myriad of conditions prevelent in the developing world. However, it was

decided that these sites did present enormous diversity in the forces which restrict the rural poor from full involvement in the development process.

This report is divided into five sections. The following three present major findings drawn from the work of each research team and they synthesize the results from West Africa, Asia and Brazil. The ordering of these sections is not arbitrary. Findings from West Africa are reviewed first since they provide a benchmark where land is a relatively abundant resource and agricultural technology and infrastructure are poorly developed. The Asian sites present a stark contrast. Many families have less than .2 of a hectare of land and a broad spectrum of improved rice technology is available. The Brazilian sites form an anchor. Here exists a considerable range in the factors bearing on rural poverty. However, they all fall within the same national context of policies and development objectives. We can then guage the determinant forces of rural poverty within the context of a single country. Each university research team has prepared a comprehensive monograph from which these summaries were abstracted. Interested readers are referred to these monographs for greater detail and references.[1/] The final section of this report is in essence a distillation of summaries. Here the most important findings are set forth with comparisons across study sites.

[1/] The three major summaries are fully referenced on page 195.

WEST AFRICA

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INTRODUCTION

The absolute income gap separating the rich and poor has widened substantially in all but a few developing countries during the past two decades. In spite of emerging national commitments toward more broadly based growth, efforts to reduce inequality have been hindered by insufficient knowledge of how to design policies which ensure broad participation, how to implement them and how to measure their impact. Underlying these policy questions is a general paucity of information on incomes, on the occupational and demographic characteristics of the poor and on how the poor respond to and are affected by alternative development policies.

Among the developing areas least is known about the size, distribution and structure of personal incomes in Africa. The available information tends to be highly aggregated and has been used primarily to estimate national averages and to compare administrative regions or industrial categories. Moreover, coverage is almost exclusively limited to the modern urban sector. The present study was designed to analyze rural incomes in the West African countries of Sierra Leone and Nigeria.

Four characteristics of the study areas importantly influenced the approach taken in this report. First, West Africa is generally characterized by relatively low man/land ratios and as a result, landlessness is uncommon. Since the rural poor are small farmers with typically

secure land tenure, programs of land redistribution or job creation to absorb landless workers have less relevance than in the Latin American or Asian settings.

Second, only minor technical change has occurred in the agricultural sectors of most West African countries. Thus there is typically very limited and highly localized experience on which to conduct a retrospective analysis of the impacts of technological change. On the other hand, because investment in physical and biological research in the area is now undergoing rapid expansion, there is an urgent need to identify the constraints limiting production among low-income farmers thereby contributing to the design of more appropriate interventions.

Third, with few exceptions, most West African countries are characterized by incomes and by institutional and infrastructural development generally below levels of developing nations in Latin America or Asia. The low level around which rural incomes vary points to the particularly limited impact which domestic income transfers might have in improving the living standards of the poor. Fourth, the information base on incomes at the rural household level in Africa is extremely limited.

Experience in countries which have witnessed the introduction of both biochemical and mechanical technologies has shown that the pattern of adoption can be affected critically by the existing distribution of resources and incomes. When successful adoption requires increased use of factors which are positively related to current income - such as human or physical capital - or when if access to modern inputs and to extension assistance is influenced by institutional factors similarly related to income, a concentrated traditional distribution can both retard

adoption and contribute to greater overall inequality (Ruttan, 1977). Therefore, an important assumption upon which this research was based is that if improved production systems are to be developed for the rural poor, then an improved understanding of the current distribution is essential.

The approach taken in this research has been first, to examine how interhousehold differences in resource endowment, resource use and resource productivity affect the distribution of personal incomes; and second, to identify causal factors underlying variation in resource endowment, use and productivity. Through an analysis of these relationships, household profiles at various levels of income have been constructed, including both structural and behavioral characteristics. Particular emphasis was placed on illuminating the circumstances of the poorest rural households.

Finally, it should be noted that by concentrating on production and incomes at the household level, the analysis has been limited generally to supply-side factors which affect personal incomes in rural areas. That is, prices and the underlying demand structure have been taken as givens. It is clear that with changes in the demand for rural products-either in international or domestic markets-dynamic price relationships can have a profound impact on the level of distribution of rural incomes over time. With the exception of an analysis of rural consumption patterns, these factors have not been explicitly considered.

Organization of the Study

The research was organized into four major parts:

1) The structure of incomes in Sierra Leone and in a selected

area of northern Nigeria was analyzed through a comparison of the levels, sources and distribution of income among rural households. Demographic variables were also examined to determine the effect of factors related to family size and composition on the incidence of low income,

2) Patterns of resource endowment and levels of resource use were examined to determine the relationship between the employment of conventional factors of production and incomes,

3) Causes of variation in factor returns were analyzed for both farm and nonfarm enterprises and among income strata. In particular, factors affecting the selection of enterprises as well as the effect of enterprise choice on household incomes were examined to determine the extent to which low-income producers may be constrained to activities of low returns. Variation in the productivity of farming systems was also analyzed to identify how circumstances peculiar to low-income households limit farm productivity and to derive implications for the development of technologies which are more appropriate for the rural poor, and

4) A range of currently available technologies in several farm and nonfarm enterprises was analyzed to determine the likely impacts of development policies which pursue equitable growth through the promotion of labo -intensive modes of production. Of particular interest in that analysis was whether policies affecting choice of technique were likely to be effective in improving the incomes of rural households now in poverty.

The Study Areas and Data

The data upon which this report is based were collected at the microlevel from rural household surveys conducted during 1974-75 in

both Sierra Leone and Nigeria. Both surveys employed a cost-route technique in which selected households were regularly visited at frequent intervals for a period of 12 months. The Sierra Leone survey involved more than 500 households selected from throughout that country. The Nigerian survey included 140 households living in Kano State in northern Nigeria.

The two study areas displayed similarities in several important respects. Production was organized around the family farm and practiced at nearly the same scale (average 2-3 hectares) and at low levels of technology. Landlessness among rural households was not a problem in either area. Minimal, highly localized mechanical and animal traction use was present (4 percent of sample in Sierra Leone, less than 1 percent in Nigeria) and no substantially improved seed varieties were available. While chemical fertilizer use was greater in the Nigerian case (40 percent of households applied fertilizer compared with only 3 percent in Sierra Leone), application rates were extremely low in both regions.

The institutional environments of the study areas were also generally similar. Traditional village leadership remained dominant but without a stable intergenerational class structure based on income or wealth. Land tenure institutions in both areas were relatively egalitarian with the communal assignment of usufructuary rights considerably more important than the direct ownership of land. Labor markets were somewhat better developed than land markets, although in each case the majority of farm labor was still provided by household members (85 percent in Sierra Leone and 60 percent in Nigeria).

The ecology, degree of pressure on the land and farming systems, however, offered important contrasts. The Sierra Leone case represented a considerably more land-extensive, bush-fallow system, compared with the continuous cultivation practiced in the higher density Nigerian area (population density was about 27 persons/km^2 in rural Sierra Leone compared with 50/km^2 in the Nigerian study area). Moreover, the Sierra Leone study encompassed a range of medium and high rainfall zones (2000-4600 mm per year) generally characteristic of the coastal areas of West Africa, whereas the Nigerian area represented the low rainfall regime (880 mm per year) of the semiarid savannah. Selection of crop enterprises varied accordingly; rice cultivation formed the basis of most farming systems throughout Sierra Leone, in addition to localized tree crop production. In contrast, the subsistence crops, millet and sorghum, and the cash crop, groundnuts, dominated production in northern Nigeria.

The Levels and Sources of Rural Incomes

Mean per capita incomes in both countries were barely above a minimum subsistence level, $103 in Sierra Leone and $93 in Nigeria (Eponou, 1979; Matlon, 1979).[1/] Sources of income for rural households

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[1/] Figures are US dollars, 1975 exchange rates: Leone 1 = $1.10 and Niara 1 = $1.64. Rural incomes were computed as the annual return to household land, labor, and management generated by all members of the household in all occupations. Average annual prices computed regionally from market transactions were used to value all inputs and outputs, regardless of final disposition. Loan and gift flows were not included in household earnings. Also excluded were unrealized capital gains which arose from the appreciation of assets during the survey period.

were also generally similar reflecting primary dependence on cropping enterprises, but with substantial components also generated in off-farm employment. Eighty-one percent of income in Sierra Leone was derived from cropping activities compared to 71 percent in Nigeria. The latter figure reflects the longer dry season and generally less favorable farming conditions in the Nigerian area.

Among the nonfarm activities, fishing provided approximately 8 percent of total income in Sierra Leone followed by small-scale industries at 6 percent and off-farm wage labor employment at 5 percent. Livestock and trading activities provided an insignificant proportion of rural incomes in the sample.[2/] In contrast, trading and wage labor employment were substantially more important in Nigeria, each providing 10 percent of total incomes, followed by small-scale industries at 6 percent. Livestock and fishing were not significant contributors to income among the Nigerian sample.[3/]

The data showed substantial interregional differences in both the levels and sources of income in Sierra Leone reflecting the wide ecological variation which characterized the country. Incomes were lowest and the dependence on off-farm enterprises highest in the less humid northern areas. In both respects, income profiles in Nigeria were

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[2/] Households which were engaged in trading as a primary occupation were systematically excluded from the Sierra Leone survey, thus understating the importance of this income source in the rural sector.

[3/] Only settled farmers were included in Nigerian sample frame. Nomadic herders, such as the Fulani, who derive a dominant proportion of their income from livestock-related activities were excluded in the sampling procedure.

most simila to those recorded in Sierra Leone's north, a reflection of somewhat similar rainfall patterns. Within Sierra Leone, mean regional per capita income figures varied from Le 60 in the Northern Plateau area to Le 112 in the riverine grasslands.

The composition of farming activities also showed important regional variation in Sierra Leone with tree crops (coffee, cocoa and oil palm) providing a substantially greater share of earnings in the relatively more affluent south and east (25 and 38 percent, respectively) compared with the north (7 percent) where upland rice and fundi dominated. Fishing showed the widest regional variation reflecting localized specialization derived from proximity to the coast and rivers.

An important finding of the locational analysis was that incomes within both Sierra Leone and Nigeria were significantly lower in villages with relatively higher population density. Returns to both land and labor in farming were lowest in high-density localities reflecting a history of more intensive use and declining fertility.

Inequality in Rural Incomes

In spite of substantial income differences among regions, the degree of overall rural income inequality reflected in the Sierra Leone data was in fact relatively low compared with available data in most non-African countries, and generally in line with estimates from other African countries (Jain, 1975).

Despite wide differences in mean incomes among regions, analysis revealed that the greatest proportion of rural income inequality nationally was contributed by disparities at the village level. Inequality at the village level, in fact, accounted for approximately 81

percent of total inequality, compared with only 19 percent due to intervillage differences. Moreover, at higher levels of geographic aggregation, income differences among resource regions contributed less than 8 percent to overall inequality. These results demonstrate that, while aggregate income disparities are somewhat wider over broader areas (reflecting variation in soils, climate, market and other locational factors) the widest disparities persist within the village unit. This suggests that policies directed at reducing national inequality through the regional reallocation of development investments will have negligible impact unless causes of intravillage disparities are effectively dealt with as well.

It was particularly significant that in both countries inequality at the village level was directly associated with population pressure and with improved road access. Although the mechanisms producing this result were not entirely clear, the data suggested that an improved transport infrastructure and a more concentrated population resulted in greater integration into the market economy with consequent changes in the structure of demand. This in turn created increasing opportunities for nonfarm and cash-cropping enterprises which could be most effectively exploited by higher income households with greater investment capacity.

To determine how the various sources of income contributed to overall income inequality, the contribution of each household sector to aggregate incomes was examined by stratum in both Sierra Leone and Nigeria. It was found that regional factors played a crucial role in determining the correlation between occupational emphasis and income status. In the two relatively high income and ecologically favored portions of Sierra Leone, the south and east, the proportion of income

derived from both annual and tree crops increased directly with income (increasing from 79 to 83 percent in the south, and from 75 to 91 percent in the east - figures represent the poorest third and richest third of the households, respectively). In contrast, in the less humid north where farming opportunities were generally more limited, farm derived incomes fell from 82 to 73 percent, reflecting the shift of higher income households into more profitable nonfarm enterprises. In this respect, the Nigerian sample was more similar to the north of Sierra Leone, with farming income constituting approximately 77 percent of incomes in the lower three economic quintiles and falling to 72 and 61 percent in the fourth and fifth quintiles, respectively.

Not only did the proportion of the nonfarm incomes change systematically across strata within each region, but the types of nonfarm activities changed as well. The only consistent pattern across both Sierra Leone and in Nigeria, however, was the very strong decline in the importance of off-farm hired labor earnings as incomes increased. Otherwise the patterns again reflected localized opportunities peculiar to each region which could be most effectively exploited by higher income households. For example, fishing showed little correlation with income in the south and east of Sierra Leone where freshwater fishing required little capital input. Whereas for the more profitable and more capital-intensive saltwater fishing in the north, the percent of fishing incomes increased from 1 percent in the poorest third to 16 percent in the richest. Small-scale industry showed a positive association with income in the south and north but the reverse in the east. Finally, no patterns were evident for livestock or trade in Sierra Leone.

In the Nigerian case, only the proportion of trading income increased with income status (increasing from 3 percent in the poorest quintile to 18 percent in the richest). Moreover, an examination of the timing of cash flows in both crop marketing and noncrop trading activities showed that trading among higher income Nigerian households was made possible by the dry season reinvestment of surpluses generated in agriculture.

The net effect of nonfarm earnings on overall inequality was measured by comparing inequality indexes calculated for farm incomes alone (earnings derived from cropping enterprises) with those calculated on aggregate incomes. It was found that farm incomes alone were consistently more concentrated than total incomes in both countries. The reduction in inequality reflected a resolution of the conflicting effects of hired labor earnings compared with income obtained in other off-farm enterprises. Off-farm wage labor provided an important supplementary source of income for the poorest households in both countries, thereby reducing the degree of both absolute and relative poverty. Among higher income households, however, off-farm activities tended to widen disparities by providing opportunities for the reinvestment of agricultural surpluses. Moreover, this was most clearly evident in the less humid north of Sierra Leone and in Nigeria where the cropping season is shorter and where high return, capital-intensive farming opportunities were generally more limited.

The Incidence of Absolute Poverty

A meaningful appreciation of any given distribution of income requires combining information about relative inequality among recipients with knowledge of the absolute levels of income obtained by recipients in each stratum. In an effort to translate the distribution figures into terms more meaningful from a welfare perspective, poverty lines were defined which indicated minimum income levels at which household caloric requirements could be met. Three standards were estimated at varying levels of severity. The minimum standard was defined as that level of income equal to the value of an amount of the basic food staple (rice in Sierra Leone and millet/sorghum in Nigeria) just sufficient to supply required calories. An intermediate poverty line was defined as that level of income at which caloric needs would be met if the household's entire food budget were allocated to the food staple. The highest standard was set at that income level which would just satisfy caloric needs if the food budget share of the poorest decile were allocated to the average diet in each area.

The results of the analysis revealed a surprisingly high incidence of impoverishment, particularly within Sierra Leone. Under the assumption that all income was expended on the local staple, it was found that 37 percent of the rural population could be classified as being in absolute poverty. Households located in the north were at greatest risk of falling into poverty, with 48 percent of persons sampled in that region below the lowest poverty line. Although the Nigerian income data reflected a substantially lower poverty incidence (10 percent below the lowest standard), substantial welfare problems for the poorest third of that sample were nevertheless clear.

Only the Nigerian data were in a form which permitted a direct examination of caloric intake by income strata. The analysis revealed that although on average the sample households consumed nearly 11 percent more calories than the minimum required level, there was considerable inequality across income strata. Among households in the first and second deciles, for example, domestic food crop production fell below requirements by approximately 70 percent and 50 percent, respectively. Domestic food production met consumption requirements only among households in the highest two deciles. These results reflect an unexpectedly high degree of dependence on the market in meeting subsistence needs among the majority of households. Moreover, after netting out sales and adding food purchases and gift transfers, the first and second deciles still experienced calorie deficits of approximately 25 percent and 15 percent. Substantial caloric surpluses in the form of retained food stocks were calculated only in the ninth and tenth deciles indicating that the bulk of grains sold to calorie-deficit families during the preharvest hunger period would be supplied by high-income households.

In short, although rural incomes were not highly concentrated in either case study, because of low overall levels, the income figures revealed a serious degree of impoverishment among the poorest 20 to 40 percent of the rural population.

Labor Migration and the National Income Distribution

Because migration offers a means for poor rural households to earn higher incomes in other rural or urban areas, it can serve as an income equilibrating mechanism between sectors and regions. On the other hand, since migration is closely associated with flows of both human and

financial capital, less certain secondary impacts on inequality may also occur. Data derived from a special survey of migrants in Sierra Leone were examined in an effort to determine some of the implications of migration on income disparities within rural areas and on the distribution of income between rural and urban areas (Byerlee et al., 1976).

Examining rural-rural migration first, the data showed that flows tended to follow wage-rate differentials far more closely than interregional differences in income per capita. That is, migrants tended to migrate out of rural areas where wages were low into rural areas with significantly higher wages, while no consistent pattern was evident regarding mean income differentials between origin and destination regions. In large part this arose because average regional incomes hid substantial distributional differences. For example, although the major out-migration area and the major in-migration area had similar average incomes, they were characterized by the most unequal distributions in the country.

The net effect of rural-rural migration on aggregate rural inequality was not clear. However, it was unlikely that rural income disparities had been significantly reduced as a result of labor movements. For example, the data showed that the age, sex and educational characteristics of migrants between rural areas were generally similar to those of the rural population as a whole. That is, no compositional differences were observed which would tend to change the mean income or distribution of income within either destination or origin areas. Although migration between rural areas was highly responsive to wage differentials,[4/] and as

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[4/] The elasticities of rural-rural migration were -2.7 and 2.5 with respect to mean origin area wages and to destination area wages, respectively.

such may have tended to reduce interregional income variation among hired laborers, due to the relatively modest participation of rural households in labor markets, the impact on more general income differences between regions was probably quite small.

The data on rural-urban migration pointed to two distinct migrant streams: those migrants who were largely uneducated leaving for reasons of poverty, and those who had received some education and were seeking urban jobs to reap the returns from this education. Rural-urban flows of uneducated migrants were found to follow wage rate differentials, more closely reflecting close linkage between rural and urban informal labor markets. Wage rates in the small-scale urban sector, for example, were not much higher than in the highest wage rural region. The effect of wage differentials on movements of educated rural-urban migrants was less clear. In general, because of more limited opportunities for educated laborers in rural areas, wage rates in destination areas were considerably more important than origin wages in determining the direction of movement as compared with uneducated migrants.

Finally, the impact of rural-urban migration on the national income distribution was also best seen by separating the individual effects of these two migrant streams. Uneducated migrants tended to originate in households with incomes generally below those of nonmigrants. A few who were unemployed in urban areas did experience hardship but a substantial number migrated back to rural areas when they were unsuccessful in finding urban employment. Thus, it was likely that this stream probably reduced rural income disparities and disparities between rural and urban areas, while substantially increasing inequality within urban areas.

The second stream of migrants, those with education, had quite different characteristics. This group tended to originate in higher income rural households and regions and to migrate more successfully to urban areas with very little return migration. In this sense, they reflected an important outflow of human capital from the rural sector. While there was generally a period occupied by job search, support from urban friends and relatives reduced the hardship. Furthermore, the average urban earnings of educated migrants was over twice the earnings opportunities in rural areas. Although some of their earnings were remitted to rural areas, the magnitude of these flows - only about 5 percent on average of urban earnings[5/] - was generally too small to importantly affect rural incomes. This type of migration, then, also tended to reduce disparities within the rural sector, while contributing to a widened gap between rural and urban areas.

Causes of Income Variation

A range of income determinants was examined in an effort to identify the key factors causing the incidence of low rural incomes. No single factor alone explained the major part of income variation. Rather, a set of interdependent factors - including the demographic composition of the household, land use, levels of employment, enterprise selection, factor productivity and location - affected the income status of particular households. In short, the analysis showed that even the poorest households could not be accurately represented by a single farm type.

[5/] Net remittance averaged Le 1.20 per month for all employed migrants.

Household Size and Cycle

It was hypothesized that in a rural economy characterized by a high ratio of arable land to population and by traditional hand-tool production techniques, the size and composition of the household would importantly affect the income level of household members. Within a land surplus environment, farmed area and hence gross farm income is likely to be closely determined by the number of household workers. It follows that income per consumer may be importantly determined by the ratio of workers to consumers; that is, by the household dependency ratio.

A number of writers have suggested that these relationships are systematically interrelated with the demographic life cycle of family formation, growth and decline (Chayanov, 1966; Rodgers, 1978). If most households pass through such stages, then valid normative judgements regarding the personal distribution of income and the design of prescriptive measures to affect that distribution must take into account the contribution of such factors to current income disparities (Kuznets, 1976).

The available data allowed a partial test of the life-cycle hypothesis. The analysis showed that in both Sierra Leone and Nigeria increased family size was significantly associated with declining per capita incomes. The data further suggested that this was largely the result of an increasing dependency ratio associated with household growth. While cultivated land per consumer declined among larger households, this was due primarily to the smaller proportion of workers in larger households. This was reflected in the fact that the ratio of land per worker remained nearly constant across household sizes. In

short, systematic changes in family composition, and not in access to land, was the underlying factor contributing to the lower incomes of larger households. Furthermore, it is important to note that these patterns were strongest in the Sierra Leone situation characterized by lower man/land ratios and less use of hired labor. This suggests that family structure may be of declining importance as a determinant of income in regions of greater population pressure where participation in off-farm labor markets is greater.

A detailed analysis of the Nigerian data also showed that the strength and timing of a life-cycle income pattern were importantly affected by the household's organizational structure (nuclear or extended). Among nuclear units, the highest incomes were realized by smaller families in relatively early stages of development. As nuclear units expanded, a consistent decline in income occurred with a particularly sharp reduction for large units with heads 50 years or older.[6/] The decline in incomes for extended families occurred later with respect to the age of the head, with the most rapid decline occurring in units characterized by an extremely unfavorable dependency burden and headed by persons aged 60 or greater.

Three sets of households were significantly overrepresented among the poorest 30 percent of households in the Nigerian study: (1) families headed by persons aged 60 years or greater, (2) those headed by persons

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[6/] An exception was families with heads less than 24 years of age for whom incomes were low in spite of favorable family composition and land availability. This group was probably characterized by lack of capital and inexperience resulting in poorer management skills.

less than 25 years d, and (3) nuclear households characterized by greater than average size. As a group, these three types comprised only 18 percent of the sample, but involved 47 percent of all households included in the poorest three deciles.

Although the number of exceptions to these patterns show that life-cycle factors accounted for only part of overall inequality, these results have three important implications. First, they indicate that a proportion of poverty among traditional small farmers in land-surplus areas may be associated with factors internal to the family. Only income transfers or production interventions which reduce labor requirements would be effective in alleviating this type of poverty. Second, since households currently in poverty due to demographic factors represent stages through which most families pass in the course of normal development, if a longer-term income concept were applied, it is likely that income distribution would appear to be less inequitable than that observed. And third, with evidence of the declining popularity of extended family units in West Africa in general, these results imply a tendency toward greater risk of impoverishment among the elderly.

Land Use

Many rural income studies conducted in developing countries have found that access to land is the single most important determinant of incomes. Indeed, in the absence of income data, size of land holding is commonly employed as a proxy variable to stratify households into income or welfare class. But while the land proxy may have considerable intuitive appeal in a land-short environment, or where land tenure institutions

result in restricted access to land, its relevance to the more land abundant environment of West Africa was challenged by the results of this study.

Analysis of land use and income patterns in both Sierra Leone and Nigeria showed that while there was a tendency for higher income households to farm larger areas per capita, the relationship was not strong. An examination of regional coefficients revealed that the strength of the correlation between income and land was higher in areas of greater population pressure.

The weakness of using a land proxy alone as a means of identifying poverty households was demonstrated by examining the incomes of households included in the smallest land classes. Among the national sample in Sierra Leone, for example, approximately 30 percent of the households included in the highest decile farmed land holdings amounting to less than .4 hectare per capita, and nearly 20 percent of these richest households farmed less than .2 hectare per capita. In comparison, within the overall sample, approximately 50 percent of households cultivated less than .4 hectare per capita, and 24 percent farmed less than .2 hectare per capita. The most striking results were evident in the north and south where 30 percent and 19 percent of the tenth decile farmers were in the lowest land strata, respectively. Both proportions were comparable to the regional distributions.

An important factor underlying these results was income earned in nonfarm enterprises and its generally inverse relationship with land. For example, among the 20 percent of the tenth decile households who farmed less than .2 hectare per capita, nearly 70 percent of income was earned in nonfarm occupations. Similar results were reflected in the Nigerian data.

Finally, an analysis of land tenure relationships in Sierra Leone revealed only the beginnings of a land market. Moreover, no mechanisms were apparent which would have operated to the systematic disadvantage of smaller or lower income farmers. In contrast, the market for land was substantially more developed in northern Nigeria and some potentially discriminating mechanisms were observed. In particular, the practice of pledging land as collateral for loans did suggest a means by which land could be systematically transferred from low to high income households over time.

In short, the available evidence did not suggest that limited land use alone explained a substantial proportion of either income variation or the incidence of low incomes. While the correlation between land use and income was highest in areas characterized by greater population pressure, even in those areas the continued availability of land through traditional communal land tenure systems combined with access to nonfarm employment reduced the income effect of the land constraint. However, a comparison of the Sierra Leone and Nigeria results as well as patterns within Sierra Leone, suggested that with increasing population pressure and further commercialization of the land market, access to land may well become an increasingly important determinant of income and a possible source of increased inequality.

Labor Use

Employment in both countries followed distinctly seasonal patterns reflecting the annual distribution of rainfall. Annual employment levels for all activities were substantially higher in Sierra Leone (1,500 hours per adult male) than in Nigeria (700 hours). This difference

was due to two factors. First, the cropping season extends for roughly 170 days in Sierra Leone compared to only 120 days in Nigeria. Second, the bush-fallow, rice-cultivation system practiced in Sierra Leone requires considerably more labor per unit of land than does the continuous cultivation of sorghum, millet and groundnuts practiced in Nigeria.

An analysis of labor profiles in Sierra Leone revealed that hours of recorded labor were highest among both men and women in the drier and poorer north, and lowest in the more humid east. This reflects the substantially higher levels of farm labor which occurred in the north during the June to August labor bottleneck period. The data also showed that non agricultural employment was relatively and absolutely more important in the south for both men and women, but showed the widest seasonal variation in the north. Finally, hired labor employment was least important in the east where it provided less than 5 percent of total employment for males, compared with approximately 13 percent in both the north and south.

In view of these structural differences in employment among regions, it was not surprising that few consistent patterns emerged when examining labor profiles across regional income strata. For example, while the lowest levels of annual employment occurred among poor males in the north and south with the greatest hours recorded for high income males in those regions, in the east, employment levels were in fact lowest for high income males and highest for males in middle income households. The changing composition of employment across income strata also reflected patterns peculiar to each region. Although hours of hired labor

showed the expected though weak inverse relationship with income status in the poorer north and in the east, a direct relationship was evident in the south.

Similar analysis of labor data in Nigeria revealed that employment levels were highest among middle income males. A particularly important finding was that when only labor on own fields was considered, low income farmers worked the least hours, less than 70 hours per month even during the months of peak farm activities.

As in Sierra Leone, the causes of low on-farm employment among the poorest households were not clear but probably reflected the combined effects of three factors. First, the calorie shortage experienced by the poorest households may have importantly limited the potential energy output of low-income workers, particularly during the immediate pre harvest period which coincides with peak labor demand. Second, although poor farmers expended the least hours per unit area, declining returns to labor set in at an earlier point in their farm production functions. And third, in order to generate an immediate cash inflow, low-income males allocated a substantial proportion of their labor time to off-farm activities. For example, on an annual basis low-income males in the Nigeria study spent 34 percent of their total work time in off-farm activities, compared to only 14 percent among males in each higher income stratum. And during the peak farming months when their cash and food reserves were at a minimum, low-income males allocated 22 percent of their work time off the farm. This compared to less than 5 percent among adult males in higher income households.

In view of the low overall employment levels, it might be argued that labor time as such was not a significant constraint limiting incomes among poor farmers, particularly in Nigeria. However, since time engaged in job search activities and in travel to and from off-farm employment were not accounted for in either survey, if such activities were substantially time consuming the available labor time for low-income workers may have been considerably less than was implied in these figures. Furthermore, the competition between farm and off-farm work consisted not only of restrictions on the total hours available for own farm work, but also when such work could be done. To secure regular wage employment it was necessary that laborers be available when requested, thus interrupting or postponing operations on their own fields. The effect that work discontinuity may have had on the farming productivity of lower income households appeared to be considerable.

Capital Use

Typical of much of West Africa, the farming systems observed in both Sierra Leone and Nigeria generally embodied traditional hand-tool technologies. As a result average capital use levels were extremely low. With the exception of a small number of mechanized farmers in the Bolilands (7 observations) and riverine grasslands (14) in Sierra Leone, the use of capital equipment to substitute for labor in farming was extremely limited. The stock value of farm tools per household averaged approximately Le 21 for all Sierra Leone farmers, representing an average annualized cost of less than Le 4. The stock value of farm tools in Nigeria was even lower at about N 9 representing an annualized cost of less than N 2.

An analysis of capital costs across income strata showed that although higher income households held somewhat greater stocks of farm equipment, the association with income status was not strong. Moreover, because most households were hand-tool cultivators, the relatively minor variation largely reflected differences in the size of inventories and age of tools rather than in the types of capital employed. Variable farm costs showed a weak positive correlation with income status in Sierra Leone whereas a considerably stronger relationship was evident in Nigeria, reflecting greater labor hiring among higher income households. Finally, the data also revealed that the use of both fixed and operating capital in nonfarm enterprises was substantially greater among higher income households in the north of Sierra Leone and in Nigeria. In Nigeria this represented participation in highly profitable dry-season trading activities, whereas in Sierra Leone these generally reflected expenses incurred in saltwater fishing. The observed variation in capital use with income status reflected primarily the effect of two factors - differences among income strata in enterprise selection, and in scale of operations - both of which were influenced in part by access to capital. Although it is not possible to infer from an examination of use levels alone whether capital shortage posed an important constraint to incomes, the data do suggest that capital availability may have been most closely related to higher incomes through investment in nonfarm enterprises rather than in farming. Moreover, this was most evident in Nigeria, an area where greater population density, lower rainfall and a more extended dry season created more limited farming opportunities.

Rural Farm and Nonfarm Production Systems

Enterprise Combinations

Rural households in both Sierra Leone and Nigeria generally engaged in a wide range of farm and nonfarm enterprises. This represented a diversification strategy to minimize the risk of crop failure, a means to spread the demand for labor more evenly throughout the year, as well as an attempt to vary the domestically produced diet. Depending on the cost and returns characteristics of individual enterprises, the mix of enterprises could importantly influence aggregate household incomes.

Enterprise combinations were analyzed to test two hypotheses central to an understanding of income distribution (Franzel, 1979). First, in view of the wide interregional income disparities observed in Sierra Leone, conditions in the less humid and poorer north from restricted households were tested in order to examine a distinct set of low returns enterprises. A second hypothesis is based on the preceding results which showed that capital use tended to be positively related to the household's income status. This was tested whether or not higher income households engaged in more capital intensive enterprises which generated higher returns to labor thereby contributing to existing disparities.

The effect of enterprise choice in explaining income disparities among regions and income strata was formally tested by means of expected-returns analysis. Through this approach it was possible to identify variation in factor returns among households based solely on the choice of enterprise while controlling for interhousehold productivity differences within each enterprise. Highly significant variation in expected returns to labor was found among regions when considering farm enterprises

alone with returns highest in the south and lowest in the north. These results indicated that ecological conditions significantly affected aggregate profitability through the types of crops grown thereby explaining in part the lower incomes of northern households.

A similar analysis conducted to determine the effect of enterprise selection on factor returns across income strata revealed no significant variation among cropping enterprises. However, with the addition of nonfarm activities, analysis showed that lower income households tended to pursue a significantly less profitable enterprise mix than middle and high income households. The margin in expected returns to labor between low and high income households was particularly wide, 53 percent, with the addition of nonfarm enterprises.

The enterprise mix of the poorest rural households in Sierra Leone, those included in the first decile, was particularly interesting. Five activities ranking lowest among 17 enterprises in returns to labor--upland rice, fundi (digitaria exilis), groundnuts, an onion-pepper-tomato mixture, and hired wage labor--provided 61 percent of the income of the poorest households. This compared with 41 percent for the overall sample and only 29 percent among households in the highest decile.

Nearly identical results were obtained in a similar analysis of the Nigerian data (Matlon, 1979). Although no significant differences were observed with respect to factor returns implicit in the crop mixes among income strata, returns to labor in off-farm enterprise mixes showed a high positive correlation with income status.

In an effort to determine factors associated with enterprise selection, and in particular to explain differences in enterprise mix

among income strata, relative factor requirements were examined. It was found that farm and nonfarm enterprises associated with high capital/labor ratios also tended to realize higher returns to labor. The relationship between capital use and enterprise emphasis among income strata, however, was less clear. Applying a procedure analogous to the expected returns analysis, no significant variation was observed in either the fixed or variable costs per hour implied in the crop mixes of various income strata in Sierra Leone. Since this was true both nationally and within each region, it was concluded that capital was probably not an important factor influencing the observed selection of generally traditional farm enterprises. With the addition of nonfarm enterprises, however, a strong and highly significant positive relationship was found between the value of capital stocks and annual user costs per labor hour and income status. These results suggest that the magnitude of initial fixed capital costs posed an effective entry barrier preventing lower income households from engaging in high return nonfarm activities.

An analysis of the Nigerian data showed similar results regarding nonfarm enterprises with the exception that variable costs in the form of cash expenditures appeared to be the more excluding factor than fixed costs. Variable costs also tended to influence the selection of crop enterprises in the Nigerian case. Indeed a peculiar relationship between factor returns and variable cost requirements for cash crops and food crops created a situation in which the lowest income households gave disproportionate emphasis to groundnut production at the expense of the food staples, millet and sorghum. By diverting their land and labor from the food staples, which were characterized by low variable costs

but also low returns, to groundnut, a high return cash crop requiring relatively low variable costs, lower income households were able to purchase a greater amount of calories in the market than they could have produced on their own land. However, this strategy, imposed on the poorest households by economic necessity, also placed them in a clear position of dependence on higher income surplus grain producers in meeting their subsistence requirements.

Productivity Variation Among Income Strata

Having determined that lower income households tended to emphasize less profitable enterprise combinations, due in part to capital limitations, the next step was to examine productivity variation within enterprises. Although only limited technical change has occurred in rural Sierra Leone and northern Nigeria, an important degree of productivity variation was observed within the traditional farming systems, variation which was a function of both ecological and management factors.

The Sierra Leone and Nigerian data sets differed significantly in the extent to which they could be used to explain productivity variation for specific enterprises. While the Sierra Leone farm survey captured a wide range of ecological conditions, that survey did not attempt to identify differences in cultural practices. In contrast, more detailed information on management practices was obtained in the Nigerian survey within a single, generally homogeneous ecological zone.

Rice Production in Sierra Leone

Only two enterprises in Sierra Leone, upland rice and inland swamp rice, had a sufficient number of observations to permit farm budget analysis by regional income strata. In terms of land use, these were

the two most important crop enterprises representing approximately 62 percent and 6 percent of total farmed area, respectively.

Examining costs and returns to upland rice, two important patterns were observed. First, yields were consistently lowest on the fields of the poorest households and highest on those of the richest households. For example, in the north where income inequality was highest, average yields for third tercile farmers were more than 140 percent greater than yields of first tercile farmers (1,192 vs. 489 kg/ha); in the south this margin was 70 percent (979 vs. 581 kg/ha); and in the east it was 30 percent (1,029 vs. 778 kg/ha). But second, data on production costs failed to explain these production differentials. The intensity of land use, as reflected in both labor inputs and in variable costs per hectare, did not vary consistently among income strata. As a result, differences in returns to household labor and management among income strata were substantial. Thus again comparing extreme terciles, returns per hour of family labor varied in the north between 3.0 and 10.7 cents per hour; in the south these figures were 2.5 and 13.0 cents per hour; and in the east 7.9 and 15.5 cents per hour.

The budget analysis of inland swamp rice production revealed even more interesting results. As with upland rice, substantial yield differentials among income strata were again evident, with yields consistently lowest on the fields of the poorest households. But in contrast to upland rice, most indicators of land use intensity were in fact highest among the poorest producers. Thus in the north, farmers in the poorest tercile expended on average 2,680 hours per hectare compared to 1,640 hours among the richest tercile; in the south these figures were 1,730

and 1,000 hours, respectively; and in the east, 2940 and 1,710 hours. Similarly, although fertilizer use was observed only in the north, use rates showed an unexpected strong inverse correlation with income. As a consequence, returns to all factors reflected consistently wide differentials between low and high income households.

In short, the budget analyses suggested that differences in intensity of factor use and in production technology did not explain the observed returns patterns across income strata. Further analysis permitted a partial test of the effect of soil quality variation associated with location. Although labor/land ratios were generally low throughout most of Sierra Leone, with recent population growth, pockets of high population density have begun to emerge. It would be expected that as population pressure increases, fallow periods would decrease. In the absence of significant fertilization, this would lead to a decline in soil fertility and productivity.

To test this relationship, sample households were divided into two groups on the basis of location in either high density (greater than 40 persons/km^2) or low density (less than 40) enumeration areas. As expected returns to both land and labor in upland rice production were substantially lower in high density areas, with the widest differences recorded in the north. Within that region returns to land in high density villages were less than 30 percent of levels achieved in low density areas, and returns to family labor were only 50 percent of those in low density areas. The causes of these productivity differences, however, were not clear. Although when comparisons were made nationally and in the south, fallow periods tended to be shorter in high density villages, the magnitudes of the differences were not significant.

Moreover, in the north where productivity differentials were widest, contrary and significant fallowing differentials were observed. What the data may have reflected were differentials in land use intensity which occurred during periods previous to the years covered in the scope of the survey. If this is correct, it points to a chronic future decline in both farm productivity and incomes as rural populations continue to grow (given existing technologies).

Farm Production Systems in Nigeria

Farm budget analysis for Nigerian farmers showed results similar to the Sierra Leone findings. Each measure of productivity - the value of output per hectare gross margins per hectare, and returns to household, labor, management, and capital - indicated a strong direct relationship between productivity and household income status. However, in contrast to the Sierra Leone results, higher income households tended to farm their fields more intensively with respect to both fertilizer and labor. Although fertilizer use was generally low overall, high income farmers, on average, applied 27 percent more fertilizer per hectare than low income households. They also used 21 percent more labor, primarily through hired workers. In comparison, the differential in value of production per hectare between extreme income classes was 49 percent.

These relative differences indicate that unless there existed increasing returns to fertilizer and labor, variation in the use of conventional inputs alone did not explain the substantial production gradient. Production function analysis was conducted to examine the contribution of each factor to output variation. To determine whether

production relationships differed structurally among income strata, separate Cobb-Douglas functions were fitted to data from each class.[7/]

Two results of the production function analysis were particularly important. First, whereas factor MVPs for both land and labor generally increased with income status, fertilizer showed the opposite relationship. This implies that a fertilizer program which concentrated distribution to lower income households would satisfy both equity and output objectives. Second, in spite of the fact that higher income households used substantially more labor per hectare, the estimated MVP to labor on fertilized fields also increased with income status. Since each equation exhibited diminishing returns to labor, this implied that structural differences distinguished the production relationships of the three income classes.

A Chow test for structural differences in the production functions of the various income strata found that the null hypothesis of structural similarity across income classes could be rejected at the two percent level of significance. These results mean that there were fundamental differences among income strata either in the quality of factors applied or in the techniques of production which were not adequately captured through conventional production function analysis. The possible nature of these structural differences was further examined by means of technical efficiency analysis.

[7/] Constant elasticity of substitution production functions were also fit, but reduced goodness of fit compared to the Cobb-Douglas results. Moreover, in all cases the elasticities of substitution estimated from the CES functions were found to be not significantly different from unity.

Technical Efficiency in Nigerian Grain Production

Technical efficiency differentials can be defined as the variation in output across a set of firms using the same combination of inputs which is not caused by differences in technology or by random disturbances. These differentials can be depicted either as neutral displacement about an average production function (Mundlak, 1961) or by deviations from the most efficient envelope isoquant in factor space (Farrell, 1957; Timmer, 1970; Shapiro, 1977).

The approach taken in this study was to compare the relative deviation of field output values about their expected values as estimated by coefficients from an average production function (Matlon and Newman, 1979). The procedure was in three steps. First, a Cobb-Douglas production function was fit to a subset of upland fields characterized by a similar mixture of millet and sorghum. Second, using the estimated coefficients of that regression, expected production values were calculated for each field as a function of the levels of labor, land and fertilizer actually employed. Third, a technical efficiency index was calculated for each field representing the percent by which actual production deviated from the average level that would be expected given the levels of conventional inputs actually applied. The next phase of the analysis was directed by explaining technical efficiency as a function of several sets of factors both internal and external to the household.

An econometric analysis showed that 16 variables representing factor quality and management practices explained two-thirds of the variation in technical efficiency on these millet and sorghum fields. After controlling for all other factors, productivity was significantly lower where population density was greatest, a result consistent with the

Sierra Leone findings. Similarly, productivity was lower on fields held temporarily by the household through rental or pledging arrangements, reflecting lower levels of previous fertilizer application. Among the management variables examined, output was significantly reduced by delays in the mean planting date and in the mean date of first weeding. Finally, output was significantly increased by labor allocated to late season weeding and by intercropping.

Examining the distribution of these factors among income strata, it was found that a disproportionate number of the poorest households included in the efficiency analysis were located in the high density village and farmed rented fields. This indicates that lower income farmers may have been farming soils of lower current nutrient status. However, an important finding was that, with the exception of the degree of intercropping, poorer households followed management practices shown to reduce output - they planted later, delayed their first weeding and weeded less intensively late in the season.

Although it is plausible that each practice reflected poor management thereby explaining in part the low-income status of the poorest households, an alternative explanation was equally compelling - that poor households were constrained by low food and cash reserves and thus acted in part out of economic necessity. For example, lower income households short of both cash and seed would be expected to plant somewhat later to ensure the arrival of the rains thereby avoiding the risk of low germination and replanting. The liquidity position of the poor farmer also offers a possible rationale for suboptimal weeding. An analysis of cash flow patterns showed that lower income households experienced an acute cash

shortage during the months immediately preceding harvest. As a result, they were under considerable pressure to generate an inflow of cash in order to purchase grain during the weeding period (Matlon, 1978). The cash required to make these purchases was obtained primarily through off-farm labor. An examination of weekly labor profiles for that period suggested that the time allocated to off-farm employment by poor farmers may have competed with operations on their own fields.

Finally, the low liquidity position of the poorest households not only affected the labor allocation of their own members, but also their ability to obtain hired labor for timely execution of key tasks. Low-income households were at a clear disadvantage in obtaining hired labor for late weeding, employing 56 percent of the level of hired labor per hectare as middle-income households, and only 17 percent of the level of high-income households.

In summary, what emerged was a set of poverty-trap relationships through which factors caused by low incomes may have importantly constrained the management options of households already in poverty thus reducing their farm productivity. These results demonstrate that the level of personal income may affect the small farmer's ability to modify current farming systems in more pervasive ways than generally thought. In particular, income may directly affect the amount of farm labor available at key points in the cropping cycle as well as the willingness and ability to perform operations at optimal times. The implications of these findings for the development of appropriate technology are critical. For example, within the present Nigerian environment, improved technologies which require early planting, timely execution of key operations or

substantially increased labor during the immediate preharvest period would be expected to achieve lower increments to yields as well as lower rates of adoption among poorer households.

Choice of Technique and Income Distribution

Because technical change in the rural sectors of both Sierra Leone and Nigeria has been limited, the preceding analysis concentrated on generally traditional production systems which currently are in widespread use. Through an examination of supplemental firm data describing both modern and traditional production systems in several rural sectors of Sierra Leone, the analysis was broadened in an effort to determine the most likely distributional effects of government policies which influence the choice of production technique (Byerlee, et. al., 1979). The analysis included the following sectors: agriculture, agricultural processing, fishing and manufacturing.

In particular, a strategy which is commonly suggested as a means of reducing income disparities is the promotion of labor-intensive modes of production through pricing policies in factor and product markets. Within the Sierra Leone context, three issues were examined which are basic to this strategy: (1) whether a range of alternative techniques in fact existed through which pricing policies could affect factor demand, (2) whether the evidence on choice of technique in Sierra Leone implied a necessary conflict between the national objectives of employment generation and output, (3) whether there exists adequate consumer demand for products of labor intensive sectors - and especially whether such demand is elastic to changes in income, and (4) whether policies influencing choice of technique toward more labor-intensive processes would be likely to improve the incomes of rural households now in poverty.

The data revealed a wide range of technologies within each sector with substantial variation in capital-labor ratios and in production scale. An important finding in that analysis was that in each of the main economic sectors, small-scale and more labor-intensive processes were consistently associated with higher output-capital ratios; that is, they were more efficient users of capital. These results suggest that it is possible both to promote employment and to maximize output through the efficient use of capital using labor-intensive production techniques.

Factor Market Distortions

In an effort to identify prevailing factor price differentials between the small- and large-scale sectors of the economy, further analysis examined price relationships in capital and labor markets in Sierra Leone as well as distortions stemming from the existing tariff structure. The data revealed major dichotomies. Large-scale firms were favored in capital markets as a result of privileged access to formal credit sources which extended low cost, highly subsidized loans. In contrast, small-scale firms generally depended on their own finances, on loans from relatives and friends and on loans extended by traders on purchases, generally at interest rates several times higher than those charged in the formal market.

There was also systematic variation in wage rates for unskilled labor in Sierra Leone. For example, the wage rate for urban unskilled labor in large-scale firms was nearly double that in small-scale firms. Finally, under the import tariff structure which prevailed during 1974-75, small-scale firms paid substantially higher tariffs on imported inputs than did large-scale firms while receiving considerably less protection against competing imports.

The sensitivity of choice of technique to such market distortions was tested through a combination of linear programming and budget analysis. Within the agricultural sector, the profitability of tractor cultivation was found to be highly sensitive to the subsidy rate for tractor services (Spencer and Byerlee, 1977). For example, under factor prices representing an 85 percent subsidy for tractor services, mechanical cultivation reduced production costs by 10 percent when compared to hand cultivation. However, with the removal of these subsidies, the cost of production using mechanical cultivation was more than double that of hand cultivation. This was reflected in the optimization analysis by a switch from mechanical to hand cultivation when factor prices were changed to reflect the real cost of capital. Moreover, labor use was almost doubled when opportunity cost prices were used.

A linear programming approach was also used to analyze the choice of technique among rice processing firms in Sierra Leone (Spencer, et. al., 1976). The results indicated that if existing policies were continued - low cost of capital to large mills, overvalued foreign exchange and high rice prices - efficiency in the rice processing sector would dictate that all hand pounding should be eliminated in favor of small and large mills. The employment effect of this transition would be substantial, with over 40,000 full-time rural jobs lost. On the other hand, with factor prices reflecting opportunity costs, the amount of hand pounding was only slightly reduced from current levels and large mills were completely eliminated from the solution. Similar analysis in the fisheries sector showed that if large-scale firms operating trawlers were charged the same factor prices as small-scale firms, there

would be a substantial replacement of large-scale trawlers by small-scale firms (Linsenmeyer, 1976). Finally, analysis of the choice of technique in the small-scale manufacturing sector indicated that variation in the interest rate and tariffs generally did not have large effects except in baking and carpentry industries where there was greater variation in factor intensities among techniques (Liedholm and Chuta, 1976).

The Demand for Labor Intensive Commodities

An analysis of rural consumer demand showed that not only was there substantial demand for goods produced in the small-scale, labor-intensive sectors of Sierra Leone, but that it was highly income elastic (King and Byerlee, 1978). For example, 84 percent of marginal expenditures for all rural households were for goods produced through labor-intensive processes. Furthermore, although the income elasticity of demand tended to decline somewhat among higher income rural households, in general most such commodities were characterized by elasticities near unity. In short, the analysis confirmed that there was an adequate and expanding market to support the labor-intensive strategy on the demand side.

Importance of Alternative Techniques

In view of the range of available technologies and their demonstrated sensitivity to changes in factor and product prices, and given the relatively high income elasticity of demand for labor-intensive commodities a remaining issue was the extent to which removal of market distortions would reduce relative inequality while improving incomes of the poorest rural households. Such income effects depend on three properties of each technology: (1) enterprise profitability, (2) changes in the demand for nonhousehold labor, and (3) the magnitude of fixed and

variable costs relative to the investment capacity of low-income families. The latter two aspects critically determine in what manner and to what extent low-income households could be expected to participate in the expansion of small-scale, labor-intensive enterprises. An examination of firm data representing a range of technologies in both agricultural and nonagricultural sectors provided evidence on each point.

The potential of the labor-intensive strategy and its distributional effects vary importantly by sector. Within agriculture the only improved technique of production examined which increased the demand for labor - an improved inland swamp rice package - was not sufficiently profitable to warrent general adoption. In contrast, mechanized cultivation would probably reduce aggregate demand for hired labor. Similarly, in the rice processing sector traditional techniques were generally superior to large-scale, capital-intensive processes both in terms of employment and profitability, particularly when factors were priced at their respective opportunity costs. Within both of these sectors, then, it was clear that the removal of factor market distortions would help prevent the reductions in employment and incomes for the poorest rural households which were likely to occur with the spread of available modern techniques.

Analysis of choice of technique in the fishing and small-scale industry sectors produced more problematic results. Although labor-intensive firms were economically more efficient within both sectors, the distributional effects of improving price relationships for such firms were mixed. Entry costs associated with even the most labor-intensive firms were substantial compared with the investment capacity

of lower income rural households. Moreover, employment per firm was not only small, but limited almost entirely to family members thereby restricting gains to owner/operators.

Within both the fishing and small-scale industry sectors, the removal of distortions in factor and product markets would probably be beneficial both from the point of view of national output and as a means of reducing rural-urban disparities and disparities within urban areas. However, unless access to loan capital was substantially increased for poor households, or unless entry costs substantially decreased, the benefits from such policy adjustments would be concentrated among middle and particularly high-income rural households. Thus rather than reducing rural inequality, it is likely that the strategy would increase relative inequality within rural areas while leaving the incidence of absolute poverty largely unaffected.

Implications for Policy

Multiple Causes of Poverty

Formulating development and income policies which have general relevance to a broad spectrum of the rural poor has proven extremely elusive in most developing countries. Because rural populations tend to be highly dispersed geographically, often working within widely different ecological, institutional and market conditions, it has been difficult to design policy instruments which affect more than a small proportion of the rural poor.

The results from this study further emphasize the limited potential of individual policy instruments in reducing rural poverty. One of the more important findings of the present analysis was that no single factor explained the major part of poverty incidence. Rather, a set of factors including the demographic composition of the household, land use, levels of employment, enterprise selection, factor productivity and location each contributed in various degrees to the income status of particular households. The diverse and interdependent set of causes underlying rural poverty makes it especially difficult to prescribe individual policy interventions which would be effective in reducing rural poverty. Finally, the finding that life-cycle factors contribute importantly to poverty incidence further underscores the limits within which conventional rural development policies can influence existing income disparities. With these qualifications in mind, it is useful to assess the proper scope for setting rural income policy objectives as suggested by the study.

Implications of Relative and Absolute Poverty

In drawing policy implications, it is convenient to distinguish between relative inequality and absolute poverty, and between current patterns of distribution and future trends. Income profiles constructed in both Sierra Leone and Nigeria showed that incomes were not highly concentrated but rather displayed fairly equitable distributions. Given the production technologies available in both areas, existing farming systems were not sufficiently profitable, capital intensive, nor technically complex to produce extreme income differentials. Further, the continued availability of surplus land combined with relatively

egalitarian social institutions and land tenure systems have contributed to the maintenance of income equality.

Nevertheless, in spite of the comparatively modest range over which incomes varied, because average incomes were not greatly in excess of minimum subsistence requirements, a serious degree of absolute impoverishment occurred among the poorest 30 percent of households in both areas. From a policy perspective, however, the problem of absolute poverty is not best addressed within a framework of relative inequality, that is, through policies focused on the redistribution of either assets or income. Rather the major problem is the generally low level of income overall and the limited capacity of those now in poverty to improve their incomes given available resources and production technologies.

In contrast to current patterns of relative income equality, however, the study identified several indicators which point toward the emergence of widening income disparities in the future. These include both structural changes in the location and composition of employment which are associated with growth, as well as several preconditions for the emergence of agricultural dualism. For example, increasing income inequality was found to be directly associated with the emergence of market towns and urban centers in both countries. As urbanization proceeds, unless fundamental structural changes occur, income inequality is almost certain to increase.

Relationships on both the demand and supply sides of rural nonfarm enterprises also point toward widening inequalities within rural areas. Since the demand for nonfood goods produced in rural areas is highly income elastic, improved rural incomes will generate increasing demand for such commodities. Although a range of techniques was observed

permitting some choice of relative capital or labor intensity, initial equipment costs and variable costs associated with even the least capital-intensive, nonfarm enterprises are generally high compared to the incomes of the poorest rural households. Increased capital costs observed for farm technologies introduced in Sierra Leone will induce similarly biased participation with respect to farm production.

It was also observed in the Nigerian case that village leaders had preferred access to extension assistance and used their positions to divert government supplied farm inputs for their personal use. As more profitable crop production technologies are developed, such patterns of privilege will lead to greater inequality.

Finally, the Nigerian data revealed that lower income families were critically dependent upon high-income households, both for peak season employment and for the purchase of grain during the preharvest hunger period. This suggests that if an income-based class structure were to emerge with a parallel decline in current communal support institutions - as has been observed elsewhere in West Africa (Norman, et. al., 1979; Harriss, 1979) - at least some of the preconditions for an exploitative system of exchange already exist at the village level.

Policy Options for Equitable Rural Development

It follows that the challenge for policy makers is to devise strategies which not only raise the profitability of rural enterprises, but which also ensure the participation of low-income households thereby restricting the tendency toward dualism. Since the incomes of the rural poor are primarily generated from agriculture on their own farms and as hired laborers, primary emphasis must be placed on strategies which

increase the demand for and returns to labor in agriculture, with particular emphasis on disadvantaged regions.

Perhaps the most basic means of increasing incomes while promoting broad benefit incidence is through the development of improved crop production packages which are compatible with the factor endowments of low-income producers. Since a disproportionate number of the poorest households live in less humid areas and either specialize in grain production (Sierra Leone) or are net grain purchasers (Nigeria), priority should be given to the improvement of food-grain technologies suited to low rainfall conditions. In Sierra Leone priority should be given to upland rice and fundi, and in Nigeria to the millets and sorghum.

Moreover, in order to permit broad patterns of adoption, the technical package should economize on those factors most limiting for low income producers - capital, peak-period calories and management. Both of the improved technologies examined in the Sierra Leone context were incompatible with high adoption rates among poor farmers. More incremental "minimum input" packages with a credit component offer an alternative approach. Since labor required in weeding and to some extent planting tend to be the primary constraints on production, the development of more modest technologies which conserve and increase returns to peak period labor should be given priority. Improved seeds which do not require large inputs of complementary factors such as land preparation, water control or weeding may affect this by increasing output and labor use at other than peak seasons. Chemical inputs such as fertilizer and herbicides may also be appropriate if provided at low cost and with assured access by low-income producers.

It is particularly important in the design of such packages that the special circumstances of low-income households be explicitly recognized. An analysis of the Nigerian grain production system showed that personal income profoundly affects the small farmer's ability to modify existing practices. Previous studies have repeatedly affirmed that low incomes directly affect the ability of poor farmers to invest in new technologies as well as the poor farmer's willingness to accept the increased risk or uncertainty attendant to adoption. But in addition, the present analysis showed that low incomes and limited liquidity create a poverty trap situation which may restrict both the amount of labor available at key points in the cropping cycle, and the farmer's ability to perform operations at optimal times. Thus within the circumstances of the Nigerian environment, it was concluded that improved technologies which require timely execution of key operations, or substantially increased labor during the immediate preharvest period would achieve lower yields and lower rates of adoption among poorer households. An additional means of breaking the circularity of poverty thereby promoting proper use of inputs would be to add a consumption credit component to input packages. This could both add to the energy available to low-income workers while reducing the time spent in off-farm labor.[8/]

[8/] The returns to proper input use would have to be at least equal to the foregone earnings in off-farm employment. An additional benefit of adding a consumption loan component would be to reduce the immediate resale of inputs received on credit. For example, low-income farmers (those in the poorest quintile) in the Nigerian sample sold 33 percent of all fertilizer received through government extension programs (Matlon, 1978). This compared with less than 10 percent for all higher income households. Moreover, analysis showed that while it was profitable for poor farmers to sell the subsidized fertilizer at market prices, the marginal return to actual field use was several times greater than the profits realized from resale.

A second general policy area which may affect the degree of equity in both rural and urban areas is pricing. Factor price distortions caused by existing tariff structures, overvalued exchange rates, and by fragmented capital markets in Sierra Leone have created a distinct bias in favor of capital-intensive production technologies thereby restricting employment. In both the farm and nonfarm sectors existing policies tend to restrict the growth of small-scale and more labor-intensive enterprises which are generally located in rural areas in favor of more capital-intensive, large-scale and urban-based firms.

It is important to note, however, that the equity effect of removing price distortions within the fishing/rural/small-scale industry sectors is mixed. Incomes of rural households engaged in such enterprises would increase at the expense of generally higher income urban workers. Although this would reduce rural-urban income disparities and improve the overall national distribution, since these rural firms employ few hired laborers, little additional employment for workers from low-income households would be created. Thus unless initial capital costs were substantially reduced, it is likely that very little benefit would accrue to households now in absolute poverty.

With this qualification, public action to bring factor prices more into line with their opportunity costs constitutes an important step in creating conditions conducive to more equitable growth. A broad set of individual policy adjustments could be considered: (1) interest rates charged by formal lending institutions should be raised, (2) formal lending operations should be reoriented to perform a saving function for small-scale producers in rural areas; (3) exchange rates should reflect foreign exchange and capital scarcity, (4) tariff structures should be

modified to encourage the importation of inputs which are complementary to labor-intensive techniques of production, (5) urban wages in the public and large private sectors should be adjusted to better reflect labor scarcity by skill type, and (6) export taxes on labor-intensive agricultural export crops should be removed. While these suggestions are hardly new, they do constitute the kind of comprehensive approach which could beneficially affect future patterns of growth.

In view of the limited potential of labor markets to reduce regional income disparities, other priority areas for government action involve the allocation of infrastructural investment in transport, education and health to low income areas. In both Sierra Leone and Nigeria, such investments should be concentrated in poorer northern regions. Moreover, they should involve labor-intensive approaches in the construction stages to absorb surplus dry-season labor.

Finally, it must be recognized that obstacles to ensuring broad participation in programs of development are not only economic and technical in nature, but also institutional. While efforts to diffuse decision making in both the design and implementation of projects down to the village level may reduce biases introduced at the national or district levels, substantial problems may nevertheless remain. Although traditional political systems can provide a means to facilitate greater local involvement in the design and implementation of village level programs, it should not be assumed that the traditional leadership will in fact represent the interests of all classes. The record on this issue is not yet clear in much of West Africa. But it is likely that with greater commercialization, political and economic institutions at the

village level will become less equalitarian. In order to minimize abuses which may occur regarding access to development assistance, the roles played by the village leadership in implementing interventions must be better understood. Ultimately, it may be necessary to promote the formation of alternative village institutions which mobilize wider segments of the rural population and which serve a broader range of interests.

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SOUTHEAST ASIA

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INTRODUCTION

The widely held conception of changing rice technology in Asia is that of the Green Revolution, which is associated with the introduction of higher yielding semidwarf rice varieties. These modern varieties (MV) were first released for commercial production by the International Rice Research Institute (IRRI) in 1965-66 and have since been widely adopted throughout Asia. The complementary adoption of MV and inorganic fertilizers plus improved water control, constitute the central aspects of technological change in rice farming. The benefits of the adoption of these technologies accrue in two ways: First, they provide for significantly higher yields per crop. In many areas it is of equal or even greater importance that the MV have permitted increased multiple cropping - in some cases as many as five crops in two years. To achieve high levels of cropping intensity, improved water management is essential but the availability of faster maturing modern varieties also plays an important role, as does the adoption of improved systems of transplanting seedlings. Second, there have also been significant changes in the adoption of other modern inputs, such as tractors, mechanical threshers, pumpsets, herbicides and insecticides. Since these inputs substitute for labor and traditional factors such as animal power, their adoption gives rise to

especially significant policy issues relating to the distribution of output between labor and other factors of production. It is clear that the reasons for adopting these other technologies are not to be found solely in the technical and economic conditions brought about by the introduction of MV. There was a significant level of adoption of some modern technologies prior to the introduction of MV (Table 1). Seventy-five percent of the sampled Indonesian farmers, 62 percent of those in Pakistan, and a sizable number of those in the other study areas had employed inorganic fertilizer prior to 1966. Tractors were relatively common in Pakistan and the Philippines before 1966 and mechanical threshers and herbicides were employed on more than 30 percent of Philippine farms; insecticides were widely used in all the areas except Malaysia and Pakistan. Evidence that technologies other than fertilizer and possibly insecticide are not necessarily complementary with MV is provided by the fact that in several countries their use was negligible or significantly lower than the rate of adoption of MV.

Farm size has an interesting influence on the technology adopted (Table 2). There is comparatively little difference between the three size classes in their rate of adoption of the complementary technologies of MV, fertilizer and insecticide. In fact, the largest farms appear to have a marginally lower rate of adoption of these technologies than the smallest farms. In contrast, the largest farms show a markedly higher rate of adoption of mechanical technology (tractors and threshers) and herbicides. This confirms that these particular inputs are not indispensable complements to MV, fertilizer and irrigation, and being substitutes for labor, they have no significant place in the production systems of labor-abundant small farms.

TABLE 1--Cumulative Proportion of Farmers Who had Used Modern Technology in 31 Villages in Selected Areas of Asia, by Technology Type, by Country, 1960-1972 a/

	1960-1960	1961-1966	1967	1968	1969	1970	1971	1972	Percentage Using in 1972
	-percent-								
Modern Varieties of Rice c/									
India	0	0	27	43	77	93	96	96	NA
Indonesia	0	0	28	64	83	88	90	90	NA
Malaysia	0	0	--	—	—	—	100	100	NA
Pakistan	0	0	0	11	21	38	100	100	NA
Philippines	0	0	36	71	91	99	100	100	NA
Thailand	0	0	0	0	0	41	92	82	NA
Fertilizer									
India	6	41	60	70	91	97	98	100	99 (100) b/
Indonesia	32	75	81	91	99	99	99	99	99 (96)
Pakistan	27	62	66	72	79	80	81	81	76 NA
Philippines	15	33	51	67	77	80	83	84	72 (76)
Thailand	2	20	27	38	50	61	76	82	69 (82)
Tractors									
India	0	9	11	13	20	22	27	27	26
Indonesia	0	0	1	3	5	14	15	15	2
Malaysia	--	--	--	--	--	--	—	96	96
Pakistan	3	46	57	67	72	73	73	73	73
Philippines	10	24	37	46	57	61	61	61	58
Thailand	0	5	6	9	15	22	33	33	25
Mechanical Threshers									
India	0	7	8	9	9	9	9	9	9
Indonesia	0	0	0	0	0	0	0	0	0
Pakistan	0	0	0	0	0	0	0	0	0
Philippines	19	27	38	50	62	65	65	66	63
Thailand	1	6	11	27	38	45	55	55	44
Insecticide									
India	3	31	48	63	80	89	91	91	88
Indonesia	31	69	74	92	93	96	96	96	92
Malaysia	—	—	—	—	--	--	—	45	45
Pakistan	4	9	9	25	42	55	58	58	58
Philippines	16	43	59	75	89	95	97	97	97
Thailand	5	32	39	42	50	56	76	76	71
Herbicide									
India	—	1	1	2	2	2	2	2	0
Indonesia	—	0	0	0	0	0	0	0	0
Malaysia	—	—	—	—	—	—	—	8	6
Pakistan	--	0	0	0	0	0	0	0	0
Philippines	--	32	45	51	67	71	72	76	65
Thailand	--	4	6	6	7	10	10	10	8

Source: IRRI (1978a), pp. 16, 99, 100.

Notes: a/ Data missing for Malaysia for all or part of the period.
b/ The figures in parentheses are for the dry season, the others for the wet season.
c/ Modern rice varieties were introduced in India in 1965/6.
d/ Modern rice varieties were introduced in Malaysia in 1965.
e/ The data on adoption of modern rice varieties is for 32 villages. Data for Zarain in India was omitted in calculating the other statistics.

TABLE 2--Cumulative Rate of Adoption of Some Improved Rice Culture Practices by Farmers in Selected Areas in Asia, 1900-1972.

Farm Size	Cumulative rate of adoption (percent)							
	1900-1960	1961-1966	1967	1968	1969	1970	1971	1972
				Modern Varieties				
1 ha or less	0	13	35	69	85	89	93	93
1.1 to 3.0	0	9	27	56	89	98	99	99
over 3 ha	0	7	19	34	49	68	92	92
				Fertilizer				
1 ha or less	22	55	73	92	96	97	98	98
1.1 to 3.0	10	34	48	64	78	83	86	88
over 3 ha	14	50	61	73	81	86	90	91
				Insecticide				
1 ha or less	23	49	64	84	89	92	93	93
1.1 to 3.0	12	39	53	67	87	94	95	95
over 3 ha	6	32	45	52	62	70	83	83
				Herbicide				
1 ha or less	0	0	0	0	0	0	0	0
1.1 to 3.0	6	13	16	21	29	31	32	32
over 3 ha	3	27	39	48	56	63	71	71
				Tractor				
1 ha or less	0	18	19	20	21	25	25	25
1.1 to 3.0	6	13	16	21	29	31	32	32
over 3 ha	3	27	39	48	56	63	71	71
				Mechanical thresher				
1 ha or less	0	0	1	1	1	1	1	1
1.1 to 3.0	8	12	15	22	31	32	33	33
over 3 ha	9	21	30	35	39	41	44	44

Source: IRRI (1978a), p. 91.

Further justification of this last assertion is provided by the results of Hart's (1978) Indonesian study. The land farmed by all farm-size classes in the study village was virtually homogenous in quality, yet Hart's data (Table 3) indicate that the smallest farms apply 76 percent more labor per hectare than the largest farms and obtain nearly 60 percent higher yields. This is consistent with the results from other Asian sites, which show that small farmers apply their abundant labor intensively in order to maximize output per hectare, and are receptive to technology which permits them to achieve higher yields in this manner.

Constraints to the Adoption of New Technology

Yields achieved on experiment station test plots are considerably higher than those realized in farmers' fields. It may be unrealistic to express test-plot performance as a target; however, it is important to consider factors which bear on the gap between what is technically feasible and farm-level performance. Quantification of components of the yield gap, and ascertaining a target which farmers might realistically be expected to reach, are extremely difficult.

While it is easy to understand the frustration of national planners attempting to increase rice production, it seems that expectations are frequently pitched too high. Most research to date has concentrated on improving rice technology for areas with good water control, while less progress has been made for lowland, rainfed, upland or deep water rice. Thus, only in those countries where irrigated riceland represents a substantial proportion of the total rice-growing area can large increases in yield and input use be expected.

TABLE 3—Labor Input[a] and Yields by Farm Size in Rice Production Preharvest Activities, Village A, Central Java, Indonesia (Wet Season in 1975-76)

		Farm Size Classifications (hectares)				
		A	B	C	D	E
		>1.0	.50-.99	.30-.49	.19-.29	<.19
Average area (hectares)		3.147	0.676	0.377	0.271	0.118
Absolute labor input (hours)						
Female:	Family	40	45	54	87	65
	Hired	1209	211	109	72	27
	Total	1249	256	163	159	92
Male:	Family	127	88	135	119	68
	Hired	1335	210	84	49	17
	Total	1462	298	219	168	85
Total absolute labor		2711	554	382	327	177
Labor input per hectare (hours)						
Female:	Family	20	66	143	354	455
	Hired	360	306	306	266	233
	Total	380	372	449	620	688
Male:	Family	70	133	383	456	619
	Hired	374	296	223	180	147
	Total	444	429	606	636	766
Total labor input per hectare		824	801	1055	1256	1454
Yield per hectare (tons of wet paddy)		1.965	2.318	2.220	2.546	3.123
No. of observations		6	13	13	11	17

Source: Hart (1978), p. 143.

[a] A female labor day (transplanting and weeding) is between four and five hours, whereas the average male labor day is seven hours. Labor data exclude supervisory work and travelling time. They also exclude activities such as protecting the crop from birds in the period before the harvest and preparing food for laborers.

Even in the well-irrigated areas to which the new technology is adapted, it appears that there may be a serious danger of overestimating potential. This is suggested by the results of an interesting research program conducted by IRRI in South and Southeast Asian countries (IRRI, 1975; Herdt, 1976). This research was conducted in irrigated areas where all farmers employed MV, where rice was the main or only crop and where husbandry practices could be considered progressive. The research was carried out in farmers' fields and was designed, (1) to test the contributions to yields attributable to the use of fertilizer, insecticide and weed control, (2) to estimate the economic optimum use of these inputs, and (3) through surveys accompanying the field experiments, to determine the reasons why farmers' use of inputs was below the economic optimum. It was found that high input applications on fields led to lower yields than those of experiment stations, due to differences in environment and to nontransferability of the technology.

There were significant differences depending on the season. In the wet season, only comparatively modest increases could be made by increasing the levels of the three inputs, the average potential yield gain being 0.9 metric tons per hectare, with a range from 0.1 to 2.0 (Table 4). In the dry season, larger potential yield gains were possible, with an average of 1.5 metric tons per hectare and a range of 0.4 to 2.2 (Table 5). It should be noted that due to a peculiarity in the definitions used, the maximum attainable dry-season yields at several centers were significantly higher than the "potential" levels. Nevertheless, these maximum yields are less dramatic than experiment station results might suggest were possible. A most significant finding is that at many study sites it would have been uneconomic for farmers to have increased input application

TABLE 4—Wet Season: Measured Potential Rice Yield[a], Actual Yield, Yield Gap[b] and Contribution of Three Types of Inputs in Experiments on Farmers' Fields, Selected Asian Sites, 1974-75

Location	Year	Trials (no.)	Yield: Farmers' Actual	Yield: Potential	Yield: Gap	Contribution of: Fertilizer	Contribution of: Weed Control	Contribution of: Insect Control	Contribution of: Residual
			(t/hectare)						
Philippines									
Nueva Ecija	1974	10	1.9	2.3	0.4	-0.1	0.2	0.4	-0.1
Indonesia									
Subang	1975	4	2.2	2.4	0.2	0.1	-0.1	1.3	-0.1
Bangladesh									
Joydebpur	1976[c]	9	2.7	2.8	0.1	0.1	-0.1	0.1	0
Sri Lanka									
Giritale	1975/76	4	2.9	4.0	1.1	0.2	0.2	0.8	-0.1
Philippines									
Nueva Ecija	1975	11	3.2	3.9	0.7	0.3	0.1	0.2	0.1
Laguna	1974	10	3.6	5.6	2.0	1.1	0.3	0.8	-0.2
Laguna	1975	20	3.6	5.3	1.7	0.7	0.3	0.7	9
Camarines Sur	1975	6	3.6	4.6	1.0	0.4	0.1	0.6	-0.1
Thailand									
Supan Buri	1974	3	3.7	5.1	1.4	0.7	0.3	0.3	0.1
Supan Buri	1975	7	3.9	4.6	0.7	0.5	0.1	0.2	-0.1
Indonesia									
Yogyakarta	1974/75	3	4.2	4.7	0.5	0.7	-0.1	-0.1	0
Taiwan									
Taichung	1975	3	5.6	6.6	1.0	0.5	0.2	0.1	0.2

Source: Herdt (1976), table 4.

[a] The high input packages which produced the potential yields were not in all cases the highest input packages which could have been applied with positive marginal yield. Thus potential in this case is not strictly equivalent to maximum attainable yield.

[b] This refers to yield gap II.

[c] Aus season.

TABLE 5—Dry Season: Measured Potential Rice Yield[a], Actual Yield, Yield Gap[b] and Contribution of Three Types of Inputs in Experiments on Farmers' Fields, Selected Asian Sites, 1975-76

Location	Year	Trials (no.)	Yield: Farmers' Actual	Yield: Potential	Yield: Gap	Contribution of: Fertilizer	Contribution of: Weed Control	Contribution of: Insect Control	Contribution of: Residual
			(t/hectare)						
Indonesia									
Yogyakarta	1975	2	2.6	3.9	1.3	1.0	0.4	-0.3	-0.4
Tubang	1976	2	3.1	3.5	0.4	0.3	0.1	0	0
Bangladesh									
Joydebpur	1975/76[c]	6	3.5	5.2	1.7	1.3	0.4	NA	0
Philippines									
Camarines Sur	1976	8	3.3	4.8	1.5	1.3	0.1	0.2	-0.1
Camarines Sur	1975	3	3.9	5.6	1.7	1.1	0.1	0.4	0.1
Thailand									
Supan Buri	1975	7	4.1	6.3	2.2	1.5	0.5	0.3	-0.1
Philippines									
Nueva Ecija	1976	8	4.2	6.2	2.0	1.3	0.3	0.6	-0.2
Nueva Ecija	1975	3	4.3	5.2	0.9	0.2	0.5	0.2	0
Laguna	1976	12	4.4	6.1	1.7	1.0	0.2	0.6	-0.1
Laguna	1975	9	5.6	7.4	1.8	1.3	0.2	1.0	0.1
Taiwan									
Taichung	1976	3	6.2	7.0	0.8	0.5	0.2	0.1	0

Source: Herdt (1976), table 5.

[a] The high input packages which produced the potential yields were not in all cases the highest input packages which could have been applied with positive marginal yield. Thus potential in this case is not strictly equivalent to maximum attainable yield.

[b] This refers to yield gap II.

[c] Boro Season.

to the level required to realize maximum yields. This is shown clearly and indicates that the returns maximizing input levels were generally lower than those required to maximize yield per hectare (Table 6). In the wet season it appears that use of inputs was not markedly below the economic optimum. Farmers used inputs at an economically rational level, rather than striving for maximum yields through high levels of input use. In the dry season the highest input levels were economically justified in 5 of the 8 areas studied.

It should be recognized that the rice acreage in the dry season is appreciably smaller than that in the wet season and that increases in dry season yields will have only a comparatively small effect on annual average rice yields. It is estimated that for the period 1970-75, only 7.4 percent of the rice acreage of all Asian countries was double cropped in the dry season. Of an estimated total rice area of 78.3 million hectares, only 5.8 million were double cropped with rice.

It should be observed that though the potential for increased yields is greatest for the dry season, it is still comparatively small (Table 7). The second crop can be taken as being equivalent to the dry season irrigated acreage. On this basis it can be estimated that for the 11 countries listed, the dry season irrigated acreage amounted to only 22 percent of the wet season irrigated acreage. The same data also show clearly that the optimal habitat for MV-irrigated land-comprises only 34 percent of the rice-growing area in the wet season. The dominant land category is rainfed, which accounts for 51 percent of the wet season area. It is clear, therefore, that further research to develop superior technology for growing rainfed rice is likely to

TABLE 6—Increased Profit and Rice Yield of Alternative Input Management Packages Compared to Farmers' Practices, from Experiments on Farmers' Fields, Selected Asian Sites, 1974-76

Location	Year	Trials (no.)	Units	Increased net Return per Hectare Over Farmers Practices				Increased Yield	
				M2[a]	M3	M4	M5	At Max Net Return[b]	At Max. Yield
								- - -(t/hectare) - - -	
Wet Seasons									
Philippines									
Nueva Ecija	1974	10	Peso	31	-358	-902	-2053	0.2	0.7
Nueva Ecija	1975	11	Peso	205	146	-178	-256	0.2	1.2
Laguna	1975	5	Peso	-841	-1751	-1262	-1056	0	1.3
Camarines Sur	1975	6	Peso	381	658	-158	-846	1.1	1.1
Thailand									
Supan Buri	1974	3	Bhat	336	836	-540	-2281	0.9	1.4
Supan Buri	1975	6	Bhat	-422	-1023	-3034	-4316	0	0.4
Indonesia									
Yogyakarta	1974	3	Rupiah	-14000	11330	-1660	10660	0.5	1.0
Sri Lanka									
Giritale	1975	4	Rupees	1528	1399	829	855	0.5	1.2
Dry Seasons									
Philippines									
Nueva Ecija	1975	3	Peso	-486	-522	280	357	2.1	2.1
Nueva Ecija	1976	9	Peso	a/	820	1748	1864	2.3	2.3
Laguna	1975	9	Peso	-690	-666	-65	-768	0	1.5
Laguna	1976	7	Peso	a/	1045	1296	2153	2.1	2.1
Camarines Sur	1975	3	Peso	-525	177	307	-181	1.5	2.0
Camarines Sur	1976	5	Peso	a/	283	221	561	1.8	1.8
Thailand									
Supan Buri	1975	7	Bhat	365	488	-1167	-1455	1.1	2.2
Indonesia									
Yogyakarta	1975	2	Rupiah	22000	51000	80000	157000	2.7	2.7

Source: Herdt (1976), Table 6.

a/ M2, M3, M4 and M5 are increasingly higher combinations of input management packages.

b/ Note that for the dry season at the majority of centers the economic optimum yield increase exceeds the yield gap shown in table III.11. At several centers this may partly reflect a change in sample size, but in general is due to the point raised in footnote (a) in tables III.10 and III.11.

TABLE 7--Estimates of the Proportion of Rice Area in Five Major Environmental Categories, 11 Asian Countries, 1970-75

Country	Total Rice Area a/	Proportion of Area				
		Irrigated	Rainfed	Upland	Deep-water	Second Crop
	000 ha	-percent-				
India	37,755	40	50	5	5	5
Bangladesh	9,766	16	39	19	26	10
Indonesia	8,482	47	31	17	5	19
Thailand	7,037	11	80	2	7	2
Burma	4,985	17	81	1	1	1
Philippines	3,488	41	48	11	0	14
Vietnam b/	2,713	15	60	5	20	5
Pakistan	1,518	100	0	0	0	0
Nepal	1,200	16	76	9	0	0
Malaysia (W)	771	77	20	3	0	50
Sri Lanka	604	61	37	2	0	25

Source: Herdt (1976), Table 1.

a/ 1970-74 average area, FAO data.

b/ Former South Vietnam

contribute most significantly to lifting constraints to the further adoption of modern inputs in rice production.

The dominant reasons for the low level of input adoption revealed by the IRRI study were poor water control, lack of knowledge, infrequent extension contact, difficulties in obtaining credit and problems of obtaining inputs on time. It is important to note that these constraints are largely outside the control of farmers and do not imply inefficiency or ineptitude on their part. It is, however, within the realm of policy to expand credit facilities, increase extension services and improve the input supply system, although the IRRI research suggests that the returns to such policy developments may be modest.

Though the IRRI research did not explore constraints to the adoption of MV, this aspect was examined by Pachico (1979), in a study of the middle hills of Nepal. Pachico's research concentrated on the factors determining the proportion of the wet season lowland rice acreage allocated to each of three rice varieties - Taichin, a nitrogen-responsive dwarf variety; Pokhareli, a comparatively high-yielding Nepalese variety; and Thapachinia, formerly the most commonly grown local variety. Of these, Taichin is the highest yielding, though it is more difficult and time-consuming to thresh than the lower yielding Pokhareli. Taichin's slightly shorter growing season also makes it an attractive variety, offsetting the fact that it has somewhat poorer taste and cooking qualities. Pokhareli requires more transplanting labor than Taichin, and the Pokhareli plants are frequently bound together before harvest to prevent lodging. This practice amplifies labor requirements before and during the harvest period. The seasonal labor requirement profiles of the two main varieties are therefore distinctly different. Thapachinia, the local variety,

has markedly lower yields than Pokhareli, but it also has a much shorter growing season and excellent cooking qualities. As a consequence of the interaction of these varietal differences, a place exists for each of the varieties within the system, although Taichin is dominant. The complexity of the interactions can be illustrated with three points: (1) the higher yielding Taichin is preferred by small farmers operating close to subsistence, but with adequate family labor to cover the harvest peak, (2) larger farmers, who must hire labor, react to the cost and difficulty of obtaining harvest labor by growing a relatively high proportion of Pokhareli, which has a lower harvest labor requirement than Taichin, and (3) larger farmers combine a higher proportion of Thapachinia with the other two varieties because its early maturation spreads the harvest labor peak, and it supplies fresh rice at an earlier date for festivals. These findings give an indication of the constraints that exist to the introduction of a new variety, such as Taichin, into an existing farming system. Such a system operates within certain patterns of labor availability and food needs, which dictate the use of a combination of varieties rather than one single variety, and so represents constraints to the complete adoption of any new high-yielding varieties.

It has already been noted that the economically optimum level of input use is sometimes lower than might have been expected and that economic considerations impede the adoption of technology. However, the economic optimum is a function of the price of rice, the prices of inputs and the cost of credit. In many cases these are largely determined by agricultural and industrial pricing policy, and as has been reported, these prices do appear to be discernably related to the levels of adoption of the new technology. Thus, the economic constraints to adoption

perceived by farmers are to a large extent determined by policymakers, and are outside the control of farmers.

The Hart (1979) and Ranade (1977) studies used production function analysis to examine economic and technical efficiency in the use of factors of production. Their findings are of greatest interest relative to the use of labor. Hart found that with respect to labor, larger farms tend to operate at a point which is suboptimal in terms of profit maximization. Her empirical results cast doubt on the presumption that very small farms tend to be inefficient and suggest, in fact, the opposite. The analysis also indicated that the marginal value product of rice labor in this Indonesian village is far from zero. In the case of activities performed by males, increasing labor inputs per hectare did not decrease the marginal value product of labor, whereas it did produce significantly higher yields.

In the Philippines, Ranade found that farmers using traditional technology operated at the optimum level for labor use, given their supply of land. It was concluded that laborers were not paid less than their marginal product on either traditional or mechanized farms. The analysis showed that modern technology was both land and labor-saving; the land-saving bias substantially outweighed the labor-saving bias. In both areas, production function analysis bore out the conclusion that farmers were rational in their use of labor in combination with available land and other inputs. [1/]

[1/] Interested readers will find a specialized bibliography concerning constraints to improved rice yields in Asia on pages 104, 105 and 106.

The Effects of Technology on Income, Employment and Factor Returns

Clearly the new rice technology should not be examined as if it were an indivisible whole but rather the separate components of that technology must be studied. With survey data, it is generally too difficult to disentangle the separate effects of new varieties, fertilizers, tractors, pumpsets etc., and some compromise is necessary. Such compromises were adopted by Ranade (1977) and Doraswamy (1979) in their studies of the impact of technological change in the Philippines and India. In Ranade's study of Laguna and Central Luzon, the combined effect of the adopted package of technology on employment, and the revenue accruing to the various factors of production, as well as the different socioeconomic classes, were examined. In addition, there was extensive analysis of the effects of tractors and mechanical threshers, plus some partial results for the effects of irrigation and the use of chemicals.

In Doraswamy's study of Chittoor District, India, attention was focused principally upon the effects of mechanization (tractors) on employment, output and cropping patterns. Doraswamy's study is especially interesting in this latter regard, for unlike the studies by IRRI and those by Ranade (1977) and Hart (1978), which took place in areas where rice was virtually the sole crop, the Chittoor District study examined a situation where rice was only one of a number of major crops (the others being sugar cane, groundnut and other grains), thus permitting analysis of the effect of tractors upon cropping patterns and intensity.

Ranade's results for the Philippines confirmed that in irrigated areas, farmers adopting MV and fertilizers can expect marked increases in

both yields and net returns. In fact, over the study period it appears that the adoption of these inputs increased average yields by up to 50 percent and benefited all participants: landlords, tenants and landless laborers. It was determined that there were positive returns to the factors of production themselves. That is, it was economically rational to use fertilizer, insecticides and herbicides. The distribution of the additional output between the different factors and the different participants was by no means equal. This, however, was due in part to a highly effective land reform scheme carried through in the Philippines, which disadvantaged landlords and favored operators.

In the Philippines it was expected that MV, fertilizer and irrigation would have significant output-increasing effects; this is entirely consistent with other survey results, including those published by IRRI. Ranade's findings with respect to the impact of mechanization can be summarized as follows:

1) There is no evidence to suggest that the use of tractors or mechanical threshers had a positive effect on rice yields.
2) Tractors in the Philippine study were not employed in activities other than land preparation and they substituted for labor, mainly from the operator's family, in this task. The reduction of labor demand for this task on tractor-using farms tended to be more than offset by increased demand for labor (mainly hired) in planting, weeding and harvesting. None of these latter effects, however, can be attributed to the use of tractors. The first two were probably due to improved husbandry practices such as the adoption of straight-line planting and row-by-row weeding; and since there was no evidence that tractor-using farms had higher

yields, the reason for the latter effect is unclear.

3) Since hired labor constituted a high proportion of harvesting and threshing labor, the employment effect of threshers fell mainly on hired labor. This contrasts with the effects of tractors, and suggests that the effects of threshers upon income distribution may be much less desirable socially than those of tractors.

4) In Central Luzon, the shares of operators and operators' residuals were appreciably higher on farms employing tractors than on non-mechanized farms.

5) The use of threshers was associated with operators' shares and operators' residuals even higher than those on farms using tractors only. This suggested the existence of a strong private incentive for the adoption of threshers in Central Luzon, against which the social cost of job displacement must be set in perspective.

6) As a result of changes in the labor task composition due to mechanization, average wage rates were lower on tractor using farms than on nontractored farms, and even lower on farms employing mechanical threshers. From the standpoint of the welfare of hired laborers, this is a most interesting finding which does not appear to have been considered in other studies.

Doraswamy's results for the impact of tractor use in Chittoor District, India are very similar to the Philippines. Again, tractor use in crop production was found to be almost exclusively confined to the plowing operation. Hence the only crop operation in which tractor use was found to significantly affect (reduce) labor demand was plowing and,

since plowing labor constituted an average of only 5 percent of labor demand, the effect on the total labor required for any particular crop was small. The possibility therefore, was that the main effect of tractor use on labor demand might be to change the composition of crops produced and to increase the proportion of those requiring more labor.

An interesting analytical technique was conducted to test this hypothesis, with the expectation that if the use of tractors for plowing showed any effects on cropping patterns it would be for one of two reasons: (1) Because of its effect on timeliness, it might permit expansion of the acreage of crops with a short plowing to sowing interval - primarily paddy on wet land and groundnut on dry land, and permit expansion of crops which are highly specific with respect to planting date - this applies chiefly to groundnut on wet land, and (2) because it reduces labor and bullock requirements for plowing, it might permit expansion of the acreage of paddy, which has an especially high demand for plowing time. A third effect might also have been expected: the possibility that acreage used to produce forage for draft animals would be freed for the production of other crops. This was not the case. Since in the study site draft animals were fed largely on grain stubble, there was, therefore, little forage acreage to displace. It was anticipated that any crop effects of mechanization would show up largely in increased paddy and groundnut acreages. This in fact was what the statistical analysis showed, but the effects were undramatic and in several cases not significant.

The main results of this analysis can be summarized as follows:

1)In general, the net effect of tractor use on plowing labor demand

was negative; the change to crops requiring more plowing labor was outweighed by the displacement of labor in the plowing operation.

2)The main crop effect associated with tractor use on labor demand was found in all nonplowing operations, and this was positive in most cases. The largest of these effects was found to be on tractor-hiring (vs. owning) farms. The increase was 28 percent on farms owning tractors and 70 percent on farms hiring tractors.

3)One of the notable features of the results was that from the point of view of increasing hired labor demand, the hire of tractors was more favorable than ownership, since farms hiring tractors used them more sparingly than the owning farms.

4)If the four Indian sites are aggregated, it appears that tractor hiring was associated with some increase in total (plowing and nonplowing) labor, but the effect was not marked. No such conclusion is possible for tractor ownership.

5)In view of the difficulty which is usually encountered in separating the employment effects on tractorization from (the independent) yield effects, it is worth noting that Doraswamy's procedure successfully differentiated the separate effects.

The results obtained by Ranade (1977) and Doraswamy (1979) confirm that tractors are not necessary for increased rice output in the areas studied. They also fit into the pattern of results presented by Binswanger (1978) in his recent review of over one hundred studies of the effects of tractors in South Asia. He concluded that:

> The tractor surveys fail to provide evidence that tractors are responsible for substantial increases in intensity, yields, timeliness and gross returns on

> farms in India, Pakistan and Nepal. At best, such benefits may exist but are so small that they cannot be detected and statistically supported. . . . Indeed the fairly consistent view emerging from the surveys largely supports the view that tractors are substitutes for labor and bullock power, and thus implies that, at existing and constant wages and bullock costs, tractors fail to be a strong engine of growth. They would gain such a role only under rapidly rising prices of those factors of production which they have the potential to replace. (Binswanger, 1978, p. 73).

The results could be interpreted as indicating that tractor mechanization is neutral in a rice-based economy; however, this conclusion must be tempered by two additional considerations. First, at present the use of tractors appears to be primarily confined to plowing. It can only be assumed that in order to make better use of tractors, the range of activities in which they are employed must increase, with a resultant increase in labor displacement. Second, although adoption of tractors may not appear to reduce the demand for hired labor in the areas studied, the supply of hired labor has increased rapidly as a consequence of population growth. Thus, to the extent that tractor use has retarded growth in labor demand it has important social implications.

The Economic Condition and Behavior of Differing Socioeconomic Classes

The distributional impact of technological change upon different socioeconomic classes is conditioned by 1) any scale biases in that technology, 2) any biases in the institutions involved in the factor and product markets, and 3) by differences in the economic behavior and reactions of the different socioeconomic classes. This latter topic has been the object of an in-depth study by Hart (1978) in Indonesia, with complementary findings emerging from the other studies. The research findings

provide a valuable background for any consideration of distributional issues relating to rice technology. Hart's study illuminates the marked differences in the capacities of the different classes to advance themselves, by demonstrating the relative lack of dependence of the richer members of the rural community upon the poorer. Hart's analysis indicates that social and technical changes are weakening the dependency between classes.

Three classes of households were identified in the Indonesian village. These classes were based on ownership of land sufficient to generate various levels of income. The poverty level is defined as income equivalent to the value of 300 kg milled rice per person and subsistence as an income equal to 150 kg milled rice per person - the quantity necessary to meet basic staple food requirements. Class I households were those with adequate land to produce income equivalent to or greater than 300 kg per person. Class II households were those with sufficient assets to enable production in excess of the staple food requirement of 150 kg milled rice per consumer, while Class III households were those controlling insufficient assets to meet even staple food needs. The percentages of households in each of these classes were approximately 24, 33, and 43 percent, respectively. Given that the principal productive asset determining asset status was agricultural land controlled, it is evident that the largest class, Class III, consisted essentially of landless families who had to find wage employment or some role in the informal sector to attain even subsistence levels of consumption. While a further third of households operated small amounts of land and generated sufficient own-production to cover subsistence needs,

they also needed to find employment in order to achieve the poverty standard of consumption.

Hart observed major interclass differences in employment patterns, and the nature and extent of these differences is particularly interesting. In terms of hours worked, class differences were found to have the least effect upon men, for whom only a small direct relationship was noted between hours worked and class. Naturally, however, the nature of adult male employment differed greatly with asset status, with men from Class I spending 87 percent of their time working with their own assets, while men from Class III spent 91 percent of their income-earning time in wage employment (Table 3).

However, in terms of income earning contribution, the main impact of class was revealed in the economic role of women and children whose contribution increased substantially as asset status declined. Indeed, in the poorest families there was surprisingly little difference on average, between the total working hours of any type of family member over nine years of age. Boys in Class III were recorded as averaging 1,368 hours of work per year, girls 1,751 hours, women 2,342 hours, and men 2,374 hours. This contrasts with the comparable figures for the richer Class I households of boys/645, girls/483, women/2,013, and men/2,667 hours, respectively. Thus women and children in families with little land were forced to participate more extensively in income earning activities. It is important to add that despite their efforts, the average Class III household only achieved an average income of 274 kg milled rice equivalent per consumer, which was below the 300 kg poverty level. Moreover, because of their need to find a relatively sure source of income, members of poor families (particularly women and children) exhibited a tendency to accept

TABLE 8--Average Hours Worked per Year at Different Job Types, by Class, Sex and Age, Village A, Central Java, Indonesia, 1975.

Job Type	Class	Hours per Household	Hours by Females	Hours by Males	Average Hours per Person: Persons 10 yrs	Girls 10-15	Women 15	Boys 10-15	Men 15
Own Production[b/]	1	3,813	321	3,492	1,048	44	242	508	2,246
	2	1,567	240	1,327	431	44	183	437	839
	3	299	59	240	92	17	46	178	141
Trading[b/]	1	615	462	153	171	0	369	0	108
	2	448	418	30	122	43	325	36	1
	3	237	170	67	75	5	132	14	56
Wage Labor[b/]	1	552	222	330	153	54	158	52	299
	2	2,798	996	1,802	771	416	641	304	1,291
	3	4,164	1,984	2,180	1,290	1,168	1,202	554	1,706
Gathering[b/]	1	65	45	20	19	23	28	22	5
	2	341	224	117	94	172	97	97	45
	3	467	277	191	147	169	162	124	120
Ocean Fishing[b/]	1	29	-	29	9	-	-	32	9
	2	582	-	582	160	-	-	421	265
	3	536	-	536	169	-	-	461	290
All Income Earning Activities[b/]	1	5,074	1,050	4,024	1,400	121	797	614	2,577
	2	5,736	1,878	3,858]	1,578	675	1,246	1,290	2,441
	3	5,763	2,499	3,214	1,773	1,359	1,542	1,331	2,313
Housework[a/]	1	1,812	1,666	145	499	362	1,216	31	90
	2	1,589	1,443	146	437	438	1,003	57	82
	3	1,254	1,173	80	390	392	800	37	61
All Activities[b/]	1	6,886	2,716	4,169	1,899	483	2,013	645	2,667
	2	7,325	3,321	4,004	2,015	1,113	2,249	1,347	2,523
	3	6,957	3,672	3,294	2,163	1,751	2,342	1,368	2,374
Travel to and from work	1	713	126	587	nc	nc	nc	nc	nc
	2	723	229	494	nc	nc	nc	nc	nc
	3	690	291	399	nc	nc	nc	nc	nc

Source: Hart (1973), pp. 124, 126, 128.

a/ Hours per male < 10.

b/ Including travelling time.

nc. not calculated.

low wages in return for some security of employment. These and related findings assume particular significance within the context of Hart's study, since they support the main conclusion of her theoretical model that households with no or few productive assets will be forced by survival considerations to participate continually in the labor market, even if this involves working long hours for very low returns. It is also significant that it was women, elderly males and children who provided this anchor role for the household economy leaving men, who had a wider range of income earning opportunities, to participate in higher return employment. In striking contrast, ownership of even very small amounts of land allowed household production of rice at a subsistence minimum, thereby making it unnecessary for women of Class II households to participate as much in low-wage contract labor.

There is a further noteworthy economic dimension to the extensive participation by the 10 to 15 year-olds in Class III households in the labor market; it restricts their attendance at school, thereby limiting any opportunities to escape from their poor circumstances through education. Thus, they are effectively caught in a low-income trap. This is reinforced when it is noted that Hart observed that even children below 10 years of age played an indirect but important role in the economy of the poorest households. In the poorest households, children between the ages of 6 and 9 were responsible for looking after younger siblings in order to free mothers for paid employment.

The overriding impression presented by Hart's study is of family members forming in an integrated work team, with individuals adopting roles which permit the family, as a unit, to maximize income and security of work. Furthermore, the observations support the theoretical hypothesis

that this behavior is dictated by poverty and that the degree of coordination within families declines as their productive asset base increases.

It is also worth noting that the conclusion regarding the economic role of women and children within the family is also supported from an entirely different standpoint by a hypothesis proposed by Doraswamy (1979), in his study of mechanization in Chittoor District, India. The situation there is essentially one of a much higher level of affluence than that found in Indonesia, and is one in which educational levels are higher. Based on cross-farm analysis, Doraswamy hypothesizes that increased school enrollment may cause increased mechanization on farms by reducing family labor availability. It does this by removing children from direct participation in farm work, but more importantly it necessitates the withdrawal of women's labor from the farm in order to take over the child care formerly performed by older children.

Class differences in household work patterns are not solely the direct product of asset ownership and household preference; they can also be influenced indirectly by asset ownership (Hart, 1978). This is to say there are restrictions or preferences on access to jobs which depend upon class (asset ownership). Hart identified a number of mechanisms for the distribution of patronage in assigning available work. The overriding effect of these was that the small land-owning households in Class II had an advantage over the landless Class III households in gaining access to the employment offered by large landowners. One result of this was the systematic tendency of wage rates paid to Class II members to exceed those for Class III. The existence of these biases calls into serious question the notion that in traditional rural systems, institutions exist to share work

with the poorest. Instead, what exists is a highly competitive labor market into which are built mechanisms which actively discriminate against landless households.

The Influence of Technological Change on the Labor Market and Other Institutions

The distributional consequences of technological change are, in part, a function of institutional arrangements in the factor markets. This is especially true of labor markets and it is therefore important that significant changes were observed in the arrangements for hiring and paying harvesting labor in Indonesia and the Philippines. Harvesting labor is the main source of wage employment for landless laborers.

A major change which has been observed in both countries is the moving away from the traditional situation where anyone who wished to participate in a farmer's harvest could do so in return for a predetermined share of the harvest, to one in which there is restriction on who is permitted to undertake harvest work. In addition, the changes serve to restrict the share of the harvest which is paid for harvesting labor. More specifically, in Indonesia a change has been observed from the traditional bawon system, in which harvesting was open to all, towards closed bawon systems, in which only certain people can participate, and more significantly to the tebasan system, in which the landlord pays a contractor to organize the harvest. These changes have been accompanied by a reduction in the share of the harvest paid out to labor, although to the extent that yields have increased this does not necessarily signify that total payment to harvest labor has declined. In the Philippines (among other changes) there has been a movement away from the system in which all could participate in the harvest in return for a sixth share, to a system in which

workers must provide free weeding labor during the growing season in order to participate in the harvest and receive the one-sixth share.

Although these institutional changes cannot be wholly attributed to the introduction of new rice technology, it seems entirely reasonable to argue that it has provided a significant stimulus for them. Given that the higher yields obtained with the new varieties are not primarily attributable to harvesting labor, there is an obvious rationale for reducing the share of production distributed to such labor. The changes noted in Indonesia and the Philippines have provided an effective means of accomplishing this. Of course the other major incentive for these changes has been the growth in the number of landless people and those with inadequate productive resources of their own. This has swelled the supply of harvesting labor to the point where some mechanism other than price for rationing available work has become necessary in certain places.

It is debated by Hayami and Hajid (1978) whether or not these institutional changes, caused in part by changing rice technology, can be interpreted as being biased against the landless and other poor. It is certainly conceivable that if the price of harvesting labor were allowed to find (fall to) its equilibrium level, total returns to labor might be lower than in the emerging labor rationing systems. Nevertheless, these institutional changes do represent some breakdown of the paternalistic ethic which has often been assumed to operate in rural communities. They discriminate against poor job seekers and they represent a significant element of the process whereby economic change excludes poorer people from its benefits.

The raising of this issue of marginalization through institutional change and through the way in which economic institutions and relations operate, indicates a shortcoming in the work summarized here. In the studies reported, no results have been obtained regarding possible impacts of the new technology upon the size distribution and number of holdings, or upon the pattern of control over land and wealth in general. Rather, the inquiry has been from the opposite end, how the adoption of technology is influenced by these factors. There is an expanding literature (especially for areas of Asia, where mechanical technology has been introduced) which suggests that the new technology intensifies forces leading to concentration of land ownership/control and to increasing inequality in incomes. The main reasons for such tendencies are thought to be attributable to the large farm biases in factor markets, and this is particularly true of credit used for the purchase of tubewells, tractors, pumps, fertilizer, etc. If such tendencies are inherent in the new rice technology, as authors such as Griffin (1974) argue, then any adverse distributional consequences noted for the new technology in this summary would be increased.

It would be anticipated that the higher yields resulting from adoption of the seed-fertilizer technology would be accompanied by increased labor demand. It is here that the difficulties of disentangling this effect from the labor demand effects of other technological changes presents problems. While the Cornell research does not address this issue directly, evidence from other sources does indicate that adoption of MV and higher fertilizer use increases labor demand, but this increase is proportionately smaller than the increase in yields, so that labor input per ton of rice declines.

Policy Implications

The research conducted by Cornell provides support for the prevailing view that the new rice technology has had a significant positive impact on rice yields, output and to a lesser extent, employment in South and Southeast Asian countries. It is also apparent that there is further progress to be made, since the use of modern varieties (MV) and associated inputs could be increased in many countries. This is particularly true since use of the associated inputs (fertilizer, insecticide and improved weed control) are apparently being used below economically optimum levels. Care must be taken not to exaggerate the potential for further development with the current MV and technology. The main thrust of plant breeding research to date has been directed to rice varieties with high fertilizer response on irrigated land, while less research has been directed at increasing potential yields for rainfed, upland and deepwater rice varieties. The potential yields of MV are appreciably higher for the dry season irrigated rice crop than for the wet season crop. It should be noted that the dry season irrigated rice acreage is relatively small compared to wet season irrigated acreage (Table 7). Furthermore, it was found that in the wet season, farmers who grew MV were applying associated inputs at levels far closer to the economic optimum than might have been expected (Table 6). In part, this is because the economically optimum application of inputs from the farmer's point of view was less than the level required to maximize yields per hectare. In the dry season, it was found that the extent to which farmers were using input levels below the economic optimum was more marked. The principal restrictions on this acreage are (1) that in

the colder northern latitudes in Asia the dry season is too cold and has too short a growing season for rice, so that any second irrigated crop must be hardier than rice (e.g., wheat), and (2) that water supplies are inadequate to provide irrigation for significant portions of the area during the dry season. To lift these restrictions calls for further research to develop cold-resistant varieties and also calls for more investment in irrigation, where this can be economically justified.

The research also indicates that farmers in Asia have been highly receptive to the new seed fertilizer technology, have reacted rapidly and are very capable of perceiving what is to their economic advantage. Evidence of this has emerged in a number of ways. First, adoption of inorganic fertilizer and other new inputs had been quite extensive in some areas prior to the drive to introduce MV. Adoption of MV has proceeded rapidly since their introduction in 1966 and there has been a rapid further increase in the use of other modern inputs. It is also notable that the smallest farmers appear to have been the most avid adopters of the seed fertilizer technology, applying their abundant family labor to these and traditional inputs at higher levels than larger farmers, and obtaining higher yields. Indeed, the evidence supports the position that breaking up larger holdings will result in increased production. Certainly the land reform carried out in the Philippines appears to have been successful in the study areas and to have had no adverse impact on production.

It is particularly relevant for policy that the constraints causing farmers to underemploy resources were found to be largely outside their control, but susceptible to policy action. In some cases, significant numbers of farmers were found to be ignorant of the economic possibilities of the new technology. While from one standpoint this could be interpreted

as a reflection on the drive and initiative of farmers, from another, it reflects weaknesses in the institutions which disseminate technical and economic information. Many farmers were aware, however, that higher returns could be expected from employing more inputs. Risk (an uncontrollable factor) was one reason given as inhibiting higher input use, but from the policy standpoint it is more significant that the cost and availability of credit, and the physical nonavailability of inputs at times when they were wanted appear to have been major constraints to higher input use. There are economically rational reasons for not fully adopting the modern rice varieties. Such reasons were identified by Pachico (1979) in Nepal, and help to explain the rationale for continuing to plant some of the rice acreage to traditional local varieties. These reasons suggest that expectations about the potential penetration of MV should be tempered.

At an even higher level of policy, it should be observed that the economic returns from adopting technology are directly influenced by political intervention in factor and product markets. It is not uncommon to observe government agencies exhorting farmers to greater efforts, while pursuing pricing policies which restrict the economic returns to such efforts. This is particularly significant in that technically feasible rice yields are held up as targets, but they may exceed the economic optimum. Changing policy-determined prices will change the economic optimum production levels of farmers.

It should be emphasized that the modern technology being applied to rice production is not an indivisible set of complementary inputs. It is true that there is a very high degree of complementarity between irrigation facilities, MV and inorganic fertilizers. In certain localities

insecticides, and less frequently, mechanization may be highly productive. From a social welfare standpoint, the most questionable inputs are tractors and mechanical threshers, which appear to be crucial complements only in special situations. Tractors are being increasingly adopted in most rice growing areas and mechanical threshers are also being used in a few countries. The evidence, however, suggests that in most of the areas where mechanization has occurred its impact on yields is negligible, but more critically, mechanization has had no detectable influence on the potential for double cropping in rice production. The social benefits from mechanization thus appear to be rather small, in general, although they may be high in special circumstances.

The private benefits of mechanization are evidently high. This appears to be especially true of threshers in the Philippines, where their labor-saving effect was observed to be large. In contrast, the labor-saving effect of tractors was found to be quite modest and to be confined almost entirely to land preparation activities, which account for a small proportion of total labor demand. This contrasts with the impact of tractors in wheat-growing areas of Asia, in which larger four-wheeled tractors are being used for a wide range of cultural tasks. In the few areas of South and Southeast Asia which still have relatively favorable land-labor ratios, the divergence of private and social returns to these mechanical technologies may be small at this stage, but in more densely populated areas the divergence may be large, and be exacerbated by policies of cheap credit and subsidies on inputs. In such areas, the spread of mechanical technology should be geared to the size of social returns and policy should be directed to reducing the gap between these and private returns.

This last observation raises the issue of the distribution of the benefits of the new technology, that is, of how the returns are distributed between different socioeconomic groups. This is of particular significance against the background of increasing rural landlessness in large parts of Asia and the fact that while the economies of virtually all Asian nations are growing, the absolute number of people living in abject poverty is expanding. Thus, critical issues for policy are whether additional employment for hired laborers and particularly landless laborers is created and also of whether the new technology sets up forces leading to further concentration of land control and increasing landlessness.

Regrettably, no complete answer to these questions is possible, but there are a number of partial indicators which are suggestive. Cornell research conducted in the Philippines (Ranade, 1977) concluded that all relevant socioeconomic groups (landlords, operators, hired labor and input suppliers) have gained where the seed fertilizer package has been adopted, although the size of these gains has been affected by the land reform program which restricts the extent to which the results can be generalized. What is clear, however, is that the seed fertilizer technology has resulted in higher yields and in an associated increase in total labor demand, although labor requirements have increased at a slower rate than yields. Hired labor demand, however, has been observed to increase at a faster rate than that for total labor, since there appears to be a discernible tendency for families operating larger land areas to decrease the amount of family labor performed by sending their children to school, by reducing female labor input and by diverting some male labor to other activities. Nevertheless, the rate of increase in hired labor demand remains less than the increase in yields.

Hart's (1978) study in Indonesia has provided evidence that the landless do not benefit from the increase in labor demand to the same degree as small farm operators and that large land operators exhibit a bias in their hiring policy in favor of those owning land. This suggests important impli ations relating to policy decisions which promote rural employment through public works projects, such as construction of roads, dams or educational facilities. Few rural people view public works employment as permanent or reliable. Consequently, the survival strategy of the landless would probably induce them to maintain established work patterns. In contrast, self-sufficiency in rice production places small landowning households in a stronger position to accept the risk associated with this employment. Even if the landless are willing to disregard job uncertainty, there is reason to suppose that unequal work opportunities would operate against them. It therefore appears that public works projects would be only marginally successful in providing increased employment for the landless.

When tractors are employed in conjunction with the seed fertilizer technology, the increase in labor demand is moderated somewhat. Where threshers are employed, there is a marked saving in threshing labor on a scale which may be sufficient to nullify the demand-increasing effect of adopting MV with fertilizer. In addition, where machines are employed, there is evidence from Ranade's (1977) work in the Philippines that average wage rates are reduced. Presumably this is due to the changing task composition of the work performed towards traditionally less well-paid tasks, for example, weeding. This cannot be interpreted as being due to the direct effect of mechanization on the average price of rural labor,

although the wage rate has been recorded as declining in real terms in several Asian countries, evidence that the growth of agricultural labor demand in rice growing areas in the poorer Asian countries has not kept pace with the growth in labor supply. Undoubtedly the adoption of modern rice varieties, fertilizer and irrigation have ameliorated this position somewhat.

The main gains from the new technology appear to have been made by land operators and landowners rather than by labor. This raises the important issue of whether or not the institutions organizing the diffusion of the technology have a built-in bias toward large land operators and against the small farmers, despite evidence that the latter tend to achieve higher yields with the new varieties. There is also the ancillary quandry of whether or not the new technology actually serves to heighten this bias in some way, despite the inherent scale neutrality of modern varieties and chemical inputs. The studies undertaken were not specifically directed to these issues, but they have produced a number of relevant insights. In both the Philippines and Indonesia, similar changes were observed in the institutions governing the harvesting of rice. From traditional systems, in which the harvest was available to laborers willing to work for a traditionally determined share of production, these changes involved a shift to more restricted arrangements of reducing the share of the harvest paid to labor and in various ways controlling access to harvesting work. It is not surprising that labor's share of the harvest would be reduced, since the higher yields associated with MV are not attributable to labor; thus in part, the new technology has provided a stimulus for the abandonment of harvesting arrangements, which in their original form guaranteed the landless some rice. It should be kept in mind that preservation of

traditional relationships is increasingly unmanageable, due to the rapid increase in total labor, particularly landless labor.

The new technology has provided an excuse, as well as a stimulus for erosion of patron/client relationships, which can be interpreted as a breakdown in the traditional arrangements of community assistance to its poorer members. The adoption of tractors and threshers reflects something of the same phenomenon, in that it permits farmers to overcome difficulties in adjudicating the issue of who will be hired in a labor-surplus situation, and provides yet another incentive for setting aside traditionally recognized rights. From a policy standpoint this is an undesirable secondary consequence of the adoption of these mechanical technologies, especially if their social returns are small, and it underscores the desirability of pursuing policies which keep the gap between private and social returns negligible. Noting that the social cost of mechanical threshing is particularly high, Ranade suggested the possibility of landless laborers forming cooperative units which, with government-backed, low-interest loans, could purchase mechanical threshers. The landless might then capture a portion of the private benefits accruing from the ownership of labor-saving threshing equipment.

Although the key inputs of the new rice technology - water, seeds, fertilizer and insecticides - are highly divisible, can be supplied in small quantities and are inherently scale neutral, it has nevertheless been widely accepted that there is a bias towards larger holdings in the economic processes set off by the new technology. In part, this is because the means of delivering water do not always lead to equitable distribution; there is a minimum size of holding required to justify the acquisition of tubewells and pump sets.

Where tractors and threshers are important elements of the technology, this problem of technological indivisibility in private ownership becomes even more acute. It is, however, also evident that in certain areas, this large farm bias is reinforced in the provision of credit for the purchase of the divisible inputs; subsidized government credit may be available more readily and cheaply for large landowners with extensive holdings for collateral.

In this situation small farmers, despite their demonstrated industriousness, may be trapped into debt situations where they are forced to mortgage or sell their land to larger landowners. Clearly, the new technology has intensified this tendency to increasing concentration of land control by raising the returns to land and providing the incentive to the larger economically powerful land operators to increase their holdings. It is concluded that strong public policy must be formulated in a manner which will build on the scale-neutral aspects of agricultural technology and direct benefits toward small farmers and landless families.

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INTRODUCTION

Until recently the major focus of development efforts in many poor nations has concentrated primarily on increasing productive capacity within the agricultural sector. Increased availability of modern inputs, irrigation, price policies and improvements in the rural infrastructure were commonly used tools of development. While instrumental in increasing overall production, these tools often bypassed two groups: families with limited land holdings and the households of landless laborers. In some lacales it can be demonstrated that the relative economic condition of these poorest income groups deteriorated, while overall farm production rose.

In Brazil the group which has not been able to participate in overall development or whose participation has been marginal constitutes a significant proportion of the rural population. There is a pausity of data concerning not only the economic status of these families, but also the constraints limiting improvement in their level of living. This lack of data has caused many development efforts to be poorly conceived or fail to target and reach the truly needy. The research reported here is an attempt to enhance our understanding of the low-income problem in Brazil. It is hoped that it will provide valuable insights relative to this problem in a broader international context.

The Study Regions

Groups designated for study in Brazil included the small owner-operated farms, sharecroppers and landless laborers. Small farms were those with less land than the modulo unit defined by the land Reform Agency to provide full employment and an adequate income for a family. This group constituted over 60 percent of Brazil's total farm labor force and also shared the major burden of poverty in the country. In all, 608 households were selected for intensive surveys. The sample was drawn from three states of Brazil. Within the states, regions were selected as representative of the agrarian practices of poor rural households and incomes within that state. The states, with regional names in parentheses follow: Sao Paulo (Vale do Ribeira), Minas Gerais (Campos das Vertentes and Zona da Mata) and Ceara (Caninde).[1/] Data from the sample households were collected for the agricultural years 1972-73 and 1973-74 by survey using prestructured questionnaires.

All the regions were relatively low-income regions and to that extent they were not statistically representative of Brazilian agriculture. However, they did represent conditions and problems of the low-income groups typical of major rural areas in Brazil. Also, because of differences in locations, study of the three regions sheds light on some of the important differences in regional characteristics, resource endowments and agroeconomic conditions that impose constraints on regional development.

The four study areas as represented by regions exhibited fairly wide differences in climatic characteristics. The Vale do Ribeira

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[1/] See map on page 110.

STUDY AREA 1: Caninde
STUDY AREA 2: (1) Zona da Mata
(2) Campos das Vertentes
STUDY AREA 3: Vale do Ribeira

Figure 1: Map of Brazil Showing the Study Regions.

region receives annually 1500-2000 mm of rainfall without a pronounced dry season. In both Campos das Vertentes and Zona da Mata, the annual rainfall exceeds 1000 mm but there is a period of about two months of very little rainfall. The Caninde region in the north has the most unfavorable climatic conditions with only 600 mm of annual rainfall concentrated almost entirely in a three-month period of the year. Additionally, the distribution of this scanty rainfall in the region is highly erratic both over time and space.

Caninde had the highest proportion (76 percent) of its total population living in rural areas, while Campos das Vertentes, had the lowest (45 percent). In the other two regions, Vale do Ribeira had 66 percent and Zona da Mata, 57 percent. Population density was the lowest at 10 persons per km^2 in Vale do Ribeira, while it was the highest (50) in Zona da Mata. For Caninde and Campos das Vertentes the densities were 18 and 28 persons, respectively.

One common characteristic of the cropping system practiced by the small farmers of the four regions was that subsistence crops covered a fairly large portion of cultivated land. Differences were evidenced in the nonsubsistence or cash crop. The important food crops in Vale do Ribeira were corn, rice, beans and cassava (manioca). The cash crops were confined to horticultural crops, bananas and tea. Livestock tended to be comparatively unimportant and were limited mostly to small-scale poultry and swine production. The principal food crops grown in the Zona da Mata region were corn, beans and rice, but coffee and cassava were also important. In Campos das Vertentes the main food crops were corn and beans, while the principal cash crops were sugarcane and coffee. Additionally, dairy cattle were important in the region. The most common production system in Caninde involved cattle, cotton and subsistence crops.

Three tenure groups were studied in each of the sampled regions: owner operators, sharecroppers and landless laborers. It will be useful to describe differences between these tenure groups. The distribution of age in the sample households disclosed intergroup and interregional differences in the average age of the household heads and their spouses. Of the three studied, the landless laborers were the youngest with the average age of males at 38 years in Vale do Ribeira and 42 in Campos das Vertentes and Zona da Mata. The owner farmers were the oldest ranging from 49 to 57 years. Similarly, age differences existed among the regions with average age in the Caninde highest and that in Vale do Ribeira lowest.

The educational level was extremely low in the sample with an average schooling of about one year for adults. The owner farmers generally had more schooling than either the sharecroppers or the laborers. In Vale do Ribeira, Campos das Vertentes and Zona da Mata, the landless laborers had a lower level of schooling than the owner farmers and the sharecroppers. Among the regions studied the level of schooling was the lowest in Caninde.

Another important characteristic of the entire sample was the fact of relatively large family sizes. The owner farmers in Caninde had 7.5 surviving children per married couple, while those in Campos das Vertentes and Zona da Mata had 6.2, and in Vale do Ribeira 4.7 children. For the sharecroppers this figure varied from 3.9 children in Vale do Ribeira to 7.6 in Caninde. The landless households in the sample had a relatively smaller number of children, ranging from an average of 3.6 for Vale do Ribeira to 4.2 for Campos das Vertentes and Zona da Mata. In

terms of the number of persons actually living in the households, this was again the highest for Caninde region with 7.1 persons per household in the case of sharecroppers, while it was the lowest in Campos das Vertentes and Zona da Mata at 5.2 persons in the case of landless households.

The data on landholdings indicated that the average size owned or operated as small farms is much below the modulo, which varies from region to region based on varying environmental factors. The average size of a farm owned by the small farmers in Vale do Ribeira was 20.6 hectares, 51.5 percent of the modulo; in Campos das Vertentes and Zona da Mata 8.3 hectares or 22 percent of the modulo and in Caninde 32.7 hectares, 40 percent of the modulo. While some of the sharecroppers in Vale do Ribeira, Campos das Vertentes and Zona da Mata regions owned some land, none in the Caninde region had any land of their own. The estimated per capita income revealed that the low-income households in the Vale do Ribeira region enjoyed a relatively higher standard of living than the rest of the regions. For the year 1972-73, the lowest estimated per capita income (US $82) was that of sharecroppers in the Campos das Vertentes region, while the highest (US $180) was that of the owner farmers in Vale do Ribeira in the southeast. The landless households in Vale do Ribeira had the highest per capita income (US $170). It is important to note, however, that the estimated per capita overall income for all of the groups in the sample was extremely low (US $137). Because the sample was restricted to specific groups in selected regions, these income figures do not represent estimates of the per capita income in agriculture as a whole nor even for the sections of the country from which they were selected. On the average a person in the overall sample of low-income households earned an income which is less than one fifth of

the national average. Thus it is felt they represent an accurate portrayal of conditions among the Brazilian rural poor.

Income and Consumption

Poverty in Brazil is heavily concentrated in the agricultural sector (Langoni, 1973). In 1970 over 44 percent of the economically active population was employed in agriculture but generated only 14 percent of the internal income in Brazil. Evidence also shows that the agricultural sector has not benefited from the recent economic boom. During the 1960s the Brazilian economy experienced rapid growth. However, the proportion of labor employed in agriculture decreased from 47 to 40 percent of the total. Farmers share of income declined from 29 to 20 percent which resulted in a decrease in the income per laborer in agriculture relative to the urban sector.

Income Sources

In the 1972-73 agricultural year, net annual family income varied from $540-1022 (US) for sharecroppers and landowners, respectively. For salaried workers the estimated net family income ranged from $407-737. Although these figures are not particularly low in an absolute sense compared with other LDCs, they are substantially low in the Brazilian context, where the average per capita income was US $730 in 1973. In general, landowners have higher family incomes than sharecroppers and landless workers have the lowest incomes.

The main source of income for small landowners and sharecroppers was "net agricultural production" defined as the sum of sales, home consumption and changes in inventory of agricultural products and livestock

minus purchased inputs, hired labor costs and payments for land rented or sharecropped. For the landless workers, the salaried work in agriculture was the major source of income. All of the groups were largely dependent on the agricultural sector and, excluding landowners in Vale do Ribeira, received from 83 to 95 percent of the family income from it. Nonagricultural employment was a source of family income for all the groups except temporary workers in Campos das Vertentes. Other sources of income included pensions, gifts from relatives, handicrafts, etc., and in general were of limited importance.

Income Generation Model

Based on the small farm income generation model (Patrick and Graber, 1977), it was found that an additional labor equivalent of available labor would increase family income by an amount equal to about 20 percent of the annual minimum wage. The small increase in household income resulting from additional labor may be partially due to the lack of complementary resources. However, the increase in net household income resulting from additional use of some of the other resources was also limited. For example, if the use of purchased inputs and hired labor in regions of Minas Gerais were doubled, net household income would increase only slightly more than 10 percent. In other cases (e.g. livestock, machinery and equipment in the Minas Gerais regions) the estimated net returns were relatively near the real rate of interest and large increases in the variable might not be economically sound. The results of this study further indicated that within regions of relatively homogeneous agriculture, such as Caninde or the regions of Minas Gerais, landowners did receive higher incomes from the same resources than did

sharecroppers. However, the small landowner's income was probably not sufficiently higher than that of a sharecropper to provide a market rate of interest on the landowner's capital investment. In Vale do Ribeira, probably because of crop pattern differences, the renter-sharecropper group achieved greater incomes than landowners from the same quantity of resources.

The contribution of land to net household income in Vale do Ribeira and Minas Gerais implies a return on the capital invested of about 15 and 6 percent, respectively. These relatively low rates of return may be due to two factors. First, the price of land may be increased because of the demand for real assets as a hedge against inflation. Second, the unrealized gains in property values were not included as a return. However, in both regions, an increase in the area cropped would lead to only a small increase in current income. Given present technology, labor can only cultivate a limited amount of land and this will not provide an income for the small farmer comparable to that of the urban worker.

The adoption index used to measure knowledge obtained from extension contacts and other sources had substantially significant coefficients for Vale do Ribeira and Caninde. The Minas Gerais regions coefficient was not statistically significant, although it had a positive sign. This might have been due to intercorrelation between purchased inputs and the adoption index.

Improving the functional literacy of the small farmer would also increase net household income in the states of Minas Gerais and Sao Paulo. If the average household head changed from being able to read slowly and with difficulty, to being able to read rapidly and without difficulty, the results suggest net household income would be increased

about 20 percent. However, such a change would involve substantial social and private cost. Perhaps the greatest effect of education is in preparing the next generation for nonagricultural employment.

Income Distribution

The data on income distribution in all of Brazil (Langoni, 1973) show two noteworthy features. First is the inequality of incomes among sectors, and second is the unequal distribution of income within the agricultural sector. Langoni's analysis of income distribution in Brazil indicates that income was more unequally distributed in the tertiary and secondary sectors than in the primary sector. For example, the Gini coefficients for the tertiary, secondary and primary sectors were 0.5668, 0.4952, and 0.4403, respectively.

Analysis of income distribution in the country's primary sector during 1960-70 shows that the lowest four deciles of the income distribution increased their share of total income, while the share of the next five deciles declined. However, the share of the top decile increased by a larger amount than any of the other deciles. Furthermore, the largest percentage gains were attained by the top 1 and 5 percent groups. The average income of the highest decile group in agriculture was over 17 times as large as for the lowest decile in agriculture (this difference was 46 times in the urban sector). The average income of the top 1 percent of the primary sector increased almost 37 percent between 1960 and 1970, the largest increase of any group in the primary sector, while the average income in the urban sector increased 42 percent. The average income per member of the agricultural labor force increased only 14 percent in the 1960s. This emphasizes the fact that the income problem in

Brazilian agriculture is two-fold. First, rural incomes are low relative to the urban sector. Second, the rural-urban disparity is growing due to the lack of growth in agricultural income.

Analysis of the distribution of income among rural households was undertaken in two of the study regions based on a subsample of households consisting of 104 sharecroppers and small owners in Caninde and 156 small owners, sharecroppers, renters and agricultural workers in Vale do Ribeira.

In the Vale do Ribeira region in 1972-73, the distribution of income among all the sample households was rather skewed with the top 20 percent of the households accounting for about 36 percent of the income and the lowest 20 percent of the households only 9 percent of the income. In the next year, 1973-74, the share earned by the households in the top 20 percent of the Vale do Ribeira study region increased markedly to 47 percent of the income. In contrast, the lowest 20 percent of the households experienced a decline to 6.3 percent. These results indicate that in the Vale do Ribeira region, even among the small farm households, the income gap between the relatively well-off farmers and the relatively poor farmers tended to widen over the two time periods considered.

In Caninde, the income distribution among the sample households for the period 1972-73 was similar to the distribution in Vale do Ribeira. The top 20 percent of the households earned about 41 percent of the total income while the households in the lowest two decile groups earned only about 10 percent of the income. There is, however, one noteworthy difference between the two sample regions. Whereas these percentages varied over time for Vale do Ribeira, they varied little for the two time-periods in Caninde.

Almost the same pattern of income distribution is illustrated by the coefficients of variation and the standard deviations of the logarithm of income estimated for the study regions. Both of these measures showed a larger increase in income dispersion for Sao Paulo from 1972-73 to 1973-74 than the increase in income dispersion in Ceara which occurred from 1972-73 to 1974-75.

The greater inequality in the distribution of income as well as the faster growth over time in this inequality observed for the sample households in the study region of Sao Paulo may be considered from two viewpoints. Because of higher levels of economic development in the Vale do Ribeira region, income levels were relatively higher there than in Caninde. More importantly, Vale do Ribeira is closer to sources of development and growth than is Caninde. The income gains associated with location advantages of growing urban-industrial centers, or of development as such do not seem to have been evenly distributed among rural households. In fact, as the data revealed, discrepancies in income distribution among the sample households in the rural region of Vale do Ribeira have increased over the two time-periods.

Consumption Patterns

Per capita expenditures estimated for 1972-73 varied from $133 (US) for sharecroppers to $153 for landowners in Vale do Ribeira, while in Caninde these were $67 and $104, respectively. As expected among low-income households, the largest component of household consumption expenditures was for food (70-78 percent), housing, clothing and other items were minor. In Caninde consumption expenditures appeared to be higher among the owners than among the sharecroppers who had a relatively lower level of income. In the Vale do Ribeira region on the other hand

consumption expenditures were about the same for sharecroppers and owners; the average income of these two groups was also about the same. The proportion spent on food in both regions declined with the average level of income. In Caninde, households with annual income up to $333 spent on the average as high as 90 percent of their income on food as compared with 48 percent for those households with incomes in the range of $1000-1667. For Vale do Ribeira, food expenditures were 83 percent and 62 percent for the lowest and highest income groups, respectively.

The results of regression analysis have shown that, among the households analyzed, income is the largest determinant of the level of consumption expenditures. In Sao Paulo, where the mean income is higher than in Ceara, the average level of consumption expenditures tends to be higher.

The analysis did not show consistent results in regard to the effect of the number of persons in the household on consumption expenditures. The coefficient of this variable was consistently small and statistically nonsignificant in all the equations for Ceara.

Income: Policy Implications

The research suggests that a single specific barrier to higher household incomes does not exist. A number of changes would have minor impacts on incomes, but none of the changes would result in a doubling of income, the approximate level required by comparing land operated to the modulo. This suggests that government policy must be relatively comprehensive in coverage in order to substantially increase income levels of the small farmer.

The results of the estimating equations for both regions are fully consistent in showing a strong consumption-income relationship. When

income levels are already low, increases in consumption can be expected. The estimated coefficients for the income variable for both rural areas fully support this hypothesis. However, the data provide limited coverage of both time and cross section of households. This should be recognized before drawing generalized conclusions.

Production Systems Technology

Resource Efficiency

The production characteristics of low-income farms within the three sampled regions of Brazil were similar. The Ceara (northeast) sample included farms of up to 33 hectares in size whereas the Sao Paulo and Minas Gerais samples included only those up to about 30 hectares. As determined by INCRA, the land reform agency, the sizes of farms intended to provide full employment and an adequate income for a family with four workers in these areas begin at the upper limits of these ranges.

A low level of mechanization was prevalent. The Sao Paulo area had a few farmers with tractors, jeeps and trucks, but for the most part, the hoe was the principal agricultural implement used to cultivate and prepare land. Most of the farms had some poultry with minor sales of eggs and poultry meat. In Ceara less than half had cattle but the majority kept swine for both family use and sale. About two-thirds of the farmers in the Ceara sample kept draft animals. This percentage was considerably higher in Sao Paulo (87%) and lower in Minas Gerais where less than half had work animals. This includes horses for transportation as well as draft oxen.

Ceara was selected for an in-depth comparison of efficiency in resource use among tenure classes of owners, part owners and share croppers (Teixeira, 1976). The production of owner operators tended to be

more responsive to capital and labor whereas the sharecroppers' output was more responsive to land. As expected, the part owners usually fell between these two groups with minor exceptions.

The landowners' capital-labor ratio appeared economically efficient when the price or wage rate was taken as that under the current practice of labor guaranteed to the landowner under the sharecrop rental arrangements (sujeicao). On the other hand, landowners used less capital relative to land than was most economically efficient under conditions prevalent in the sample period. Under these same conditions sharecroppers had less of both capital and land in proportion to labor than was economically efficient. Making credit and education in the use of credit available appear feasible as policies to improve the incomes and productivity of these farmers.

Analysis of the on-farm market for family labor indicated, as expected, that the demand for labor for farming activities was responsive to changes in the imputed wage rate or return to labor in farming. The households' supply of such labor was responsive but inelastically so. Owners' families tended to be more responsive than sharecroppers' families in furnishing labor when the imputed wage rate increased and vice versa. Increases in nonfarm income were associated with increases in household labor going to farm activities. Increased education appeared to lead to high imputed wages for land owners but not so for sharecroppers.

Possibilities for increasing farm incomes with currently used technologies and enterprises are very limited.[1/] Substantial

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[1/] Studies in this area include: Graber, 1975; Garcia, 1975; Teixeira 1976; Patrick and Graber, 1977; Barbosa, 1973; Patrick and Carvalho Filho, 1975; IPEA/INPES, 1972; Panagides and Ferreira, 1972; Cesal and Bandeira; White and Roche; Patrick 1974; Sanders and Hollanda, 1976; Carvalho, et al, 1974; Junqueira, 1973; Ferreira, 1975; Lisboa Sobrinho, 1975; Gomes, 1974; Magalhaes, 1971; Lima and Sanders, 1975.

inefficiencies in resource allocations do exist and generally more family labor is available than can be effectively used during most or all of the year. Even extremely large changes in resource allocations result in only limited changes in the absolute level of the marginal product of labor. Linear programming analysis was used and the results indicate that the additional income resulting from a recombination of resources with current technology is very limited.

The inability to obtain substantial increases in income by reallocations of resources should not be interpreted as suggesting that farmers not be informed of resource adjustments needed or that resource adjustments should not be encouraged. Policies which encourage an outflow of young people should reduce the long-run aspects of the income problem in agriculture. In addition to reducing the supply of labor in the shortrun, outmigration will reduce the pressure for continued subdivision of holdings.

Linear programming studies using sample data commonly suggest that the problems of farmers differ greatly even within the small farmer category. For the very small farm, one with substantially less than the modulo, excess family labor is commonly a problem. In the Zona da Mata, even the introduction of labor-intensive activities did not provide employment opportunities on the farm for the available operator and family labor. For households in these situations, off-farm work is a critical need as a source of income. In contrast, farms of about the modulo in size, in both the Zona da Mata and Serra Talhada in the northeast hired additional labor during certain periods of the year to assist with various seasonal cropping operations.

The large seasonal variations in the labor requirements for crop activities leads to households having excess family labor during certain periods and facing the need to hire labor in other periods. This also makes clear the pressure for selective mechanization observed in some areas in which labor was generally assumed to be abundant. In some instances it may be possible to expand livestock activities to effectively utilize labor and other resources available.

Alternative technologies provide possibilities for increasing incomes on farms of the size being studied. In both Ceara and Minas Gerais, properly designed technology resulted in large relative increases in production and incomes. Some technologies which did not meet the needs of the farms considered resulted in very limited increases and sometimes decreases in production and income.

Production Technologies: Policy Implications

Considerably greater attention should be given to the economic evaluation of the technologies which appear agronomically feasible before they are recommended for adoption by farmers. Ideally, these technologies should be evaluated in a whole-farm context because of possible deleterious interaction with other phases of the production process. Additional research is necessary for the continual evaluation of newly developed production technologies. Information on the economic viability of individual practices or packages of technology is very important for guiding additional agronomic research as well as advising farmers. For example, the research showing that fertilization is not economical in the semiarid Ceara indicates that physical scientists should emphasize other techniques.

Although properly designed alternative technology can increase the potential income of small farmers, technology alone is not the answer. As indicated previously, despite substantial increases in income levels, the absolute levels of income are generally low in comparison with the minimum wage. This is especially true for the farms which are substantially smaller than the modulo. The effectiveness of technology can be increased if combined with other programs such as relaxing constraints to credit availability.

It is important for researchers and policy makers to recognize that some farms are simply too small to provide a family with an income equal to the minimum wage. Technology will not provide an answer to their problem and major investments in an attempt to discover technology or enterprises to solve their income problem would be futile. Instead, programs which will facilitate the transfer of these people or their children to situations in which their labor and other resources can be more productive appear to offer better pay-offs. In some cases because of age or other characteristics, welfare programs may be the most effective and efficient means of improving the household's situation. For the long-run solution of the rural poverty problem it is of crucial importance to avoid perpetuating the current situation in which the younger generation is entrapped in the circumstances of the parents.

For the small farm with a more adequate resource base, new or alternative technologies and enterprises can become the heart of a comprehensive program to improve income levels. Currently, much of the research underway in Brazil is not directed specifically at the problems of this size farmer. This is probably not too serious a problem with much of the

biological research, but the problem of selective mechanization does deserve some attention. The land-saving, labor-using types of technologies need to be carefully evaluated to see that they do not create bottlenecks in the production process. In fact, this type of technology has the potential to create a demand for labor-saving technology.

Experiments analyzing level of fertilizer use, comparing varieties or the effectiveness of different chemicals are often evaluated in isolation. However, the interaction effects of these technologies, individually or in a package with the rest of the production process make it necessary to analyze the whole farm when attempting to evaluate whether a particular type of technology is economical. Given the large number of small farms in Brazil, improvements in technology could have a substantial impact on both rural incomes and employment.

Increases of 25 to 50 percent in net incomes from use of new technology would be essential to alleviate the problems of rural poverty. These changes are very substantial but would not solve the problem if such incomes cannot provide returns for labor and capital similar to that which they receive in other uses. However, technology does have a major role in increasing potential incomes of the small farmers and contributing to the process of overall development even though it should not be expected to solely resolve all the problems.

Factors in Technology Adoption

Production techniques surveyed among the Brazilian small farmers were classified according to whether their use might be induced by land-saving or labor-saving purposes. Furthermore, each of the techniques in these two groups were classified according to whether they required

investment or only current expenses. This was thought to be as relevant as the usual breakdown into mechanical and biochemical techniques. As it turned out, the techniques requiring investment were of a mechanical nature while those requiring only operating expenses were of a chemical nature. No purely biological technique was considered in this study. The mechanical techniques (working animals, tractors, cultivators, etc.) involved investment capital due to the nonexistence of well-functioning markets where the services of such factors could be rented.

The four types of techniques defined were: labor-saving mechanical, labor-saving chemical, land-saving mechanical and land-saving chemical. A farmer was considered to be adopting labor-saving mechanical techniques if animal or mechanical energy was used in the land-preparation and/or cultivation process. Labor-saving chemical techniques were defined if herbicides were used in the cultivation process, even if the ultimate objective is land augmenting.

The farmer was considered as adopting land-saving mechanical techniques if conservation practices were used to avoid erosion, e.g., building terraces and planting on level curves on the hillsides. Land-saving chemical techniques included the use of chemical treatment of seeds before planting and/or the use of chemical fertilizers.

Logit analysis (Tollini, 1977) was used to associate the adoption of the various production-techniques with location (region), type of land tenure, education of the farmer and the use of institutional credit. The results were statistically significant at the 5-percent level with the exception of labor-saving mechanical techniques. However, the coefficient of determination for only one of the equations was particularly high.

Several observations came to light. A large proportion of the Brazilian small farmers still relied on human energy and primitive processes to carry on their agricultural production activities. This proportion, however, varied a great deal with the type of practice and was very much affected by profitability which was related to the product and factor markets, institutional credit, land tenure and farmers' management abilities.

Considering types of practices, it is not possible to affirm without qualifications that mechanical techniques have a higher probability of adoption than chemical techniques. Although this is true in conjunction with labor-saving techniques, in conjunction with land-saving techniques it is not uniformly true. Mechanical techniques do have a higher probability of adoption in the northeast (Ceara), where the environment (physical and economical) implies an extremely low, or even negative, return on the risky land-saving chemical techniques (Hollanda, and Sanders, 1976). In the southeast (Sao Paulo and Minas Gerais), land-saving chemical techniques have a higher probability of adoption than land-saving mechanical techniques. This difference in the adoption behavior of farmers in the two areas may be the consequence of different levels of investment in research and extension (Thompson, 1974). Mueller argues that mechanical practices are more easily-transferred and adapted to local conditions than chemical practices and that the lack of a good research system may reduce the technological alternatives available to farmers. The results of this study seem to lend empirical support to this hypothesis. Given the crop mix and the factor and product markets in the two areas, the lack of a responsive research organization

in the northeast restricted the adopting of new technology in that region. Mechanical techniques, being easier to adopt, are more likely to be used than chemical techniques.

Education was found to substantially affect the probability of adoption of chemical techniques. The role of education in the adoption of mechanical techniques, however, was less important. This may be caused by the different degrees of difficulty in decoding these two types of techniques, resulting in differences in the required management abilities (Welch, 1970).

Although education increases the probability of adoption of technology, and more so in the case of chemical techniques, profitability was an essential condition. The lack of profitability of chemical techniques for small farms in the northeast made their probability of adoption nil, regardless of the educational level of the farmer.

Profitability also dominated the positive effect of institutional credit. Credit was very important for the adoption of labor-saving mechanical techniques and of land-saving chemical techniques. It also had a small but significant effect on the adoption of labor-saving chemical techniques.

Surprisingly, land ownership did not increase the probability of adoption of any type of practice. Renters and sharecroppers showed a higher probability of utilizing land-saving practices and of labor-saving chemical practices. Even for mechanical, labor-saving practices, land ownership did not play any significant role in the adoption process.

Agricultural Information Systems

The majority of the low-income farms in the sample acquired information from informal sources such as transistor radios and newspapers; only a small portion of the information furnished by such sources is relevant to production management decisions. On the other hand, only a small fraction (less than 25 percent) of the farmers utilized institutional and formal sources such as the agronomists and extension workers working with government agencies that provide mostly production information. Sharecroppers, especially in the study areas of Ceara (northeast) and Minas Gerais (southeast), acquired much less information from these sources than did the owner-operators.

The fact that a vast majority of low-income farms remain outside of the orbit of public institutions concerned with dissemination of agricultural information should be of concern to policy makers. The relationship or association between information acquisition and the characteristics of the decision maker and the household, including its resource endowments and environs under which decisions are made, is pertinent here. Hence, variables that were incorporated in the information model included education, income sources, land tenure and regional characteristics.

The results of regression analysis support the hypothesis of a positive association between information and education. The coefficients of both the household head's schooling and the schooling of children in the household were positive. Thus, it is not only the education of the head of the household but also the education of children that was important in influencing the household's search for information relevant to farm production and resource allocation. The present evidence shows a

relatively greater impact of the education of children suggesting that with an increase in the level of education among the farm people there will be greater search for production-related information. The economic value of information realized through education can be explained by two improvements: efficiency of resource allocative decisions on the farm, and mobility of labor leading to off-farm employment.

Farm size had a positive effect on the quantity of information acquired by small farm households. The coefficient of this variable was positive in the institutional and all-credit models tried. It was statistically significant in the institutional credit model at the 10-percent level, and at the 15-percent level in the all-credit model. This also suggests that households with the larger sized farms have made greater use of institutional sources of information such as governmental research and extension agencies. This information/land relationship might have been more pronounced if the sample had also contained medium and large sized farms using higher level production technologies.

Farm households which own land acquire higher levels of information than those not owning land, other things held constant. Proprietors (owner-operated farms) acquired significantly higher levels of information from the institutional sources as well as from overall sources.

The variable representing nonagricultural sources of income appeared consistently positive in all four information equations tried. In three out of the four equations, the coefficient of this variable exceeded the standard error of estimate and the coefficient was statistically significant at the 10-percent level in the institutional credit model. A part of the nonagricultural income is accounted for by migrants' income transmitted

to farm households from outside the region or locality. From migrant-members, the households could also receive information by exchange of letters, visits and gifts. Gifts such as transistor radios and bicycles help households acquire information. It is reasonable to expect that households with outside contacts will perceive the benefits of information better than those that do not have them. Migration from this standpoint enhances the economic value of information. Although the converse may also be true, information in this study was the dependent variable.

The variables, education, land and off-farm income influence the demand for information positively because they enhance the economic value of information to the household through more efficient resource allocation. The impact of these variables on the search for production information can be viewed through a cost-benefit perspective of household economics.

Information Systems: Policy Implications

Public agencies engaged in disseminating production and other kinds of information in agriculture need to make concerted efforts to break the various constraints that have prevented the low-income farms from acquiring relevant information and hence from taking advantage of improved farm practices. It is equally important, however, to supplement and complement the efforts of public agencies in charge of information and extension services with appropriate policies in other areas, such as farmers' education, development of technology suitable for the small farms, the release of credit and land constraints and removal of labor market imperfections.

Credit Availability

Analysis of macrolevel data on rural credit distribution in Brazil shows that the major proportion of credit advanced by institutional sources has gone to large farms. Empirical evidence also shows that small farmers are receiving only limited credit. Farms less than 100 hectares (247 acres) which account for 90 percent of total farms in the country (24 percent of land area and 58 percent of total production) during 1975 received only 38 percent of total credit advanced by the government, whereas farms with 100-1000 hectares of land which account for 8 percent of total farms (37 percent of total land area and 27 percent of total production) received 44 percent of the total amount loaned. The remaining 18 percent went to farms with 1000 or more hectares of land. This trend in Brazil is, of course, in line with the general phenomenon of the low-income small farms having been bypassed by development efforts made in recent years in most of the developing countries.

The present study of small farm credit investigated the borrowing activities of low-income farm households and sought to identify some of the factors that determine household borrowings or the household demand for credit. The study utilized the data from a subsample of 129 small farm households (out of a total of 608 sample farms), comprised of owner-operated farmers and sharecroppers. Lack of completeness in the data on credit and other related variables was the reason for confining this analysis to a subsample.

Credit Sources and Constraints

In the rural regions studied, only 13 percent of all sample households received credit from institutional sources, while another 7 percent received credit from noninstitutional sources such as private money lenders, traders and merchants, friends and relatives, etc. A greater proportion of the landowners (owner-operated farms) received credit from institutional sources than did the sharecroppers. Also, their average amount borrowed was much higher than that of the sharecroppers in the sample.

The majority of landowners and sharecroppers felt they had credit restrictions in their production and investment decisions. This was felt most in Ceara in as much as 93 percent of the owners and 97 percent of the sharecroppers on small farms reported credit restrictions. In Sao Paulo these figures were 37 percent and 54 percent while in Minas Gerais they were 51 percent and 59 percent, respectively.

The single most important item of intended credit utilization for both tenure groups was future investment in agriculture. The sharecroppers showed a greater tendency to use credit for land purchase. Lack of adequate security in the form of capital assets such as land and livestock, and lack of ownership title were offered by sample households as important reasons for denial of credit by organized institutions.

The data on institutional credit utilization show that most of the credit obtained was used to purchase land (51 percent of total credit in Minas Gerais, 63 percent in Ceara.) Data for Sao Paulo were not available. Sharecroppers tended to spend relatively more credit funds on implements and working animals than did owner farmers. Likewise, sharecroppers used

more credit on consumption than landowners. Unwillingness to finance consumption may be another reason why institutional sources are reluctant to advance credit to sharecroppers.

Factors Influencing Demand for Credit

The results of regression analysis indicated that income sources were a major determinant of the household's borrowings. Both the agricultural income and nonagricultural income variables had positive and statistically significant impacts on household's borrowings from institutional and other sources of credit. The coefficient of the land variable on the other hand, although positive, appeared nonsignificant statistically. Land in models without income variable did not reflect agricultural income among small farmers since it did little to explain credit obtained. Of the two income variables, nonagricultural income exercised a much greater impact than agricultural income with respect to both magnitude and statistical significance of the coefficient. The positive and statistically significant effect that the nonagricultural income variable had on borrowings may reflect increased information transmitted to households through members who had worked off farm, as well as the ability of such households to spread their risk; both conditions are conducive to household borrowing. Also the presence of nonagricultural income helps assure the lending institutions that loans will be repaid on time.

Possession of nonland capital assets (small implements, household durables, livestock) by small farm households was another factor that had a positive effect on borrowing from institutional sources. This indicates that those who possessed savings in alternative forms had a

better chance of receiving credit. The variables representing livestock and other investments in capital equipment, both farm and household, generally reflect farmers' ability to save.

The regression analysis also highlighted the education variable. Despite the fact that overall schooling is low among low-income farmers, the schooling variable did have a positive effect on credit obtained. The positive effect of farmers' schooling on credit usage is probably brought about in several ways. It enables farmers to acquire relevant credit information at lower cost and increases their ability to make better use of credit in combination with other farm resources. Farmers having some schooling have an advantage over those with no schooling when dealing with credit agencies. Their perception of the potential returns from credit is better also.

The coefficient of the household head's age variable was negative and statistically significant in both the institutional and noninstitutional credit models. This may imply two things. First, an older farmer is less willing to take risks or search for newer opportunities, and consequently uses less credit, other things being equal. Second, credit institutions may prefer to advance loans to relatively younger farmers.

Credit: Policy Implications

Two things bear on policy. First, credit is perceived as a constraint by the operators of small farms but the institutional credit agencies have directed the major share of their credit to large farms. Second, if the credit constraint faced by low-income farms is to be relieved as a part of concerted efforts to help the low-income households participate in

and derive benefits from Brazil's developmental efforts, provision of credit as such will not be adequate. Along with it must be provided information and training in obtaining and using credit if the small farmers are to make productive use of this scarce resource.

Time Allocation

Decisions to allocate time to different activities are important for several reasons. First, labor supply is linked with the pattern of time allocation of household members. Second, the way a household allocates its time resource between market and nonmarket activities has important bearing on its economic well-being. Third, the way individuals allocate their time between good-intensive and time-intensive consumption activities also reflects the economic opportunities in society and the way different groups of individuals and households avail themselves of such opportunities. Low-income households face a number of constraints which deny or substantially limit their opportunities to participate in productive activities outside the household and the farm. The analysis of time allocation had two objectives: 1) to provide a descriptive analysis of the existing pattern of time allocation of household members, and 2) to analyze with the help of the new household economic model the time-allocation behavior in order to identify the major factors that influence the pattern of time allocation of the household members.

The major part of the husband's total work time was devoted to farming activities. The proportion of time devoted to off-farm activities was generally small among the low-income rural households, although in the study regions of Sao Paulo and Minas Gerais there was more of this than

occurred in the study region in Ceara. The dominant consumer of the rural wife's labor services, on the other hand, was the household sector accounting for about 55 percent of her total work time in Sao Paulo and 68 percent in Ceara. Work on own-farm did not account for more than 10 percent of her total time.

The percentage distribution of children's time among various activities indicated that children in low-income rural households begin to participate in economic activities of one kind or another from as early as 7 years of age. The activities performed in the household such as work on maintenance, child care, cleaning, cooking, collection of firewood, etc. took the major share of children's total work time in all regions.

The household members' time allocation relationships among the low-income groups were estimated with models of basically the Becker-Lewis type (Becker and Lewis, 1973). It includes five labor supply equations; three explain the total work of the husband, the wife and the children, and two explain off-farm work of the husband and other members of the household (Lopes, 1979).

Husband's Time

The regression coefficient for the husband's implicit wage variable (value of the marginal product) appeared consistently positive and statistically highly significant in all the equations tried. The own wage of total labor supply of the husband was relatively inelastic to wage change. A 10-percent increase in the own implicit wage is likely to induce a 3.6 percent increase in the total quantity of labor supplied by farm husbands. The results of the regression give no evidence that income variables influenced the husband's time allocative decisions.

The statistical results did not exhibit the predicted effect of husband's education on his total labor services supplied to work. The coefficient of this variable was negative, though statistically non-significant. The already low level of education that characterizes the low-income rural heads of households may explain why the education variable remains in the background in influencing the time allocative behavior of the husband. The opportunity wage of the husband defined in terms of his perceived wages in off-farm activities (if he were to leave his present occupation) did not appear to affect his total time allocation in any important manner.

Wife's Time

The wife's implicit wages (value of the marginal product) had the predicted positive impact on her labor services supplied to farm and off-farm work. The elasticity coefficient for the implicit wage variable was consistently greater than one and over three times that of the husband. It was statistically significant at the 1 percent level in all the models. This implies that with a rise in the implicit wages, the value of the wife's time will increase and she will shift greater amounts of her total time away from domestic activities to work on own-farm and outside. The negative and significant coefficient of the husband's implicit wage variable on the other hand suggests that the husband's time may be a substitute for the wife's time allocated to work activities.

The education of the wife had a negative and statistically significant influence on her total time allocated to work activities. It is generally assumed that education will enhance the productivity of time in work outside of the household; the results do not support this. The

explanation may or may not lie in some socioeconomic reasons, such as the following: 1) the value of her time increases more in the household than outside, 2) limited alternative employment opportunities available to the educated wife within the locality, 3) difficulties in her movement outside the locality as it is dependent upon that of the husband as well as deficiencies in transportation facilities, 4) working on farming activities of the small farms does not require formal education, nor are wages related to schooling, and 5) low prestige attached to farm work outside of own farm for the educated wife, however low that education may be.

The coefficients of total earnings, household size and number of young children in the household had the expected signs but were statistically nonsignificant. The coefficient of the number of older children appeared negative and statistically significant at the 15-percent level. This implies that the older children's time substitutes for the wife's farm and off-farm work time. However the job opportunities off farm are very limited so most of this substitution takes place in own farm work. Age of the wife had the expected effect in that she supplied less total work as she became older.

Children's Time

The children's time allocation model yielded mixed results. The coefficient of the own-wage variable was negative and significantly different from zero. A negative work-wage response implies that the supply curve of children's total work is downward sloped. The coefficients of the husband's wage and wife's wage did not affect the total work from children. The coefficients were not statistically significant

and were small in size. Similarly, the statistical results do not support the view that the husband's opportunity wage affects total work of children.

The coefficient of total earnings was positive and statistically significant at the one-percent level Such positive income elasticity suggests that a rise in family income would reduce children's home work time and increase their total work allocation. However, the sign on this coefficient is probably related to the failure to identify the parameters of the wage variable as indicated by its negative coefficient. The coefficient of the nonlabor income variables: children's education and husband's education, had signs consistent with expectations but were not statistically significant.

The size of household had a deterrent effect on children's time allocated to work. It seems this variable picked up the effect of an increased demand for home produced services, particularly subsistence needs, induced by a larger number of household members. The coefficient of number of younger children was positive, relatively large in size and statistically significant at the one-percent level. An increase in the number of younger children in the household will lead to greater allocation of older children's time to work on own farm and outside of own farm.

Agewise, the 7-13 year olds spent relatively more time in the household (16-36 percent) as compared with older children (12-20 percent). Interestingly, children of all ages devoted a comparatively greater fraction of their total time to the farm than did their mothers. Rural children had limited off-farm opportunities, although the older children aged 18 years and above in the household supplied relatively more labor

services to the market than did younger children. This suggests a substitution of labor services within the household consistent with relative wage and employment opportunities available to the household. The younger children perform work in the household while the older children supply more labor services to the market, where their marginal productivity is higher than in domestic work which can be performed by younger children.

The data on children's time allocation exhibited rather marked interregional differences. For all age-groups, Caninde in the Ceara region has the lowest participation rate (0.4-1 percent) in off-farm activities while Vale do Ribeira in Sao Paulo has the highest rate of participation (9 percent). Minas Gerais region is in between (1.4-6.5 percent). These differences reflect labor market conditions in the three regions.

Regional Differences in Time Allocation

The coefficient of the regional dummy for Minas Gerais was negative and statistically significant in all the models, implying that, other things equal, the level of total time allocation to work by the husband, the wife as well as the children in the Minas region is significantly lower than that of the Sao Paulo region. This could be due to the fact that the Sao Paulo region has a relatively better job market as it is economically more developed with richer resource endowments including infrastructures.

The coefficient of the off-farm wage variable was positive and significant at the 10-percent level. Implicit wages consistently exercised a strong negative effect on the husband's off-farm work in all the

equations tried. Off-farm work was competing with on-farm work for his time.

The coefficient of the total earnings variable was positive, relatively larger in size and statistically significant. An increase in total family earnings induced an adjustment towards off-farm work and away from farm work, with husband consumption time remaining unchanged. Statistical support for an effect of nonearnings income (gifts, etc.) and capital on the off-farm work of the husband was, however, weak. Increase in farm size did have some deterrent impact on the husband's off-farm labor supply.

Surprisingly, the education variable had a significantly negative effect on the husband's off-farm time allocation. At extant low levels, education enhances his own-farm productivity more than his off-farm productivity.

Time Allocation: Policy Implication

Important policy implications flow from the analysis of time allocation of household members. Farm and off-farm wage rates influence the level of employment. The greatest impact is on the supply of labor by the wives, but there is a response as well by the husbands, suggesting that labor market policies such as minimum wage can influence the level of employment. The low wage-supply elasticity for the husbands indicates that policies which shift the terms of trade against agriculture will have little influence on their employment, although the implicit wage they receive will decline proportionately more. The impact of such policies on the wives, however, is likely to reduce their level of employment relatively more than the wage rate they receive. The increased employment of women in Brazilian agriculture in recent years is a logical

response to the increase in wage rates in the agricultural sector and does not appear to be the result of declining family income as is often alleged. The failure to find statistically significant cross elasticities for the various wage variables suggests that wage policies can be focused on particular groups of the labor force if so desired. This has important implications for measures designed to influence school attendance of the young. The statistical results pertaining to the real income variable suggest that, within the range of the data, increases in income do not seem to lead to any substantial change in work effort. To that extent it does not appear likely that labor supply would decline with rising income. Finally, the amount of off-farm time allocation appears to be responsive to wage rates. This indicates that as wages continue to rise in the nonfarm sector, there will be an increase in the amount of off-farm work. This in turn may lead to an increase in farm wages if the labor market functions in a competitive way.

Fertility Behavior and Human Capital

The Brazilian experience exhibits a characteristic of marked interregional differences in the levels of both numbers and schooling of rural children (Singh, Schuh and Kehrberg, 1978). Regions with high fertility rates are also regions of low level of quality in terms of the education of children. The number of children born per married couple in the sampled regions varied from as high as 9.1 in Caninde to as low as 4.8 in Vale do Ribeira. In terms of schooling per child, the range was from 1.5 years in Ceara to 2.3 years in Sao Paulo for all groups of households. School enrollment also differs among the three regions under study.

While demand for number of children is quite high, investment in their schooling (quality) is quite low in low-income, rural households. The Becker and Lewis (1973) generalized household economic model for schooling and fertility was extended and accounted for some of the special economic conditions of poor rural households and their environment in Brazil which may have bearing on the household decision-making process.

Data used for empirical testing of the model were drawn from approximately 500 households out of the total of 608 households in the sample. In the macrolevel analysis of the demand for schooling, however, secondary data collected from census reports were used (20 states being the units of observation).

At the microlevel child quality was measured in two ways, school enrollment and average school years per school-age child in the household. The latter performed better in explaining household demand for child quality in the regressions. Overall, school years per child is conceptually a better measure of the level of child quality in the household and to that extent it also gives a truer reflection of the effect of household investment in child quality than does school enrollment.

Demand for Children

This study indicated that the economic value of children to the household is a major determinant of fertility behavior. In poor rural households economic value of children comes from participation in household activities, own-farm activities and off-farm earnings.

The parents' schooling and contacts outside of the household vicinity had a negative, although relatively weak statistical influence on the

number of children per household. The mother's age, as expected had a pronounced effect on fertility. On the other hand, the allocation of her time to farm activities whether own-farm or outside of own-farm had little significant influence on household demand for children.

Amount of land farmed had very little impact on fertility, but household annual income evidenced a significant positive effect on fertility at low-income levels. However, at higher levels of income the effect on fertility from increasing income would be less and conceivably could be negative. This was supported by a negative coefficient on the quadratic income variable in the regression.

Use of modern agricultural technology tended to be associated with reduced numbers of children per household. Agricultural technology was reflected in the model through purchased input and capital assets variables.

Another significant determinant of fertility behavior in low-income households is infant mortality. Infant mortality may reflect, 1) physical health of the mother and/or 2) availability of medical care facilities in rural areas. The statistically significant positive coefficient for this variable supports a partial replacement theory. The greater the incidence of mortality among young children in the household, the greater the uncertainty about the number that will survive, and hence there is increased incentive for the parents to have more children.

The tenure characteristics (owner-operatorship and sharecropping) did not appear to lead to any significant difference in the number of children per household, other things equal. The purely landless household did have fewer children per household with other conditions held constant.

Demand for Schooling

Increased schooling of children was associated with lower numbers of children per household. Children's off-farm income was negatively associated with amount of schooling although the strength of the statistical evidence varied. Participation by children in off-farm activities raises the economic value of their time. This implies a rise in the opportunity cost of schooling and hence a reduction in demand for schooling. On the other hand, allocation of the children's time to work on the family farm did not seem to hinder schooling. Interestingly, the amount of work done by children in the household such as maintenance, cleaning, cooking, etc. was positively associated with the amount of schooling. Apparently, these activities can be carried on at times that do not conflict with school attendance.

Migration was associated with greater demand for schooling. This finding is consistent with the hypothesis that with more possibility for migration, the returns to schooling are expected to be higher. Whether parents expect returns for themselves in their old age or through help from children in better jobs is not certain. The parents may simply view this as an opportunity to help their children. Education helps children take the opportunity to migrate and the incentive is probably enhanced by success.

The presence of young children and elderly persons in the household had a depressing effect on demand for schooling. This relation probably resulted from the greater amount of work required of school-age children in households that had to care for very young and very old family members. The care of young children (0 to 5 years) is particularly time intensive. Their presence increases household demand for labor services of older

children in order to allow the mother to conduct other household tasks and work outside of the household. This situation increases the opportunity cost of education and leads to a greater number of children and less schooling per child in the household.

The positive and statistically significant effect on schooling of children associated with the level of the mother's schooling suggests the importance of women's education in the human capital investment process. The educability of subsequent generations is also enhanced: a long-run social benefit in the development process. Although the mother's schooling was important, the way in which her time was allocated among household and outside activities did not evidence a strong relation to investment in children's schooling.

Evidence that children's level of schooling was associated positively with the father's schooling and outside contacts was relatively weak although coefficients in the model had the appropriate sign. Analysis of macrolevel data on enrollment in rural primary schools indicated a positive and statistically significant effect of education of older persons (15 years +) in the household on enrollment of children in rural primary schools. The father's age was more important than his schooling and its advance appeared to have a declining positive effect on the level of children's schooling.

The average number of years of schooling of children in the household increased as the area farmed increased. Land holding, whether owned or rented, was important in the context of investment in human capital. On the other hand, household income appeared to have a negative influence on schooling though the evidence was statistically weak. It would not

be unreasonable, with other factors constant, for income to increase at the expense of schooling in situations where child labor can be used to increase income.

Nonownership of land had a deterrent effect on schooling. The children of both sharecroppers and landless laborers received less schooling than those of owner-operators, with other variables at comparable levels. Children from landless labor households were the most disadvantaged in this respect.

Modern agricultural technology represented by purchased farm inputs and capital assets had a positive effect on household demand for schooling. This influence can be explained through the impact of modern technology on farm income and the household's demand for labor services. The positive effect of technology on schooling of children and its negative effect on number of children per household definitely influenced the quality-quantity mix of children in low-income farm households.

The macrolevel analysis of demand for schooling yielded an important result with respect to the child-teacher ratio variable (measured by the number of children per primary school teacher in rural Brazil). The coefficient of this variable turned negative and statistically highly significant. This means that in areas where the supply of teachers was deficient, there was less enrollment in schools, other things constant.

Average levels of schooling per child in households and the average number of children per household varied among regions of Brazil. A considerable portion of this variation may be associated with explanatory variables such as postulated in this study, but some cannot. The Sao Paulo region in the southeast evidenced the greatest tendency to reduce

the level of fertility and increase the level of schooling even when other explanatory variables were at the same levels. Of the three regions studied, Ceara had the highest number of children per household and the lowest schooling per child, other things equal. The Minas Gerais regions were between Sao Paulo and Ceara in these respects.

In terms of investment in human capital through schooling of children, Ceara was therefore making the least progress even with the explanatory variables at comparable levels. Some of the possible factors involved in these regional effects are infrastructure, low quality of resource endowments and agroclimatic conditions. Ceara's disadvantaged position in these respects tends to favor high levels of fertility and to depress the level of investment in schooling of children.

Fertility and Education: Policy Implications

The results of this study help identify variables which can be manipulated through educational policies designed to affect decisions relative to fertility and feasible levels of education. Such policies are important for a country where the educational deficiencies among its people not only place a severe constraint on development but also pose serious limitations on efforts to deal with the problem of poverty among low-income households.

The empirical evidence suggests that the quantity-quality decisions of low-income parents in rural Brazil are influenced by factors that are interpretable from a cost/benefit perspective. In the present economic environment of rural Brazil, the opportunity costs of education are high for the low-income households. Given the prevailing budget constraints, it is quite reasonable to expect that these households will substitute

quantity for quality. If a goal of public policy is to raise the level of human capital in children by inducing parents to invest in education, it should aim at easing the various economic constraints which act as deterrents to the household's demand for child quality. In addition to tuition-free schooling there are opportunity costs of schooling to the household which must be reduced before it is economically rational from the household's viewpoint to school their children.

There are at least three possible ways to reduce the opportunity costs of schooling for the poor households. First, the government might provide direct monetary incentives by means of cash payments to the families which send their children to schools. These payments might have to be equivalent to the prevailing wages for child labor. Perhaps better, the government might provide on a modest scale school-going children with meals and school supplies. Three out of every five school teachers who were interviewed in the study regions indicated that these provisions would provide low-income parents a strong incentive to send their children to schools.

A second possibility is to lower the opportunity costs of schooling through classes in shifts. The shift system allows children to attend schools when free from the wage-paid jobs or farm work which hinders their attendance during normal school hours. Our evidence does not support this measure strongly because the coefficients for the key variables are small and nonsignificant. However, if operating schools in shifts would encourage attendance by school-age children involved in child care, this policy may have some merit. This possibility can be inferred from the significant negative coefficient for the preschool children variable

which may imply that school-age children stay home to care for younger children.

A third policy device will have to deal with the barriers on the supply side of schooling. The deterrent effects of location and transportation costs could be broken by expanding the primary level educational facilities in rural areas with proper locational planning and by improving the means of transportation. However, the aim should not be to merely build primary school buildings at particular locations. Care should be taken to provide adequate numbers of teachers as well as school facilities that create incentives for parents to send their children to school.

Another significant policy inference suggested by the results of this study pertains to the role of modern agricultural technology in influencing the quantity-quality decisions of farm households. The technology variables as incorporated in this study evidence a significantly deterrent influence on the number of children and a positive influence on child quality demanded by the households. This points to the vital linkage that exists between the country's farm modernization policies and those pertaining to fertility rates and investment in education. Recognition of these rather indirect effects of modern agricultural technology further suggests the need for public policies concerned with, 1) evolving and spreading appropriate technological changes in agriculture, and 2) creating the conditions conducive to the adoption of such technologies by low-income farmers.

The empirical evidence on school-tenure relationship indicates that land ownership influences parents' investment in the education of their

children. The land tenure coefficient shows that households that own land (owner operators) had, other things equal, significantly higher levels of investment in education (per child) than those households (sharecroppers and landless farm laborers) that did not own any land. The converse was true in the case of child numbers. The schooling equation results indicated that the role of land ownership in influencing household investment in children's education needs to be recognized. Policies that assist agricultural laborers and tenant farmers through credit for land purchase may have merit.

The relationship between the education of the parents and the household's quantity-quality decisions that emerged from the regression analysis provides guidelines for public policy. The mother's schooling especially appears as a powerful factor that influences the household's decisions to invest in the education of children. The intergenerational effects of women's education on quality, and through it ultimately also on number of children, takes on importance in the context of public policy. This is in addition to other social benefits such as allocative efficiency associated with the education of mothers in decoding and interpreting new technical and economic information pertaining to production and consumption. Increasing the mother's education in rural areas - not necessarily formal education in all cases - would appear to warrant serious consideration in development policies.

The results of the fertility model indicated a positive relationship between the demand for number of children and the incidence of infant mortality among low-income households. The observed high mortality among young children may be caused by factors such as poor health of the

mother that results from nutritional deficiencies, lack of proper medical facilities and poor information. These conditions are often severe in rural areas with poor transportation.

The empirical evidence indicating that fertility decreases with decrease in infant mortality may be turned to advantage in public policy, although fertility as such is only one part of the population problem. If reduction in the fertility rates is a goal of public policy, one way to achieve this goal in the long run may be through measures which help reduce mortality rates among young children. Important among such measures could be the provision of extension centers for health and nutritional guidance (including family planning and birth control measures) as well as medical facilities. Also, improved sanitation and other forms of assistance under the general health improvement programs of governmental and other agencies could be supplied. Making these facilities accessible to poor households could form a broadly based approach to fertility reduction.

Briefly, this study has emphasized and given considerable evidence for two conclusions bearing on policies. First, whatever causes the quality of children to rise will, ultimately, cause the number per family to decline. Second, the problem of high fertility and low schooling among poor rural households should be viewed as a part of the low-income problem and vice versa. Policies to deal with fertility behavior, investment in human capital and rural development are definitely interrelated and together must form an integral part of a country's overall development policies.

Labor Market Imperfections and Mobility

The existence of an imperfect labor market constitutes an important source of economic disequilibrium and consequently of continuing rural poverty. The development process requires a large transfer of farm labor out of agriculture. The question then is whether or not and to what extent the labor market responds by transferring labor from the rural sector into the rest of the economy. Imperfections may exist in the intersectorial and interregional labor markets causing sectorial and regional differences in the levels of living and hence poverty. Such imperfections can be caused by a number of factors such as geographic dispersions of agriculture, imperfect communications, underinvestment in schooling and training systems and economic policies of the government.

Labor Force Participation and Wage Structure

The sectorial distribution of the labor force indicates that significant structural transformation has taken place in Brazil's labor market over the last three decades (Schuh and Singh, 1976). The relative role of the nonagricultural sector as a hirer of labor has increased in recent years and employment in the economy as a whole expanded at an average annual rate of 2.7 percent during the decade 1960-70. In the early seventies it even exceeded 3 percent, with the highest rates of growth in the nonagricultural sectors, i.e., social services and industry. Also, the labor market has experienced some increased participation by women. As compared with 13.6 percent of all women participating in the market in 1950, there were 18.5 percent in 1970. The increase in the rate of their participation has been accompanied by a relatively small

decrease in the male participation rate. A part of this decline can be ascribed to the increasing enrollment in schools causing withdrawal of the young men from the active labor force. Changes have occurred also in the sources of employment, with agriculture as a source declining for both men and women.

Interregional characteristics of the labor market experienced some noteworthy developments. First, employment growth was so generalized in the period 1960-70 that little interregional migration of labor was required. Hence, intersectorial migration took place largely within regions - the one exception being Minas Gerais. Second, agricultural employment in this period continued to decline absolutely in two important regions of Braizil: Sao Paulo and Minas Gerais. Finally, there was a substantial replacement of men in agriculture by women - only one part of an overall increase in participation rates of women in the labor force.

The research findings regarding mobility suggest a favorable situation for the adjustment of labor out of agriculture. However, the wage data present a rather different picture. Relative wage rates in Sao Paulo increased most for the upper income groups and least for the low income groups. The marked widening in the wage structure occurred in a relatively short period of time. Although the economy created a large number of high-paying jobs, it failed to increased demand for labor to relatively the same extent at the lower end of the wage structure. A number of factors are involved. First, the dynamic sectors of the economy require a relatively high skill intensity. This situation probably reflects the capital intensity of these sectors as well as the level of

technology. Second, most of the additions to the nonfarm labor force consisted of migrants from agriculture and women entering the labor force; both groups lack education. This reflects a lack of investment in education and training at the appropriate levels and failure of the educational system to equip these people with the necessary skills.

Compared with prevailing wages for various categories of workers in different regions, the northeast salaries were below the national average throughout the period 1966-75 and they have tended to fall relatively since then. The Minas region witnessed much faster increases in wages for skilled labor than did the urban center of Rio de Janeiro and Sao Paulo. It appears that some equilibrating adjustment has taken place in the labor market of the sourthern regions to narrow wage differentials between farm and nonfarm sectors. However, the northeast has moved relatively further from equilibrium.

In order to compare the relative rural-urban wages within each of the regions, wages for two groups of workers were considered: those paid to unskilled farm labor in the rural sector and those paid to unskilled labor employed in the construction industry of the urban sector. Again, it was found that the northeast was lowest, while the highest farm wage relative to construction wage was in the state of Sao Paulo in the southeast and the south (Parana, Santa Catarina and Rio Grande do Sul). One might have expected the northeast to catch up because of the Government's special development efforts in this region during recent years. Instead, it moved farther out of adjustment in the country's labor market by manifesting an almost continuous decline in its farm wages relative to almost all other categories. Rio de Janeiro in the southeast represented

the next lowest rural-urban wage, with rural wages as low as 53 percent of the urban wages for comparable occupations as compared with 45 percent in the northeast.

Education and Training

Difficulties in the labor market arise in part because the market is unable to match available skills with its requirements and because the educational and training system is not able to respond quickly enough to provide the appropriate skills. The widening imbalance in wage structure appears to reflect an educational bottleneck, suggesting that education and training can be an important means of facilitating a larger out-migration from agriculture, while at the same time providing much needed skills for the nonfarm sector. The fact that deficiencies in educational systems cause problems in the labor market may not be given enough emphasis in Brazilian approaches to labor-market policy.

The macrolevel data on income, wages and education indicate that there is a strong correlation between the level of education and the per capita income. For example, during the 60s the illiterate groups of industrial workers experienced practically no increase in per capita income, while those with higher levels of education experienced relatively large increases. The labor supply was not keeping up with demand, with the result that income differentials increased. And, the increase in demand was more for qualified and skilled than for unqualified and unskilled labor. Unless educational attainment is broadened, earning differentials will probably continue to widen, with the result that only a relatively small proportion of the labor force will be participating in the benefits of economic growth.

The data on schooling among the household heads in the three areas sample disclosed differences in schooling among the income groups that are not very large in an absolute sense. None of the groups had an average of 2 years of schooling. However, there is a tendency for the small land owners in each region to have completed more schooling than hired laborers. Further, the educational attainment in the northeast sample is extremely low, an average of less than half a year of formal schooling.

Since lack of formal schooling is not an absolute barrier to literacy, a simple literacy test was applied to members of the sample. It was found that over one-half of the household heads in Sao Paulo and Minas Gerais could read as compared with less than a third in Ceara. Apparently informal education of various kinds has been effective. The low-income groups apparently do attach considerable importance to literacy since they have made an effort to acquire it despite lack of formal teaching.

The data on children's schooling indicating that migrant children have completed more years of schooling than the nonmigrant group, suggests that those with the higher investment in education have been able to move away from the farms in search of better employment opportunities.

Mobility

The sample appears to be particularly immobile with the exception of Vale do Ribeira. In addition to geographic mobility, job mobility within the same locality was observed. The number of individuals who had changed jobs within the locality at least once was substantially

higher than those who had migrated farther. However, data on migration of children as a subgroup in the sample areas show a rather different picture. Of the children seven years old or older, over 25 percent in the northeast and over 20 percent in the other study areas had migrated.

The reasons for migration differed by sex and region of origin of the migrant, but in all regions the main reason for migration was to increase income. In the regions studied, only a small percentage of those who migrated returned to their area of origin.

Sao Paulo provided a distinct contrast to the study regions in Minas Gerais and Ceara with respect to the mobility of the current household heads (Patrick and Ryan 1978). During the one-year period of the study, about 10 percent of the households heads in Sao Paulo migrated from the region and an additional 15 percent changed jobs but remained within the county (municipio). In contrast, there was almost no migration in the Minas Gerais sample although there were some job changes. Only landowners and sharecroppers were interviewed in Ceara and both job change and migration were essentially nonexistent among the household heads during the period of study.

The analysis of the mobility of current household heads had two basic objectives. The first was identification of factors which influence the decision of the head of a poor rural household to migrate or change jobs within a region. The second, was an attempt to discriminate among groups and develop a model which could be used to classify individuals according to their potential mobility. The discriminate functions distinguishing migrants, nonmigrants and job changers were statistically significant. However, the direction of influence of some of the variables and their relative importance differed.

Age was clearly an important variable influencing both migration and job change. Mobility was lowest among those of middle age. Much of the previous research has concentrated on migration by the young, but this study suggests that substantial migration and job change may also occur among older people. If the older migrating people were retired and moving to join family members who previously had migrated, the needs they imposed on the receiving area were quite different from people who arrived seeking employment.

Educational attainment, measured in terms of both years of formal schooling completed and level of functional literacy, had a positive effect on job change and migration. The functional literacy variable could be reflecting "drive" of the migrant group since literacy was attained without formal schooling. The very low level of formal schooling attained by the current heads of households might indicate that the advancement potential of these individuals was limited. Increasing investments in schooling or improving functional literacy is one policy which the government could implement to promote mobility.

A number of the other variables also exhibited the expected results. Birth outside the county, having made an interstate move and having family in another area all tended to distinguish migrants. In contrast, these variables had negative weights for the job changers. Landless laborers were more likely to migrate than owners or sharecroppers. Those expressing a willingness to move had greater tendencies to both migrate and change jobs. The results suggested that a high family income had a negative impact on migration, but high per capita income had a positive impact. For job changers, the effects were reversed, a situation that may be related to the perceived income possibilities associated with mobility.

Although most of the variables included in the model had the expected signs, they did not explain all of the variation in migration or job changes. Furthermore, a number of the individuals who changed jobs or migrated within the year were not correctly classified. This suggests that there may be additional factors which influence migration and job change decisions.

Mobility: Policy Implications

Educational disparities are an important source of wage differentials because it is not sufficient to move to a new location or to obtain alternative employment if one does not have the necessary education and skill. The government is expected to play a major role in providing such services and to make the educational market function more efficiently because private sector educational activities tend to favor the more affluent and talented. Government can also be expected to actively work with the problem of information and job search within the labor market because of the overall social benefits as well as returns to the individual. A strong case can be made for the establishment of a national employment service in Brazil with offices in at least the larger towns and villages of the interior. Such agencies could serve as a broker between the employees and the employers and could provide individuals and business with improved and more efficient information relative to the labor market. A third set of policies that could improve the situation has to do with subsidies to encourage migration. Public education which provides the appropriate skills is one such form of subsidy. However, a case can be made for more general forms of subsidy, or at least for alleviating the barrier of limited capital to mobility and

migration. As a minimum, credit could be provided to the prospective migrant to meet expenses on a geographic move and for sustenance until employment is obtained. A bolder program would be to provide cash grants to families in support of their dislocation expenses and to tide them over until employment is obtained. The national employment service and training programs would need to be coordinated with such financial and other programs of support provided to the prospective migrants needing such assistance.

In these policies elimination of distortion in factor price ratios would be a major priority. It would take advantage of the labor-absorptive capacity of the nonfarm sector. Another factor contributing to the high cost of labor mobility is the considerable expense in moving great distances for work. This might be alleviated by emphasis on decentralizing the industrialization process and location of new industries and development projects closer to the pools of rural poverty.

Besides rural-to-urban shifts of labor as an income equilibrating factor, efforts need to be made to promote rural-to-rural interregional migration of farm labor. Merely opening up of interstate highways and providing land to those who migrate to new production areas is not likely to be sufficient. A whole set of policies, such as provision of educational and information services, monetary assistance to facilitate the physical movements of people postmigration rehabilitation programs such as housing, recreation facilities, credit and marketing facilities and the needed technical know-how are also necessary. In other words, public policy in Brazil has, and will continue to have, a crucial role in the process of improving migrant farmers' skills and living conditions so as to induce and assist them to settle in the frontiers where the government has initiated, or intends to initiate various colonization schemes.

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Comparative Summary

Introduction

Despite the considerable success of the seed-fertiliser technologies in raising the output of some crops in low-income countries, it has become increasingly apparent that these new technologies have sometimes not been adopted by substantial numbers of farmers, especially small farmers facing severe resource constraints. The development of improved agricultural technologies which can increase production on small farms may be an attractive response both to pressing food shortages as well as to the problems of massive rural poverty. Many of the disappointing experiences of past development programs have shown, however, the difficulty and complexity of generating improved agricultural technologies suitable for small farms.

This research examines some of the key decisions that farmers are making regarding currently available technologies. Study sites in West Africa, Southeast Asia and Brazil were selected to better understand the riddle of why a significant proportion of the rural population continues to live in abject poverty while agricultural technology increases aggregate output. The study sites were selected to include a wide range of climate, soil, topography, stages of development, efficiency of infrastructure and level of adopted technology. The comparisons and contrasts distilled here flow from the research summaries presented in the previous three sections. As an organizational framework the results are summarized in six broad categories: the impact of technology on income, barriers to the adoption of technologies, the efficiency of resource use, functioning of the labor market, household time allocation and patterns of household expenditures.

The Impact of Technology on Income

The wide geographic dispersion of the study areas along with differences in rainfall and other climatic conditions led to a variety of crops and technologies at different study sites. As a consequence, farm production technologies appropriate for one region are not necessarily feasible in others.

There has been little important technological change in the African study areas. Few improved practices have been developed that are suited to Sierra Leone and Nigeria and even fewer have been adopted. This restricted an ex post evaluation of the impact of adoption on production, incomes and employment. Data from a limited number of farm units permitted an evaluation of two improved packages: a biochemical package which involved an improved variety of inland swamp rice, with fertilizer, water control and tools, and a mechanical package which involved tractor land preparation for upland rice. Unless the cost of providing this technology was heavily subsidized, changes in income for both were modest or negative. For example, in the case of the biochemical package, returns to land increased by only 10 percent compared with traditional inland swamp systems, but due to increased demand for labor in land preparation and in harvest, and due to substantially increased operating costs, returns to all labor declined by 30 percent compared with traditional packages. Within the mechanical package, when tractor costs were subsidized at 85 percent, there were no changes in returns to land compared with the traditional hand cultivation but returns to labor increased by nearly 100 percent. With removal of the subsidy, however, returns to both land and labor declined substantially in contrast with traditional systems. It was concluded that at existing prices neither

technology had important potential for improving the employment or incomes of the poorest households in West Africa.

In marked contrast, in the Philippine study site of Southeast Asia, yields and incomes have been significantly increased by use of modern rice varieties, fertilizers and insecticides in combination with improved water control. Adoption of these practices increased yields up to 50 percent. Although, the gains were unequally distributed with landholders receiving a disproportionate share of increased income, the small landowners and landless also benefited as large landowners substituted family labor which increased employment possibilities for hired laborers.

Tractors were used by farmers in both the Philippines and India study sites. They were used in most part for land preparation and displaced primarily labor of the farm operator and family, not hired labor. The reduction in labor attributable to mechanization of land preparation tended to be more than offset by increased demand for labor for weeding and harvesting. This was especially true on farms where the tractors were rented, since here they were used fewer hours and displaced less labor than on farms where the tractors were owned. Thus tractors did not seem to cause net unemployment.

The most effective use of tractors in the long run may require spreading their fixed costs over more operations than plowing. Displacement of labor would undoubtedly result. Since yields did not increase with tractor mechanization, this could have detrimental results on income distribution and overall welfare. Either the displaced labor must be absorbed more productively elsewhere or more economical combinations of crops in the dry season facilitated by tractors must offset employment attributable to mechanization. Average wage rates paid by farmers with

tractors were lower. Tractors displace the more highly paid labor even when net employment does not decrease.

Use of mechanical threshers was found to have even more serious economic and social implications than use of tractors. Because threshing typically requires considerable hired labor, mechanical threshers directly displace the labor of the landless and near landless.

The Brazilian cases were somewhat in between Asia and Africa with respect to availability and suitability of technology. In the Sao Paulo region, high value per hectare crops were produced using fertilizer and insecticides, but traditional technology was used for subsistence crops. The evidence indicated that properly designed technology could increase the potential income from small farms, in both Minas Gerais and Ceara, but technology alone is insufficient for farmers to obtain incomes equal to the minimum wage. There was no one specific barrier to higher incomes on the Brazilian small farms. For them, technology must be considered in a whole-farm context in which credit, information through research and extension and other factors are often more limiting than the lack of appropriate technology. Furthermore, the variations in crops and farming conditions means a wider variety of technological practices are required to meet the needs of all farms.

Barriers to Adoption of Technology

Small farmers have generally been relatively slow in the adoption of new production techniques. There are several reasons for this. Lack of profitability is a major factor preventing transfer of modern technology from one country, region or farm to another. Prices, production responses and institutions governing the incidence of costs and benefits vary. Under these conditions it is difficult to draw generalizations that are

not region specific since the physical and economic environment can significantly alter profitability.

Chemical techniques (fertilizer and to a lesser extent herbicides and insecticides) were among the few improved technologies currently available in the African regions. Input systems are very poorly developed in most of West Africa and knowledge of use of low-cost technical inputs is not widespread because of an ineffective extension system. Moreover, survey evidence in Sierra Leone indicated that low profitability and high costs limited the adoption of biochemical and mechanical packages to households already enjoying relatively higher income levels.

Evidence in Nigeria also suggested that directing the distribution of inputs through traditional leadership was likely to result in considerable leakage away from intended recipients at the village level. In two government programs observed it was estimated that 20 percent of inputs extended were diverted to personal use of village leaders.

An analysis of grain production systems in Nigeria also revealed that the economic circumstances of households already in poverty importantly restricted their ability to perform farming operations at necessary levels and at optimum times. Because, low-income farmers were short of both cash and food during the farming season they were forced to seek off-farm employment that competed with performance of on-farm tasks. Moreover, shortage of calories during the preharvest period also constrained their labor output. It was concluded that improved technologies which require increased labor or more timely execution might benefit the poorest householders through increased demand for hired labor. Adoption rates and yield increments should be expected to be smaller on the farms of the poorest householders. In a sense, this provides an alternative example of the poverty trap situation that is also prevalent in Asia.

In Southeast Asia, it was observed that there was an important gap between the results on experiment station test plots and on farmers' fields. There is a difference between what is techniquely feasible and what is achievable within the constraints perceived by farmers. The failure of farmers to achieve experiment station yields is attributed in part to lack of appropriate technology and specific climatic conditions. Notably in the Asian cases, most rice breeding research has concentrated on varieties suitable for areas of good water control. On upland fields, areas subject to flooding and at latitudes where growing seasons are relatively short, suitable varieties are not yet developed or are only now emerging.

An important finding for most of the Asian study sites was that in most cases it would be uneconomical for farmers to add inputs at a level required to achieve experiment station results.

Research in Nepal challenged the assumption that farmers were either users or nonusers of technology. Many farmers used both the new nitrogen-responsive dwarf rice and the traditional variety simultaneously. Alternative technologies are evaluated by farmers on the basis of multiobjective criteria. Rice yield alone, for example, does not determine the farmers' preferred systems. Labor availability, soil quality, the need for food grains in a subsistence context, the availability of draft power, among other variables, all interact to influence the choice of farmers from among alternative systems. A combination of varieties was used as risk insurance, to spread peak labor requirements and to make more efficient use of irrigation water. This suggests that a new technology may meet some of the farmers' needs. However, rational use of resources may lead to only partial adoption. Hence, it may be noted that profitability

was a major factor in the adoption of technology but many other constraints including simply lack of appropriate technology acted as barriers to adoption of modern farming techniques.

For the purpose of determining barriers to adoption of technology in Brazil, technologies were classified as mechanical, chemical or biological. This classification was generally consistent with the capital- and labor-using or saving nature of the technologies. The mechanical techniques generally implied substitution of capital in the form of machinery for labor and likewise substitution of machinery for labor and land.

In Brazil it was not possible to affirm without qualifications that one technology had greater probability of adoption than the others. In Ceara in the northeast average returns to land-saving, chemical techniques are low and uncertain whereas in the southern study sites conditions were such that adoption was profitable. Lack of education appeared to be more of a barrier to adoption of chemical techniques than to the adoption of mechanical techniques. However, profitability usually dominated such decisions, but the use of institutional credit was also important. Credit was important to the adoption of some but not all techniques. Land ownership as compared with sharecropping did not appear as a factor affecting the probability of adoption.

Some evidence emerged regarding risk as a barrier to new technology. In a region of Rio Grande do Norte risk programming analysis indicated that activities involving new crops and cultural practices were not likely to be used until income reached a level of approximately $630 (US) in 1973 prices. Traditional production techniques were less risky and more appropriate on farms which could not achieve this relatively high income level.

Efficiency of Resource Use

Efficiency as defined here refers to the fact that the resources could not have produced greater returns regardless of the way in which they were combined. Alternately, the same level of returns could not have been achieved with a smaller quantity of resources. Inefficiency may result from the individual manager's inability to predict uncertain elements and may not be the result of poor management. Individual managers may also be subject to uncontrollable factors and constraints such as lack of information leading to inefficiency in the sense indicated here.

Substantial differences in farm productivity were observed among income strata in the African sites. This was due to a combination of factors including enterprise selection as well as efficiency variation within given enterprises. In both Sierra Leone and Nigeria, higher income households consistently were engaged in nonfarm enterprises which often required relatively high capital inputs and which as a result realized significantly higher returns to labor than the more service-oriented, nonfarm enterprises of lower income households. It was concluded that capital shortage restricted poor households from pursuing high-return, nonfarm activities. In contrast, after controlling ecological factors there was very little variation in the selection of farm enterprises among income strata. In the poor and less humid north of Sierra Leone, farmers were restricted to a generally low return and highly variable set of rain-fed enterprises, especially upland rice and millet.

A survival strategy characterized the selection of crops among the poorest households in Nigeria. Under the existing pricing relationships groundnut was the most profitable crop which at the same time required

few purchased inputs. Hence, rather than attempting to be self-sufficient in the production of subsistence grains low-income households concentrated on the production of groundnut which in turn were sold to maximize available calories through the purchase of grains. However, it is important to note that the cash crop strategy adopted by the poorest households placed them in a position of dependence on higher-income, surplus grain producers to meet their subsistence needs.

After controlling for differences in cropping combinations, budget analysis in both African countries revealed wide variability in average returns to both land and labor with returns very closely related to income status. Moreover, in contrast to the Asian results, the intensity of land use and yields per hectare tended to be directly associated with farm size and income. More importantly, the use of complementary factors such as fertilizer was not significantly higher among the more affluent income farmers. In an analysis of upland rice and inland swamp rice production in Sierra Leone somewhat different patterns were observed. Whereas no relationship between hours per hectare and income status was found for upland rice, labor use per hectare in swamp rice declined strongly with income status although yields increased with income level. All of these indicators point to fundamental structural differences in production systems among income classes in spite of the general dominance of traditional practices.

Production function analysis conducted in Nigeria indicated that labor was allocated efficiently in all income strata with marginal value products not significantly different from market wages. In contrast, land and fertilizer were significantly underutilized. With respect to land, the market was not well developed and there were important social

restrictions holding land costs below its value in production. With respect to fertilizer, the marginal return was significantly higher among the poorest households indicating no conflict between output and equity objectives in the design of fertilizer distribution programs. The production function analysis also re-emphasized the underlying structural differences by revealing an increase in the use of labor per hectare with increased income but accompanied by an increased marginal value product of labor.

In the African study technical efficiency was separated from allocative or price efficiency and measured as deviation from the average production function. Such differentials represent a difference between that which could be achieved with the same resources and what was achieved when constraints and/or uncontrollable factors were present.

It was noted that low technical efficiency was associated with high population density villages and with fields obtained on low-quality rental. Less timely execution of key farm operations (especially delayed planting and low weeding) also led to lower technical efficiency. It was significant that performance of these operations were least efficient among the poor. This was due in large part to the shortage of seed which induced late planting to avoid the risk of low germination as well as to the shortage of cash and hence the need to give first priority to off-farm work to generate a steady flow of cash. In short, analysis showed that the economic circumstances of low-income households tended to restrict the performance of on-farm operations thereby constraining their efforts to improve their income from farming.

In the land scarce Indonesian village, the large farmers' use of labor was lower than efficient if profit maximization were the sole objective. In contrast, the smaller farmers in Indonesia and the Philippines tended to be efficient labor users, thereby challenging the common assumption that small farmers tend to be inefficient. Rather, these results seem to point to just the opposite conclusion. For example, in the Indonesian sample it was possible to observe farmers using identical technology at a constant level across farm size groups, the smallest class of farmers obtained 60 percent higher yields than did larger farmers. These higher yields were due primarily to more careful weeding, transplanting and other labor-intensive practices.

In the Philippines, analysis showed that farmers using traditional technology without mechanical threshing and no tractors owned or hired were operating at the economically optimum level of labor use given their supply of land. On mechanized farms, however, hired labor was used economically but less family labor was used than was consistent with its replacement cost which implies some preference for leisure or release time for education.

In India and Nepal climate and topography increased the importance of managerial skills relating to choice of enterprise. In Nepal, it was not uncommon for a single farmer to produce five different crops in complex rotation and intercropping patterns. Analysis indicated that enterprise combinations were chosen in line with profit maximization although neither site achieved what would be perceived as an economically optimum combination. However, the farmers' decisions appeared to avoid excessive risk as well as to take into account the possibility of labor bottlenecks.

The Nepalese research was noteworthy in that it dramatized the importance of looking at the "whole-farming system." In one locale, small farmers used modern varieties of rice on a higher proportion of lowland than did large farmers. At the same time, small farmers planted a smaller proportion of their upland to improved maize varieties than did large farmers. This seeming inconsistency is explained by subsistence requirements, seasonal labor bottlenecks and the inappropriateness of improved maize for intercropping.

In Brazil there was evidence of economic inefficiency in the use of land, labor and capital. However, any generalization beyond the time of the survey must be made with caution because the Purdue studies are based on evaluations of a crosssection of households at one point in time. Subject to this caveat, it may be concluded that landowners tended to use relatively less capital relative to land than is economically efficient. Their capital-labor ratio also averaged too low if labor wages were used as a basis for comparison. However their proportions of labor and capital were in line with the least-cost ratio consistent with the prevalent practice of obtaining labor through the sharecropping arrangement. This probably reflects the more relevant price. On the other hand, sharecroppers used less capital and land relative to labor than was most efficient. Apparently constraints other than the price of capital kept it from being used by both owners and renters whereas the owners tended to need more labor and the renters more land.

Variation in returns from similar resources was experienced by the farmers in the Brazilian sample. It was found that if an owner with the average quantity of resources and average production had operated with the same efficiency as those with highest returns from the same resources,

that individual's gross output would have been approximately 80-percent higher.

The Labor Market

One of the functions of the labor market is to allocate labor both within and among sectors, e.g., within agriculture and between farm and nonfarm sectors. The usual economic criteria of such a market in equilibrium involves equation of the marginal value product of labor with its wage and equation of marginal value product for comparable labor in various sectors.

One of the major characteristics of economic development under a wide range of conditions is that labor must be transferred from the farm to the nonfarm sectors. This is true for several reasons: first, the income elasticity of demand for agricultural output in the aggregate is lower than for nonagricultural output; second, with the value of time rising concomitant with increasing productivity and wages in the process of economic development, agriculture tends to substitute other resources for labor; third, the population growth rate tends to be higher in rural than in urban areas; and, finally, since land in the aggregate has only limited alternative uses, the tendency for greater in-flow of capital grows stronger as a result of increases over time in real wages. Labor has to bear the brunt of the adjustment process. When the agricultural sector experiences technological change, and when such change is capital intensive, there is a strong tendency toward displacement of farm labor. These conditions require transfer of labor out of agriculture. The capacity of the labor market to function efficiently is essential in this process.

The African labor market while not under the strains of such rapid economic development has its own peculiarities. Hired labor earnings were a critical supplementary source of income among low-income households for whom it often represented a substantial proportion of their income. However, as seen above, work as a hired worker competed with work on own farm and importantly reduced productivity within the household sector. Although labor markets were somewhat better developed in Nigeria than in Sierra Leone, there was evidence in both areas of reasonably efficient markets. For example, in Sierra Leone, patterns of labor migration closely mirrored wage rate deviations among regions. However the magnitude of labor flows was not sufficient to bring wages into equilibrium.

As in Brazil, rural-urban migration patterns in Sierra Leone reflected a clear dichotomy between labor markets for educated and non-educated workers. The educated who originated from higher income households tended to dominate rural-urban flows and they were considerably more successful in finding urban jobs. Moreover, due to support from relatives, educated migrants experienced little hardship during periods of job search. Educated migrants were also considerably more responsive to urban wages and less responsive to the region-of-origin wages than were uneducated migrants - a function of perceived opportunities. Among uneducated migrants, it was seen that real wages in the urban informal market were not greatly different from rural wages, reflecting a close linkage between unskilled labor markets. Uneducated laborers, who tended to come from significantly poorer households than educated migrants, were considerably less successful in finding employment than educated migrants, often experiencing hardship due to lack of financial support. As a result a substantial proportion returned to rural areas soon after

the initial movement. It was concluded that the net distributional effect of these two streams of rural-urban migration was to widen the income disparities between rural and urban areas while reducing inequality within rural areas.

These equilibrating tendencies have been present in the Brazilian labor market. In 1960, agricultural employment as a fraction of total employment was relatively small in the states of Rio de Janeiro and Sao Paulo. Over the decade of the 1960s the agricultural labor force declined absolutely, and also as a part of the total labor force. There was a substantial increase in real income in the agricultural sector but a decline of agricultural incomes relative to the urban sector. As another example, Minas Gerais and Espirito Santo, the areas with the second lowest agricultural incomes at the beginning of the 1960s, experienced so much out-migration that the agricultural labor force actually declined absolutely. The result was an increase in agricultural income second only to one other region and of sufficient magnitude that the relative income position of agriculture to the urban sector did not worsen. Even then, the agricultural incomes in the region were higher than only one other region in the country, the depressed northeast. Hence, one must conclude that the labor market in Brazil is functioning. There are, of course, imperfections, but the size of the labor movement in response to wage and income signals is impressive. One factor involved in this transfer has been the rapid growth of the nonagricultural services sector.

Overall in Brazil during the 1960s the incomes in agriculture lagged behind those in the urban sector. The tendency in the market can be summarized as follows: 1) rapid growth of aggregate employment, 2) labor force shift from the low productivity agricultural sector to the higher productivity industrial sector, 3) increased participation of women in

economic activities mostly in jobs requiring little or no schooling, and 4) a relatively small decrease in male labor participation in the total labor force.

Brazil was a very rapidly developing country at this time. Employment growth was so generalized in this period that little interregional migration was required. Most of the intersectorial migration could take place within regions.

It should also be noted that out-migration from a supply region tends to be the younger, more educated and more entrepreneural groups in the population. They may take physical capital with them as well. Hence, the very process of adjustment adds to the disparity of interregional distribution of income and development. The present policy in Brazil favors disaggregation of industries although concentration of growth processes still tends to be in the larger urban centers. At some stage balanced growth becomes desirable in order that all groups benefit.

At present the market place disparity between skilled and unskilled worker wages suggests an educational bottleneck. The diffusion of literacy and education among the labor force suggests a substantial difference between the rural and urban sectors. There are also interregional differences. A broadly based employment exchange service, schooling, agricultural extension programs and vocational training may be the keys to long-term equitable development. There is evidence that even in the short run the extension training can pay off in agricultural areas that are already developing.

The household supply of labor to the farmer's own farm was also examined for the county of Caninde in the northeast. There, hired labor is used primarily for harvest activities. The sharecrop rental system

includes a procedure by which the sharecroppers are forced to sell labor to the landlords at below market rates. However, sharecroppers appear to pay a negative rent for land when all benefits and wages are considered.

In this system the supply of family labor was inelastic for owners and sharecroppers. The owner families, perhaps not unexpectedly, evidenced greater responsiveness. The generally more affluent owner families could afford to divert the family labor to child care and other activities if wages were not attractive. Sharecroppers and not the smaller farmers as such tended to be more labor intensive. In Vale do Ribeira the tendency for sharecroppers and renters to specialize in labor-intensive cash crops (horticulture and fruit) led to incomes as high as those of the land owners.

There was no evidence that increases in income that are independent of the wage from farming activities will shift the time of the household members to leisure activities in Brazil. There was some evidence that modern technology had a positive impact on the demand for labor. However, due to the point in time nature of the Brazilian survey this must be viewed cautiously because the price elasticity effects of demand for the product could offset this increase demand for labor if the quantity of output on the market increased.

Time Allocation in the Household

The household is a production unit which generates agricultural output and income from farm and nonfarm sources. The household members also make decisions on family size and the spacing of children. It is the individual household that allocates time between economic and noneconomic activities. Hence, labor supply to the market and on farms is linked with the time allocation of household members. Low-income households face a number of constraints both internal such as lack of education and skills and external such as poor infrastructures, lack of employment opportunities and absence of urban-industrial growth in their locale. Such constraints can substantially limit their participation in productive activities outside the household, their farms and other domestic activities. The study of time allocation in this section offers some additional explanations of rural poverty in the search for appropriate policy guidelines.

In the three studies the time allocation of household members was related to a set of alternative work opportunities such as work on and off the farm, both in and out of the locality. In some instances maintenance and other work including child care, cooking, cleaning and similar tasks performed by members within the household was also considered.

Labor profiles among African households revealed considerable seasonal underemployment in both Sierra Leone and Nigeria. This was due both to the seasonal rainfall distribution but also to generally low employment levels overall even during peak farming periods. For example, during the busiest farming months, Nigerian men worked an average of only about 100 hours per month, Sierra Leone men 125 hours, and Sierra

Leone women only about 105 hours. This result in land-abundant areas is particularly significant and surprising in comparison to land-scarce Asia. One suggested causal factor is a calorie shortage which limits energy expenditure during the preharvest period.

Women played an important role: women from low-income households participated in the labor market, hiring out during planting and harvesting periods. This was particularly true in vegetable and noncereal grain cultivation. The Nigerian sample was predominately Moslem, but even here women made a significant contribution by producing items for sale and barter within the compound. Finally, they were often active participants as petty traders.

In Nigeria, the highest absolute and proportional allocation of adult male labor time to work off of their own farms was observed among low-income households reflecting both the low returns to labor on their own farms and the need to generate cash throughout the year, but especially during the preharvest, cash shortage period. Even during the peak month of farming, June, total hours worked by adult males at all income generating occupations averaged only 3, 5, and 3.75 hours among low, middle and high income households, respectively.

Household time allocation was studied in Indonesia in order to gain insights into factors influencing the adoption of technology. The sample households were divided into three classes depending on the amount of land controlled by the family. Class I households were the largest with Class III being landless or nearly so (averaging less than .2 hectare). All of the farms were small. The average for Class I was only 1.46 hectares. The classification was used only to facilitate analysis within the study group.

Class III households had to depend on wage employment from off-farm to meet subsistence requirements. There was little difference in the total number of hours worked by men of the different household classes. It was the character of adult male labor that differed greatly with class status. Men in Class I worked in supervisory capacity and devoted an average of over 85 percent of their time to their own land. In striking contrast, men in Class III households spent only 10 percent of their time working with their own assets.

The main impact of these classes was revealed in the role of the women and children. The participation of women and children and their contribution to the family well-being through employment increased markedly as the asset status of the household declined. Despite the extremely large number of hours worked, the earnings of women and children were not enough to bring family incomes of households in Class III up to a prescribed poverty level, defined as equivalent to 399 kg. milled rice per consumer. Women and children serve an extremely important role in the overall strategy of Class II and III households. Women in particular worked at low paying jobs which tend to provide a steady secure income flow of relatively long duration. Survival strategy forced them to work extremely long hours for extremely low pay but their anchor role freed men, who then had a wider range of job opportunities and could seek higher return employment. This employment is probably more risky since it is usually of shorter duration.

It is noteworthy that ownership of even very small amounts of land allowed home production of rice at or near subsistence levels thereby making it unnecessary for at least some of the children and elderly to participate in the extremely low-wage, contract labor market.

A further implication is that the forcing of children into the labor force reduces school attendance thereby lessening the possibility of escape from this poverty trap. This is especially insidious because it is coupled with the fact that even children of six to nine years old were kept at home to care for younger siblings in order to allow the mother to participate in the labor force. Under these conditions, acquisition of even a rudimentary education in these low-income families is virtual impossible.

It is clear that family members form an integrated work team. Individuals adopt roles which allow the family as a unit to simultaneously maximize income and to meet their basic food needs. The degree of coordination of work effort among family members to reach these objectives is reduced as the household control over assets increases.

Several of these conclusions reached in the extremely limited resource base area of the Indonesian site were reinforced by an examination of Indian farms which either owned or hired tractors. On these more affluent farms, older children attended school and women withdrew from the labor force to care for preschool children. Again this is evidence that tractor mechanization may not displace as much labor as might be thought from casual observation.

Research in Indonesia and the Philippines also identified a number of mechanisms for distribution of patronage in the dispersion of employment opportunities. Households with even small parcels of land had an advantage over the landless in gaining access to employment offered by larger land holders. A systematic bias resulted whereby women in most of the landless households were engaged in the lowest paid and most menial tasks. The research casts serious doubt on the concept of altruistic labor markets of traditional rural systems that have patronage

relationships to share work possibilities with the poorest members of society. Instead, these turn out to be highly competitive markets which regulate the way in which family labor is allocated among members of households with different land holdings.

In the rural Brazilian areas household maintenance activities as well as working one's own land and at wage labor contribute materially to the household economic well-being. Any rise in the value of the children's time in such work raises the opportunity cost of schooling and consequently reduces the demand for schooling. On the other hand, the increased economic value of children is accompanied by an increase in fertility rates.

Farm and off-farm wage rates definitely influence the level of employment in Brazil. The greatest impact is on the supply of labor by the wives, but there is a response as well by the husbands. The husband's response to wage changes is inelastic indicating that shifting the terms of trade against agriculture will not effect their supplying labor as much as it will their wages or incomes. The farm women, however, are more responsive and the increased employment of women in Brazilian agriculture in recent years appears to be a response to higher wages rather than to declining incomes as is sometimes postulated.

Household Expenditure Patterns

If lower income households consume products which require less of the scarce factors of capital and foreign exchange, and more of the relatively abundant factor of labor, efforts to increase the incomes of poor families could result in consumption of more labor-intensive commodities. This in turn could increase employment and tend to equalize income among

sectors. Rural household expenditures have linkages with the rest of the economy. On the one hand they are expected to have weak linkages because of emphasis on subsistence consumption while on the other hand, their cash expenditures may be oriented toward home produced goods. This is apparently equally true of rural nonfarm employment possibilities. Their income and multiplier effects are thus of considerable interest in an economic development context.

The effects of income status of rural households on consumption are best analyzed through expenditure elasticities and marginal propensities to consume. Among the three studies, consumption relations were analyzed in Africa and to some extent in Brazil. In the African situation, the expected Engel relationships were observed with food as a proportion of expenditure declining with income status and luxury goods increasing. For example, in Sierra Leone the income elasticity of demand for food declined consistently with income from 1.25 to .85 between extreme deciles. Nevertheless, due to low incomes overall, 84 percent of total expenditures were used to purchase goods from the labor-intensive, small-scale sector. Thus important secondary employment effects could be expected from a general rise in rural incomes.

As expected, higher income households consume goods with lower labor inputs and higher imported content, but due to relatively equal income distribution in Sierra Leone, the composition shift was not substantial. An important finding was that income elasticity of rural, small-scale industry products was nearly unity (.88) indicating a growing demand for such products with rising incomes.

It was also observed that the locational linkages of rural demand with urban production sectors in Sierra Leone were very weak. Thus, there was very little leakage of the multiplier effect into the urban sectors with rising rural incomes. In short, expenditure patterns demonstrate that important beneficial secondary effects will occur within the rural sector with general increase in rural incomes. Higher multiplier effects were observed resulting from increments to incomes among the poorest households.

In Nigeria, an analysis of food consumption showed that on the average the households consumed 11 percent more calories than minimum requirements. However, there was considerable unevenness across classes with the poorest 30 percent of the population below minimum standards. An important finding was the considerable dependence of all but the richest 20 percent of the households on purchased foods to meet minimum standards - indeed, only the richest 20 percent met minimum calorie requirements out of their own production. The poorest income households were most dependent on purchased foods. For example, domestic food crop production fell below requirements by 70 percent and 50 percent among the poorest two deciles. These results underline the critical reliance of the poorest households on a continual inflow of nonfarm generated cash to purchase food. This was achieved through sales of cash crops such as groundnuts as well as off-farm cash labor.

Finally, the data showed that only the poorest 20 percent of the households purchased more grain than they sold. Thus, increasing grain prices would substantially worsen relative inequality given existing production patterns.

No study of the consumption expenditures was specifically carried out in the Asian area. However, the fact that the landless and near landless women entered the labor markets to allow their families to reach reasonable subsistence levels along with the finding that even a little land helped tremendously in increasing income and furnishing subsistence would indicate that the situation is very similar to the African situation and the poorest classes spend for labor-intensive rural products whereas those with higher incomes can save more (invest) and spend more on nonfood products such as education and manufactured imports. As in the African case only the more affluent would be able to supply their own food needs. The poorer income groups depend on cash purchases. Women worked at contract labor on sugar and tobacco plantations at wages well below one dollar a day to insure adequate daily family rice consumption.

In Brazil, the largest part of the consumption expenditures was for food and as expected this proportion declined as income increased. In the northeast area of Brazil it was also found that tenure status was a significant factor in explaining food consumption. The owners obtained a larger part of their food from home production than did sharecroppers. This is reasonably consistent with the African finding since the owners are more affluent than the sharecroppers.

However, in the Sao Paulo study area the tenure status was not as important. This was probably due to the fact that sharecroppers in that area had incomes which were about the same as those of the owners. Somewhat unexpectedly, the number of persons in the households, other things equal, was not closely associated with consumption expenditures.

Many important factors influencing incomes of rural households are not under the control of individual farmers. A seeming unwillingness to adopt modern technology and operate in a manner deemed efficient by outsiders may often have roots in constraints beyond individual farmer's control. These may be institutional such as governmental regulations and social custom. Some are physical constraints such as weather, soil and water while still others involve uncertainties in the system. It is often necessary to use a survival strategy in the face of uncertainty or variability in yields and income. An important finding was that, while many technical improvements appear viable in an experiment-station setting, they may not be adopted on individual farms for the simple reason that they are unprofitable.

Analysis indicated that social and technical changes were weakening the interdependency of classes such as those existing between landlords, tenents and landless laborers. This is particularly true in Asia where landowners adopting technology felt that they had incurred the expense and risk of change. Consequently the gains in yields and production may not be shared proportionately. Households with very low incomes cannot afford strategies which give good incomes on the average but leave the family below subsistence levels for periods of time. A lower but steady certain income in this case is the rational choice.

This factor was a powerful influence in both the African and Asian studies where it especially affected the lowest income groups. Those with small parcels of land had to slight their farming from a maximum farm production viewpoint in order to maintain an overall subsistence level. Their off-farm employment could not be neglected in order to gain

better timing on the farms. The wage earning job might not be available when they needed income the most. Similarly women from the lowest income groups took low paying menial jobs with long hours of work in order to insure subsistence and release men for less certain but higher paying short-term job opportunities.

These forces bear directly on good cultural practices and timing of farming activities. At peak labor periods, wage rates are highest. This is precisely when labor should be used on owned land. However, cash and capital deficiencies force family members to seek off-farm work at these critical times. Incomes remain low with no capital accumulation.

Education is frequently looked to as a means of breaking the poverty trap. Unfortunately, severe poverty may make the acquisition of necessary education virtually impossible. When women must work long hours to assure adequate cash for food, children of school age must assume housekeeping and child-tending roles. This prohibits them from attending school and the circle of poverty and illiteracy is perpetuated. This suggests that merely providing educational facilities is not an adequate strategy for improving the lot of the very poor.

An underlying conclusion of all research components of this study was that careful farm-level data gathering and analysis is necessary if problem areas are to be identified and properly addressed. It is apparent that technical change in agriculture does not in itself provide a panacea to rural poverty. Given the physical, social, political and economic constraints to adoption of improved agricultural techniques, it is imperative that companion changes in these areas accompany scientific advances if efforts to reduce rural poverty are to be effective.

SOURCES

Many individual pieces of research conducted under the aegis of three universities (Michigan State, Cornell and Purdue) were summarized in papers referenced below. This paper is, in essence, a distillation of the three. Interested readers are referred to the original summaries for clarification and expansion of the material herein.

WEST AFRICA

Peter Matlon, Doyle Baker, Thomas Eponou, Steven Franzel, Derek Byerlee. "Poor Rural Households, Technical Change and Income Distribution in Developing Countries: Two Case Studies from West Africa." African Rural Economy Working Paper #29. Department of Agricultural Economics. Michigan State University. East Lansing, Michigan. August 1979.

SOUTHEAST ASIA

Daniel Sisler, David Colman. "Poor Rural Households, Technical Change, and Income Distribution in Developing Countries: Insights from Asia." A.E. Res. 79-13. Department of Agricultural Economics. Cornell University. Ithaca, New York. June 1979. This research paper includes contributions from Gillian Hart, Chandrashekhar Ranade, Gorantla Doraswamy and Douglas Pachico.

BRAZIL

Ram D. Singh, George F. Patrick, George E. Schuh, Earl W. Kehrberg. "Poor Rural Households, Technical Change and Income Distribution in LDC's, Brazil: A Summary." Department of Agricultural Economics. Purdue University. West Lafayette, Indiana. 1979.