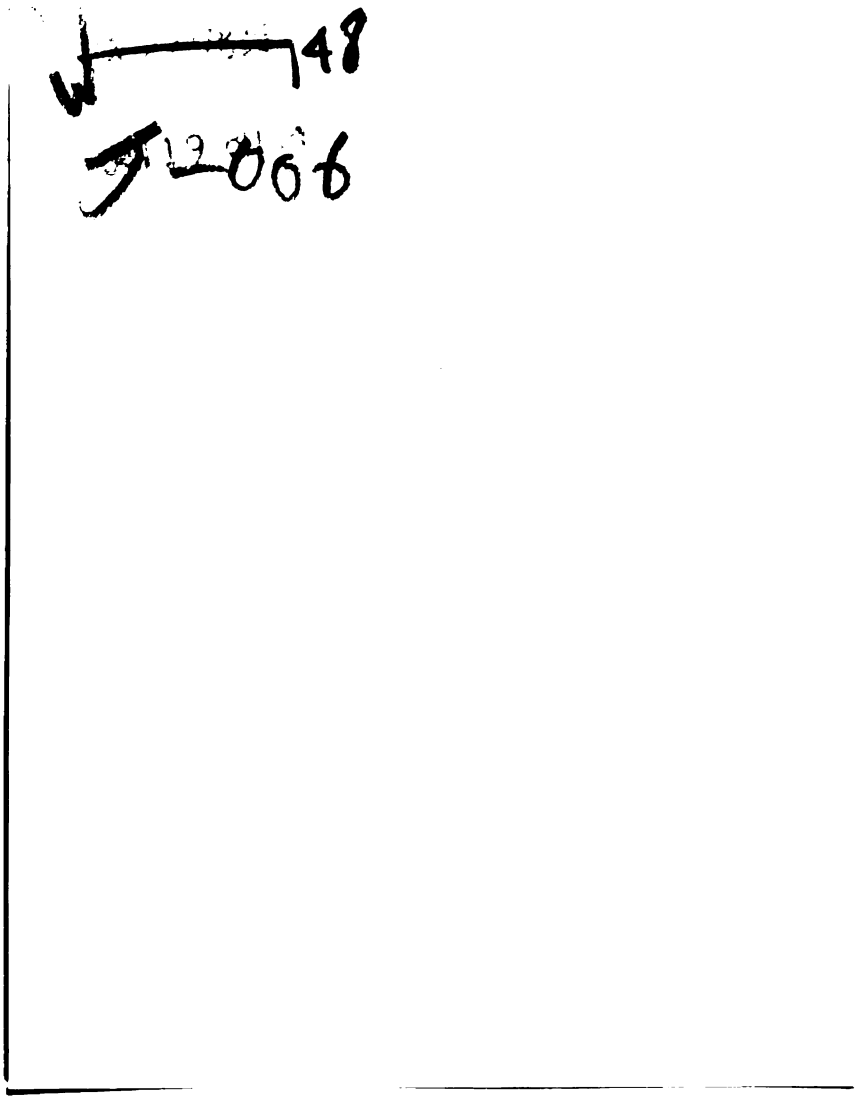

W
48
F12066

ABSTRACT

REDISTRIBUTING INCOME THROUGH TECHNOLOGICAL CHANGE IN AGRICULTURE: IMPLICATIONS FOR SRI LANKA'S PADDY SUBSECTOR

By

S. Nicholas Samuel

This study sought to identify policies to increase paddy output in ways contributary to both growth and equity objectives of Sri Lanka's Five Year Plan. Technological and institutional variables were examined as to interacting effects for increasing paddy productivity among small farmers and significantly expanding rural employment opportunities.

Agricultural technology constituted a link between growth and income distribution. Modern technology which is the chief source of agricultural growth is not neutral with respect to either personal or functional income distribution; it implicitly influences both. Hence explicit cognizance of equity factors in formulating policies to foster growth reduces the need to rely upon fiscal and welfare policies for income redistribution.

A conceptual framework was developed to explain the interaction of the primary variables of technology and institutions upon output and the resultant income

distribution. Resource endowments were shown to influence the interaction of technology with institutions but only to the extent that the political process chooses to discover shadow price signals, and once discovered, chooses to be guided by them.

If equity considerations are to be explicitly incorporated into policies aimed at increasing growth, such policies need to acquire a focus by being directed at preidentified groups. The program objectives were defined as increasing the productivity of paddy holdings below 4 acres in size, and effectuating institutional modifications that will concurrently increase employment opportunities.

A regression of five technical and five institutional variables on interdistrict paddy yields revealed that for policy purposes the seed-fertilizer package was (as expected) highly significant for yields. Other variables that were significant were row transplanting, rotary weeding and handweeding, the risk factor in production, and farm size. Chemical weeding and the renting of holdings had a positive and important though statistically insignificant effect on yields. The statistical analysis indicated that tractor use and production credit were not important for explaining differences in inter-district paddy productivity. An R^{-2} of .76 indicated that 24 percent of paddy yield was not explained by the included variables.

The variables were then assessed as to applicability to small farms (size neutrality) and capacity for generating employment. The relation between farm size and output indicated more scope for double cropping among small farmers than is generally supposed. Tractorization, found not significant for yields, was antagonistic to equity. But there were a need to ensure technical flexibility in the use of tractors. Despite scale neutrality in the physical seed-fertilizer package, a positive relationship exists between farm size and adoption, mainly attributed to small farmer lags in adoption. Since technical information flowed unevenly through the farm size structure, small farmers postpone innovation until perceived risks are reduced through adequate information from the demonstrations of early adoptors, the development of informal local channels, and formal extension contact. Hence time (adoption lags) was a proxy variable for information costs to the farmer.

Possible factors inhibiting small farmer access to technical information were: indivisibility in the time needed to learn how to use new inputs, extension biases against small farmers, and non-peer group control over some multipurpose cooperatives.

Input costs were higher for small farmers due to high fixed costs in input acquisition.

Production credit was discounted as a factor in the perceived positive relationship between farm size and adoption of biological technology, although this may not continue. The analysis suggested that credit was mainly facilitative and that less reliance should be placed on credit as a primary means of inducing technological change.

Contrary to theoretical presumptions, tenants have higher adoption rates than owner-operator counterparts. But this factor justified extension rather than tenancy because it underlines the importance of information and reveals limited productivity potentials in concomitant crop-sharing arrangements.

The risk factor was statistically significant for inter-district paddy yields and affected small farmers much more than large farmers for several possible reasons; the limited credit alloted for pesticide use, lack of technical knowledge, and externalities in pesticide use.

Considerable congruence exists between growth and equity for row transplanting and handweeding, but their relatively greater revenue benefits vis-a-vis chemical weeding seem offset by higher relative costs.

Policy suggestions sought to de-emphasize variables antagonistic to the objectives of the Five Year Plan, and to emphasize those contributary to these objectives. Limitations of the study were expressly recognized.

The tentative recommendations suggest alternatives for further exploration and empirical study, not a blueprint for action.

The analysis suggested consideration of the following: (1) Changes in the foreign exchange rates, interest rates, and tax allowances for machinery and (change in) labor costs applicable to agriculture. (2) Elimination of quantity controls over machinery and spare parts and the use of both public and private distribution channels. (3) Reactivation of the credit scheme but assigning it a neutral role in development strategy. (4) Greatly increasing the emphasis on extension, reducing costs of input acquisition to small farmers, reducing search and organization costs of labor utilization, and socialization of the costs of pest and disease control. (5) Conducting research into the development of simple water control systems in the wet zone, task specific machines, and defining relative costs of labor intensive versus capital intensive techniques.

REDISTRIBUTING INCOME THROUGH TECHNOLOGICAL CHANGE IN AGRICULTURE: IMPLICATIONS FOR SRI LANKA'S PADDY SUBSECTOR

by

S. Nicholas Samuel

A DISSERTATION

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

Department of Agricultural Economics

1973

To My Parents

ACKNOWLEDGMENTS

During the course of my research I have been fortunate to receive the generous and able assistance of many persons. I am pleased to acknowledge here my indebtedness to them and to recognize those that provided special help.

Sincere gratitude is acknowledged to Dr. Lawrence W. Witt, my major professor and chairman of my thesis committee, for his immeasurable aid, unfailing courtesy, and scholarly guidance in directing my thesis and making my work both pleasant and rewarding. Thanks are also extended to Dr. Robert D. Stevens and Dr. Lester Manderscheid for their constructive counsel, expert guidance, insightful suggestions, and enthusiastic assistance.

General acknowledgement is due to the Agricultural Development Council for its financial support, and to the Central Bank of Ceylon for the leave of absence granted.

Finally, I am pleased to acknowledge my gratitude to my wife, Suramya, for perseverence in decoding my hieroglyphics and indefatigability in typing numerous drafts. My thanks to my son, Migara, for bolstering my spirits at times when the need for such assistance was dire.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

CHAPTER I

INTRODUCTION

Problem Setting

There is widespread evidence that technological changes in agriculture, through the use of modern scientific mechanical and biological inputs, have increased and have demonstrated a potential for further increasing agricultural output in less developed countries.[1] In three South Asian countries the growth in agricultural output from 1966 (the year before the first major distribution of new high-yielding varieties) to 1971 was fairly substantial.

Sri Lanka	14 percent
India	25 percent
Pakistan	17 percent

While on a per capita basis the increase is much less, due to fairly high rates of population growth of over 2.5 percent, the change is nevertheless positive varying

---

[1]For instance, Lester Brown regards the new seeds as being "likely to be a greater force for change than any technology ever introduced into the poor countries." The Social Impact of the Green Revolution (International Conciliation, 1971), p. 44.

[2]Food and Agriculture Organization, Production Yearbook 1971 (Rome: FAO). All quantitative data in this chapter will be from this same source unless otherwise stated.

between 5 and 12 percent between 1965 and 1971, depending upon the base chosen. Productivity increase in wheat and rice yields have been substantial, due to the estimated acreage planted with new high-yield varieties increasing from 200 acres in 1964 to 30 million in 1971, and the adoption of modern methods. For instance, in Sri Lanka rice yield increased from 38.8 bushels per acre in 1963-64 to 51.1 bushels per acre in 1969-71,[1] while total production increased from 50 million bushels to 77 million bushels in the same period.[2]

However, the adoption of modern methods has not been widespread on an overall basis. At the time the productivity increases were being hailed as constituting a "Green Revolution," some writers cautioned against exaggerating the magnitude or scale of the changes.[3] Some writers considered it merely an "enclave" development

---

[1]Department of Census and Statistics, Statistical Pocket Book of Ceylon, 1971.

[2]While the innovations were mainly in respect to inputs, it was also a product innovation to the extent that the new wheat and rice products differed from the traditional products in taste and cooking characteristics.

[3]See Walter Falcon, "The Green Revolution: Generations of Problems" (paper presented at AAEA meeting, Columbia, Missouri, 1970). See also U.S., Department of Agriculture, Rice Situation, USDA ERS RS-15 (March, 1970); and C. R. Wharton, "The Green Revolution: Cornucopia or Pandora's Box?" Foreign Affairs, April, 1969.

leading to "dualism."[1] By 1971 only about 12 percent of rice land and 25 percent of wheat land in Asia was in improved varieties.[2] Hence there is considerable scope for further changes.

The Problem

The very process of technology diffusion has the inherent characteristic that it affects income disparities, and hence the distribution of income.[3] More knowledge about this relationship between growth and equity will make it possible to identify policies for Sri Lanka that will increase output, and at the same time contribute towards an acceptable distribution of income.

The process of diffusion affects income disparities in both relative and absolute terms. Future increases in income will occur as those who have already adopted

---

[1] K. N. Raj, "Some Questions Concerning Growth, Transformation and Planning of Agriculture in Developing Countries," Journal of Development Planning, No. 1 (1969).

[2] Although according to FAO statistics the trend rates of growth in production as well as productivity before and after the "Green Revolution" do not differ materially except for wheat, these results cannot be relied upon too much for information on South Asia because it probably subsumes regional trends. FAO, The State of Food and Agriculture 1970 (Rome: FAO), p. 131.

[3] The concept of income distribution is wider than the concept of income disparities. A redistribution of income could either increase or decrease income disparities depending on the relative income levels of those who pay and those who benefit.

modern methods move towards a more complete (optimal) adoption of a given technology, and as those who have not yet adopted move towards experimental adoption. Currently the degrees of adoption are infinitely many, varying from complete adoption of a given technology to no adoption of that technology. This implies that the process of diffusion inevitably involves differences in the rates of increase of output on different farms, depending on the degree of innovation. Such differences therefore have a direct bearing on relative income disparities. Two cases in this "relative disparity" category need to be distinguished: differences among adoptors of technology and differences between adoptors and non-adoptors, given the farm size group. Absolute income disparities can increase due to structural differences in (irrigated) farm size. Thus even if the rate of increase in output is the same for different farms, absolute income differences could increase due to difference in the size of (irrigated) land holdings.

The fact that the very process of technological change influences income disparities suggests a need to understand more about the nature of this relationship, both for national-level policy formulation and for local-level implementation. A better knowledge of these relationships likely will provide improved insights into the policies needed in Sri Lanka that will contribute

toward a desired distribution of income, while at the same time increasing output. It seems preferable that the "Green Revolution" stimulate an agricultural transformation rather than an agricultural dualism. More specifically, more knowledge of these relationships may indicate the type of projects needed, the form such projects should assume, their direction and orientation, their focus, and the manner in which they could dovetail into integrated programs at the national or regional level, in order that the "Green Revolution" may be made more pervasive. Such knowledge also likely will suggest the type of complementary institutional modifications needed to enable the programs to achieve their desired goals.

Several research studies, as listed in Appendix A, have dealt with technological change and its effect on income distribution either centrally or incidentally. These studies have been of a micro nature and related to specific locations in India, Pakistan, and Bangladesh. They could be expected to contribute useful information for policy formulation and implementation at the local level. Less attention however appears to have been paid to the assembly of such information into the broad integrated picture necessary for macro-level, national, decision making. To the extent that these issues have been considered at this national level, the decisions have

tended to be based on conceptual formulation and intuitive judgments. Some of these micro-level studies may have made a modest input into these judgments, or will in the future (since many are only recently completed). But there does not appear to be an attempt to integrate these studies and develop analyses of national policy options based on such firm empirical foundations. Similarly there does not appear to be an adequate reaching out by national policy formulators for empirical evidence to enable them to better assess the potential performance of relevent alternative programs and institutional modifications.

Importance of the Problem

Although fairly substantial rates of growth of agricultural output have occurred, there are indications that the poverty rate, as measured by the percentage of the persons below a predetermined poverty line, has increased. A recent study in India shows that 40 to 50 percent of the total population has a per capita income below the official poverty line. Moreover, the per capita income of this group has declined over the last two decades, while the average per capita income increased.[1] In Sri Lanka, despite an increase in per

---

[1] M. Haq, "Employment in the 1970s: A New Perspective," in Inernational Development Review, December 1971 (Ottawa: Society for International Development), pp. 9-10.

capita agricultural output of around 12 percent in the period 1966 to 1971, a growth of real GNP of 14 percent in this same period, and an average increase in per capita real incomes of roughly 2.1 percent per year during the period 1959 to 1971,[1] unemployment has increased from 3.5 percent[2] of the labor force in 1959, to 15 percent[3] of the labor force in 1971.[4] Also, there are indications that the extent of poverty increased during the period 1960-68. A recent study based on the data gathered by a 1969 Consumer Survey in Sri Lanka revealed that the extent of poverty (measured by the number of persons below the $100 per annum income level) increased from 49 percent to 60 percent during the period 1960 to 1968.[5] There is also evidence that real wages in agriculture have drifted downward and, if the mid-1950's are compared with the early 1970s, they have fallen about 4 percent.[6]

---

[1]Central Bank of Ceylon, Annual Report 1971 (Colombo).

[2]National Planning Council, The Ten Year Plan (Colombo: Planning Secretariat, 1959).

[3]Department of Census and Statistics, Socio-Economic Survey 1969-70, First Round (Colombo: 1971).

[4]Different methods of measuring unemployment in the two years probably were used, thus limiting the reliance that can be placed in comparing these data.

[5]Ranier Schickele, "Improving Income Distribution as a Development Goal," Staff Paper P72-17 (Ag. Econ. Department, University of Minnesota, 1972).

[6]Central Bank of Ceylon, Bulletin (Colombo: August 1971), Table 37.

That poverty is widespread is clear. In 1969-70, 44 percent of the non-estate (i.e., traditional) rural households received less than Rs. 200 ($33) per month per person in an (average) household of five persons.[1] Poverty also gives every indication of growing. One forecast expects the number of people economically active in agriculture to grow by 50 percent from 2.4 million today to 5.3 million in 1985.[2]

Growing evidence of this phenomenon has stimulated increasing concern for equity considerations and contributed to the demise of the ideology of economic growth. Interest has shifted from the narrower considerations of economic growth to the broader issues of economic development. Development is increasingly viewed in multidimensional terms, and defined to include issues of poverty, unemployment, and the distribution of wealth, besides growth. Concern has thus tended to move from increasing productivity to concern for whose productivity is to be increased. The United Nations, by addressing itself to the problems of poverty, has in the Second Development Decade moved away from its reliance on the rate of growth of GNP as a primary indicator of economic

---

[1] Department of Census and Statistics, Socio-Economic Survey (Colombo: 1972).

[2] International Labor Organization, "Matching Employment Opportunities and Expectations," Report (Geneva: ILO, 1971), p. 86.

development.[1] World Bank president Robert McNamara has commented as follows:

> The state of development throughout most of the developing world is unacceptable. It is unacceptable because hundreds of millions of people are living at levels of deprivation that simply cannot be reconciled with any rational definition of human decency. . . . Current development programs are seriously inadequate because they are not significantly reducing the poverty which shapes and limits these lives. And though the matter is complex, basically we know why. . . . the developing countries are not moving decisively enough to reduce the severe social and economic inequities among their own peoples. . . . The broad statistical evidence is clear that there is dangerously skewed distribution of income both within developing nations. . . . Development simply cannot succeed unless that massively distorted distribution of income is brought into a more just and reasonable balance.[2]

It is thus increasingly being recognized that growth does not necessarily imply development,[3] and that development is a multi-dimensional concept that encompasses growth, employment, and equity factors.[4] Development has been equated with "the fulfillment of

---

[1] United Nations, Report on the Second Development Decade, UN Sales No. E 71, 11, A.2.

[2] Robert S. MacNamara, "The Environmental Dilemma," in War on Hunger (Washington, D.C.: U.S., Department of State, December, 1971).

[3] See for example the experience of Liberia: R. W. Clower et al., Growth Without Development (Evanston, Ill.: 1966). Also, W. J. Barber "A Critique of Aggregate Accounting Concepts in Underdeveloped Areas," Bulletin of the Oxford University Institute of Economics and Statistics (November, 1963); and I. Adelman and M. Taft, Society, Politics and Economic Development (Baltimore: 1967).

[4] D. Byerlee and C. K. Eicher, Rural Employment, Migration and Economic Development: Theoretical Issues and Empirical Evidence from Africa (East Lansing: Department of Agricultural Economics, Michigan State University, 1972).

human potential,"[1] the "upward movement of the entire social system,"[2] a reduction of poverty,[3] and reduced unemployment.[4]

Sri Lanka's economic objectives, as enunciated in The Five Year Plan, are consistent with the foregoing conceptions of development. The Plan states:

> The trend in Gross National Product does not indicate the growing crisis in unemployment, in income disparities, and in the balance of payments. Statistics of Gross National Product at per capita income are insensitive both to the distribution of income and to the virtual stagnation of certain vital sectors of the economy. Nor do these statistics indicate the maturing crisis within society.[5]

Objectives

The broad objective of this study is to examine how technological changes in paddy cultivation could be made to contribute to the growth and equity objectives of Sri Lanka's Five Year Plan. This will require an identification of the factors that presently inhibit

---

[1] Dudley Seers, "The Meaning of Development," Communications Series Br. 44 (Sussex: Institute of Development, 1970).

[2] G. Myrdal, Asian Drama (New York: 1968), p. 1869.

[3] Ranier Schickele, Agrarian Revolution and Economic Progress (New York: Praeger, 1968).

[4] International Labor Organization, Towards Full Employment; A Programme for Columbia (Geneva: ILO, 1970).

[5] Ministry of Planning and Employment, The Five Year Plan (Colombo: 1971). This document will hereafter be referred to as the Plan.

increases in productivity among small farmers, and prevent increased employment opportunities from developing in the rural sector. Conversely, the intention is to identify variables that have a potential for increasing paddy productivity and improving the distribution of income, with a view of activating or changing them for desired performance.

The specific objectives of the study are of a sequential nature that cumulatively facilitate the ultimate objective of identifying the policies that will permit the paddy subsector to deliver expected performance with respect to both output and equity. These specific objectives are as follows:

1. To examine the theoretical and conceptual relationships between growth and equity factors from a policy standpoint, and to utilize the insights gained to develop a conceptual framework for the subsequent analysis of the relationships between technological change and equity.

2. To translate policy norms from a social welfare function in Sri Lanka into concrete objectives for policy, by identifying socio-economic groups upon whom programs should be focused.

3. To identify the variables that are significant for paddy output and income distribution in Sri Lanka by means of statistical techniques and a review of other primary data based micro studies.

4. To use the insights gained from all of the above to identify policy changes, at primarily a macro level, that will facilitate the type of institutional change and agricultural programs that will yield desired results with respect to output and equity.

Methodology

Linear multiple regression analysis will be utilized to conduct a statistical analysis of macro data pertaining to Sri Lanka's paddy subsector. The data utilized will be primarily from published secondary sources.

The analysis will be essentially Bayesian in that the statistical results will be assessed in the light of prior beliefs. In formal terms this involves adjusting a prior distribution to take account of observed data, with the weight attached to the observed data depending on the probability of the posterior distribution.

The dominant source of this prior belief will be the several primary data based micro studies listed in Appendix A, which examine various aspects of the relationship between technological change and income distribution, in India, Pakistan, and Bangladesh. In designing agricultural modernization policies it must be acknowledged that no universal answers exist. The experience of different localities with broadly the same

ethnic, social, and cultural backgrounds, however, could be expected to provide insight and material that may be considered as possibilities for application in Sri Lanka.

The cross section of information in the micro studies, when assembled in the light of the statistical results, is expected to provide a picture of the patterns of interrelationships between growth and income distribution, and hence a reliable basis for the policy prescriptions ultimately to be made.

Agricultural Production Goals in the Plan and Their Significance[1]

The Plan demonstrates an appreciation of the contribution that the agricultural sector could make to economic development.[2] Since agriculture occupies a dominant position in the Sri Lanka economy, an increase in agricultural output and an equitable distribution of such output is likely to have an overall effect on economic development. In 1970 the agricultural sector contributed 35 percent of the Gross National Product and employed 55 percent of the work force. The dominance of the agricultural sector thus makes the interplay between

---

[1]The data in this section is from the Five Year Plan, unless otherwise indicated.

[2]It has to be recognized that: "Neither growth or equity problems can be solved by . . . the agricultural sector. The employment problem in particular is total-economy in character. . . ." Falcon, op. cit.

development means and development objectives important in that sector.

The Five Year Plan states:

> . . . the agricultural sector presents the greatest scope for the expansion of output and employment in relation to investment outlay. In agriculture there are substantial growth possibilities which are not constrained by a shortage of foreign exchange. This is due to the scope for more intensive use of land and labor, for increasing output with high yielding strains in a variety of crops, and for better use of available water resources. The possibilities of import substitution are also greatest in agriculture. . . . The gap between population and resources has to be met by an expansion and diversification of small-scale agriculture on a wider and more systematic basis. . . . Since a large proportion of the unemployed live in rural areas this task is urgent.[1]

In terms of strategy, the Plan shifts the emphasis for agricultural development from the three major export-oriented plantation crops of tea, rubber, and coconut to the mainly traditional crops[2] of rice, pulses, chillies, and onions. A significant nontraditional crop to be expanded is sugar cane. Trends over the past fifteen years suggest a very limited potential for cumulative development in the plantation crops due to low income and price elasticity of demand factors,[3] and the oligopolistic structure in production and marketing which, particularly

---

[1] The Plan, p. 33.

[2] A traditional crop would be one which has historically been cultivated under traditional as opposed to modern methods.

[3] Terms of trade declined by 7.6 percent in 1971.

for tea, is controlled mainly by foreign interests.[1] During the period since 1956 tea production increased by approximately 35 percent, rubber production by approximately 40 percent, and coconut by some 15 percent. Yet even these modest gains in output were offset by declining prices.[2]

The shift to traditional crops represents an attempt to earn foreign exchange through import displacement rather than through export expansion. The Central Bank Report for 1971 states:

> As in previous years, the commodity terms of trade moved unfavourably and had a more severe effect in absolute terms than in any previous year. . . . It would appear that the major obstacle to economic development in Ceylon continues to be the shortage of foreign exchange. In fact, in 1971, due to the constraints of the external payments position, restrictions had to be applied on a wide range of goods, including intermediate and investment goods, which probably contributed to the lower rate of growth of the economy. . . . Given the generally unfavourable prospects for the prices of the three major exports, it is inevitable that development strategy must, in the short run, lean more heavily on a policy of import substitution. . . .[3]

The substantial need for foreign exchange can be inferred from the fact that the value of investment goods imported was cut back by 23 percent in 1971, at a time when the

---

[1]Food and Agriculture Organization, Tea Trends and Prospects, Commodity Bulletin Series (Rome: FAO, 1960).

[2]Central Bank of Ceylon, Annual Reports 1956-71 (Colombo).

[3]Central Bank, Annual Report 1971, p. 233.

value of rice, pulses, onions and sugar imports increased by over 4 percent.[1]

Considerable development potential exists in the development of the paddy subsector alone. Although government programs have been directed at the traditional subsector producing paddy in the past eight years, and an increase in yield of about 6 percent per annum occurred during the period 1966 to 1971, yet 40 percent of Sri Lanka's rice requirements were still being imported in 1971. Rice accounted for 46 of the import bill in 1971, which was 8 percent of the GNP.[2] Hence, the import displacement that is likely to occur with an increase in domestic rice production could, if complete, release nearly half the total import bill for the import of investment goods. In fact, this is substantially an objective of the Plan which envisages a 45 percent increase in rice output in five years. If achieved, this would meet 97 percent of domestic rice requirements by the end of the Plan period in 1976.

The Plan places primary emphasis on intensive, as opposed to extensive, paddy production. Although the program for irrigation and land development is expected to bring into production about 100,000 new acres, the major portion of the increase in output (80 percent) would take place through increasing productivity on land already

---

[1] Ibid. [2] Ibid.

under paddy cultivation. The newly prepared lands are expected to account for only 9 percent of total rice output in 1976--up from 1 percent in 1972. This is consistent with the urgency of the need to increase output, as stimulating output is usually easier than initiating production; the former requiring only a complement of resources to combine with existing land, labor, and capital.

Organization of Thesis

Chapter II examines the theoretical and conceptual relationships between growth and equity factors with a view to developing a conceptual framework for subsequent analysis, obtaining clues with regard to the subsequent direction of the study, and for generating relevant hypotheses for later verification.

Chapter III develops a short-run conceptual framework which is expected to be helpful for both analyzing the micro studies cited in Appendix A and for tidying up the analysis of relationships between variables in the rest of the study.

Chapter IV translates political values in the social welfare function into specific objectives for equity policy by identifying the socio-economic groups upon whom policies should be focused.

Chapter V identifies the variables that are statistically and economically significant for explaining interdistrict paddy productivity.

Chapter VI assesses the variables already identified, from the viewpoint of equity; their applicability to small farms and their employment generation potential.

Chapter VII uses the concepts and facts previously developed to identify policy steps that should be taken that will contribute towards the growth and equity objectives of the Five Year Plan.

Chapter VIII summarizes and synthesizes the thesis.

CHAPTER II

AN EXAMINATION OF THEORETICAL AND CONCEPTUAL MATTERS RELATING TO INCOME DISTRIBUTION AND GROWTH AND THEIR INTERRELATIONSHIPS

Introduction

This chapter first examines the theories of growth and income distribution, and then proceeds to examine their interrelationships. Two aspects of equity factors will be explored: (1) The question of whether it is desirable or feasible to leave matters relating to equity to be dealt with independently of policies designed to increase agricultural output (the separation issue), and (2) the basis for, and validity of, the belief that the two goals of growth and equity are in conflict (the conflict issue). The discussion of these interrelationships is directly relevant for and related to the development of a conceptual framework for analysis presented in the following chapter. It will also be shown that these interrelationships are central to the objective of this study, that the conclusions with respect to them are useful for suggesting a direction for the study to take, and for generating relevant hypotheses for later verification.

A Theory of Technological Change and Agricultural Growth

Increasing agricultural productivity is more than a problem of investment, as investment in traditional factors involves a movement along an existing production function yielding only low returns at the margin. T. W. Schultz[1] argues that comparatively few significant inefficiencies exist in the allocation of the factors of production in traditional agriculture. To the extent that this is true, no great increase in agricultural production is likely to occur either by reallocating the factors already at the disposal to farmers, or by applying more units of traditional inputs to the production process.

His argument stresses concentration on new technology, which clearly brings much greater and more rapid increases in agricultural output. Such technology pushes out the production function through the use of inputs embodying modern scientific knowledge, and provides both the incentive and the opportunity for investment in agriculture through potentially higher returns.[2] Since most

---

[1] T. W. Schultz, Transforming Traditional Agriculture (New Haven: Yale University Press, 1964).

[2] This model fits into the transitional stage II of the Perkins-Witt, Johnston-Mellor and Hill-Mosher models of the agricultural development process that are based on historical analogies. M. Perkins and L. Witt, "Capital Formation: Past and Present," Journal of Farm Economics, Vol. 43, No. 2 (May, 1961); B. F. Johnston and J. W. Mellor, "The Role of Agriculture in Economic Development," American

such inputs are purchased, one index of modernization would be the ratio of purchased to total inputs in a farm. This ratio would be useful for determining the degree of modernization and for deciding if it is significant.[1]

The extent of the increase in output resulting from the application of modern inputs depends on the availability of complementary inputs that together constitute a package, and the institutional context in which such technology is applied. Thus, if the input package is incomplete, or if the institutional context is inappropriate, the output effect could be less than optimal.

Agricultural technology is important not only because it is the primary source of agricultural growth but also because it has direct implications for the functional and personal distribution of income. Technology constitutes a primary element in the conceptual framework to be developed. Hence a theoretical classification of technological changes appears relevant.

Economic Review, Vol. 51, No. 4 (September, 1961); E. F. Hill and A. T. Mosher, "Organizing for Agricultural Development" (New York: Agricultural Development Council, 1963; mimeographed).

[1]This index of modernization could, however, be an unreliable indicator of the degree of integration of farms in the product market, as although the degree of modernization may be significant, an inadequate land base may prevent the generation of a marketable surplus above subsistence needs.

The following analysis is based on Hicks' theory[1] as applied to agriculture by Heady,[2] and is postulated in a Cobb-Doublas world which assumes constant returns to scale, constant product prices, equilibrium in the factor market, and two factors of labor and capital. Under these assumptions a change in technology which affects the relative shares imputed to the two factors in the total product may be classified as labor saving, neutral, or capital saving, depending on whether the change increases the marginal productivity of capital by relatively more, in the same proportion, or relatively less.

These changes may be relative or absolute. A labor saving technical change may increase the marginal product of both factors, but the marginal product of capital is increased by relatively more. Thus it becomes profitable to apply more of both resources to the production process, but proportionately more units of capital will be applied. Also, technical changes may increase the marginal productivity of capital, while at the same time decreasing the marginal productivity of labor. In this instance, fewer units of labor will be employed. Thus, while in both cases the relative share imputed to

---

[1] J. R. Hicks, "Distribution and Economic Progress: A Revised Version," The Review of Economic Studies, Vol. IV (1), pp. 1-12.

[2] E. L. Heady, "Changes in Income Distribution in Agriculture with Special Reference to Technological Change," Journal of Farm Economics, XXVI (3), pp. 435-47.

labor is changed in the same direction, the absolute share moves in an opposite direction.

The distinction is made in the literature between mechanical and biological technology, the former being regarded as labor displacing while the latter is regarded as being land replacing.[1] This distinction, although conceptually useful, is not mutually exclusive. For instance, tractors that break a timeliness bottleneck can be land rather than labor replacing over the spectrum of one year. This difficulty of making a distinct classification between labor-saving and land-saving technologies could be traced to the fact that when new factors are applied the whole production function may change and hence induce changes in the use of other factors not directly applied.

The foregoing analysis assumes that product prices remain unchanged. However, it is possible for prices to fall within limits without reducing the profitability of (or incentive for) investment in agriculture. Such profitability is determined by the difference between per unit price and per unit costs. There is a theoretical presumption that the unit costs from package cultivation are usually much less than from traditional methods. While the application of modern inputs increases

---

[1]This distinction can be traced to Earl O. Heady's Economics of Agricultural Production and Resource Use (New York: Prentice Hall, Inc., 1952), pp. 818-19.

total costs of production, the productivity of these inputs can greatly increase output, and thereby reduce average costs considerably. Thus, innovators who increase net output faster than the product price falls could still gain.

Theories of Income Distribution

The theories of distribution in the literature can be classified into two categories: (a) those dealing with functional distribution and (b), those relating to personal distribution.[1] The former attempts to explain the distribution of income among factors of production while the latter relates to the distribution of income to people (households) by size brackets of income.

The theory of functional distribution could be traced to the Ricardian theory which seeks to explain the distribution of income to the various factors of production in terms of their marginal productivity. It is in fact the theory of factor prices--an extension of price theory. Relative shares in the distribution of income depend on (a) relative factor prices that have been determined by the interaction of supply and demand and

---

[1]Some writers distinguish a third category called the Theory of Distributive Shares, which is an aggregation of functional distribution at the macro level. This is of limited use for this study. See, for instance, Jan Pen, Income Distribution (London: Allen Lane Penguin Press, 1971), and J. Marchal and Ducros, eds., The Distribution of National Income (New York: Macmillan, 1968).

(b), the elasticity of substitution which is a technical factor, having its basis in the production function. Market forces will generate a set of factors to clear the market and make their individual price equal to the value of their marginal product.

Generally, however, the neoclassical theory of income distribution per se, which is the theory of income distribution, is of limited usefulness for the purpose of this study. It has been labeled a theory of "pseudo distribution."[1] This functional distribution accepts the ownership pattern of income generating assets (wealth) as given and therefore directly reflects the extant distribution of wealth. It is also based on the assumptions of perfect competition in both product and factor markets. Besides these shortcomings, its relevance to this study exists only to the extent that it coincides with personal income distribution. This implies that its relevance depends upon the payment of labor being the sole source of low income, while capital income accrues to high income recipients. This requirement therefore limits the usefulness of the neoclassical theory in a subsistence and small farmer situation where often no division exists between the ownership of capital and labor, and where returns to both can be low. This

---

[1]Term attributed by Jan Pen, op. cit., to E. Cannon, "Division of Income," Quarterly Journal of Economics (1905).

latter point implies that even if levels of income can be associated with factor shares, such factor shares do not usually correspond to distinct socio-economic groups.

Of greater relevance in a welfare and policy sense is the size distribution of income to people. The distribution of personal income provides the link between technological change and income disparities. For reasons of convenience and practicability, such personal distribution will be disaggregated into economic groupings. Hence this study is concerned with the income that accrues to economic groups, rather than whether the income consists of wages, profits, rent, etc. A quite different concept underlies personal income distribution. Changes in governmental transfer payments to nonproducers, for example, will affect size distribution through the change in personal income, but leave functional distribution unchanged. Conversely, labor intensive technology could change the personal distribution of income by changing the functional distribution.

A search of the literature reveals that no general theory concerning personal income distribution exists. The redistribution of personal income involves interpersonal comparisons of utility and non-Pareto better changes. Fundamentally, questions relating to income redistribution deal with matters of relative property rights, where property rights are defined to be "the set of rights and

obligations established by law, custom and covenant which define relations among members of a community in respect their control over resources."[1] Questions addressed to the bundle of property rights are prior to those asked by classical economists, who accepted the institutional variable as datum and subsumed it in ceteris paribus. Ultimately the distribution of personal income must be determined by the political process and reflect the distribution of political power. Economic theory therefore cannot be expected to provide all of the guidelines concerning the redistribution of income. Such guidance must derive directly from some exogenous social welfare function.

Relationships Between Growth and Equity Factors

Introduction

Technical changes that greatly increase output do not necessarily promote development. As previously stated, economic growth is a necessary but inadequate condition for development, which has been defined in multi-dimensional terms to contain both growth and equity components. Both in the theoretical literature and at the level of practical planning, the two goals of "economic growth" and "equity" (i.e., greater equality

---

[1] J. D. Shaffer, Property, Market Structure and Efficiency, Agricultural Economics Miscellaneous Report 1966-69 (East Lansing: Department of Agricultural Economics, Michigan State University).

in incomes) often have been considered as amenable to separate treatment and also often regarded as being in conflict.

The question of whether policies directed at equity objectives are amenable to separate treatment, and can be dealt with independently of policies designed to increase agricultural output, relates to planning and programming strategy. The second aspect of whether the objectives of equity and growth are in conflict, deals with the consequences of growth and income redistribution policies. Therefore, although the policies may be implemented separately, a trade-off could still result in terms of effects. To the extent that growth policies can be dealt with separately, the income redistributional aspects could be left for some subsequent (second) stage, through the device of fiscal policy, after growth has generated increased income flows, and after such income flows have accrued to the owners of the various factors of production. To the extent that the objectives are in conflict, a trade-off between growth and equity is implied, and growth could be expected to cause, and be caused by, the skewness in the distribution of income.

This section first explores the extent to which it is desirable and feasible from an operational standpoint to deal independently with equity policy--the separation issue. Later it examines the theoretical

reasons for believing that growth and equity may be in conflict with each other--the conflict issue.

The Separation Issue

Theories of separation.--Several writers have advocated a separation between growth and equity objectives. Two schools of thought may be identified: (a) those who believed in "contrived dualism" and (b), those who regarded growth as an intermediate goal with equity being an ultimate one.

The contrived dualism model advocated by Owen[1] and modified by Thiesenhusen[2] evinces a concern for both growth and employment. These objectives are to be achieved concurrently through the creation of two subsectors, one emphasizing growth of output (a marketable surplus), and the other emphasizing equity (the creation of employment opportunities). However, contrived dualism in effect argues for disparities in income between households.

The other school of thought considers growth as a means to an end, the end being equity. Hence policy should concentrate on maximizing rates of growth in the

---

[1]Wyn F. Owen, "The Double Development Squeeze on Agriculture," American Economic Review, Vol. LVI, No. 1 (March, 1966), p. 64.

[2]William C. Thiesenhusen, "Latin America's Employment Problem," Science, Vol. 171 (March 5, 1971), p. 871.

first instance, and on dealing with redistributional equity aspects at some subsequent (second) stage. The following quotation seems representative of this viewpoint:

> We should hypothesize that economic efficiency is a less ultimate goal than an appropriate distribution of income. As a consequence, economic efficiency becomes a means to an end rather than competitive to those ends. . . . Economic growth appears (here) clearly in a supportive role to higher objective of men. It is not likely, however, that such ultimate goals can be achieved when the production of economic wealth in a society is at a low level . . . improved national income is viewed as an input and individual fulfillment is considered to be the product.[1]

W. Arthur Lewis also supports this notion when he says, "The advantage of economic growth is not that wealth increases happiness, but that it increases the range of human choice."[2] To advocate the foregoing supports the following positions by implication: (a) that income redistribution refers to the redistribution of income flows through government taxing and spending and (b), that the redistribution is to take place ex post, after income vests--i.e., after such income accrues to the owners of the various factors of production.

---

[1]Emery Castle and Russel Youmans, "Economics in Regional Water Research and Policy," American Journal of Agricultural Economics, Vol. 50 (December, 1968), p. 1662.

[2]W. A. Lewis, "Is Economic Growth Desirable?" in Theory of Economic Growth (Homewood, Illinois: Richard D. Irwin, Inc.)

Three reasons can be identified against the advisability of leaving income distribution matters to be dealt with at a later stage:

(a) To regard income redistribution as the transfer of income flows through fiscal policy raises the issue of the possibility of a trade-off between capital formation and equity, and thus between higher incomes and employment in the future versus higher income and employment in the present.[1]

(b) To concentrate on growth in the first instance may give rise to factors that render difficult or wasteful the movement toward the ultimate equity objective of increasing employment and reducing poverty. There is evidence that growth can be rapid if concentrated in a small number of larger farms utilizing large-scale capital-intensive techniques.[2] But this gives rise to fixed assets and costs in the form of capital equipment, as well as institutional and organizational infrastructure geared to the needs of large farms, which would be the major market participants. It also gives rise to vested interests, which are the political

---

[1]This issue is examined later in this subsection.

[2]W. Falcon, "The Green Revolution: Generations of Problems," American Journal of Agricultural Economics (December, 1970). Also, ILO, Towards Full Employment, op. cit.; Carl K. Eicher, et al., Employment Generation in African Agriculture, Institute of International Agriculture, Research Report No. 9 (East Lansing: Department of Agricultural Economics, Michigan State University, 1970).

manifestations of fixed assets. Once these fixed assets get established they are by definition difficult to change, and so limit the feasibility of moving towards the ultimate equity objective. Such difficulty could for all practical purposes make the intermediate growth objective an end in itself, at least in the "short run."[1]

(c) The third objection to separating equity from growth policy is because of administrative insufficiencies in the rural areas of developing countries, which limit the efficacy of government taxation and spending. Such machinery tends to have an inelastic supply in the short run, and cannot be expanded except at high financial and social costs, due to the high opportunity cost of scarce talents.[2]

Redistribution of income sources.--The aforementioned difficulties can be reduced by a redistribution of the sources or assets from which such income flows are generated. This accomplishes the same objective in a rather more fundamental way, and provides a direct link between income redistribution and growth policy. It involves changing the pre-tax distribution and thus tends to reduce the need for subsequent redistribution through

---

[1] "Short run" is defined as the period during which the MVP of an asset is greater than its salvage value.

[2] This point is probably of limited applicability to Sri Lanka which has an abundance of high school and university graduates.

fiscal measures. It refers to redistributing the capacity for income, rather than income per se, which in traditional agriculture involves the provision to low income farmers of what T. W. Schultz calls "low priced sources of permanent income streams."[1] These include modern scientific inputs like high yielding seed, fertilizer, water control, weedicides, pesticides, inter alia, as well as education and knowledge, which act to broaden horizons, increase farmer receptivity to innovative techniques, and contribute toward their capacity for making economically rational choices. This notion is therefore broader than the human capital notion, which was originally stated by Alfred Marshall when he wrote that "capital consists in great part of knowledge and organization."[2]

Redistributional impact of public intervention.--When income sources are to be redistributed through governmental agencies, the intervention by the state designed to provide farmers with low priced sources of income streams in order that they may increase their output, has implications for income distribution.

1. To the extent that these low priced sources of income streams have to be publicly provided, they

---

[1]Schultz, op. cit., p. 130.

[2]Alfred Marshall, Principles of Economics (8th ed.; New York: Macmillan, 1961), p. 139.

must be publicly funded, and to the extent that they are funded out of progressive taxation, these policies implicitly have an impact on income distribution.

2. The subsequent expenditure of these funds for the provision of low priced sources of permanent income streams and human capital investment has distributional effects, directly through its effect on productivity and employment, and indirectly through its effect on the institutional wage.

The final effect on income disparities of the foregoing will depend on the relative income levels of those groups who pay and those who benefit. A recent study supports the conclusion that the larger the government's share in total investment, the smaller the share of the wealthiest 5 to 10 percent.[1]

The case for public provision of low priced sources of permanent income streams is partly stated by T. W. Schultz. These "sources" have to be produced by research, because "there are very few reproducible agricultural factors in technically advanced countries that are ready-made for most poor countries."[2] Public provision is necessitated by externalities and indivisibilities. The output of research is in effect a public good with

---

[1] I. Adelman and I. Morris, "An Anatomy of Income Distribution Patterns," Development Digest, Vol. IX (October, 1971).

[2] Schultz, op. cit., p. 147.

public good characteristics.[1] As the output of research is of limited appropriability, underinvestment by private investors in research is a certainty, because when marginal private gains have fallen to zero, marginal social gain will still be positive. Another reason why public production of technology is required is because of

> known indivisibilities, primarily in the methods and staff of scientists required when a firm undertakes the production of modern factors suited to the agriculture of particular poor communities starting with the known scientific and technical (agricultural) knowledge.[2]

Moreover, such inputs have also to be distributed through publicly created marketing channels for the same reasons; namely, externalities and indivisibilities. The distribution of modern inputs could set in motion a cumulative spiral of growth the (external) benefits of which could only be captured (internalized) by the comprehensiveness of the state. The low rate of capital formation in traditional agriculture would probably preclude private pricing policies that will cover costs.

In general it may be stated that because technological change is non-marginal change, market prices cannot be expected to provide ex ante signals indicating

---

[1] F. Bator, The Question of Government Spending (Collier, 1960), Chapter 6. The two components of public goods are: (1) MC = 0, which means that as the cost of additional use is zero or near zero, consumption by one individual does not deprive others; (2) Potential users cannot be excluded if the product exists at all.

[2] Schultz, op. cit., p. 150.

the direction and quantum of change. This is because larger price changes result from change when the change is non-marginal. This factor increases the uncertainties of investments. Uncertainty would tend to discourage private investments, probably requiring that technological changes be publicly induced in less developed countries, rather than be left to the "non-dictates" of underdeveloped markets. This position appears to be supported by implication by Galbraith's description of the various "anti-market" institutions that firms in the U.S. must adopt in order that they may cope with the uncertainties that inevitably accompany non-marginal technological changes.[1] Institutional devices like vertical coordination, integration, contracting, and advertising, enable U.S. firms to "supersede" and "suspend" the market. However, they are of limited availability and applicability in the less developed economies of less developed countries, due to traditional institutions like familism, lack of capital and capacity for risks, absence of standard weights and measures and grading systems, an inadequate legal code, inter alia.

Public intervention to induce technological changes in less developed countries has a dual effect on income distribution. First, when public funding is

---

[1]John K. Galbraith, The New Industrial State (Boston: Houghton Mifflin, 1967), Chapters 2 and 3.

out of progressive taxation, income redistribution occurs. Whether income disparities will become reduced will depend on how these funds are subsequently spent, and the income levels of the beneficiaries whose productivity is increased by their acquisition of sources of income streams. Only when such "sources" are provided to groups whose income levels are relatively low, are income disparities likely to be reduced. Second, appropriate technological changes could, if combined with suitable institutional variables, increase employment opportunities and thereby reduce income disparities. Technical changes could shift the production function, increase the marginal value product of the abundant factor, which is labor, and make it worthwhile to apply more units of labor to the production process.[1] Also, quick maturing new varieties make multiple cropping possible--a factor likely to have a most significant effect on employment and thus income. For instance, Japanese farmers using new mechanical and biological technology employ three to four times as much labor per acre of land than Indian farmers.[2]

---

[1]Two points may be noted: Whether employment effects are negative or positive will depend on the type of technology used and the institutional context in which such technology is applied; second, even though employment per acre of land may increase, the labor component in each unit of output is likely to decline.

[2]See, for instance, John Mellor, The Economics of Agricultural Development (Ithaca, N.Y.: Cornell, 1970), p. 229. Also, the official estimate for 1964 shows that

To the extent that technical innovations reduce unemployment in agriculture they influence income distribution. Where underemployment and unemployment are high, to achieve a higher level of employment results in a reduction in income disparities. Dudley Seers says:

> Unemployment is itself a big element in the explanation of the shape of the income distribution. Not only does it deprive large numbers of people of income (including many who do not seek work because they think the search is hopeless and therefore do not appear in unemployment statistics), it also depresses wage levels and causes thousands of people to stay working on tiny farms or in small family businesses.[1]

The distribution of income therefore reflects the existence of unemployment. If employment is provided for those persons who are disguisedly unemployed with zero or near zero marginal value productivity, the income of higher income groups remaining the same, income disparities are reduced. To the extent that the incomes of higher income groups are reduced, income disparities are reduced still further.

A reduction in disguised unemployment has an indirect effect on income distribution through its positive

---

rice cultivation consumed about 180 man-days per hectare per crop. In Taiwan the National University has estimated the labor requirement at 150-160 per hectare. These figures compare with a range of 60 to 120 man-days per hectare for crops of traditional varieties in most of South and Southeast Asia. Robert A. Shaw, "Jobs and Agricultural Development," Development Digest, Vol. IX, No. 1 (January, 1971), pp. 88-97.

[1]Dudley Seers, "Income Distribution and Employment: Some Issues Raised by the Colombia Report," Bulletin of the Institute of Development Studies (Brighton, England), Vol. 2, No. 4 (1970).

effect on the institutional wage. Disguised unemployment has its basis in the institution of familism and exists when labor receives a wage that is higher than its MVP. In a situation where the institution of familism facilitates disguised unemployment, the average product per family is the institutional wage. As the number of persons who are subsidized by the family decrease, there could be an increase in the institutional wage, because then the total product will be shared among fewer persons. In the alternative, the product will be larger as the newly employed person's earnings or part of them are added to the family income. An increase in the institutional wage will reduce income disparities if we assume that the incomes of higher income groups do not increase.

To conclude, although the actual effect of particular technologies on income disparities is a matter for empirical investigation, the foregoing analysis seems to demonstrate that the same factors that cause growth also influence income distribution. Policies designed to influence growth are usually not neutral with respect to income distribution. In fact such policies, when implemented, influence income distribution ipso facto. Hence there are fairly strong reasons for believing that income distribution considerations are best explicitly taken into cognizance at the time that policies are formulated to increase the rate of growth of agricultural

output. Furthermore, there are fairly good practical reasons (like the establishment of fixed assets, and administrative difficulties) for not leaving income distributional questions to be dealt with separately at some subsequent stage. The above two factors reinforce each other in suggesting the advisability of incorporating equity objectives into growth policies.

The Conflict Issue

As was mentioned, there is a widespread belief that the objectives of growth and equity are in conflict with each other, and thus competitive rather than complementary. This implies that trade-offs are involved in pursuing both policies, whether concurrently or separately. A primary objective of this study is to examine the empirical evidence on this point. This subsection examines the *a priori* reasons for the possible existence of a trade-off with a view to determining its theoretical foundations. The degree of acceptability of the conceptual framework presented in the following chapter depends on whether a conflict between growth and equity exists and, if so, whether it can be regarded as significant. A theoretical background also contributes to understanding the interrelationships between growth and equity, when micro studies are analyzed. To this extent it will facilitate an identification of the institutional variables that do or do not cause a conflict situation to

arise. An understanding of the conflict issue could also be useful in identifying socio-economic groups who are potential beneficiaries of agricultural development programs. Hypothetically, the degree of conflict between growth and equity resulting from the provision of sources of income streams would vary with the characteristics of different socio-economic groups.

Theoretical and conceptual relationships.--The relationship between agricultural growth and income distribution has been conceptually developed and historically documented for developed countries. Kuznets has demonstrated that over long periods as GNP increases income disparities are reduced because of the structural transformation in the national economy that has accompanied economic growth.[1] Some evidence exists that, even in Asian countries, development tends eventually to reduce inequality for similar reasons.[2]

Within this argument, the possibility of conflict between the two objectives arises at a national level in

---

[1]Simon Kuznets, Modern Economic Growth (New Haven: Yale University Press, 1966); and Simon Kuznets, Six Lectures on Economic Growth (New York: The Free Press, 1959). Recent U.S. evidence, however, seems to indicate that income disparities, both before and after taxes, appear to have increased moderately.

[2]Harry T. Oshima, "The International Comparison of Size Distribution of Family Incomes with Special Reference to Asia," Review of Economics and Statistics (November, 1962), pp. 444 ff.

developing countries from structural rigidities which stem from state intervention, traditionalism, underdeveloped markets, and high rates of population growth (which reduces the coefficient of differential growth).

Besides these structural reasons, other (mainly monetary) reasons for a possible conflict between growth and equity objectives may be of greater relevance in respect to the agricultural sector. These reasons have their basis in the Keynesian premise that the rate of savings is a function of the level of disposable income. For this reason, high income groups have a higher marginal propensity to save than lower income groups. Hence it is assumed a redistribution of income tends to reduce the savings rate, capital formation, and growth. Therefore, a trade-off could arise between higher incomes in the present and higher incomes in the future. This is a basic ingredient of the Harrod-Domar growth model which is a prototype of post-Keynesian growth theory. Some empirical support for this theory is found in a study of Brazilian macro data, which concluded that the redistribution of incremental income in favor of the middle stratum of income caused the gross domestic savings ratio to decrease, even though per capita incomes were rising.[1]

---

[1]N. H. Leff, "Marginal Savings Rates in the Development Process: The Brazilian Experience," Economic Journal (September, 1968).

Keynes, however, did not regard the propensity to consume as being competitive with investment. Assuming as Keynes does that the aggregate supply function is given, the thesis of the "General Theory" is that employment is determined by aggregate demand, with the propensity to consume and the amount of investment at a given time as complementary components. Hence, the transfer of hoardings, or funds earmarked for imported "luxury" goods, to the consumption of those goods that may be produced domestically, have multiplier effects. These multiplier effects would increase effective demand and stimulate the agricultural economy into achieving higher levels of income and employment, given the relatively high income elasticity of demand for agricultural goods in developing countries. If so, then growth and equity would be complementary rather than competitive objectives.

But Keynes' theory was meant to apply to a depressed, developed, national economy, and not an underdeveloped, traditional agricultural sector. Even with regard to a developed economy, some doubt exists as to whether an income-leveling policy will significantly help raise consumption and increase employment.[1] Consumption is less likely to increase in a stagnant traditional economy. If workers are unemployed or

---

[1] H. Staehle, "Short Period Variations in the Distribution of Incomes," Review of Economic Statistics (1937), pp. 133-43.

underemployed when idle productive capacity exists, the under-consumption theories probably have a message. But this would hardly apply to a traditional agriculture where output must increase primarily through technological change. Even if idle capacity in productive equipment (like large tractors) exist, the under-consumption theories would apply only if the idle capacity is due to a lack of effective demand and not to other constraints like the lack of foreign exchange for spare parts or raw materials, or the absence of skilled manpower. The operation of the multiplier in a (traditional) economy where the supply is inelastic is likely to generate inflation rather than growth.

Even the notion that income redistribution reduces investment and hence future growth seems of doubtful validity, especially in a developing economy. There are four broad considerations, one at the level of pure theory, which question the notion of a trade-off, and which when taken together, may weaken it:

1. The theories of Duesenberry, Friedman, and others do not establish a clear connection between the level of income and the rate of savings.

2. When income redistribution is regarded as a redistribution of the sources of income streams, resources are not transferred from investment to consumption but investments by high income groups, both productive and

nonproductive, are replaced by investments by low income groups.

3. Even if the funds are transferred from the savings of high income groups, this redistribution of personal income is likely to have a positive effect on growth through its functional redistributive effect and the release of high opportunity cost foreign exchange resources.

4. From a negative standpoint, the skewness in income distribution which the Keynesian hypothesis seems to advocate for high rates of growth, may not yield a high savings rate if high income recipients engage in conspicuous consumption instead of saving.

The validity of this fourth factor rests upon a definition of savings that may be of limited practical value. Each of these factors will be examined in turn.

Taking the first objection; other hypotheses on the relationship between the level of personal income and the savings rate do not support the Keynesian notion that income redistribution necessarily reduces aggregate savings. With Milton Friedman's permanent income hypothesis,[1] redistribution of income would not affect savings so long as all families believed the new incomes to be permanent. In Duesenberry's relative income

---

[1]Milton Friedman, A Theory of the Consumption Function (New York: National Bureau of Economic Research, Inc., 1955).

hypothesis,[1] the effect of income redistribution on savings and thus future growth cannot be stated a priori. This is so because the average propensity to save depends on the level of income relative to the national average income, and the effect of income redistribution on savings depends on the specific nature of the relationship between actual and average income.

In other theories, savings depend on factors other than the level of income, such as the rate of interest, age of saver, expected income, etc.

The supposedly adverse effect of income redistribution on the savings rate, the second objection, assumes that the redistribution consists of primary income flows already vested, and that this redistribution will be accomplished through fiscal policy. In this case, differences in marginal propensities to save between high and low income groups could cause the redistribution to substitute consumption expenditure for investment expenditure. However, when the redistribution refers to the provision of sources of income streams, investment by high income persons is replaced by investment by low income groups.

Besides, small farms make up such a large proportion of the rural acreage that an increase in

---

[1] J. S. Duesenberry, Income, Saving and the Theory of Consumer Behaviour (Cambridge, Mass.: Harvard University Press, 1949).

productivity on these farms is likely to have a significant effect on output.

Moreover, the redistribution of sources of income streams also minimizes the possible adverse effect of income redistribution on incentives since whatever adverse effect such transfers may have on the incentives of high income groups are offset by the opportunities created for low income groups.

Furthermore, the growth in agricultural output per se can have equity effects because it increases the supply of goods for which the income elasticity of demand is relatively high, from 0.6 to 0.9 percent.[1] The benefits would be negated, however, if the shift in the supply schedule results in a more than proportionate fall in the price (due to the inelastic nature of the demand curve) and thus smaller incomes to farmers. But this is unlikely because of the interdependence between supply and demand factors in the underdeveloped rural economy. The level of per capita income in the rural economy is largely determined by the level of agricultural output; per capita income cannot increase without an increase in agricultural output. Consequently, a supply shift in agricultural goods will, through its effect on per capita income and high income elasticity factors, actuate an outward demand shift which dampens the price-reducing

---

[1]Mellor, Agricultural Development, op. cit., pp. 73-77.

effect of the initial supply shift. Even if prices do fall, real incomes do not decrease if unit costs are reduced proportionately more.

Trade-offs could arise, however, if within a given time span relatively high return private investment is replaced by relatively low return public investments in rural infrastructure. Since such investments tend to yield lower returns over a longer period, their discounted present value would be lower, given a discount rate that reflects the scarcity of capital and the urgency of the need to develop. Also, public investment in regions where infrastructure is weak would, by being deprived of "Marshallian" externalities that derive from physical propinquity like pools of skilled labor, common services, infrastructure, etc., yield a lower return per unit of capital investment. This is what Gunner Myrdal refers to as the "backwash effect," in terms of which externalities of infrastructure cause capital to pour into the more advanced "development poles."[1]

Even if the funds transferred to low income farmers yield a rate of return per unit of capital investment that is equivalent to that which might have accrued to high income investors, the differences in marginal propensities to consume is likely to result in the lower

---

[1] G. Myrdal, "The Inequality Issue," in The Challenge of World Poverty (New York: 1970), pp. 49-77.

income persons spending on consumption a larger portion of the incremental income generated by their newly acquired sources of income streams.

Third, if progressive taxes transfer funds from high income groups to low income groups for consumption, this redistribution of personal income could, though not necessarily, have favorable effects on growth through its effect on the functional distribution of income, and the reallocation of high opportunity cost foreign exchange resources from consumption to investment. If progressive taxes are utilized to redistribute income to lower income groups, this would transfer control over real resources from persons with a relatively high marginal propensity to consume income elastic (luxury) goods to those with a relatively high marginal propensity to consume the more income inelastic (basic) goods. If luxury goods have a high import content, and basic goods a low or nil import content, such a transfer would shift outward the demand curve for domestically produced income inelastic products like food. To the extent that the foregoing is valid, such a transfer has a potential for reducing unemployment, and thereby income disparities, in the following ways. First, it achieves a functional redistribution (i.e., an increase in the share of labor in the total product) by increasing the demand for goods that have a higher domestic labor content. An increase in the demand

for basic goods implies that these goods can be produced locally and by relatively more labor-intensive methods of production. The increase in the demand for goods with a higher labor content contributes to reducing unemployment, and therefore reduces income disparities (on the assumption that the income of higher income groups do not increase). Second, the shift away from goods that have a high import content releases foreign exchange resources for the import of capital goods, and therefore increases employment potentials in the economy. These two favorable effects on unemployment actuate a third indirect effect on income disparities by exerting an upward pressure on the institutional wage, which is the average product per household in the rural sector. Thus reduced unemployment not only reduces income disparities directly by providing persons with low MVPs with employment and incomes, but also ceteris paribus, reduces income disparities by increasing the institutional wage.

A qualification to the foregoing argument exists. All movements toward a more equal income distribution will not necessarily increase total employment unless relatively labor intensive final goods are also labor intensive with regard to intermediate goods in comparison with capital intensive final goods. Also, there must

be no significant degree of involuntary short-time working in the labor intensive sector.[1]

Mention might be made of the "Economy of High Wages" factor in terms of which higher consumption levels could lead to better nourishment and hence higher productivity levels. In this case a rise in real wages becomes another form of investment.[2]

Fourth, the Keynesian hypothesis with regard to savings and income levels seems to advocate a skewed distribution of income for a high rate of capital formation and growth. However, there seems to be a growing consensus that the level of income does not affect the savings rate in developing economies. The proposition that savings is not a function of the level of income has been strongly supported by several writers, including the authors of the ILO studies on Columbia and Ceylon.[3] These writers have taken the position that in developing countries income constitutes a means of purchasing

---

[1]John Weeks, Employment and the Distribution of Income (unpublished; Brighton: Ms. IDS, 1972).

[2]Myrdal seems to attach considerable, and probably exaggerated, importance to this factor. Myrdal, Asian Drama, op. cit., Vol. II, p. 745 ff.

[3]See Dudley Seers, "New Approaches Suggested by the Columbia Employment Programme," International Labor Review (October, 1970), as well as V. K. R. V. Rao, "Re-distribution of Income and Economic Growth in Underdeveloped Countries," in Income and Wealth, Series X (1964). This same point has also been made by Kaldor and Myrdal in UN Publication E/CN/5/At13/R3/Addl.

status and hence gets disassociated from production. Thus despite the skewed distribution, the savings rate remains low and the rate of growth is consequently slow.

However, these theories tend to become merely academic, and lose their practical usefulness for policy if "savings" is defined to include both actual and potential savings--a distinction which corresponds to the dichotomy between voluntary and forced savings. The foregoing theories attempt to explain actual and voluntary savings. Potential savings refers to funds that would have been spent on "nonessential" consumption and "nonproductive" investments like land speculation, and are potentially available for conversion into public savings through taxation. In this case the savings potentially available will depend on (a) the private expenditure that is normatively, though not necessarily arbitrarily, deemed by the state to be nonessential or socially unproductive and (b), the prevalent level of income. Thus if the voluntary savings rate is low, and public investments are needed for agricultural development, savings could be "generated" through taxes. To regard savings as the surplus above "necessary" consumption appears to be realistic if, as in the case of Sri Lanka, the distribution of wealth fails to match the distribution of real political power. However, public savings must in the long run depend on an efficient fiscal system and a widening tax base.

Some writers also discount the possibility of a conflict between growth and equity objectives on the basis that redistributional policies promote social and political stability and thereby create a climate suitable for investment and growth.[1] This expectation seems valid only if we assume a more or less fixed standard of living with an upward moving level of living that progressively closes the gap between attainment and desires. But this belief does not seem to have empirical validity, as distributional policies could widen the gap between levels and standards of living by activating latent needs. This could bring into existence social discontent which did not previously exist, not because there was no cause, but because there was no hope.

One summary of the evidence on the relationship between growth and equity was presented at AID's 1970 Spring Review of Land Reform where E. Lang noted:

> The most important finding of the review is that the social and political goals of wider distribution of opportunity, power, and employment among farm people are not in conflict with increased agricultural productivity and efficiency.[2]

---

[1] See, for instance, ILO, Towards Full Employment, op. cit., and G. Myrdal, "Differences in Initial Conditions," Asian Drama, op. cit., Vol. I, Chapter 14.

[2] Quoted in report on subsession by Peter Dorner, "Discussions on Equity and Productivity," in the American Journal of Agricultural Economics (December, 1970), p. 717.

Probably, the degree of conflict between the goals will depend on whether the groups at whom agricultural development programs are directed are willing and able to utilize such technology to increase their productivity and levels of income. Some groups at the very low level of the income spectrum or having paddy lands of very small size probably would be incapable of utilizing the sources of income streams for the purpose of generating greater income flows. This may be due to low levels of ability, inadequate land, or other factors. If so, the extent to which technology can promote both growth and income distribution objectives will depend on the receptivity to and responsiveness of different groups to agricultural modernization. Conflict is likely if the groups are not responsive. Therefore the degree of success in achieving both growth and equity objectives, and the degree to which they are complementary, appear to depend on the judiciousness with which policies are focused.

Summary and Conclusions

The foregoing analysis has demonstrated that technological change constitutes a link between growth and income distribution. The main source of agricultural growth is not reduced productivity slack (i.e, more efficient allocation, or more investment in traditional inputs),

but new technology--modern, off-farm, purchased inputs, that embody scientific knowledge.

Technology links growth to both functional and personal income distribution. Technology directly affects the functional distribution of income, depending on whether it is labor-saving, neutral, or capital-saving. The precise effect of technology on functional distribution depends on the nature of the shift in the production funciton that such technology actuates. For this analysis, however, the functional distribution of income is important, not for its own sake, but only insofar as it influences personal income distribution.

The link between agricultural technology and personal income distribution arises from the following factors:

(a) Most agricultural technology has to be produced off-farm (because it can be produced more cheaply under large-scale specialized conditions) and marketing channels therefore need to be developed to bring such technology to traditional farmers. Externalities, indivisibilities, and uncertainties with regard to technological change make public production and distribution necessary. Public funding to provide inputs and complementary infrastructure through progressive taxation has redistributive effects.

(b) The acquisition of technology by farmers has income effects, directly through the impact of such technology on productivity and employment, and indirectly through its influence on the institutional wage.

Technology, the primary source of agricultural growth, therefore is not usually neutral with respect to income distribution. In fact, implementing policies for promoting agricultural growth implicitly affects income distribution by increasing or decreasing income disparities, either relatively or absolutely. The same instruments that promote growth can be utilized to move toward a more desired distribution of income. Consequently, it seems advisable to explicitly take income redistribution objectives into cognizance at the time policies are formulated to increase output. This conclusion seems reinforced by the practical difficulties of leaving income distribution questions to be dealt with at some later stage through fiscal policies. These difficulties include the possibility of conflict between the policy goals of growth and equity, the establishment of fixed assets, and administrative insufficiencies affecting the efficacy of fiscal policies. As a corollary conclusion, income distribution should not be regarded as a matter exclusively for fiscal policies, to be carried out independently of policies designed to increase output.

To the extent that the foregoing is valid, a major task of planners is to identify groups, on the basis of some homogeneous characteristics, who are to be the beneficiaries of policies, and that agricultural development programs should be focused on these specific socio-economic groups. This conclusion would be supported by the position, if valid, that the degree of conflict between growth and equity will vary with different socio-economic groups. Therefore, the degree of success in achieving growth and equity objectives, and the degree to which they are complementary or competitive, partially depend on the judiciousness with which such policies are focused.

CHAPTER III

CONCEPTUAL FRAMEWORK FOR RESEARCH

The conceptual framework relies on the belief that technological changes cannot be isolated from socio-political milieu. Gotsch[1] has proposed that the effect of technological change on income distribution be analyzed within the conceptual framework of four broad interacting variables: (1) the characteristics of "abstract" technology (efficiency and factor intensity); (2) the absolute magnitude and distribution of productive assets (land tenure factor); (3) the type and distribution of institutional services; and (4) local social customs and traditions. This conceptual framework (a) shows how the characteristics of technology, local institutions, and the rural social structures are related to each other at a point in time, and (b) how these relationships can be expected to evolve in a dynamic rural system.

The conceptual framework proposed here utilizes Gotsch's variables but adapts their arrangement and flow

---

[1]D. H. Gotsch, "Technical Change and the Distribution of Income in Rural Areas," Economic Development Report, No. 205 (Cambridge, Mass.: Centre for International Affairs, Harvard University, 1971).

directions to suit the purpose in hand, which is a review and analysis of micro level studies. The framework is of a hierarchical nature, with two broad sets of (primary) variables, which interact at the local level to determine the distribution of personal income and agricultural growth. These two sets of variables have their basis in other (secondary and tertiary) variables which determine their efficacy, efficiency, viability, and character. These secondary and tertiary variables could also determine the focus of the primary variables. The framework is valid primarily in a short run (five year) situation. The conceptual framework is diagrammed in Figure 1.

The two sets of primary variables that interact to determine personal income distribution and growth in agriculture are: (1) technology, and (2) institutional-organizational factors.[1]

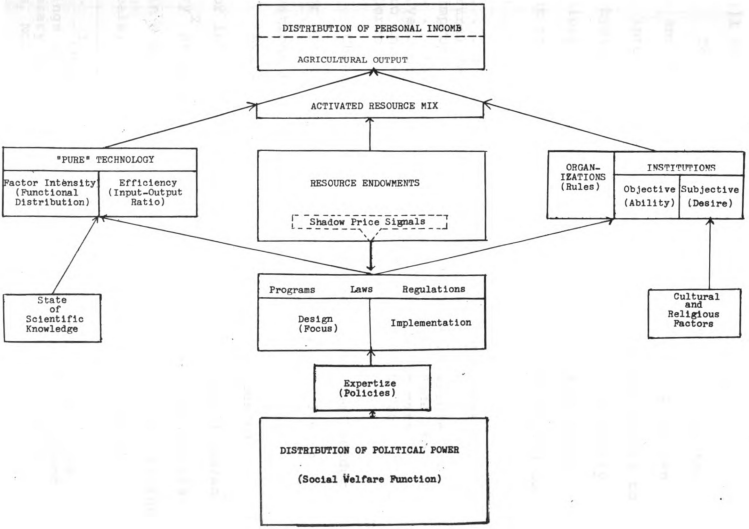
Technology

The effect of a technological change in agriculture on inter-farm income distribution would depend on the nature of the technology itself. Thus if the

---

[1]As with Gotsch, ibid., and Schultz, op. cit., institutions are treated as variables. Subscription is made to the belief that small farmer development has to be studied in the context of surrounding economic and political processes. See also Walter E. Coward and Wayne Schutjer, "The Green Revolution: Initiating and Sustaining Change," in Civilizations, Vol. 20, No. 4 (1970), pp. 473-83.

Figure 1. Conceptual Framework Showing Short-Run Primary Relationships Between Categories of Variables Affecting Output and Income Distribution



technology is capital intensive it will be biased against the capital-poor farmers or, if it requires water control, it will favor farmers with irrigated farm land.

Technology has two main aspects to it: (a) the level and change in the efficiency factor, and (b) the input intensity factor. The efficiency factor refers to the physical productivity of inputs. It is the purely technical engineering notion of the ratio of physical output to physical input. Gotsch states with regard to this:

> . . . a critical ingredient to any broad-based rural development effort is a significant improvement in the value-added by agriculture . . . the increase to resources owned needed to overcome the reticence of traditional farmers to innovate must be on the order of 30 to 50 percent.[1]

Changes in efficiency may be due to the broader use or optimal use of existing technology, or due to innovations that are new to the system.

The second aspect of technology relates to factor intensities. This has its origin in the Hicksian theory[2] as applied to agriculture by Heady,[3] and postulated in a Cobb-Douglas world which assumes constant returns to scale, constant product prices, equilibrium in the

---

[1]Gotsch, op. cit. This is consistent with the findings of Dobbs who considered a return of 25 percent necessary if new practices are to be adopted. (J. L. Dobbs, No. 1, Appendix A.)

[2]Hicks, loc. cit. [3]Heady, loc. cit.

factor markets, and two factors of labor and capital. Then, a change in technology which affects the relative shares imputed to the two factors in the total product may be classified as labor saving, neutral, or capital saving, depending on whether the change increases the marginal productivity of capital by relatively more, in the same proportion, or relatively less.

These two aspects determine the divisibility of technology (i.e., the scale factor) and their potential for generating externalities (i.e., creating a divergence between private and social returns). Technology in this framework is determined by the state of scientific knowledge, and by policies such as the extent and type of research funded, interest rates for capital investment, the level at which the rate of exchange is fixed, and a wide spectrum of fiscal policies, such as investment credits, tariffs, and depreciation allowances.

Institutions

The second set of variables is the institutional variables (including organizational factors) which interact in the conceptual framework with technology to determine income distribution and increases in output. These institutional variables are of two types. First are the subjective institutional factors like social values, farmer goals, rural perceptions, etc., that stem from culture and religion. These factors affect receptivity

to innovation and the desire to change. The other component is the subset of objective variables that create the opportunities for farmers to be able to change. These include tenure conditions, credit availability, price supports, and the whole gamut of factors that can be manipulated through programs for agricultural development. The framework recognizes two aspects to programs--the design of programs, and the efficacy with which they are implemented. Thus, well designed programs may not yield desired performance due to unsatisfactory implementation. Organizational variables are an appendage of institutional variables because the viability of organizations are to a large extent determined by the rules under which they operate; i.e., institutions. Thus, organizational performance to a considerable extent is determined by organizational rules.

Resource Endowments

Resource endowments have been included in the conceptual framework, and some resources are shown to be capable of influencing and be influenced by both primary variables of technology and institutions.

Two categories of resources can be distinguished. One category consists of immutable factors, the other of changeable factors. Some resources like the number of monsoons or amounts of sunlight may be given and unchangeable either because change is technically infeasible or

because it is economically unprofitable, even though technically feasible. Hence a conceptual differentiation separates those factor endowments that can be changed (e.g., through irrigation, fertilization, etc.) and those that cannot. The flow directions in Figure 1 indicate that resource endowments send relative price signals on the one hand, and directly contribute to the final resource mix available on the other.

Recent writings, based on empirical research, propose that factor endowments, technology and human capital, account for 95 percent of labor productivity growth and labor productivity differences.[1] The conceptual framework recognizes that resource endowments could influence both technical and institutional changes. Such recognition infuses into the framework the fundamental notion in the Hayami-Ruttan induced development model, that institutions and technology can be endogenously determined by relative prices. To say that these primary variables are endogenously determined proceeds beyond T. W. Schultz's high pay-off input model in which they are exogenous and unresponsive to economic forces. In the Hayami-Ruttan induced development model, factor endowments could generate relative prices that provide

---

[1] Yujiro Hayami and Vernon W. Ruttan, "Sources of Agricultural Productivity Differences Among Countries," in Agricultural Development: An International Perspective (Baltimore: John Hopkins Press, 1971), pp. 86-107.

appropriate signals to public and private sector suppliers of knowledge and technology, and stimulate the responses of institutions to new economic opportunities. For instance, the desired physical properties of plants can be predetermined by policy makers, and the research biologists can then be asked to design such a plant.[1]

However, while relative prices could send such signals to innovate, it does not follow that they actually do so successfully. Evidence exists that economic signals have not succeeded in influencing the design and focus of programs, policies, and laws that determine the nature and type of institutions and technology. In fact, numerous instances can be cited where capital intensive technologies have been accepted in labor abundant situations.[2]

Hence the conceptual framework would be deficient for analyzing real world situations if it failed to take cognizance of the possible lack of efficacy of relative price signals in actually influencing the policies of public and private agencies. Part of the discrepancy between what is and what should be may be attributable to the fact that the induced development

---

[1]The process referred to as "biological engineering" by the Rockefeller Foundation.

[2]See the instances cited by Eicher, Gotsch, and Falcon, loc. cit.

model is built upon the foundation of shadow rather than market prices.[1]

Shadow prices are invisible prices that have to be painstakingly discovered through careful analysis and computation. Whether social shadow prices convey appropriate signals to public and private agencies depends on whether such agencies choose to discover them in the first place and whether, having done so, choose to use them for policy guidance.

The Distribution of Power

The conceptual framework proposed here seeks to explain the factors that actually influence the type and nature of technology and institutions as they exist in the real world. This it does by tracing back through policies and laws to their source, which is the distribution of real political power. As the lines of interaction indicating flow directions suggest, whether the (shadow) price signals do influence technology and institutions, and the extent to which they are successful in doing so, depends on whether they are permitted to do so by vested interests and the political process. Since both technology and institutions determine relative

---

[1]Time lags may also partially account for a lack of response in the short run.

property rights,[1] those who hold power can be expected to perceive policies, laws, the distribution of new flows of productivity, etc., as possible threats or reinforcing to their existing position. Dorner recognizes this when he says:

> The significant distributional questions are not those defined by marginal productivity theory, but those concerned with economic and political power and the patterns of resource ownership and control to which they give rise.[2]

A recent publication by Nulty arrives at essentially the same conclusion with regard to technical changes in West Pakistan. Nulty[3] says:

> Technical innovations in and of themselves would appear to be insufficient to the demands of development; they inevitably force some kind of adjustment in prevailing institutional relationships and the outcome of this adjustment is likely to be determined by the distribution of political power and the relative political awareness of the affected groups.

Thus the conceptual framework recognizes that, since the relative level of technology among users, and the relative rate at which users and potential users of improved technology adopt it, determine relative rights, the question of who should gain and who should lose is ultimately a political decision.

---

[1]Warren Samuels, Welfare Economics, Power and Property, Department of Economics, Michigan State University. (Mimeographed.)

[2]Dorner, op, cit., p. 718.

[3]Leslie Nulty, The Green Revolution in West Pakistan: Implications of Technological Change (New York: Praeger, 1972).

Similarly, with regard to institutions the framework demonstrates that the distribution of income and ownership of productive assets must ultimately reflect (and later interact with) the distribution of real political power. The nature, design, and responsiveness of institutions cannot adequately be explained solely in terms of relative prices. The nature, design, innovativeness, focus, and radicalism of policies and programs that modify institutions, and the degree of effectiveness with which such policies and programs are implemented, can (must) ultimately be explained in terms of the actual and expected distribution of real political power.

Given resource endowments, the primary variables of technology and insitutions interact in the conceptual framework to influence the quantity and mix of resources finally available for increasing output and the productivity of low income groups.

Constraints

The exogenous constraints identified are probably valid only in the short run (five years). They are: (a) Cultural factors, including religion, which are the subjective institutions which influence the farmers' receptivity to new technology. This variable recognizes the importance of the farmers' subjective evaluation of the technology, and that the success of programs depends

on the response of people at whom they are directed.[1] The flow directions indicate that the urgency associated with increasing paddy productivity does not permit the modernization of farming communities through a change of existing culture and values to modern practices. (b) The state of scientific knowledge limits the type, quality, and variety of the technology that can be produced. (c) The level of skills of experts and administrative personnel will have a pervasive limiting influence on all of the relevant variables.

Focus of Variables

The framework developed here can be used to analyze the reasons for both growth and income distribution in agriculture. This stems from the assumptions that income distribution in developing countries should be dealt with by increasing the productivity of low income groups, rather than through transfer payments using the device of fiscal and welfare policies. While increasing output depends on the quality of policies and programs and their implementation, their consideration for income distribution hopefully only requires in addition that legislation, policies with regard to factor intensities,

---

[1] C. R. Wharton has discussed the importance of this factor in "Risk, Uncertainty and the Subsistence Farmer" (paper presented at the Joint Session of the American Economic Association and Association for Comparative Economics, Chicago, December, 1968; mimeographed).

and the design of programs be given a focus--i.e., be directed at preidentified economic groups, and reflect a concern for whose productivity should be increased. This is a matter for subsequent verification. To the extent that this is valid, the framework illustrates that the same instruments (variables) that have a potential for increasing growth may, if appropriately focused, be made to contribute toward a desired distribution of income. This it does through changes in the relative control over resources exercised by the preidentified groups.

Whether programs and policies will be focused is a political decision. But whether programs and policies can be focused will depend on:

(a) the divisibility of rice technology (scale factor),

(b) the magnitude of externalities involved (divergencies between private and social benefits/costs),

(c) the extent to which institutional and organizational variables can be designed to capture economies of scale and internalize (externalize) enough of the external benefits (costs), given the small size and large number of producing units (households), and

(d) the extent to which (at least the) early benefits can be concentrated in the target groups.

Conclusion

The two primary variables of technology and institutions interact to determine both agricultural growth and the distribution of net benefits. These variables are endogenously determined, through the interaction of the resource endowment situation with the power distribution. The distribution of power and the attitudes (values) of those who wield it, have a dominant influence on the extent to which relative prices influence the design and focus of agricultural development programs and laws, as well as the manner in which they are implemented. Thus the conceptual framework recognizes that the extent to which relative prices could influence the various variables depends ultimately on the pattern of distribution and use of real political power. The effectiveness with which political power can bring about desired results is limited by the exogenous constraints of culture, the state of scientific knowledge, and the skills or lack of them on the part of experts and administrators.

The conceptual framework presented has attempted to compromise between the need for consistency with the intricacies of the real world, and the need for a relatively simple tool for analytic application. The number of permutations have been kept to a minimum through a hierarchical arrangement, a distinction between primary and nonprimary variables, and a short run perspective.

The short run perspective makes it possible for the primary flow lines to be the only ones shown. In the long run other lines of interaction would be needed.

CHAPTER IV

AN IDENTIFICATION OF EQUITY NORMS AND PROGRAM OBJECTIVES

Introduction

In order to incorporate equity goals into programs for agricultural development, these goals must be stated in concrete operational terms, with primary reference to Sri Lanka. This indicates the direction in which to proceed, suggests the relevant measures of inequality, and helps identify the groups for whom the programs should be focused.

Program objectives serve as a link between political values and program specifications. The characteristics of programs cannot be determined directly from a social welfare function.[1] If program specifications are regarded as inputs, and program objectives the output, these inputs would have to be translated into outputs so that they can be evaluated with reference to

---

[1] Charles L. Schultze, The Politics and Economics of Public Spending (Washington, D.C.: The Brookings Institution, 1968), Chapter 4.

R. N. McKean states with regard to the social welfare function: "There is no mysterious, unique set of 'correct' group of goals that can be identified by thinking deeply of reading the right books, or turning over the right rock." Public Spending (New York: Mc Graw Hill, 1968), p. 4.

political values. If we work downward, therefore, we go from political values (norms) to program objectives (social outputs) to program specifications (inputs).

Questions relating to income distribution historically have posed difficulties for economists. The classicists subsumed the institutional variables in ceteris paribus. Income redistribution involved interpersonal comparisons of utility which did not permit objective or reliable measurement. This difficulty led positivists like Lionel Robbins to regard economists as being "social" engineers or technicians, who are neutral between ends, which they must regard as given.[1] If so, however, "an economist would have nothing to say about the merits of policies, and this would have virtually ruled out his education and policy role."[2]

In dealing with such interpersonal comparisons, a rough guide can be found in the Kaldor-Hicks compensation principle as refined by Scitovsky.[3] According to this criterion, policy is socially desirable if the gainers can potentially bribe the losers into accepting the change and if, in turn, the losers cannot bribe the

---

[1]Lionel Robbins, An Essay on the Nature and Significance of Economic Science (2nd ed., 1952; London: Macmillan, 1935), p. 30.

[2]Luther Tweeten, Foundations of Farm Policy (Lincoln: University of Nebraska Press, 1970), p. 503.

[3]Tibor Scitovsky, "The State of Welfare Economics," American Economic Review, 41, pp. 303-15.

gainers into not making the change. In effect this condenses to recommending policies if the social benefit-cost ratio is greater than one.

The process of ensuring that the Scitovsky criterion is satisfied does not assume significant proportions in this study for several reasons. For one thing, income redistribution is conceived in terms of redistributing sources of permanent income streams. If appropriate groups utilize these sources to generate as much income flows as previously, the resultant increases in productivity (and possibly employment) could stimulate a cumulative spiral of development, the gains from which are likely to be so great and widespread that the losers would be unable to bribe the gainers in terms of the Scitovsky criterion. Secondly, this conclusion is reinforced if it can be assumed that the marginal utility attached to a monetary unit is greater for low income groups than it is for high income groups--the rationale used for the initial redistribution of income streams. In any case, the social welfare function, as manifested in the Objectives of the Five Year Plan (quoted below), palpably indicates that income disparities should be reduced.

Income Distribution Objectives in Sri Lanka

The equity goals of the Five Year Plan have been clearly stated:

> While the immediate social objective of the Plan is to provide employment, it also aims to bridge the disparities in income and living standards by raising the income and living conditions of the low-income households.[1]

This goal of reduced income disparities implies in negative terms that income disparities should not be permitted to increase. This statistically translates into making the Lorenz curve in Figure 2 an outer bound for income inequality, thus endowing it with significance for policy.

While stating positively that income disparities should be reduced, the Plan fails to expressly indicate a norm. Nevertheless it can be inferred that it is not a policy goal to reduce income disparities to the point that it disappears altogether. That absolute equality is not a norm can be inferred from the many references in the Plan to the need to "encourage . . . the cultivator," and to provide "incentives" to "work hard."[2] These statements, which emphasize incentives and rewards for added effort (including risk bearing), tend to be incompatible with an absolute equality norm. Absolute equality in incomes is antithetical to incentives because of its tendency to generate externalities that encourage free riding.

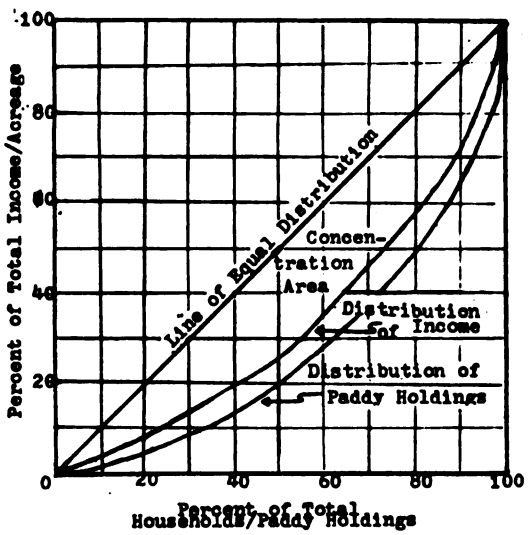
The conclusion that emerges from a statistical standpoint is that the line of equal distribution (Figure 2) fails to assume normative significance for policy

---

[1]The Plan, p. 2.

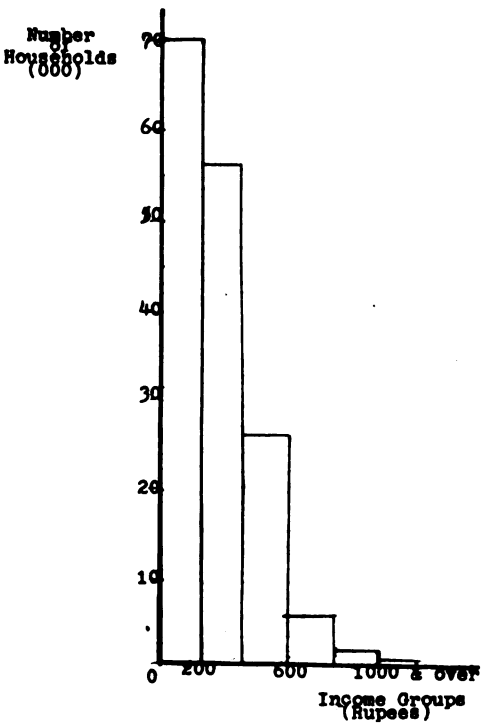
[2]The Plan, p. 36.

Figure 2. Lorenze Curve of Distribution of Rural Income and Paddy Holdings



Source: Socio-Economic Survey 1972.

Figure 3. Income of Households in the Rural Sector



Source: Socio-Economic Survey 1972

formulation. Even the principle of equal opportunity (or equal access to sources of increased productivity) is not necessarily compatible with the goal of reducing income disparities. Given the initial inequality, the application of the equal opportunity principle could merely reinforce or increase the extant disparities in income. This suggests that the goal of reducing income disparities requires that disadvantaged groups receive privileged treatment. This gives added credence to the hypothesis that agricultural development programs should be focused upon specific preidentified socio-economic groups.

Some Relevant Measures of Income Distribution

This subsection will examine complementary measures of income distribution that seem to be relevant to the objectives of the study, and useful in defining program objectives. These include the frequency distribution, Lorenz curve, and poverty rate. The discussion will be in the context of the distribution of household income in the rural sector of Sri Lanka. Table 4.1 indicates the distribution of income in the rural sector by size brackets of income of households.

The data show that 46 percent of households in the rural sector receive incomes of less than Rs. 200 ($34) per mensem, while over 80 percent receive incomes

TABLE 4.1.--Distribution of Households and Total Income by Income Groups in the Rural Sector.

Income Groups (Rs.)	No. of Households	% of Households	Total Income (Rs.)	% of Income
Below 100	142,500	9.4	10,671	2.7
100-199	554,800	36.7	82,138	20.6
200-399	558,600	37.0	154,270	38.6
400-599	167,200	11.1	79,958	20.0
600-799	57,000	3.8	37,208	9.8
800-999	17,100	1.1	15,632	3.9
1000 and over	14,280	0.9	17,529	4.4
Total	1,511,450	100.0	399,406	100.0

Source: Extracted and synthesized from Socio-Economic Report, Department of Census and Statistics, Colombo, 1971.

of less than Rs. 400 ($68). The data are graphed in Figures 2 and 3.

Whether the achievement of a normal distribution of income should be an objective of policy will probably depend on the validity of the "untestable" hypothesis that innate abilities are normally distributed, at least within homogeneous ethnic groups. If so, a skewed distribution results from socio-economic, institutional factors.[1] Asymmetry could be attributed to a multiplicity of reasons, some relevant to traditional agriculture, including attitudes of different persons toward uncertainty-bearing

[1]This theory was propounded by A. L. Bowley, "The National Income in the U.K.," Economica (1933).

(Friedman)[1] wealth inheritance, mainly land (Fisher),[2] distribution of educational opportunities (Becker),[3] and access to, and distribution of, institutional services (Gotsch).[4]

As stated, the Lorenz curve in Figure 2 provides an outer bound for income disparities, but the line of equal distribution fails to provide a limiting case. Hence the desired pattern of income distribution must lie somewhere in the concentration area. The exact statistical location of the norm will depend on a definition of a poverty line and poverty rate, which together determine the poverty gap.

The concept of the poverty rate is supplementary to the measures just discussed, and is tied to the notion of a poverty line. Once a poverty line is defined, the proportion of the total population (households) below this line could constitute the poverty rate, while the

---

[1]Milton Friedman, "Choice, Chance and Personal Distribution of Income," Journal of Political Economy (August, 1953).

[2]Irvin Fisher, Elementary Principles of Economics (New York: Macmillan, 1912), where he attributes a skewed distribution to "inheritance, constantly modified by thrift, ability, industry, luck and fraud."

[3]Gary S. Becker, Human Capital (New York: Columbia University Press, 1964), pp. 61-66; also Gary S. Becker and Barry R. Chiswick, "Education and the Distribution of Earnings," American Economic Review (May, 1960), pp. 365-68.

[4]Gotsch, loc. cit.

poverty gap would refer to the income it would take to reduce the poverty rate to zero.[1] According to Schickele the poverty line is at the level of income at which a family suffers from lack of certain minimum needs, and which he says the economist should regard as given. He says:

> Clearly, the concept of the 'poverty line' is not a subjective or arbitrary judgement of some individual, but represents a consensus of society, based on studies of consumer budgets, on what people concur to consider necessities of life in their country and at the present period of time. This socio-economic consensus is evidenced by general public acceptance and by legislative or administrative action with reference to the poverty line and renders it 'objective' in the same sense as many other institutional facts such as standards of individual and group behaviour established by law or custom are objective facts to an economist.[2]

If we accept the findings of the ILO Report on Sri Lanka, we can fix the poverty line at Rs. 200 per mensem, or Rs. 2400 ($600) per annum per family. The Report states:

> . . . In Ceylonese conditions the income level of Rs. 200 per month per household may be taken as above the poverty line, at least amongst those with medium or small families. The minimum estimated to be required for adequate nutrition of a family of two children was Rs. 178. The poverty line falls generally somewhere in the Rs. 100 or Rs. 200 group, depending on size (and composition) of family and on living costs in particular areas.[3]

---

[1] Schickele, Agrarian Revolution, op. cit., pp. 49-53.

[2] Schickele, "Improving Income Distribution," op. cit., p. 15.

[3] ILO, Report, op. cit., p. 35.

This conclusion is supported by an earlier study[1] which arrived at the same poverty line, but for an average family of six persons.

The Objectives of the Plan, however, evidence a concern for a broader class in the income spectrum; namely, those receiving less than Rs. 4800 per annum ($800), who constitute 80 percent of households. Hence while Rs. 2400 may be a povery line, Rs. 4800 may be regarded as an adequate level of living line.

The arithmetic mean for rural household incomes from paddy cultivation is Rs. 157 ($26) per mensem or Rs. 1880 ($313) per annum, as shown in Table 4.2. The measures of income distribution discussed and data on incomes will be utilized for the purpose of identifying program objectives in the following sub-section.

Output Objectives

As stated, program objectives constitute a link between the social welfare function as manifested in the Objectives of the Plan, and the program characteristics that have yet to be specified. These program objectives could be expected to have two components; a growth component, concerned with efficiency, and an equity component designed to give the program a focus. A base will need

---

[1] T. Jogaratnam and Rainer Schickele, Practical Guidelines to Agricultural Development Policies in Ceylon (Peradeniya: Agricultural Economics Research Unit, University of Sri Lanka, 1970).

TABLE 4.2.--Household Income Received Annually from Paddy Cultivation.

No. of Income Receivers	Money Income (Rs. '000)	Imputed Value of Paddy Consumed (Rs. '000)	Total Income (Rs.'000)	Average Income (Rs.)
551,000	68,734	17,476	86,210	156.73

Source: Extracted from Socio-Economic Survey data, Department of Census and Statistics, Colombo, 1971.

to be identified in respect to each of these components in order that the desired change, as embodied in the progam objectives, may be measured.

The objectives with regard to the output of paddy are stated in the Agriculture Sector Program, as in Table 4.3.

Given the time horizon of the Plan (five years), over 80 percent of the total increase in output is expected to come from land already under paddy. Paddy output is expected to increase by roughly 40 percent, over present levels in traditional areas, and by around 10 percent on newly developed lands in the Dry Zone. As mentioned, scarce water and low population density in the Dry Zone require that output expansion in that region be brought about through medium and long term capital investments in irrigation and colonization schemes. In absolute terms, the required increase in paddy output

TABLE 4.3.--Output Target for Paddy.

	1972	1973	1974	1975	1976
On land now aswedhumised (million bushels)	77.0	90.0	95.0	101.0	107.0
On land newly aswedhumised (million bushels)	1.0	4.0	5.0	6.0	9.0
Total	78.0	94.0	100.0	107.0	116.0
Less 10% for seed, etc.	70.0	85.0	90.0	96.0	104.0

Source: Agriculture Sector Programme, The Five Year Plan, Ministry of Planning and Employment, Colombo, 1971.

from presently cultivated paddy land is about 30 million bushels (80 percent) by 1976.

Equity Objectives

Program Focus

When income distribution is conceived of in terms of redistributing low priced sources of permanent income streams, achieving equity objectives could reduce essentially to a matter of focus. Groups will need to be identified on the basis of some homogeneous economic characteristic(s) toward whom programs could be directed. Identifying such groups is also important because of the presumption that the degree of congruence between the twin goals of growth and equity will depend partly on the success with which such groups are chosen. This implies that some groups at a very low level of the income spectrum, or having paddy holdings of very small size, may

be incapable, for technical or institutional reasons, of utilizing the sources of income streams for the purpose of generating sufficiently increased income flows. Technical reasons may stem from limits to divisibility in technology, for instance, while other reasons may be such factors as low levels of intelligence, poor health, extreme traditionalism, etc. Therefore, as was concluded in Chapter II, the degree of complementarity will depend on the receptivity to and responsiveness of different groupings to agricultural innovation. Hence the success of agricultural development programs will depend not only on the specifications of programs and their manner of implementation, but also on the judiciousness with which such programs are focused.

When programs are focused it implies that projects that constitute such programs will be directed at pre-identified groups. The focusing of programs for promoting rice technology could vary in stringency from concentration of administrative attention on preidentified groups, to absolute exclusion of other groups. The degree of focus that should be applied would probably need to be decided at the project level, when the objectives of projects are specified. The basis for deciding the degree of focus is examined below.

Size Groupings

The groups will be distinguished in this study on the basis of size of paddy holdings, and within each group a distinction will be made between owner operator, tenant cultivators, agricultural laborers, and off-farm workers. The benefits of new technologies are expected to be different for each group.

Groups are classified therefore on a categoric as opposed to geographic basis. The geographic approach may be appropriate in a situation of socio-economic homogeneity within a specific region or district. On the other hand, a categoric approach would be more suitable when the farm households that a specific program is supposed to reach are scattered in the midst of others that are outside the scope of that specific program.

The basis of classification or grouping is a compromise--a compromise between generality needed for ease of implementation, and the detail really needed to identify the target households or farms. The simpler the classification the easier and cheaper it would be to administer. At the same time it is recognized that simplicity may reduce overall program accomplishment. Some households, particularly at the end points of a class may more appropriately be in a different group than in the one assigned. As the foregoing implies, the classification inevitably contains an element of arbitrariness.

Economic size classification.--A more useful grouping of farms from the viewpoint of income distribution is on the basis of economic rather than physical size of farms. Such a classification would help minimize some of the difficulties caused by the overlap of the small farm category with the agricultural laborer and off-farm worker category, and include the effects on family income of differences in resource endowments and family size. A classification on the basis of economic farm size would also help in overcoming the difficulty caused by the possibility that the physical size distribution of farm units may be egalitarian, but the distribution of land ownership may be very unequal. (In such a situation yields and technology may vary less with farm size than with the form of tenure.)

The economic size refers to the income generation potential of a farm in relation to the poverty line. Thus whether a farm size is economically small, medium, or large will depend on whether its annual income is below the poverty line (Rs. 2400 p.a.), between the poverty line and the adequate level of living line (Rs. 2400-4800 p.a.), or above the adequate level of living line (above Rs. 4800 p.a.), respectively. Hence increasing the economic size of farms could be synonymous with improving the distribution of income (if we assume that the incomes of "high" income groups do not increase).

The variables that influence the economic size of farm are thus crucial to this analysis. They are in fact substantially the same variables of technology and institutions which were said to be the primary determinants of income distribution and growth in the conceptual framework in Chapter III. An identification of these variables and an assessment of their applicability to Sri Lanka is a matter for subsequent chapters.

One institutional variable which has a direct bearing on the economic size of farm is the institutional wage or the average value product per household. It depends on the level of income of the household divided by the number of persons in that household. The level of income is the aggregate of income earned by the income receivers in the household. A decrease in the ratio of income receivers to non-income receivers (including unemployed members) would ceteris paribus increase the level of the institutional wage and hence the economic size of farm.

The relationship between the size of household and the institutional wage in Sri Lanka is evident in Table 4.4. The data indicate the household variable assumes significance in determining the economic size of farm in Sri Lanka. A decrease in the size of household or an increase in the number of income receivers ceteris

TABLE 4.4.--Households Classified by Size and Number of Income Receivers in the Rural Sector.[a]

Household Size	Average No. of Income Receivers
2	1.2
3	1.3
4	1.4
5	1.5
6	1.6
7	1.6
8	1.8
9	1.9
10	2.0
11	2.6

Source: Socio-Economic Survey data, Department of Census and Statistics, Colombo, 1972.

[a]The arithmetic mean size of rural households is 5.8 persons and a median 5.0 persons, while the average number of income receivers per household is 1.6 persons. The discrepancy between the mean and the median size suggests that the rural household size distribution is somewhat positively skewed.

paribus increases the level of the institutional wage, and therefore the economic size of farms. The positive correlation between the household size and the number of income receivers nevertheless does indicate that the decline in the institutional wage is less rapid than if the number of income receivers had been fixed.

Target Groups

Introduction.--It was stated earlier that the degree of congruence between growth and equity objectives probably depends on the judiciousness with which paddy

development programs are focused. Groups have to be distinguished on the basis of their income generation potential, given the extant structural distribution of holdings.

It is assumed for the purpose of group identification that (a) the attitudes of farmers toward technical changes, (b) the entrepreneurial ability of farmers, (c) costs per unit of output, and (d) the quality of farm resource endowments, are not correlated with farm size.

Given these assumptions, the holdings of some groups may be identified as being too small to enable them to utilize rice technology to rise above the poverty line. On the other hand, some groups may be found to be not in a poverty condition, and would hence need to be treated somewhat differently from those who are. A third middle group of farmers may be distinguished who are presently below the poverty line, but whose structural circumstances will permit them to utilize rice technology to rise above it.

Specification of Criteria for identifying mean groups.--Two criteria can be applied to identify the (third) middle group of farms, One criterion is to define the poverty gap for the average farm in each size group, and then determine whether an optimum or near-optimum application of technology, combined with appropriate

institutional modifications, will increase output sufficiently to close the poverty gap, given the time horizon of five years. The criterion is whether this is realistic; that is, technically feasible. The second uses the output target in the Plan to see whether, if the average farm in the size group succeeds in increasing its output by a target percentage, the mean farm will succeed in rising above the poverty line.

The former criterion approaches the issue from the side of family income with a residual output effect, while the latter approaches it from the size of output, with a residual income effect. The second criterion is more practical, but only concerns itself with relative increases in income. This is because even though the mean farms in each size group increase their output by the same percentage, the differences in farm sizes could cause absolute income differentials to increase.

Both approaches will be used in this study to enable an informed judgment to be made on the selection of groups that are to be the focus of different programs.

Transformation of structural data.--In order that this judgment be made, structural information on paddy holdings will need to be transformed into income and output information. This will be done by identifying the mean farm by size in each of the structural groupings, and then applying average income data to determine

approximate income levels, subject to the assumptions enumerated at the beginning of this subsection. This transformation, although approximate, is nevertheless expected to be useful.

The structural information on paddy holdings in Sri Lanka is provided in Table 4.5. The data indicate that nearly 74 percent of paddy holdings are below 5 acres in size. A Lorenz curve of the data in Table 4.5 indicates that there is greater inequality in the distribution of paddy holdings, than there is in the distribution of income (Figure 2).

As stated, it would be possible to utilize this structural information to determine the increase in output

TABLE 4.5.--Area under Paddy in Sri Lanka by Size of Holding.

Size of Holding	No. of Holdings with Paddy	% of Holdings	Extent of Paddy Land	% of Paddy Land
Less than 1 acre	67,630	12	25,150	2
1 - 2 1/2 acres	179,230	32	147,780	13
2 1/2 - 5 acres	173,131	30	299,901	27
5 - 10 acres	111,761	20	378,232	33
Greater than 10 acres	35,901	6	284,125	25
Total	567,653	100	1,135,125	100

Source: SEANZA Lectures compiled by the Central Bank of Ceylon, Colombo, 1968.

per acre needed to reduce the poverty rate, if the distribution of returns to land is transformed into the distribution of returns to households--personal income distribution being the focus of interest.

This in turn will require that net returns to farmers be calculated by deducting costs of production from the gross value of output. Such cost of production data is provided in Table 4.6.

Too much reliance cannot be placed in the following data both because of inflation and changes in the cost structure and perhaps the method of charging for labor since 1969. Latest reports indicate that the cost

TABLE 4.6.--Average Cost of Production per Acre and per Bushel--All Island.

Inputs	Cost per Acre		Cost per Bushel	
	Rs.	Percentage	Rs.	Percentage
1. Labor	211.15	56.57	6.32	56.58
2. Fertilizer	17.57	4.70	0.52	4.66
3. Seed	30.56	8.17	0.91	8.15
4. Rent				
(a) Land	26.19	7.08	0.79	7.07
(b) Machinery	48.37	12.94	1.45	12.98
(c) Buffaloes	11.97	3.20	0.36	3.22
5. Maintenance cost				
(a) Machinery	5.94	1.59	0.18	1.61
(b) Buffaloes	9.76	2.61	0.29	2.60
6. Weedicides and Pesticides	4.34	1.16	0.13	1.16
7. Other	7.39	1.98	0.22	1.97
All Island	373.90	100.00	11.17	100.00

Source: Central Bank of Ceylon, Cost of Production Survey, 1969.

per acre for the average farm is around Rs. 650 per crop. At an average yield of 50 bushels per acre per crop, this amounts to a cost of Rs. 13.00 per bushel, without including the imputed cost of family labor. If, as the study indicates, about 15 percent of labor cost is for imputed family labor, then the net return per acre for the average farm would be Rs. 700 ($117) per annum. The method of computation is as follows:

Average output per acre per annum (bushels)[1]	100
Value of Output @ Rs. 18 per bushel under GPS[2]	Rs. 1800
Cost of Production @ Rs. 13.00	Rs. 1300
Annual return per acre	Rs. 500
Add imputed cost of family labor[3]	Rs. 200
Total net return per acre per year	Rs. 700

This information could now be related to the structural data in Table 4.7 to determine the poverty gap under the assumptions previously enumerated.

As can be inferred from the data in Table 4.7, the size of farm needed for a net average return at the poverty line is about 3.4 acres, given present levels of

---

[1]The choice of a spectrum of one year seems advisable not only because it enables a more realistic assessment of the average monthly income and the comparison of income levels with the poverty and adequate level lines, but also because it permits an assessment of the income effects of multiple cropping.

[2]The GPS refers to the Guaranteed Price Scheme, under which the Paddy Marketing Board is the sole legal outlet for paddy, at the assured price of Rs. 18.00 per bushel.

[3]According to the Central Bank of Ceylon, Survey on Cost of Production of Paddy (Colombo: Economic Research Department, Central Bank, 1969), 15 percent of total cost was imputed to family labor.

TABLE 4.7.--Structural Data in Income Terms.

Size of Holding (Acres)	Income Generated by Average Holding[a] (Rupees)	Poverty Gap[b] (Rupees)	Output Gap[c] (Bushels per acre per year)	Productivity Gap[d] (Bushels per acre per year)	% Change in Productivity Needed to Close Poverty Gap (1972 base)
Less than 1	Less than 700	Over 1700	Over 243	Over 143	Over 143
1 - 2	700-1400	1700-1000	243-143	143-43	143-43
2 - 4	1400-2800	1000-nil	Less than 143	Less than 43	Less than 43%
4 - 7	2800-4900	nil	--	--	--
Over 7	Over 4900	--	--	--	--

[a]Computed by multiplying average net return per acre by the average size of farm in the size group, and assuming a normal distribution in each size group, and scale neutrality.

[b]The increase in income needed to close the poverty gap, which is the difference between the level of actual annual income and the poverty line.

[c]The number of bushels per acre per year needed to generate sufficient income to close the poverty gap.

[d]Change in the productivity needed from present levels to close the poverty gap.

adoption of presently available technology, and the extant institutional context. This is tantamount to stating that farms below 3.43 acres are economically small. This, however, does not mean they are too small. Whether this is so will depend on their output potential--the potential to increase paddy output sufficiently as to enable the farm household to rise above the poverty line.

Application of criteria for identifying middle group.--In terms of the first criterion proposed, whether a group will qualify as the middle group will depend on its ability to meet the output gap. We find from Table 4.7 that the average paddy holding in the below 2 acre class would have to increase its output by over 143 percent in order to qualify, while the holdings between 2 and 4 acres in size would need to increase their output by less than 43 percent. If a 43 percent increase is regarded as being reasonable (given the time horizon of five years and the technology available), while an increase of 143 percent is regarded as not, then "viability" will commence somewhere in the upper region of the 1 to 2 acre class.[1] Since the specific cut-off point cannot be universally determined, it is considered appropriate in this instance to accept the supportive opinion of the ILO Report

[1] A viable paddy farm is one which can utilize paddy technology to rise above the poverty line.

that for all Ceylon an effective floor for an adequate level of living would be 2 acres of paddy.[1] In terms of the analysis so far, such a floor would seem to be somewhat too high (since viability would seem to commence in the upper ranges of the 1 to 2 acre class) but will be accepted because it seems reasonably consistent with the data in Table 4.8.

The second criterion will now be applied to approach the same question (determine the size of a viable unit for paddy) from the side of income. In terms of this criterion the groups are distinguished on the basis of the likely increase in annual income for the average farm in the size category, if the Plan target in respect of paddy output is to be met. Since the increase in output expected from paddy land already under cultivation is 40 percent or 30 million bushels in five years, it is assumed that paddy output will increase by at least 40 percent in five years on the average farm in each size group. The resultant income information is tabulated in Table 4.8.

The data in Table 4.8 indicate that of the size groups, only the 2 to 4 acre category of holdings will be able to change its income level from below the poverty line to above it if it were to meet its share of the output target. This conclusion substantiates the

---

[1] ILO, loc. cit. How they arrived at this conclusion is not clear. But this same conclusion was reached in a 1970 study by Jogaratnam and Schickele, op. cit.

TABLE 4.8.--Relationship of Farm Size to Potential Income Increase.

Size of Holding (Acres)	No. of Households (approximate)	Percentage	Cumulative Percentage	Present Income Levels of Average Farm (Rupees per bushel per year)	Poverty Gap[a] (Rupees)	Expected Increase in Income[b] (Rupees)
Under 1	68,000	12	12	350	2050	490
1 - Under 2	180,000	21	33	1050	1350	1470
2 - Under 4	160,000	28	61	2100	300	2940
4 - Under 7	115,000	20	81	3850	nil	5390
Over 7	45,000	19	100	over 3850	nil	over 5390

[a]Computed by taking the difference between present income level and the poverty line of Rs. 2400.

[b]Expected increase in income if output of the average farm is increased 40 percent to meet output targets, assuming scale neutrality.

conclusion reached in terms of the first criterion; namely, that 2 acres constitutes a safe and effective floor, for purposes of determining viability.

The target groups can therefore be identified as being the below 4 acre groups. These groups qualify as targets of primary focus of programs designed to promote a more widespread and optimal utilization of rice technology. They are also to be in the vanguard of the effort to achieve self-sufficiency in rice and improve income distribution. This group consists of 408,000 or 72 percent of all households in the paddy subsector, and occupies 32 percent of the total paddy acreage. A 40 percent increase in output from this acreage will meet roughly 48 percent (14.2 million) of the targeted increase in paddy output of 30 million bushels.

Target group characteristics.--Three target groups are distinguishable on the basis of the income data: (1) the below 1 acre category, (2) the 1 to 2 acre category, and (3) the 2 to 4 acre category. The first two groups (below 2 acres) are similar in that they are made up of largely nonviable holdings, while they are different in degree in that the income problems of the smaller group are likely to be more acute. Using the definition of economic farm size made earlier, the below 2 acres category would be "too small," while the above 2 acre group is of adequate size. This adequacy

of farm size with respect to the 2 to 4 acre group depends upon the ability to utilize rice technology to rise above the poverty line in the time horizon contemplated.

On the other hand, the data in Table 4.7 suggest that the chances of being able to render viable, through the application of existing rice technology, the class of small farms that are below 2 acres in size, seems exceedingly small. The 2 acres refer only to the upper limit of this class of farms. Moreover, the size distribution of holdings within the below 2 acre class is not normal, as the mean size in the below 2 acre class is 0.8 acres.[1] This structural factor would require that such (average) farms have a level of productivity per acre that is almost one and one-half times the national average in order for them to be able to rise above the poverty line. Even this, moreover, is based on assumption that the farm household is not larger than average (5.8 persons) in size.

The degree of specialization in paddy increases with farm size.[2] Hence the smaller farms are more diversified than large farms. These farms have supplementary sources of income from off-farm sources and/or the

---

[1]Department of Census and Statistics, Census of Agriculture, 1962 (Colombo).

[2]Jogaratnam and Schickele, op. cit.

cultivation of non-paddy crops, such as vegetables, coconut, rubber, or tea.[1] The bulk of the agricultural labor force comes from the households on these farms, their participation in the agricultural labor market probably related to the amount of income accruing to them from non-paddy agricultural products. The income from paddy would, for those who own tiny paddy plots, be a supplementary income source that provides insurance against unemployment and/or the vicissitudes of the market for non-paddy crops.

Program effects.--While this analysis suggests rice development programs be focused on the below 4 acre groups, the relative effect of such programs could be expected to differ depending on the structural condition of affected farms. While all affected farm households could be expected to experience increases in the institutional wage emanating from increases in output and employment, the income from output is likely to be greater relative to the income from employment for the households on the large farms when compared to small farms. Conversely, the potential increase in income from employment is likely to be greater than that from output for the households on the smaller farms. It is obvious, in fact, that under the assumption that family size is not

---

[1] Ibid.

correlated with farm size, the potential returns from capital should be relatively greater for the households on larger farms.

Surplus labor from small farms would need to find work on the large farms for a fulfillment of such potential, due to differences in the per farm labor input requirement, given structural differences, and independence between the farm size and household size variables. Given similar production functions it is preferable that labor be employed on a larger number of smaller farms, as in that case the demand curve for labor is likely to have an elasticity near to zero, and a greater number of persons are likely to be employed.

However, the extent to which the surplus labor on the small farms could expect to gain from employment opportunities on the larger farms will depend on (a) the extent and nature of the shift in the production functions of larger farms, and (b) the employment slack already on those farms. The extent of the shift of the production function is determined by the absolute impact of technology on production, while the nature of that shift (bias) is a function of the type of technology applied. The former changes the absolute levels of labor demanded, while the latter changes the relative amount of labor demanded.

If labor requirements increase on large farms consequent upon their application of improved technology,

the extent to which the surplus labor on the smaller farms could expect to benefit will depend on the extent of disguised unemployment already existing on larger farms. Theoretically, if the marginal product of labor is less than the market wage level on the larger farms, the adoption of new technology which increases the marginal product of labor would not lead to an increase in the demand for hired labor until the marginal product rose above the wage level. It is possible, however, that the larger farms may withdraw some (female) members of the family from the labor market when they experience an increase in the level of their institutional wage.

But unlike the case of larger farms, rice development programs will constitute only a partial solution to the income problems of farms below 2 acres in size for several reasons: (1) Rice technology alone may not be able to create a sufficient increase in demand for labor to absorb the some 400,000 unemployed persons on the below 4 acre paddy farms; (2) Since there is greater diversification on smaller farms, rice technology would have a smaller absolute impact on incomes, unless there is increased specialization; (3) Inadequacies in managerial and other talents may be proportionately greater on the smaller farms due to lower incomes and fewer educational opportunities; (4) There may be limits to scale neutrality.

However, the below 2 acre paddy groups that cultivate other crops such as tea, rubber, coconut, and onions could expect to benefit from other programs that make available improved technology relating to those crops. The below 2 acre groups that do not cultivate these other crops would constitute the target of other programs pushing rural industrialization, land settlement, and colonization in the dry zone, inter alia. A detailed examination of these other programs falls outside the scope of this study.

Other groups.--The groups that generally fall outside the direct focus of rice development programs are the categories above 4 acres in size, who constitute 38 percent of farm households in the rice subsector. These households already have incomes above the poverty rate, and as relatively major market participants may be presumed to have preference and production functions susceptible to demonstration effects. They are of their own volition more capable of translating felt needs into technological changes in response to market signals.

No absolute exclusion of these groups is possible and desirable because private market alternatives may not be available to them. Their eligibility for specific access to benefits from programs may be decided on at the project or scheme level depending on the market alternatives available. For instance, all farmers must have

access to the Guaranteed Price Scheme because the Paddy Marketing Boards are the sole legal outlet for paddy output. However in the case of production credit, a network of state-owned Peoples' Bank branches are available, besides the local level money market, as alternatives to supervised credit provided by the state through the quasi-government agency of multipurpose cooperatives.

The performance of the larger farms could be made to contribute to equity objectives by making their operations more labor absorptive. A low cost method would identify and use the critical institutional variables that need to be manipulated to yield socially desirable results.

Summary

To be able to identify the program specifications needed in contributing to the output and equity goals of the Five Year Plan, it would first be necessary to determine program objectives. Program objectives constitute the link between the social welfare function as manifested in the Objectives of the Five Year Plan and the program characteristics that need to be identified.

The need for determining cardinal utility does not arise because the ends or goals are regarded as given. In any case, an effective increase in the productive capacities of a large number of small farmers could set in motion a cumulative process of development, which would probably make it difficult for the losers to

bribe the gainers, in terms of the Scitovsky criterion. These conclusions seem reinforced if it can be assumed that marginal utilities of monetary units vary between high and low income groups.

As income disparities are not permitted to increase, according to the stated development plan, the present Lorenz curve constitutes an outer bound. However, since income is not to be equalized, the line of equal distribution fails to acquire normative significance. Neither does the normal distribution curve provide a practical guideline for policy. The concept of the poverty rate, when used in conjunction with the Lorenz curve, seems useful for identifying the objectives and focus of programs.

Program objectives with regard to output are clear. Since the subject of interest was distribution of income to households rather than to land, the distribution of output data must be transformed into distribution of income data. Such a transformation enabled the judgment to be made that the target groups were to be those with paddy holdings below 4 acres in size.

The group with holdings above 4 acres usually is above the poverty line. From a social point of view, the activities which these larger farmers should be encouraged to emphasize include those which increase their demand for labor, and thus supply employment opportunities for

other rural residents whose land base is inadequate. They, too, must increase productivity if the output goals of the agricultural sector are to be attained.

CHAPTER V

ASSESSMENT OF VARIABLES AFFECTING INTERDISTRICT PADDY YIELD

Introduction

Given the focus for agricultural development programs proposed in the previous chapter, an attempt will now be made to identify the technological and institutional variables (including concomitant techniques and infrastructure) that are important for explaining interdistrict variation in paddy yields in Sri Lanka.

An important but not exclusive means for identifying the relevant variables for Sri Lanka is through an econometric assessment of variables. Such an analysis is likely to provide or deny statistical support for the prior beliefs which exist with regard to the significance of variables included in the model, and the unincluded variables for which the included variables are proxy. It may also provide an indication of the relative importance or weights of the significant variables. The econometric analysis is thus expected to improve the relevance and focus of the study.

The Econometric Model

The Regression Equation

This subsection specifies the model in terms of a linear multiple regression equation, and thereafter discusses the rationale for (a) the exclusion of some variables from the model, and (b) the past and present role in agricultural development of the variables that are included.

The linear regression Model A is as follows:

$$X_1 = \alpha + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_9 X_9 + \beta_{10} X_{10} + \beta_{12} X_{12} + \beta_{13} X_{13} + e$$

where:

X_1 is the average annual paddy yield per acre

α is the intercept term determining the height of the regression

X_2 is the percentage paddy acreage in district subject to tractor plowing

X_3 is the percentage paddy acreage in district subject to chemical weeding

X_4 is the percentage paddy acreage in district subject to row transplanting

X_5 is the percentage paddy acreage in district under improved seed varieties

X_6 is the percentage paddy acreage in district that is irrigated

X_7 is the percentage paddy acreage in district that is rented

X_9 is the ten-year (1962-71) average of harvested extent as a percentage of extent sown

X_{10} is a dummy variable where $X_{10} = 1$ if in wet zone and $X_{10} = 0$ if in dry zone

X_{12} is the percentage of paddy holdings in district below 2 acres in size

X_{13} is the proportion of government production credit loans defaulted in the previous year, 1970-71

e is the error term, where e_i are assumed to be independent random variables with a mean of zero and constant variance.

The data utilized for this analysis are tabulated in Appendix F. Generally, the data are for 1971-72 unless otherwise indicated, and are district averages for the 22 districts in Sri Lanka.

The hypothesis to be tested is the null hpothesis $H_0 : \beta_1 = 0$ against the one-sided alternative $H_A : \beta_i < 0$ for variables X_6 and X_{13} and $H_A : \beta_i > 0$ for the rest, at a 10 and 5 percent level of significance.

Explanation of the Structure of the Model

Unincluded variables.--The problem of deciding which variables should be included condenses to one of a trade-off between multicollinearity and specification error. While multicollinearity does not cause the estimated coefficients of the independent variables to be biased, their statistical significance may not be established because of the largeness of the standard deviation of their coefficients. This would therefore reduce the reliance that could be placed on the coefficients for

policy guidance. At the same time, the exclusion of relevant variables will increase the stochastic component in the error term and cause the coefficients of the included variables to be biased, with the same adverse result for policy decisions.

The foregoing econometric reasoning could be utilized to identify some unincluded variables and explain the rationale behind their exclusion. Thus the area that is row transplanted is included, but not the area that is seeded directly by broadcasting (on a dry or mud field), or the area that is transplanted in a random (ordinary) way. The reason for this exclusion is because of probable high multicollinearity between the area that is not subject to row transplanting and the area that is chemically weeded (which is included). This presumption is based on the belief that it would be economically irrational to spray chemical weedicides when transplanting is in rows, given the fact that 70 percent of farms are below five acres in size. Weeding in these circumstances would be carried out by rotary methods on the larger holding or by hand on the smaller ones. Hence the "chemically weeded" variable (X_3) that is included serves as a proxy for the "direct seeded," "random transplanted," and "rotary weeded" variables that have been excluded.

As regards seedbed preparation, only the percentage of land area that is tractor plowed is included. The areas that are subject to the traditional practices of animal and hand plowing are excluded because they are together the reciprocal of tractor plowing with which they are collinear. Besides, they are presumed to be closely collinear with the traditional practice of hand weeding, which is excluded for the reasons stated above.

The paddy area under new seed varieties is included as a variable notwithstanding its expected collinearity with the area that is tractor plowed (X_2), chemically weeded (X_3), transplanted (X_4), irrigated (X_6), and possibly via the "irrigated" variable (X_6) with the "risk" variable (X_9). The importance of this variable is considered large enough to justify its inclusion. Conversely, the misspecification resulting from its exclusion would be expected to cause the coefficients of variables X_2, X_3, X_4, and X_6 to be "significantly" biased.

The inclusion of the percentage of land under new seed varieties as a variable has, however, justified the exclusion of a variable for fertilizer application. This is due to the strong complementarity between these inputs, and hence the high degree of collinearity that can be expected between them.

Similarly, the share of output received by the landlord as rent per district has been omitted because of its expected relationship with the included variable X_7 (the percentage of land rented by district).

Description of included variables.--The previous subsection discussed the relationship between included and excluded variables, with a view to explaining the rationale for the noninclusion of some variables in the model. This subsection attempts to describe the nature and role in Sri Lanka of the variables that are included.

X_2 (Acreage Tractor Plowed): As much as 46 percent of paddy land is tractor plowed. Government encouragement of tractor imports through the granting of a favorable exchange rate,[1] liberal allocations of exchange,[2] and numerous tax allowances[3] resulted in the importation of over 10,000 tractors between 1965 and 1969.[4]

The capital allowances allowed for tractors and other agricultural equipment include a lump sum depreciation of between 66 2/3 and 80 percent and development

---

[1]Sri Lanka has a two-tier exchange rate system.

[2]Almost all imports require import licenses.

[3]Department of Inland Revenue, Tax Concessions for Agriculture (Colombo: 1966).

[4]ILO, Report, op. cit., p. 74.

rebates of 40 percent on the cost of the asset in addition to the depreciation allowance.[1]

Many of these tractors are used in the dry (irrigated) zone, where ". . . very considerable use of tractors . . . is probably without parallel in South Asia."[2] Besides tilling, tractors are also used for threshing and transport. In fact, the extent to which tractors are used in Sri Lanka suggests that tractorization may be induced by factors other than farm size.[3] While there is evidence that the intensity of tractor use in Sri Lanka is generally higher in areas where relatively large-sized holdings predominate, the area tilled by tractors have in several districts exceeded the area under cultivation on farms above 5 acres in size--thereby implying that tractors were used even in holdings below 5 acres in size. In fact as early as 1962, the total area under paddy in holdings of 5 acres and above fell short of the area tilled by tractors in 10 out of 22 districts. Significantly, almost all of the 10 districts belong in the dry zone--which, according to Raj, accounts for 60 percent

---

[1]Department of Inland Revenue, op. cit.

[2]ILO, Report, loc. cit.

[3]The remainder of this paragraph draws heavily on K. N. Raj's article entitled "Mechanization of Agriculture in India and Sri Lanka," International Labor Review, Vol. 106, No. 4 (Oct. 12), pp. 315-34.

of the area sown and about 75 percent of the area tilled by tractors.[1]

X_3 (Acreage Chemically Weeded): The percentage of paddy land in Sri Lanka that is chemically weeded averages 31. As previously mentioned, the need for chemical weeding arises when the seed is either broadcast or transplanted randomly. About 20 percent of all paddy lands are hand weeded, while less than 4 percent are rotary weeded.

X_4 (Acreage Row Planted): The percentage of row transplanted paddy land is around 3.5, which corresponds to the percentage of acreage that is rotary weeded.

X_5 (Acreage under Improved Varities): The percentage of paddy acreage under improved seeds averages 75 percent for all of Sri Lanka. Two categories of improved seeds are used in Sri Lanka: the "old improved varieties" (OIV--H8, H4, Ponnulot, Dickwee) which mature in four to six months, and the "new improved varieties" (BG 34/8, GB 34/11, IR, MI, K, etc.) which mature in three to three and one-half months. Of about 1.4 million

---

[1]As Raj points out, the dry zone, which receives an annual rainfall of less than 75", does not have the benefit of the South-West Monsoon, and the soils are therefore apt to be hard until the North-East Monsoon set in. Draught animals would probably lack the intensity of energy required to till very hard soil. Tractors substitute for both water and animals, and even land, to the extent that land with very low opportunity costs is brought under cultivation. Thus even small holders may find it worthwhile to use (hire) tractors in the dry zone.

acres subject to new varieties, the "old improved varieties" account for 45 percent of the acreage under both categories of improved varieties, and the "new improved varieties" 55 percent.[1]

X_6 (Irrigated Acreage): The irrigated paddy area constituted 66 percent of the total cultivated paddy in 1967-68.[2] Of the total irrigated area, 20 percent is served by major works for the two seasons, while about 46 percent is served by minor works. About 34 percent of the annual cultivated acreage is thus rainfed. Most of the irrigated land (70 percent) is in the dry zone, where about 98 percent of the land cultivated in the Yala season is irrigated.

A major and costly input provided almost free is water. Although there is a flat tax of Rs. 5.00 per acre in the colonization schemes, hardly any amount is collected.[3] According to the ILO Report, the state is subsidizing paddy lands under major irrigation schemes to the tune of at least Rs. 300 ($50) per acre, and lands

---

[1]Ministry of Agriculture and Lands, Implementation Programme 1973 (Colombo: 1972).

[2]Department of Census and Statistics, Statistical Abstract of Ceylon, 1969 (Colombo: 1970). All data in this paragraph is taken from this source unless otherwise indicated.

In view of the fairly long gestation period for irrigation schemes, these figures are probably indicative of the current position.

[3]ILO, Report, loc. cit.

under minor schemes to the extent of Rs. 60 ($10) per acre, by not collecting any irrigation rate.

X_7 (Acreage Rented): According to the source of this data,[1] rent of paddy land is measured by the share the tenant gives to the landlord, less the expenses borne by the landlord. About 25 percent of the cultivated area had been rented out on this basis in 1969. The percentage was highest in the Hambantota District (57.3 percent) where the crop share received by the landlord was also high (80.7 percent). The actual rent paid per acre, less the expenses borne by the landlord averaged 24 percent in 1969.[2]

The land tenure structure is summarized in Table 5.1.

TABLE 5.1.--Land Tenure Structure of 1962 Holdings under 50 Acres, 1962.

Ownership Pattern	Percentage of Total Holdings
Full owners	62
Part owners	20
Full tenants	18

Source: T. Jogaratnam and Rainer Schickele, Practical Guidelines to Agricultural Development Policies in Ceylon (Peradeniya: Agricultural Economics Research Unit, University of Sri Lanka, 1970).

[1] Central Bank of Ceylon, Cost of Production of Paddy, op. cit., p. 36.

[2] Ibid.

Crop sharing (Andé) arrangements fall in the part ownership class, because the landlord provides some inputs. Andé accounts for 70 percent of tenure arrangements in the part ownership class.

X_9 ("Risk" Variable): The percentage of area harvested to area sown may be regarded as a variable showing the partial risks in cultivation by district. In general, the greater the risks, the fewer would be the variable inputs applied, and hence the lower the yield per acre. The shortfall in the area harvested which averaged 5.3 percent over a 10 year period (1962-1971) can be classified as those emanating from: (a) natural factors (e.g., floods, drought, etc. that would be regarded as being outside the control of the individual farmer); (b) institutional-organizational factors (e.g., timeliness of input availability, price of output, etc.); (c) technological factors (e.g., seed failure, failure to apply fertilizer at the appropriate time, neglecting to use complementary inputs like insecticides, weedicides, etc.). The risk from natural factors is likely to be higher in the wet zone where a major portion of the paddy land area is rainfed.

The crop failure data for 1966-67[1] reveal that at a national level the percentage difference between the

---

[1]Department of Census and Statistics, Statistical Abstract, op. cit., pp. 118-19.

area sown and the area harvested was 4.8 percent in Maha and 6.5 percent in Yala. This information is however not consistent with the 10 year average data which were synthesized for use in the regression analysis as independent variable X_9. The 10 year average data show that the difference between the area sown and the area harvested is 6.2 percent for the Maha season, and 4.4 percent for Yala season.[1]

The relative causes for crop failure is apparent in Table 5.2. As the data in Table 5.2 indicate, the largest single reason for crop failure (between 67 and 71 percent) could be traced to the water control factor. It is also evident that the risk from this source is roughly the same in both the dry and wet zones and for both seasons. The second most important cause for the shortfall in the acreage harvested (about 15 percent) is attributable to institutional and other factors, while pests account for 9.3 percent, and seed failure for 7.6 percent.

X_{10} (Dummy Variable): The dummy variable has been included to make a distinction in the intercept term between dry zone and wet zone regions in Sri Lanka. This is likely to reduce the bias and variance in the coefficients of the other included variables.

---

[1] It should be recalled that 1966-67 was a non-typical year in that the shortfall in the harvested area was less for Maha.

TABLE 5.2.--Amount of Crop Failure Classified by Cause in Sri Lanka, 1966-1967.

Cause	Dry Zone				Wet Zone			
	Maha		Yaha		Maha		Yaha	
	Acres	%	Acres	%	Acres	%	Acres	%
Seed failure	2,885	8.8	604	4.7	450	3.2	526	5.3
Pests	2,396	7.3	591	4.6	2,666	18.2	689	6.9
Lack of water control	23,345	70.8	8,757	68.1	10,407	71.0	6,687	67.5
Other (Institutional, etc.)	4,264	13.1	2,901	22.6	1,142	7.6	2,155	20.3
Total	32,890	100.0	12,853	100.0	14,665	100.0	10,057	100.0

Source: Department of Census and Statistics, Statistical Abstract of Ceylon, 1969 (Colombo: 1970).

The basic difference between the two zones is obviously climatic and ecological, the most important single difference being in the limited amount of annual rainfall (less than 75 inches) in the dry zone, which is confined to the months from November to March. A fairly distinct drought season between the months of May and September causes soils to be hard and evapotranspiration (which determines the precipitation that is effective for plant growth) to be low.[1] This in turn influences the variables included in the model.

The dry zone condition influences the included variables in the following ways. The hard soil makes tractor plowing necessary and the lack of rainfall makes it worthwhile to use certain types of weedicides and pesticides which otherwise would be washed away by "overhead" water. Much of the land is irrigated and colonized under government sponsored schemes. This factor influences the "irrigated land" variable, "improved seed" variable (since its yield response is partly a function of water control), and the "land rented" variable (as much of the population is made up of colonists who are outside traditional tenure patterns).

---

[1]George Thambyahpillay, "Climatological Research and Agricultural Development in the Dry Zone," in Development of Dry Zone Agriculture, ed. by O. S. Perera (Colombo: Ceylon Association for the Advancement of Science, 1967).

These factors also influence the average size of farm, and perhaps also the risk variable.

X_{12} (Paddy Holdings Size): This variable measures the proportion of farms below 2 acres in size by district. This variable was found to be preferable to taking the average farm size in each district, due to the possibility of a disporportionate influence on the mean of a few very large farms in each district.

The average size of all holdings reporting paddy is about 1.6 acres.[1] The average size of holdings is larger in the dry zone (2.6 acres) than in the wet zone (0.6 acres). The wet zone contains most of the traditional areas of cultivation, and although no data are available, the man-land ratio in this zone is known to be high. The wet zone has about one-half the total paddy acreage, while containing about three-fourths of the rural population.[2]

X_{13} (Credit Default): Sri Lanka's Agricultural Credit Scheme was introduced on a nationwide basis in 1967. The Scheme of 1967 was designed to accelerate an incipient "Green Revolution," and its timing was expected to coincide with the adoption of new technology by farmers. The salient features of the scheme were as follows:

---

[1] A farm may cultivate other crops besides paddy.

[2] This conclusion is inferred from the data in Department of Census and Statistics, Socio-Economic Survey, op. cit.

(i) The ultimate source of funds was to be the Central Bank, a quasi-autonomous body, rather than the Department of Agrarian Services, a department of the government.

(ii) The rate of interest was to be a maximum of 12 percent with provision for a 3 percent rebate for prompt payment.

(iii) The maximum granted was to be Rs. 262 per acre for non-IR-8 cultivation and Rs. 370 per acre for IR-8 cultivation up to a maximum of 10 acres (Table 5.3.).

(iv) Government and extension workers were expected to collaborate with cooperative societies in preparing a detailed cultivation program for the season, showing the total area to be cultivated, the area to be subjected to improved methods, the estimated requirements of inputs and cash capital required.

(v) The collateral was to be farmers' ration books of one year validity which entitled them to a pound of "free" rice per week supplied by the government. Default was to disqualify farmers from receiving further loans the next year, but not from receiving "free" rice.

(vi) The loans were to be released in three stages and were to be partly in kind.

One of the provisions of the scheme made defaulters ineligible for further loans, Hence theoretically the default rate in the previous year could be said to affect

TABLE 5.3.--The Maximum Sums Granted for Meeting Input Costs Under the 1967 Credit Scheme.

Purpose	IR-8 Loan Rs.	Non-IR-8 Loan Rs.
Seed paddy	25	32
Ploughing[a]	60	60
Fertilizer	160	95
Transplanting and row seeding[a]	25	25
Hand weeding[a]	25	25
Pesticides	75	25
Total	370	262

Source: Report of Cooperative Commission, 1970, as quoted in the Report of the Cooperative Commissioner for 1968-69.

[a]Payment for these is necessary in order to hire labor for short periods for timing reasons. These payments are made in cash.

yields negatively in the following year by imposing capital rationing on farmers. But this would be true only if production credit loans were utilized for their intended purpose of increasing paddy productivity.

There is evidence that credit is not being used for its intended purpose. In looking at the performance of the credit scheme we observe a negative correlation between changes in productivity and changes in repayment levels. Although average annual per acre yields have increased from 41 bushels in 1966-67 through 51 bushels in 1969-70,

to about 55 bushels in 1970-71,[1] repayment levels show a declining trend in the same period. Voluntary repayments, which were 70 percent of loans granted in Maha 1967-68, declined through 49.7 percent in Maha 1969-70 to 39.0 percent in 1970-71.[2]

Results

Overall, a coefficient of multiple determination or $\bar{R}^2$ of .76 indicates that 24 percent of the variance in paddy yield per acre is not explained by the variation in the independent variables that are included.

Statistical significance of independent variables.--The least squares estimates fitted to 22 observations are as follows:[3]

Constant	Tractor	Weeded	Transplanted
$X_1 = -127.55$	$+ 0.02\ X_2$	$+ 0.12\ X_3$	$+ 0.60\ X_4$
	$(S_{\beta_2}=0.10)$	$(S_{\beta_3}=0.13)$	$(S_{\beta_4}=0.32)$
	$(t_2=0.21)$	$(t_3=0.87)$	$(t_4=1.87)$*

*Significant at 5 percent where t = 1.80.[4]

---

[1]Department of Census and Statistics, Statistical Pocket Book, op. cit., p. 61; and Ministry of Agriculture and Lands, Implementation Programme, op. cit.

[2]Central Bank of Ceylon, Annual Report 1971, op. cit.

[3]The computer printout is in Appendix B.

[4]The t-value at the 10 percent level of probability is not shown because all t-values of estimates that are significant at 10 percent are also significant at 5 percent.

Seed	Irrigated	Rented	Risk
$+ 0.30 X_5$	$- 0.03 X_6$	$+ 0.17 X_7$	$+ 1.71 X_9$
$(S_{\beta_5} = 0.10)$	$(S_{\beta_6} = 0.09)$	$(S_{\beta_7} = 0.13)$	$(S_{\beta_9} = 0.57)$
$(t_5 = 3.18)^{**}$	$(t_6 = 0.28)$	$(t_7 = 1.28)$	$(t_9 = 3.01)^{**}$

Dummy	Size	Default
$- 0.67 X_{10}$	$- 0.28 X_{12}$	$+ 0.06 X_{13}$
$(S_{\beta_{10}} = 8.89)$	$(S_{\beta_{12}} = 0.12)$	$(S_{\beta_{13}} = 0.07)$
$(t_{10} = 0.08)$	$(t_{12} = 2.36)^{*}$	$(t_{13} = 0.88)$

*Significant at 5 percent where t = 1.80.
**Significant at 1 percent where t = 2.72.

S_{β_i} is the estimated standard errors of coefficients, and t_i the corresponding t-value. Since there are 11 independent variables and 22 observations, there are 11 degrees of freedom. The critical point with 11 degrees of freedom at the 5 percent level of probability is 1.80 and at the 1 percent level of probability, 2.72. If the null hypothesis H_0 is true, β_i will be centered on $\beta_i = 0$ and there will be only a 5 or 1 percent probability of observing a t-value exceeding 1.80 and 2.72, respectively. These critical values define the rejection region for determining the degree to which (if any), the independent variables are significantly related to the dependent variable (paddy yields).

The observed values that fall in the region where the null hypothesis ($H_0 : \beta_i = 0$) is rejected are t_4, t_5, t_9, and t_{12} at the 5 percent level of probability and t_5 and t_9 at 1 percent.

Economic significance of variables.--In Bayesian terms, a distinction may be drawn between economic and statistical significance in the light of prior beliefs. Although an observed t-value may fall in the "acceptance" region, it does not necessarily mean that the null hypothesis (that the estimated coefficient is zero) would be accepted. Whether or not it is accepted depends on the reliance that can be placed on the observed t-value. In formal terms, the prior distribution is adjusted to take account of observed data, with the weight attached to the observed data depending on the probability of the posterior distribution.[1]

It may be that the lack of statistical significance is due to the sample being too small, and the standard errors consequently large. Multicollinearity may also have contributed to the largeness in the standard errors, thus causing the observed t-values to be statistically insignificant.

In applying Bayesian logic to the foregoing results we may conclude that the renting of land and the practice of chemical weeding have at least some positive effect on yields. The coefficient of the variable measuring the credit default rate (X_{12}) is positive, thus justifying a reversal of a prior belief that the

---

[1]See, for instance, Ronald J. Wonnacott and Thomas H. Wonnacott, Econometrics (Toronto: John Wiley and Sons, Inc., 1970), pp. 209-12.

disqualification of farmers from receiving paddy loans due to default adversely affects average productivity the following year. The result supports the hypothesis that credit disbursement may not have contributed to productivity increases. The weakness in the t-value with respect to the effect of irrigation on yields makes it advisable to regard the results with respect to this variable as being inconclusive. However, the results with regard to tractor use fit a prior belief that tractors are more important potentially for cropping intensity rather than yields.[1]

Unincluded Institutional Variables

In looking at the results overall, the $\bar{R}^2$ value indicates that 24 percent of paddy yields is not explained by the included variables. There is reason to believe that most of the unexplained variation is attributable to institutional-organizational and resource endowment factors. The reason for this belief lies in the fact that most of the variables relating to technology (including techniques) were included in the regression analysis,

---

[1]For instance, in the Pakistan Punjab tractors had very little influence on yields. The tractor farms did not have tractor implements for deep plowing, row crop sowing, and fertilization. Also tractor use had not been accompanied by a simultaneous increase in the bundle of inputs and improved practices. See Bashir Ahmed, "Farm Mechanization and Agricultural Development: A Case Study of the Pakistan Punjab" (unpublished Ph.D. dissertation, Michigan State University, 1970).

either explicitly or by proxy (to the extent that the included variables were representative of other excluded variables with which they were collinear). Hence much of the unexplained variation is probably due to unincluded institutional, infrastructural, and resource endowment (including weather) factors. The institutions examined below are those that may account for some of the unexplained variation in the econometric analysis. They are categorized into objective and subjective institutions and are examined from the standpoint of their possible effect on interdistrict adoption and hence on yields.

Objective Institutions

Information.--Information to farmers flows chiefly from extension channels, informal local channels, and the demonstration effects of early adoptors (3).[1] While some studies identify extension as having the most effect on adoption, other studies emphasize less formal local channels. The Comilla study reports that "the training of model farmers from the village cooperatives is a major educational input which is multiplied by the subsequent discussion held by these individuals in their villages, often aided by written material" (8, p. 51). Also, that "through local communication channels, the agricultural knowledge extended through the cooperative passes to all

[1]The number in parentheses refers to the study listed in Appendix A.

members of the village. . ." (8, p. 59). Similarly, the West Pakistan study also reports the importance of informal channels (5, p. 85). On the other hand, in the Barant Development Block, North India, "dealing personally with extension agents was found to be the most important factor after per capita income influencing the adoption behaviour of farmers" (7, p. 25).[1]

It is not clear to what extent less formal local channels substitute for deficient extension. To the extent that this is so, the importance of less formal communication channels will diminish relatively if extension is strengthened.

There is evidence which suggests that: (a) extension is deficient in Sri Lanka, and that the distribution of extension agents varies among districts, and (b) informal channels are resorted to because of extension weaknesses.

No data are available to develop a statistical assessment of extension on yields in Sri Lanka. It is known, however, that in Sri Lanka there are some 1,669 extension workers to serve the needs of 1.2 million farmers with holdings below 50 acres in size and that extension efficacy varies among districts.[2] Experience in other

---

[1]See also Arthur Niehoff, A Casebook of Social Change (Chicago: Aldine Publishing Co., 1966).

[2]Director of Agriculture, Administration Report 1967-8 (Colombo: Department of Agriculture, 1970).

Asian countries suggests than an extension worker rapidly loses impact if he has to serve more than 250-300 farmers.[1] Yet in Sri Lanka a village level operator has to deal with 1,500-3,000 farmers, which is about five to ten times this rate. Not surprisingly the recent Central Bank Survey on loan defaults reports, "Extension work does not seem to have been conducted in most of the areas to which these (credit) defaulters belonged. The extension officers had not visited farmers even once in certain areas."[2] The survey also reports that ". . . input utilization is (often) left entirely in the hands of the farmer. He himself does not supervise its usage as he has no understanding of modern scientific methods."[3] These numerical weaknesses in extension are probably exacerbated by quality weaknesses.

There is also evidence which suggests that informal channels in Sri Lanka are a substitute for extension. The Central Bank Survey states that due to "absence of help of a scientific nature from the extension officers he (the farmer) relies on his own 'hunches' or he is influenced by his neighbours about modern

---

[1] Rainer Schickele, Ceylon Papers 1967-70 (New York: A/D/C, 1972). In Japan the ratio is 1:550 according to Naseem, #1, Appendix A.

[2] Central Bank of Ceylon, Survey of Defaults in the Repayment of New Agricultural Loans (Colombo: Department of Economic Research, 1972), p. 67. The word in parentheses is the writer's.

[3] Ibid., p. 35.

methods of production."[1] That interpersonal localite channels are a less preferred substitute is also suggested by the Recife area study where it is reported that farmers who use "direct" sources of information (extension) rely less on "indirect" (informal) sources (2, p. 175). This factor, to the extent that it is valid, has the effect of further emphasizing the importance of the extension variable in explaining the unexplained variance in inter-district yields.

Input supply.--Differences in the efficacy of institutions governing the adequate and timely supply of inputs could also account for a considerable portion of the unexplained variation in the regression analysis.

Fertilizers in adequate quantities are often not readily available when needed[2] due to :

(a) structural defects in the organization of some cooperatives which are exclusive outlets for inputs including credit, and

(b) the need to satisfy cumbersome bureaucratic requirements on the part of multipurpose cooperatives in order to get fertilizers for farmers, and the consequent imposition of complex procedures on farmers in order for them to qualify for such subsidized fertilizer.

---

[1] Ibid.

[2] Ibid.

1. The major structural deficiencies in cooperatives are as follows:[1]

(a) Unsatisfactory personnel in some cooperatives leading to poor organization and management inefficiencies;

(b) Lack of consolidation and centralization which makes supervision of management difficult and inhibits economies of scale;

(c) Lack of small farmer influence due to large farmer control over certain cooperatives.

2. Elaborate bureaucratic procedures have been established to ensure that subsidized fertilizer is used for specific crops. Fertilizer subsidies vary among crops, while some crops do not qualify for any subsidy. Fertilizer for paddy cultivation receives a 50 percent subsidy, necessitating intricate bureaucratic checks to ensure crop specificity. Hence multipurpose cooperatives, which have exclusive distribution rights, have problems in ensuring the timely availability of inputs to farmers. Once such fertilizer becomes available at the local cooperative, farmers have to satisfy complex and time-consuming procedures to receive fertilizer. These defects impose costs on farmers that serve to at least partially offset the benefit of the 50 percent subsidy. These costs may also be said to vary between districts depending on

---

[1]The sources of this information are "The Royal Commission Report of 1969," and the report on the Socio-Economic Survey of the Elahera Colonization Project in Ceylon Papers by Schickele, op. cit.

the number of farmers serviced by a given cooperative, and the quality and influence of the local personnel.

In general, the price subsidy on strategic seed and fertilizer inputs can be expected to increase paddy output, including paddy productivity. It would, by reducing average costs of production increase the profitability of paddy cultivation (given demand) in relation to other less profitable crops. This would involve a more intensive use of paddy land and a transfer of land, labor, and capital resources from the cultivation of other crops to the cultivation of paddy (since the aggregate supply response for all agricultural products is probably very low).[1] Input subsidies are more likely to encourage innovation than price supports (as it enables the farmer to discover the MVP of fertilizer), and with input subsidies government expenditure is in direct proportion to levels of input adoption.[2] But as innovation becomes widespread such subsidies could prove to be an enormous burden on the exchequer. Moreover, peasant farmers would be more familiar with output prices than input prices and hence more responsive to increases in the former.

---

[1]See, for instance, John Mellor, "The Functions of Agricultural Prices in Economic Development," Indian Journal of Agricultural Economics, Vol. XXIII, No. 1 (Jan.-March, 1968).

[2]See, for instance, Raj Krishna, "Agricultural Price Policy and Economic Development," in Agricultural Development and Economic Growth, ed. by Herman M. Southworth and Bruce F. Johnston (Ithaca, New York: Cornell University Press, 1967).

Subjective Institutions

Some subjective institutions may also contribute to explaining the unexplained variation of 24 percent. Those examined are religious, cultural, and social factors.

Religion and culture.--This variable may influence productivity by modifying farmers' responses to economic stimuli as predicted by received economic theory.[1] It may assist in explaining the resistance of some farmers in Sri Lanka to technological change. The rural sector is 78.4 percent Buddhist[2] and it would not be surprising if many slow adoptors subscribe (perhaps below a perception threshold) to the basic Buddhist belief, as stated by Alfred Marshall, that "real riches consist not in the abundance of goods, but in the paucity of wants."[3]

To desire less material goods in terms of the individual's self-concept[4] is still maximizing behavior, although the goods demanded are nonmarket in character.

---

[1]An assumption subscribed to by writers like Schultz in Transforming Traditional Agriculture, op. cit., but disputed by writers like Kusum Nair in The Lonely Furrow (Ann Arbor: University of Michigan Press, 1969).

[2]Department of Census and Statistics, Socio-Economic Survey, op. cit.

[3]Marshall, Principles, op. cit., p. 136.

[4]The individual's self-concept is a critical factor in behavior, according to Carl Rogers in "Client-Centered Therapy" as described by H. S. Hall and G. Lindzey in Theories of Personality (New York: John Wiley and Sons, 1970), Chapter 11.

However, it could certainly influence the farmer's attitude towards technological changes which promise the means of purchasing only material goods.

Questions also arise as to whether farmer resistance to more widespread use of pesticides could be ascribed to one of the Fundamental Precepts of Buddhism which forbids all killing, and is widely interpreted as applying to insects, perhaps even those that compete for Man's food.

Other social factors.--Sociological case studies of rural village life in Sri Lanka[1] suggest that a considerable interdependency of preference and production functions exists at the village level that may influence paddy productivity.

The concept of interdependency among preference functions has been incorporated into consumption theory in the form of bandwaggon, snob, and veblen effects, and between production functions into development theory as demonstration effects. From a sales standpoint such interdependency is generally regarded as a low cost means of gaining a more widespread acceptance of commodities.

---

[1]These case studies are contained in an UNRISD study titled Cooperatives and Planned Change in Asian Rural Communities, edited by Inayatullah (Geneva: United Nations Research Institute for Social Development, 1970), pp. 175-341.

However, such interdependency seems to have effects of an opposite nature in Sri Lanka by exercising a restraining influence on more progressive early adoptors. Numerous instances of hostility toward fellow villages who show signs of progressivity have been cited in the studies.

Summary

This chapter has further contributed to the objective of this study, which is to determine how to use the variables of technology and institutions to increase productivity on (small) farms below 4 acres in size. The chapter assessed the relative importance of variables as they influence interdistrict paddy yields in Sri Lanka. Since the quantitative analysis failed to explain 24 percent of interdistrict yield, other objective and subjective institutional variables were identified that could be expected to account for a considerable proportion of this unexplained variation.

It was found that the statistically significant variables were row transplanting, improved seed, risk factors in production, and farm size. The number of significant variables for policy purposes was expanded to include fertilizer use (which was unincluded but represented by the seed variable), chemical weeding, and the renting of holdings. In the case of tractor use and

and production credit, the statistical results suggested they were not important for past increases in paddy productivity.

The other institutional variables identified but not quantitatively assessed were the distribution of extension personnel, input supply factors, religious and cultural factors, and social factors, mainly those stemming from the interdependency of preference and production functions of rural inhabitants.

CHAPTER VI

POTENTIAL OF VARIOUS PRODUCTION PRACTICES INFLUENCING INCOME DISTRIBUTION

Introduction

Objectives

This chapter attempts to assess the relative importance of variables already identified, from the standpoint of income distribution in Sri Laṇka. The econometric analysis just concluded, supplemented by other information, provided some insight into the relative importance of technology (including techniques) and institutions (including infrastructure) that explain interdistrict paddy productivity. But this information is incomplete in terms of the objective of this study, which is to see how not just to increase paddy productivity, but to increase paddy productivity in a manner that will enable low income groups to gain control over sources of income streams, and see that employment opportunities are adequately generated.

The variables that determine income can be divided into those that influence farm revenue and those that influence farm costs. Revenue to farmers from the sale of their output is a function of both quantity and price.

Since price is guaranteed and administratively fixed in Sri Lanka, the critical variable from the standpoint of income is output per acre per annum. Output per acre per annum is in turn a function of yield and cropping intensity, given cropping patterns. Cost per unit is also important as income benefits from higher yield could be offset by higher costs.

Variables affecting both revenue and costs will be examined with a view to determining their relative and absolute significance for income distribution from both a statistical and an economic (policy) standpoint. Farm size will be used as the central variable against which each of the revenue and cost variables will be assessed, from productivity and employment standpoints, so as to relate to equity objectives.

Sources and Methods

The sources of information for assessing the equity significance of variables are as follows:

1. The results of the quantitative analysis.
2. Other information with regard to Sri Lanka.
3. The experience of other countries, mainly India, Pakistan, and Bangladesh.[1]

These three sources are complementary and equally important. The statistical results will be assessed in

---

[1]The number in parentheses will refer to the study listed in Appendix A.

the light of prior beliefs, which will serve to reinforce or question the statistical findings.[1]

Irrespective of whether the prior beliefs confirm or contradict the statistical findings, they serve to strengthen the foundations on which to base the policy prescriptions to be made in a subsequent chapter. The aggregate information to be gained is expected to influence the degree of certitude with which policy suggestions are made, and generally contribute to the quality of judgments.

Identification of Equity Criteria

As mentioned in connection with the conceptual framework, the interaction of pure technology with institutional variables (given resource endowments) determines growth and income distribution. It was also suggested that the same variables that determine growth could probably be made to influence income distribution if they could be given focus. The targets of primary focus were determined in this study to be farms below 4 acres in Sri Lanka. Since attention is directed at small farms, the ability to focus programs depends on the economies of scale in the primary variables.

---

[1]The methodology applied is a loose variant of Bayesian logic, but the rationale is the same: to temper statistical analysis by common sense.

Scale Neutrality

The objective of program focusing is to introduce the dynamism of growth into the production system of farms below 4 acres in size. The degree of success with which the focusing of programs could be accomplished is mainly through divisibility of inputs, which refers to scale (size) neutrality in the variables significant for paddy productivity, and the degree to which the diffusion process could be made pervasive among the target groups. Size neutrality may be said to exist if the overhead costs of technological change are not significantly different between small and large farms, at a given level of productivity per acre.

Since the interaction of technology with institutions determines both output and income distribution, consideration for scale neutrality in technology alone is inadequate for the successful focusing of programs; attention will also have to be paid to scale or size neutrality in institutions. It appears in fact that the primary variables can be successfully focused only if scale neutrality in one is not permitted to be offset by indivisibilities in the other. For instance, indivisibility in physical technology can be offset by institutional-organizational factors, as is the case when small farmers gain access to large tractors through custom hiring or cooperative ownership. Conversely,

physical divisibility in technology can be offset by indivisibilities in institutions as is the case when, for instance, small farmers do not apply the seed-fertilizer package because they cannot gain access to adequate technical information due to extension biases in favor of large farmers.

Employment Potential

The second criterion which will be applied for the evaluation of variables from an equity angle, is their labor absorption potential. To the extent that scale neutrality in variables actuates an appropriate outward shift in the production functions of small farms it would create employment opportunities on affected farms, depending on the type of technology used (whether labor or capital intensive), and the employment slack or disguised unemployment on larger farms (since some of the labor supply for large farms comes from landless or landpoor categories).

Congruence

If a technological or institutional variable that is scale neutral and/or labor absorptive is also significant from the standpoint of productivity, there would then be congruency between growth and equity objectives. This quality of congruency would be a most desirable attribute in a variable from the standpoint of the objectives of the Five Year Plan.

There is no presumption that simply because an alternative technology is socially more desirable, it will be automatically adopted. Actual adoption is a function of private profitability at the point of output where the added felt costs are equated with added perceived returns. The challenge is to identify institutional modifications that will bring private and social benefits/costs into reasonable alignment.

Assessment of Revenue Variables

The income to (small) farmers from farming operations depends on the difference between average revenue and average costs at a given level of output. The revenue aspect examined here is a function of price and output.

Since the farm level price of paddy is administratively fixed, it is unlikely that the prospective price is discounted by a risk fraction by farmers, as would be the case if a free market prevailed. However, since the guaranteed price is the delivered price, some marketing costs are internalized to the farm. These are the fixed costs of transporting the produce to the nearest collection point, and the costs associated with uncertainties regarding the timely availability of transportation facilities soon after harvest. The costs of uncertainty will depend mainly on farmer "holding power" which in turn is a function of the urgency of the need for cash, and amount of storage capacity available. A discussion of

these factors properly belongs in the subsequent subsection assessing costs.

The investigation here is directed at finding out how farm size influences yield per acre and cropping intensity. If yields and intensity are already high on small farms, or if there is limited potential for yield increases on small farms, then strategies for increasing small farmer incomes will need to concentrate more on the cost side. If they are not, the potential for catching-up with large farmers could be great, and attention will need to be directed at both cost and revenue aspects.

Yields

Evidence suggests that small farmers have a high yield potential, probably even higher than large farmers. For instance, a study of the Budaun District in India shows a negative relationship between size and yields. This study concludes that subject to operating capital being available, and fertilizers, etc. being free to move between farms in response to market stimuli, the predicted net crop return per acre on the small farms (those below ten acres in size) will average 30 percent higher than medium or large farms (9, p. 203-04).[1] A similar phenomenon between farm size and yields was observed in the

[1]The number in parentheses refers to the listing in Appendix A.

Pakistan Punjab (2, p. 108). The study of West Bengal and Andhra Pradesh reaches a general conclusion with regard to rice growing areas that after an "experimental period" of three seasons, the new varieties were adopted to a greater extent by small farmers than by large farmers. Whereas in the post-experimental period large farmers adopted on 20-30 percent of their acreage, small farmers adopted on a much higher proportion (35-80 percent) of their acreage. The Central Bank Survey in Sri Lanka[1] also concluded that a negative relationship between farm size and yields existed in Sri Lanka--the average yield on farms below 2 acres in size was 34.5 bushels, while the average yield of farms larger than 2 acres was 33.7 bushels.

The results of the statistical analysis appear to contradict the foregoing evidence. The regression coefficient of the farm size variable (X_{12}) is significantly negative at the 5 percent level of probability, where farm size is the percentage of farms below 2 acres in each district. This relationship was confirmed by a regression of yields per acre on the average size of

---

[1]Central Bank of Ceylon, Cost of Production of Paddy, op. cit., p. 54.

farm and other variables.[1] The resulting coefficient was positive but statistically not significant, probably due to the influence of a few large farms on the mean size of holdings in each district.[2]

However, there may not in fact be any contradiction between the prior knowledge of a negative relationship between farm size and yields and the posterior knowledge of a statistically significant positive relationship between them. This is because mixing adoptors and non-adoptors at an aggregated national level, particularly in a situation where early innovators are large farmers (an aspect to be examined later in this chapter), makes it possible to observe a significant positive relationship between yields and farm size without refuting the prior belief held.

Two conclusions emerge from this analysis. One is that small farmers are capable of increasing yields considerably, even more than large farmers. Hence there is greater potential for increasing incomes through increases in yields than is generally believed to be the

---

[1]The model (B) is:

$$X_1 = \alpha + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + e$$

where X_8 is the average size of farm and the other variables are the same as in Model A. The computer printout of results is in Appendix C.

[2]The critical point at 10 percent was 1.36 while the observed t-value for X_8 was only 0.24.

case. Second, if small farmers tend to lag behind in the adoption of new technology in Sri Lanka, then the significant positive relationship observed at the national level between farm size and productivity may be a valid but transient one, caused by the particular location of the Sri Lanka paddy subsector on the growth path.

Reasons for Negative Relationship

Four main reasons may be identified for the prevalence of a negative relationship between yields and farm size among innovating farms. One is the need for small farm households to make the most of what land is available, and their possibly higher utility from added income. Another stems from the inherent nature of the agricultural production process. Agricultural production processes cannot be routinized, and require frequent monitoring with many on-the-spot "snap" decisions needed to be taken. Since a farmer is able to know a smaller farm more intimately than a larger farm, there would be greater optimality in smaller farms.[1] A third reason is that the ratio of permanent labor to land and operating capital on small farms is much higher than on larger farms; consequently small farms require very little expensive hired labor in the labor scarce months. In Uttar Pradesh, India, for

[1] A point made by Schickele in Agrarian Revolution, op. cit. But this would be so only if entrepreneurial ability is not correlated with farm size.

instance, this ratio is twice that on medium sized farms farms and five times that on large fams (8, p. 204). A fourth reason is probably a need for innovating small farmers to put a larger proportion of acreage under new varieties so as to spread the overhead costs of technological changes among a greater number of output units--i.e., lower their average costs of production.

Cropping Intensity

It is now hypothesized that even if a positive relationship between farm size and productivity exists, it may be offset over the period of one year if there is a strong enough negative correlation between farm size and cropping intensity. The cropping index, which measures the intensity of paddy land use over a period of one year, seems to be negatively correlated with farm size. Evidence of this was found in the Pakistan Punjab, where the cropping index was 125.8 percent on the below 12.5 acre farms and 118.6 on the larger than 12.5 acre farms (2, p. 108). A similar phenomenon is evident in Sri Lanka, as can be perceived in Table 6.1.

The data in Table 6.1 suggest a negative relationship between farm size and cropping intensity in Sri Lanka. For the target (below 4 acre) groups the percentage of land double-cropped is about 51 percent while for other (above 4 acre) groups it is 26 percent. However, this data is neither sufficient nor conclusive. For one

TABLE 6.1.--Double Cropping by Size of Paddy Holding.

Size of Holding (acres)	Percent of Land Double-Cropped
Under 1	53
2.5 - 5	50
5 - 10	45
10 - 100	32
100 - 250	17
Over 250	10

Source: Census of Agriculture, 1962. Vol. VI as reproduced in Table 5, p. 7, by T. Jogaratnam and Rainer Schickele, in Practical Guidelines to Agricultural Development Policies in Ceylon, Agricultural Economics Research Unit, University of Sri Lanka, Peradeniya, September, 1970.

thing it does not show how farm size influences land use intensity. For another, there may be other factors besides farm size that enter into the relationship.

Improved insight into the aforementioned relationship between land use intensity and farm size may be gained by regressing the cropping index data by district on farm size and other relevant variables.[1] Such an analysis would:

---

[1]This third model (C) is as follows:

$$X_{11} = \alpha + \beta_2 X_2 + \beta_6 X_6 + \beta_7 X_7 + \beta_9 X_9 + \beta_{10} X_{10} + \beta_{12} X_{12}$$

where

X_{11} is the cropping index,

X_{12} is the size variable obtained by taking the percentage of farms in each district below 2 acres in size, and

(a) Facilitate a verification of whether or not a negative correlation coefficient between farm size and land use intensity exists and, if so, if it succeeds in offsetting any positive correlation between farm size and paddy land productivity, and thereby provides a more complete income picture over the period of one year.

(b) It would help to identify the variables that are important for gaining a more widespread adoption of double cropping, particularly among the target groups, in view of its considerable income (including employment) generation potential.

(c) It would, if valid, make a cogent contribution to the case for a redistribution of paddy holdings in Sri Lanka, and hence provide a palpable example of congruence between growth and equity objectives.

X_2, X_6, X_7, X_9 and X_{10} are the same as in the original Model A.

The computer printout showing results is in Appendix D.

The cropping index is computed from data in the Implementation Programme, 1973, by taking the percentage of the Maha season acreage that is harvested for the Yala season and adding it to 100. The acreage figures are a 10-year average. For example, since an average of 1.2 million acres were under the Maha crop in the past 10 years, but only 0.6 million acres of the same land was under Yala in the same period (which is 50 percent of the maha season acreage), the national cropping index is 150.

Results of Model C[1]

The results from regressing the cropping index on farm size and other variables show a negative coefficient for farm size, where farm size refers to the percentage of farms below 2 acres in size; i.e., as the percentage of farms under 2 acres increases, the cropping index decreases.[2] The results seriously question the validity of the relationship in Table 6.1. In fact, a t-value of -1.55 (the critical point is t = 1.35) is sufficiently strong to justify a reveral of a prior belief that there is a negative relationship between farm size and cropping intensity.

The policy significance of these findings is that since potentials exist for increasing both yields and double cropping on small farms to an extent greater than envisaged previously, there seems to be scope for increasing income more appreciably than otherwise on the revenue side. Now if average costs of production can also be reduced, even greater scope will exist for increasing the incomes of low income groups. These cost aspects are examined next.

---

[1] See the computer printout in Appendix D.

[2] This finding was verified by regressing the cropping index on the average size of farm in each district, and other variables. The coefficient in this case was also found to be significantly positive at the 10 percent level.

Assessment of Cost Variables

To the extent that variables affecting the felt costs of innovation to small farmers can be made scale (size) neutral and divisible it will decrease average costs for small farmers. Lower costs can be expected (given returns) to increase the profitability of new technology, gain its more widespread acceptance, and so increase the productivity and incomes of affected farm households. It could also actuate an outward shift in the demand curve for hired labor, and thereby increase household incomes on other farms on which labor is surplus.

The central variable with regard to scale neutrality is physical farm size. The statistical measure of the coefficient of correlation between farm size and each of the other variables that have been quantitatively assessed (Table 6.2) is expected to be at least mildly suggestive of the degree of scale neutrality (divisibility) in a specified variable.[1] The variable of farm size X_8 is the average size of farm by district.

---

[1]The verbal interpretation of the correlation coefficient in Appendix B is as follows:

Coefficient (r)	Description
$r = 0$	Perfectly divisible
$0 < r \leq .24$	Highly divisible
$.25 < r \leq .49$	Fairly divisible
$.50 < r \leq .74$	Low divisibility
$.75 < r \leq .99$	Indivisible
$r = 1$	Perfectly indivisible

Since the correlation coefficient is a measure that is inherently biased upward, it may suggest a higher degree of indivisibility than may exist.

TABLE 6.2.--Coefficient of Relationship between Independent Variables and Farm Size.

Variables		Average Farm Size X_8
X_2	Tractor plowing	0.75
X_3	Chemical weeding	0.46
X_4	Transplanting	-0.14
X_5	Improved seeding	0.54
X_6	Irrigation	0.39
X_7	Renting	-0.66
X_9	Risks	-0.06
X_{10}	Dummy (Wet zone = 1)	-0.73
X_{13}	Credit defaults	-0.55

Source: Correlation Matrix, computer printout, Appendix E. (Average farm size data is from the Central Bank of Ceylon, Survey on Cost of Production of Paddy, Economic Research Department, Colombo, 1969.

Due to the possibility of spurious correlation, the coefficient of correlation will not qualify as a full-fledged coefficient of divisibility; to regard it as such would be to attach exaggerated importance to it. The utility of the correlation coefficient for the following analysis will lie in its ability to confirm or raise questions with regard to prior beliefs that already exist with respect to divisibility. The source of such prior beliefs will, as stated earlier, be information from Sri Lanka and other countries, principally India, Pakistan, and Bangladesh. The studies are listed in Appendix A.

An integrated approach will be used for assessing the equity impact of the variables. The organization followed will discuss the following aspects in the indicated sequence: (1) scale neutrality--whether the technology is applicable to small farms; (2) employment--whether the technology or technique is labor intensive; (3) congruency--whether growth and equity objectives could both be achieved by the same technology/technique; and (4) general conclusion.

Mechanical Technology

This subsection investigates the equity and "congruity" implications of tractor use, and the use of mechanical means of exterminating weeds. The variable X_3 which measures the area chemically weeded is a proxy variable for the spray equipment that is necessary for chemical weeding. Power spray equipment would be regarded as being more "mechanical" than hand spray equipment.

Tractor plowing.--The r coefficient of .75 in Table 6.2 confirms a prior belief that tractor use is positively correlated with farm size and that economies of scale place this variable in the "low divisibility" category. The reason why the coefficient is not even higher is probably because of the countervailing influence of institutional-organizational factors such as custom hiring and ownership of tractors by multipurpose

cooperatives, which introduce scale neutrality into tractor use. This is supported obliquely by the evidence adduced earlier, that in the dry zone even farms below 5 acres in size use tractors.[1]

But economies of scale associated with the use of tractor technology in Sri Lanka could be said to have an adverse effect on income distribution. For one thing, scale neutrality in tractor use does not extend to tractor ownership. Farm size denies to small farmers the financial capacity to own tractors and the economic ability to use them profitably on their own fields. Therefore fiscal policies designed to encourage tractorization by causing tractor prices to private buyers to diverge from social shadow prices, confer (regressive) social subsidies on larger farmers, and are thus fundamentally antagonistic to the objective of reduced income disparities. Moreover, while custom hiring facilitates scale neutrality in tractor use, it does not ensure it. The actual benefits to small farmers from such scale neutrality will be directly proportional to the monopoly power exercised by the local tractor owner, as reflected in hiring rates. Such a monopoly element is very likely to exist in a given locality in view of the relative numerical differences between tractor owners (large farmers) and

---

[1] Raj, "Mechanization of Agriculture," op. cit.

and tractor hirers (small farmers).[1] Very small holdings would be denied the use of tractors at all due to the minimum physical size required for tractor operation. Tractor use is also biased against small farmers in view of the limited sum (Rs. 60 per acre) loaned in cash for plowing under the 1967 credit scheme which is much less than the actual cost of hiring a tractor (which is about Rs. 140 per acre). To the extent that the tractor owner extends credit to small farmers, interest rates which reflect the risks in lending could siphon away benefits of new technology from low income groups, and thus be inimical to the objective of improved income distribution.

At the same time there is much evidence that tractor use has adverse implications for the second component of income distribution; namely, employment. At least three different studies reach the conclusion that tractor use in Sri Lanka displaces labor as well as draught animals. The ILO Report states that tractors caused the man-days required for plowing to be reduced by five to seven days per acre.[2] FAO evidence from South Asian countries, including Sri Lanka, indicates

---

[1]For instance in the Pakistan Punjab about 80 percent of tractors were owned by 8 percent of farmers having holdings of 25 acres and above (1, p. 49).

[2]ILO, Report, op. cit., p. 74.

that while the man-hours per acre needed for primary and secondary tillage (including plowing, harrowing, puddling, etc.) is 632 with nonmechanical methods, the man-days needed become reduced to 43 per acre when mechanical means are employed.[1] That tractors displace labor in Sri Lanka is further confirmed in a study which reports that rice farms using modern technology in 1969-70 were found to use 13 percent less labor when tractors rather than bullocks were used.[2]

Tractors also adversely affect employment indirectly in Sri Lanka since tractor purchase, operation, and maintenance involve the use of foreign exchange resources that otherwise would have been used to import raw materials that would have enabled a fuller utilization of existing industrial plant capacity. The foreign exchange allocation for tractors, tractor implements, and spare parts is about 15 million per annum, whereas the cut-back in the foreign exchange allocations for investment goods imports was around 23 million in 1971, according to the Central Bank.[3]

---

[1]J. C. Moomaw and H. P. Curfs, Some General and Special Aspects of Rice Soil Tillage, AGS:MRP/71/11-1 (Netherlands: Food and Agriculture Organization, July, 1971).

[2]William H. Bartsch, Employment Effects of Alternative Technologies and Techniques in Agriculture (unpublished draft, 1972; mimeographed).

[3]Central Bank of Ceylon, Annual Report 1971, op. cit., p. 235.

This labor displacement effect of tractors is in conformity with effects observed in India and Pakistan. By synthesizing the information in the studies listed in Appendix A, we find that the change in labor requirements consequent upon the application of tractors could reduce up to 90 percent the man-hours necessary. The man-hours per acre are reduced from 1500 to 150 when tractors are employed. The percentage rate of reduction of labor per unit of output is roughly the same as in the case of labor input per acre.

Overall a judgment can be reached that when shifting from traditional methods, the labor-increasing effects of biological technology tend to be more than offset by the labor-displacing effects of mechanical technology (when such technology is used), unless tractor use enables the breaking of timeliness bottlenecks and so facilitates multiple cropping that otherwise would not be possible.

However, Model C, presented earlier, which was a regression of cropping index on tractor use and other variables, showed that tractor plowing has a statistically significant negative relationship with the cropping index in Sri Lanka. This justified a reveral of the prior belief that tractor use increases the cropping intensity in Sri Lanka. However, while tractors may not be generally effective in increasing cropping intensity in Sri

Lanka, specific instances may well exist where the opposite is in fact the case, particularly in the dry zone. As a West Pakistan study indicates, the ability of tractors to influence the cropping intensity depends on the availability of (irrigated) water and the existence of a cropping pattern in which the overlap of harvesting and planting times can be eliminated by machines (1, pp. 64-66). It is conceivable also that as more irrigation water becomes available in Sri Lanka in the future, tractor mechanization could have a positive effect on the intensity of cropping, provided the cropping pattern permits (as is likely to be the case). This points to a need for ensuring technical flexibility in tractor use.

In conclusion, tractor use does not appear to have in the past significantly contributed to either growth or to equity. Tractors were found to be statistically insignificant (at the 10 percent level) and economically weak in explaining yields.[1] Tractors were also found to be unimportant from the standpoint of timeliness. It appears that the verdict with regard to tractor use is also unfavorable from the viewpoint of equity. Since tractor use is positively and "significantly" correlated with farm size, it is inherently biased against small farmers. It thus has the capacity for widening income

---

[1] In fact, the results for Model B show a negative regression coefficient (-.042) for the tractor variable X_2: See the computer printout in Appendix C.

disparities. Further, by displacing labor, tractors contribute to further skewness in the income distribution.

Spray weeding equipment.--The degree of scale neutrality in chemical weeding in any given situation will be influenced by whether power sprayers or hand sprayers are used. Information is not available as to the extent to which power spray equipment is used. Overall, a correlation coefficient of .46 suggests that chemical weeding is a fairly divisible input, although the degree of scale neutrality appears to have been limited.

The statistical analysis showed that chemical weeding was statistically insignificant for yields at a 10 percent significance level, although the regression coefficient was not negligible, and its positive character fitted a prior belief that chemical weeding did in fact have an effect on interdistrict productivity.[1]

No clear conclusion can be drawn from the information available as to the significance of spray equipment for paddy output. Further research needs to be undertaken on the implication of spray weeding on small farms, to further verify their effects on yields and the comparative net rate of return from random planting and chemical weeding vis-a-vis row planting and hand weeding.

---

[1]The t value for the "chemical weeded" variable X_3 was 0.87, while the critical point at a 10 percent level of confidence was t = 1.36.

Other types of mechanization.--Mention may be made briefly of other types of mechanization in Sri Lanka. Dryers, seeding and rotary weeding machines, and a few water pumps are used on less than 5 percent of paddy acreage.[1] Seeding and rotary machines will be discussed in connection with the techniques with which they are associated, and with regard to which quantitative information is available. (No information is available regarding the use of the other types of mechanical equipment.)

Conclusions regarding tractors and spray equipment.--The evidence from Sri Lanka and other countries makes a good case for a substantial reduction in the emphasis on tractorization and perhaps the use of (power) spray equipment. However, there are circumstances that may justify their use in exceptionally in the present and more commonly in the future. There is, in other words, a need for technical flexibility necessitated by ecological differences within and between regions, and constantly changing points of location of different paddy growing areas along the development path. Hence policies with regard to agricultural mechanization have to be designed for Sri Lanka that will contribute to equity and increase

---

[1]Ministry of Agriculture and Lands, Implementation Programme, op. cit.

output, and at the same time assure maximum technical flexibility.[1]

Numerous variables need to be taken into consideration in deciding whether tractors should or should not be used. The situation is so complex and possibilities so varied, that no blanket endorsement or prohibition of tractorization is possible. There are benefits in particular circumstances in terms of paddy output (not necessarily yields) and employment (from multiple cropping and employment generation in secondary and tertiary sectors), increased labor productivity, changes in cropping patterns (toward more intensive crops), land reclamation, increase in livestock and dairy produce (by reducing the need for draught animals), and reduction in search and organizational costs of labor. There are also at the same time costs that need to be considered; costs in terms of labor displacement, tenant evictions, widening income disparities, use of possible crop lands for fodder cultivation, and foreign exchange efflux (deprivation of industry of raw materials), to name the major items. It should be noted, however, that tenant evictions as a by-product of tractorization may not be a significant problem in Sri Lanka because tenancy of the traditional type predominates in the wet zone, where the small size of farm is not

---

[1]These policies are identified in the following chapter.

conducive to significant mechanization.[1] Tenant evictions are an important result of tractorization in the Pakistan Punjab, however. But as the study notes, any increase in the productivity of land can engender eviction (1, p. 126).

Tractorization also requires an ongoing release of foreign exchange for the purchase of spare parts. In a situation of acute foreign exchange scarcity like that which presently exists in Sri Lanka, tractor owners face considerable uncertainties concerning the ready availability of spare parts. There is good reason to believe that draught animals are maintained in reserve to safeguard against machinery breakdown. In the Pakistan Punjab, for instance, the difficulties in obtaining spare parts caused tractorized farm to reduce (by about one-fourth) but not eliminate the number of bullocks maintained (1, p. 96). This consequently results in duplication and wastes, besides denying to society the benefits from the transfer of fodder lands for crops. In the Pakistan Punjab the area under fodder was less on the tractor as compared to the bullock farms, except for the Lyallapur district, where it was equal on both (1, p. 97).

From a "micro" standpoint, project analysis for ascertaining the social benefit-cost ratio is the obvious

---

[1]Only about 25% of acreage in the wet zone is tractor plowed, according to Raj in Mechanization of Agriculture, loc. cit.

solution. But at the broader national level the task of identifying specific types of mechanization that can, in a given situation, increase the amount of labor needed for rice cultivation, while at the same time increasing output, is likely to require a cadre of experts of a size that Sri Lanka or for that matter most developing countries simply cannot afford.

Biological Technology

This subsection evaluates the biological variables and associated techniques from the standpoint of income distribution and equity. The pivot of the analysis is the seed-fertilizer (S-F) package labeled X_5, which was found to be statistically significant for yields at one percent. The relationship between farm size and adoption will be examined using information from Sri Lanka and other regional studies. If a positive relationship seems to exist (as a priori appears to be the case), the remainder of the subsection will be devoted to identifying the (mainly) institutional variables that contribute to this positive relationship, and to assessing their relevance and applicability to Sri Lanka.

Such an analysis is expected to pinpoint the variables that will permit or actuate (1) more widespread, and (2) optimal acceptance of the S-F package in Sri Lanka, where optimality is regarded as containing the components of (a) dosage and (b) techniques. Hence a

sub-optimal application of technology would exist if (a) any component of the biological technology package is applied in other than prescribed dosage, and/or (b) the technique corresponding to the technology is not (fully) applied. Hence extension potentials would exist if either or both of these conditions are observed to exist on farms.

Extent of scale neutrality.--The physical divisibility of the S-F package notwithstanding, a positive correlation coefficient of .54 was observed between farm size and area under improved seed varieties (Table 6.2).[1] This suggests that despite its physical divisibility factors exist which inhibit the acceptance of the S-F package by the smaller farms at a given point in time.

The information on farmer utilization of production credit in Sri Lanka also substantiates this finding. As was shown in the previous chapter, productivity increase have occurred despite increasing credit default which rendered defaulters ineligible for more credit. The statistical results confirmed that noneligibility of defaulters for further credit did not affect paddy yields. The analysis in a subsequent subsection will show that

---

[1] Due to technical complementarity between improved seed and fertilizers, the "seed" variable X_5 was proxy for the unincluded fertilizer variable in the statistical analysis.

small farmers are bigger defaulters.[1] Hence the conclusion emerges that much of the productivity increases have come from large farms (unless one subscribes to the unlikely view that small farmers who default have other sources of credit for investment).

Even stronger support for the positive relationship between farm size and S-F adoption was seen in the statistically significant positive relationship between farm size and yields discussed earlier.[2]

Added credence to the positive coefficient observed between farm size and the seed-fertilizer variable is given by the experiences of other regions. In West Bengal and Andhra Pradesh a statistically significant positive relationship between adoption and farm size at the 5 percent level was found to exist, indicating that adoption levels increase with farm size. It was found, however, that differences in levels of adoption between size of farm groups were greater in bajra than in paddy-growing areas. A one acre increase in farm size typically led to a 2-3 percent increase in the probability of adoption in rice growing areas (6, p. 4). This is somewhat lower than that suggested by the coefficient r_{58} with respect to Sri Lanka. Survey results from the Pakistan Punjab show that

---

[1] See below under Production Credit.

[2] This refers to the statistical results in Appendix C.

farmers with holdings above 12.5 acres were both "leaders" and "maximum users" (2, p. 106). In 1970-71, 90.3 percent of this group planted Mexican wheat covering 92.4 percent of the wheat area, but only 73.1 percent of farmers in the below 12.5 acre size devoted only 66.1 percent of wheat acreage to high-yielding varieties. Similar relationships were observed in fertilizer and pesticide use. All these results were highly significant statistically. In the Recife area in Brazil it is reported that sampled small farmers typically prefer to observe some local experience with new practices before they try them (3, p. 162).

This positive relationship between farm size and the level of adoption of the S-F package is primarily a manifestation of the uneven flow of technology through the farm size structure, and is indicative of small farmer response at a later point in time. This phenomenon, observed in Sri Lanka and elsewhere, exists despite the physical divisibility of the seed-fertilizer package, which permits its application on paddy holdings of any size. Since the positive relationship cannot be attributed to the technology per se, it must be attributed to the other interacting primary variable; namely, institutions.

What institutional variables may contribute to the positive relationship observed between adoption levels and farm size? This subsection explores

this point using the concepts of felt costs and perceived benefits. These concepts recognize that subsistence farmer receptivity to technology is determined not just by actual money returns and costs, but by the ratio of subjectively perceived benefits to subjectively felt costs.[1] Institutions affecting the adoption of new technology, if biased against small farmers, increase the real costs of innovation to small farmers by increasing either the money or psychological component in cost (given perceived benefits), and thereby render the S-F package less attractive to small farmers, its physical divisibility notwithstanding.

Two such institutional factors that limit the scale neutrality in the S-F package are discussed here. These are (i) the technical information factor and (ii) the input acquisition factor. Other possible inhibiting variables (namely, the production credit, land tenure, and risk factors will be discussed separately because they influence the adoption and application of both mechanical and biological technology by small farmers.

(i) Information: A synthesis of this aspect in the studies listed in Appendix A indicates that

---

[1]This position is similar to Wharton's in that the farmer's subjective evaluation is the critical factor determining farmer's receptivity to new technology. C. R. Wharton, "Risk Uncertainty and the Subsistence Farmer," Development Digest, Vol. VII, No. 2 (Washington, D.C.: Agency for International Development, U.S. Department of State, April, 1969), p. 7.

difficulties (costs) in gaining access to technical information by small farmers has contributed substantially to the fairly significant positive relationship observed between farm size and seed adoption in Sri Lanka (Table 6.2). It appears that the positive relationship is substantially due to adoption lags by small farmers, which in turn is due to the reduced risk associated with later adoption. Reduced risk in turn mainly stems from improved information that reaches small farmers from the demonstration effects of early adoptors, the development of informal localite channels, and formal extension contact. Time (lags) therefore is primarily a proxy variable for information costs. If so, institutions which have the capacity to reduce the costs of technical information to small farmers (mainly extension) would need to be emphasized in the policy prescriptions to be made subsequently.

Adoption lags may be regarded as a means for reducing information costs through the internalization of externalities. Later adoptors, it is suggested, are those farmers who could not previously afford the cost of acquiring enough technical information to enable them to reduce risks of adoption to acceptable levels. Adoption lags permit the experience of others to confer an external benefit on laggards in the form of reduced risk. This externality, when internalized into the production systems

of laggards, assumes the form of a cost subsidy that operates to make adoption an attractive proposition.[1]

The reported experiences of small farmers in the Pakistan Punjab indicate that observed lags were due to felt risks associated with the adoption of new technology (2, p. 87). In West Bengal and Andhra Pradesh small farmers were later adoptors (6, p. 5). When these farmers eventually adopted after an "experimental period" of three seasons, they adopted to a greater extent than large farmers; while large farmers adopted on about 20-30 percent of their acreage, small farmers adopted on 35-80 percent. This phenomenon was attributed to the need for small farmers to spread the overhead costs of technological change over a larger number of units.

Figure 4 illustrates that the pattern of diffusion of technical change follows an elongated "S"-shaped curve

---

[1]This suggests that the adoption process may be inherently sub-optimal. If the added risks assumed by early adoptors remain inadequately compensated by the change in output alone, it is reasonable to presume that less people adopt early than otherwise would be the case. In a free market situation early adoptors receive rough justice in the form of higher initial prices, while later adoptors receive lower prices due to increased supply. If the change in output alone is inadequate compensation for early adoptors, there would exist a need to further compensate farmers who achieve a large change in output (in a given locality and in a given season) in some psychic manner by social recognition. The importance of this factor was demonstrated by the success of the model farmer program in Comilla (7, pp. 35, 47, and 51).

Figure 4. Effect of Information and Tenancy on the Diffusion Process

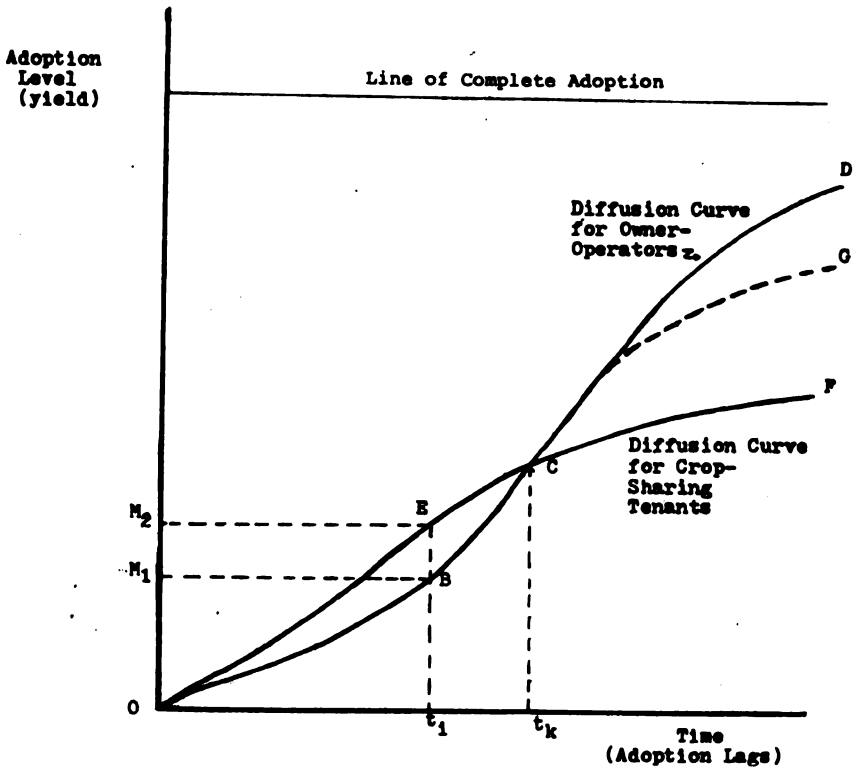
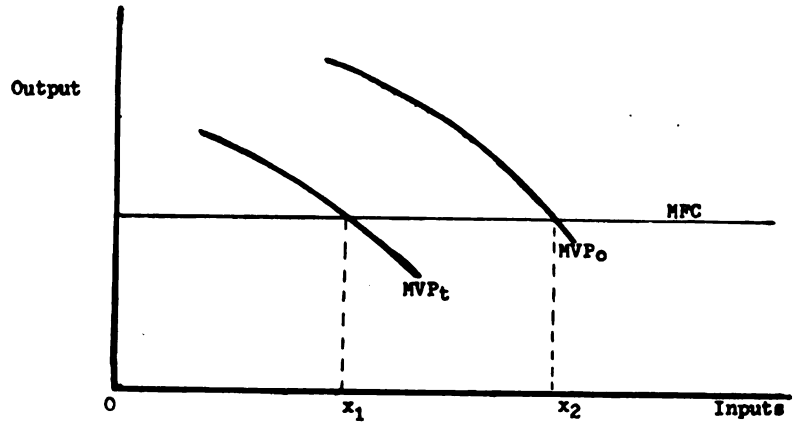


Figure 5. Effect of Crop Sharing on Input Usage (Adoption)



OBCD,[1] where the path traced out is an intersection of short-run supply and demand curves for new inputs.[2] The "S" shape results from interaction effects "which is the process through which individuals in a social system who have adopted an innovation influence over those who have not yet adopted."[3] As the "S" shape suggests, the adoption level picks up after a lag of $0t_i$ time due to interaction effects (externalities), but tends to flatten out as the optimal level is approached.

In adopting the S-F package farmers need not only the physical input but also the technical information that goes with it, indicating its improved benefits and, more importantly, describing the method of its application. The role of such information is to win farmer acceptance through risk reduction. Risk reduction is important for farmers near the margin of subsistence who place a high premium on security because of the high penalty associated with error. There are two types of

---

[1]This pattern is the same as that observed for hybrid corn in the U.S. See Zvi Griliches, "Hybrid Corn and the Economics of Innovation," Science, Vol. 132, No. 3422 (July 29, 1960), pp. 275-80.

[2]The demand curve would be the dominant variable if it is possible to assume that the supply curve is relatively more elastic, as is likely to be the case in Sri Lanka.

[3]Eugene A. Havens and Everett M. Rogers, "Adoption of Hybrid Corn: Profitability and Interaction Effect," Rural Sociology, Vol. 26, No. 4 (December, 1961), p. 411. Such a diffusion pattern was observed in the sampled areas of Hazara, Pakistan (4, p. 65).

risks in new varieties that have to be borne in addition to risks from weather that are always present. One category of risks beyond the influence of farmer information-gathering are those which stem from the proneness of new seed to disease and its increased sensitivity to weather conditions. These risks must be reduced through biological research. The second category of risks are those that cause farmers to adopt later rather than sooner. Much of this type of risk can be reduced if farmers had appropriate and adequate knowledge.

It is very important for farmers in Sri Lanka to know which of 22 different improved varieties are most suited to their particular conditions. For instance, some varieties like H4 are robust and hardy and require much less water control and ancillary inputs than the higher yielding but riskier varieties like BG 11. Farmers also need information on how to deal with pests, recognize and treat disease, effect water control, use the correct techniques like row transplanting, inter alia. Hence since new technology increases farmer options, information enables the correct (risk-reducing) choices to be made, and significantly influences farmer willingness to adopt. The foregoing would apply strictly to potential (later) adoptors: those farmers who in the absence of information cost reduction in the present will bide their time until the results of adoption by others reduce

risks sufficiently to make them willing to innovate. It does not apply to those who simply will not adopt in the foreseeable future.

Several factors seem to inhibit small farmer access to technical information, thereby in effect increasing for the farmer the (average) cost of information per unit of results (adoption).

1. Time costs needed to acquire new inputs and learn how to use them are indivisible. Regardless of whether a farm is large or small, approximately the same amount of time and effort would need to be expended in learning how to apply new inputs to the production process. A small farmer may not consider it worth his while to expend time and exert himself mentally to gain the necessary information for himself in view of the limited impact in absolute terms that increased output will have on his income. Time has an opportunity cost at least in terms of leisure foregone.

2. If extension incentives are tied to productivity of acres rather than persons, there would be extension economies in dealing with larger farmers through whom a greater number of acres could be influenced at almost the same cost (extension effort). Extension contact is one of the more important variables affecting adoption behavior, the other being contact with informal agricultural leaders, although it is not known whether

informal channels are a less preferred substitute for formal channels.[1] If extension efforts are relatively biased against small farmers, the cost of acquiring information per unit of results (adoption) will be higher for this category.

3. It is also likely that farmer receptivity to information is positively correlated with farm size, as progressivity in outlook and literacy probably depends on income levels, which in turn are a function of farm size. In the Recife area study, statistically significant positive relationships were observed between farm size, education levels, and adoption of new technology (3, p. 171). In this sense, given education levels, physical farm size is a partial proxy variable for the farmer's cost of information per unit of adoption.

Moreover, smaller farmers who tend to be more tradition bound (partly due to the positive relationship between progressivity in outlook and income) would also tend to be more influenced by the inhibiting effects of "econological" costs[2]--i.e., the economic costs associated with cultural, religious and social factors referred to in Chapter V. For instance, in the Recife area social

---

[1]This aspect was examined in some detail in the previous chapter (V).

[2]Term from Thomas R. McHale's "Ecological Analysis and Differential Economic Growth Rate," Human Organization, Vol. 21, No. 1 (Spring, 1962).

pressures were found to be statistically significant in inhibiting individual innovativeness (3, p. 302). In intuitively assessing the profitability of innovation, the fears of social, cultural, and religious sanctions may be expected to enter the calculus on the side of felt cost. These "econological" factors would make the benefits and methods of new technology seem less attractive to small farmers.[1]

4. Control over some cooperatives by large farmers in Sri Lanka (referred to in Chapter V) probably contributes to the cost of information and input acquisition for small farmers. Small farmers may be relucant to patronize cooperatives to seek information from elite (non-peer) groups to whom they have been traditionally subservient.

Indirect proof that improved channels of information have the capacity for accelerating the adoption process (and thus reducing the positive relationship between adoption and farm size) is found in the evident

---

[1]This notion finds support in Boulding's concept of an Image, in terms of which man's behavior is determined by his subjective perceptions of the world. The impact of a message on the individual's Image depends on: (a) the strength of the message, and (b) the contruence of the message with the existing Image. Kenneth E. Boulding, The Image (Ann Arbor, Michigan: Ann Arbor Paperback, 1956), pp. 1-49.

influence of (a) the perceptibility of benefits and (b) tenancy, on the adoption process.

There is evidence that when the benefits of a given technology are more easily perceived, the technology tends to be more readily accepted (provided adequate information at low enough cost is available about methods and techniques). For instance, the basic technology introduced in Comilla (tubewells and water pumps) were of such an obvious nature that even tradition-bound farmers needed to incur very low costs to gain information about its advantages.[1] The importance of low cost perceptibility of benefits for farmer receptivity to innovation is also apparent in the response of smallholders to high yielding wheat in West Pakistan (5, p. 72). It is claimed in this study that the physical differentiability between old and new varieties of wheat probably contributed to the more rapid adoption of wheat rather than maize, the new varieties of the latter not being significantly different physically from the old varieties. Rochin states as follows with regard to the perceptibility factor:

> . . . perhaps the most important characteristic (of dwarf wheats)[2] is the ability to see the difference between old and new innovations. Dwarf wheats are short-statured, with high tillering, and dark green compared to desi varieties; the physical contrasts between dwarf and desi wheats

---

[1]This is an inference from (7, pp. 12-13).

[2]The words in parentheses are the writer's.

> are very noticeable. During the second round of interviews, farmers were interviewed right next to demonstration plots with new, high-yielding varieties of maize and asked if they had ever heard of or seen any improved varieties of maize in the area. Surprisingly, many said no, even though a field of maize, which gave thirty percent more yield, was sitting in front of the respondents. What this illustrates is that new varieties need something to attract attention, whether a visible symbol or a visible characteristic such as dwarfness (5, pp. 72-73).

Second, the impact of information on adoption at a given point in time is probably evident in the productivity data of tenant farms. The effect of tenancy on adoption is examined in some detail in the following subsection. It might be mentioned here, however, that there is evidence that landlords, including those in Sri Lanka, perform an information providing extension function which causes the adoption levels of crop-sharing tenants to be higher than that of their owner-operator counterparts. at a relatively early stage of the development process. This phenomenon is also observed in the adoption levels of tenant farmers in other counties. However, it is not clear as to what degree of landlord sanction accompanies the information providing process.

(ii) Input Costs: It was stated in Chapter V that seed and fertilizer inputs were distributed through the quasi-government agency of multipurpose cooperatives with sole distribution rights, and that seed received a 10 percent subsidy while fertilizer received a 50 percent

subsidy. It was also stated that since subsidized fertilizer was only to be used for specific crops (including paddy), (a) the distributing agency was called upon to satisfy complex procedures to receive the fertilizer (thus causing timeliness problems in fertilizer supply), and (b) the agency in turn imposed similar complex procedures on farmers seeking to purchase fertilizer.

While the former defect affects all farmers served by the distribution agency (multipurpose cooperative) regardless of size, the latter affects small farmers more than large farmers, and therefore has probably contributed to the positive relationship observed between farm size and adoption. Since small farmers purchase smaller quantities than large farmers, but all farmers irrespective of size have to satisfy equally complex bureaucratic requirements, the acquisition costs per pound of fertilizer is higher for small farmers. Also, since small farmers tend to be less literate than large farmers, the filling of forms, generally knowing what procedures to satisfy and how to best satisfy them, imposes higher costs (greater difficulties) on small farmers than on large farmers.

Since average fertilizer acquisition costs are higher for small farmers than for large farmers in Sri Lanka, large farmers in effect receive a larger subsidy than small farmers per unit of fertilizer applied. This may have caused lower adoption levels, and therefore

probably contributes to the positive correlation between farm size and adoption.

Besides the acquisition costs, the subsidy itself is antagonistic to the objective of reducing income disparities. Since large farmers have higher adoption levels, the subsidy benefits large farmers more than small farmers on a per acre basis. On a total acreage basis the transfer from taxpayers to large farmers must be considerable.

There are alternative institutional modifications that could be effected that would eliminate or at least considerably reduce these differential costs. These will be examined in the following chapter.

Other Institutional and Economic Variables That Affect the Use of Both Mechanical and Biological Innovations

This subsection examines other institutional and economic variables that influence small farmer acceptance of both mechanical and biological technology. As has been observed, a positive correlation exists between the average size of farm and tractor use (.74), chemical weeding (.46), and new seed varieties (.54).

While the adoption of mechanical technology by small farmers is inhibited because of limited physical divisibility, the adoption of biological technology is inhibited in spite of physical divisibility. Nevertheless,

since both mechanical and biological technology can only influence growth and equity through their interaction with institutional variables, the institutional variables determine small farmer receptivity to both types of technology.

The relevant economic and institutional variables are to be examined from the standpoint of their applicability to small farms (i.e., their scale [size] neutrality) and, where relevant, their employment generation potential. These variables are:

1. The production credit factor
2. The tenancy factor
3. The risk factor

Credit.--This variable (X_{12}) has been described in some detail in Chapter V. As stated, the credit scheme of 1967 provided large loans for the adoption of new varieties (Rs. 370 as opposed to Rs. 262 for traditional varieties), and the amount of credit to be received by each farmer was to be worked out through the collaboration of extension workers with cooperative societies. Seventy percent of the loan (for the purchase of seed, fertilizer, and pesticides) was in kind, while 30 percent (for the hiring of labor for plowing, planting, and handweeding) was paid in cash. It was also shown that paddy productivity and credit default have moved in the same direction, despite the ineligibility of defaulters

to receive further credit. The statistical analysis also showed that the default rate in the previous year had a statistically insignificant but nevertheless appreciable positive relationship with interdistrict productivity. These factors justified a reversal of a prior belief and led to the conclusion that the ineligibility to receive credit by high default districts has not appreciably affected interdistrict paddy yields.

The concern here is to examine how the credit scheme could be made to increase the productivity of small farmers. Production credit furnishes low income farmers with the capital capacity to purchase off-farm inputs which a low savings rate and high money lending rate would otherwise preclude. The savings rate is lower for low income farmers than high income farmers, although it is possible that the savings rate may be lower than necessary among small farmers due to a lack of perceived opportunities for investment. (To the extent that this is so, it further underlines the importance of the information factor as a means of increasing levels of application of new technology.) In West Bengal and Andhra Pradesh, a statistically significant negative relationship was perceived between farm size and the use of cooperative credit (6, p. 31). The study concludes that large farmers meet a large part of their capital expenditure from their own funds.

The economic objective of increasing the productivity of low income farmers tends to be antagonistic to the financial principles of lending. Biases in credit disbursement against small farmers are partly attributable to scale economies in terms of administrative costs, the reduced risk in the granting of loans to large farmers, and to the distribution of political power. Biases in credit disbursement hence partly depend on the endogenous factor of the real administrative incentives in lending--whether the rewards are in terms of money loaned, number of loans amounts recovered or changes in productivity. Ultimately it depends on the political intent of who should gain from credit disbursement. If such biases exist in credit disbursement, the resultant increase in the cost of credit to less favored groups (small farmers) must influence the relationship between adoption and farm size, and small farmer demand for mechanical technology.

There is good reason to believe that established procedures for credit disbursement do not generally inhibit small farmer access to biological technology in Sri Lanka.[1] However, large farmer control over some cooperatives (referred to in Chapter V) makes it difficult

---

[1]S. N. Samuel, "An Analysis of Institutional Modifications for Effective Farmer Credit in Ceylon" (unpublished Master's thesis, Department of Agricultural Economics, Michigan State University, 1971).

to rule out the possibility in all cases in view of the loan disbursement procedure which requires that extension workers collaborate with cooperatives to determine loan quantums.

The credit scheme inhibits small farmer access to mechanical technology to a greater extent than it inhibits small farmer access to biological technology. As Table 5.5 indicates, the loan quantum allotted for plowing, weeding, and the use of pesticides are far less than that required for the use of mechanical technology for these purposes. For instance, the loan granted for plowing is Rs. 60 per acre (Table 5.3), although it costs Rs. 140 per acre to hire a tractor. If there are no facilities for hiring spray equipment (as is probably the case), the sum of Rs. 25 per season for weeding would not be adequate for the purchase of spray equipment and weedicide.

Although credit factors may not have influenced small farmer access to biological technology in the past, it is likely to do so in the future because of a high rate of default reported among small farmers, which renders them ineligible for further loans. The reasons for default are identified in Table 6.3. It appears that since most small farmers are also low income farmers, the small farmers are probably bigger defaulters. A negative correlation coefficient of -.55 (Table 6.2) between farm size and credit default, and the information in Table 6.4 confirm this.

TABLE 6.3.--Reasons for Credit Default.

Cause	% of Defaults
Low income	49
Weakness in lending agency	17
Borrower irresponsibility	18
Other	16

Source: Central Bank of Ceylon, Survey of Defaults in the Repayment of New Agricultural Loans (Colombo: Economic Research Department, Central Bank, 1972), pp. 28-30.

TABLE 6.4.--Amount of Loan Returned Classified by Size of Area Cultivated.

Size of Area Cultivated (Acres)	Amount Repaid (with Interest) as a Percentage of Amount Borrowed
1 - 2	39.0
Above 2 - 3	41.8
Above 3 - 4	49.4
Above 4	57.4

Source: Central Bank of Ceylon, Survey of Defaults in the Repayment of New Agricultural Loans (Colombo: Economic Research Department, Central Bank, 1972), Table A 204.

The recent Central Bank Report states that "the bulk of these defaulters are generally small farmers to whom agricultural credit is another form of static credit as it does not help them very much to raise their incomes. . . ." Moreover, the survey found that 71 percent of defaulting units received less than Rs. 250 per mensem and received 37 percent of total income.[1] Since most defaulters are identified to be the smaller farmers, this high default rate in the past can be expected to contribute to a positive coefficient between farm size and adoption in the future by disqualifying past defaulters (mainly small farmers) from further access to government credit.

A further concusion that can be drawn is that the mere disbursement of credit does not ensure greater productivity and incomes. Since 49 percent of the loans were defaulted for reasons of low income, it appears that at least half the funds disbursed have not been put to their intended purpose of increasing productivity sufficiently to enable the loan repayments with interest to be met out of the resultant change in income. The Central Bank Survey reveals that the average yield per defaulting cultivator was 35 percent less than the national averge. The average yield per defaulting cultivator was 37 bushels as against a national average of over 50 bushels. Thus credit

---

[1]Central Bank of Ceylon, Survey of Defaults, op. cit., p. 37.

disbursement in an essentially static income situation appears to have contributed substantially to the high default rate observed. It follows that the mere disbursement of credit to small farmers without regard to their ability or willingness to innovate is not likely to contribute to a reduction in the positive relationship observed between farm size and adoption. This conclusion is consistent with the findings of an earlier study.[1]

Conversely, there is evidence that special credit facilities are not a prerequisite to innovation if the technology is sufficiently profitable and fits the existing agricultural system. Farmers can find funds when significant net benefits are perceived, and income streams become identified (5). Hence the whole question of whether production credit disbursement will succeed in increasing the productivity of small farmers traces all the way back to the basic question of whether small farmers perceive enough net benefits to wish to innovate in the first place.[2]

It may generally be concluded that credit costs will contribute to a positive relationship between farm

---

[1] S. N. Samuel, "Institutional Modifications," op. cit.

[2] This conclusion is consistent with Mosher's identification of production credit as an accelerator rather than as an initiator of development. Arthur T. Mosher, Getting Agriculture Moving (New York: Fredrick A. Praeger, 1966).

size and adoption only when small farmers who are already willing to innovate are unable to do so because of the high cost of credit to them. Although a lack of credit facilities does not appear to have contributed significantly to the positive relationship that exists between farm size and adoption of biological technology in Sri Lanka, this may not continue to be the case. If due to previous default, small farmers who are desirous of innovation find themselves ineligible to receive credit, the credit factor could be expected to enter into the positive relationship between farm size and adoption in the future. With regard to mechanical technology, the position is somewhat different. The credit factor could be said to have already contributed to the positive relationship between farm size and the application of mechanical technology, because the amounts loaned in cash for the operations of plowing, weeding, and pesticide use fall far short of the actual amounts required for the hiring or purchase of mechanical equipment for the performance of these operations.

Tenancy.--As stated in Chapter V, about 40 percent of paddy holdings are rented, of which 70 percent are on a crop sharing (andé) basis. Hence about 26 percent of paddy holdings are under crop-sharing tenancy arrangements. Since these traditional arrangements are largely confined to the wet zone, it may be said to apply mainly

to small farms. A coefficient of correlation of -.66 between average farm size and land rented confirms this.[1]

Theoretical presumptions exist that tenants are less likely to adopt than their owner-operator counterparts (i.e., those in the same size group) because: (a) the lack of security reduces incentives for farm investments of a fixed nature (such as drainage and construction of bunds, fences to keep out stray animals, etc.); (b) tenants often have to bear the costs of innovation but are required to share the benefits, thus reducing the attractiveness (profitability) of innovation. As Figure 5 illustrates, the marginal value product facing a share cropper is less than that facing an owner-operator, causing maximum profitability (where MVP = MFC) to be reached at a lower level of input application (adoption).

However, the evidence from Sri Lanka and other countries shows that tenants have a higher level of productivity per acre than their owner-operator counterparts. The statistical analysis showed that the renting of land has an appreciable though not statistically significant effect on yields.[2] Since most tenancy occurs in the

---

[1] Vidé r_{78} in the correlation matrix in Appendix E.

[2] The t-value of this X_7 variable was 1.28 whereas the critical point at 10 percent was 1.36. However, the regression coefficient for the tenancy (land rented) variable X_7 was statistically significant at 10 percent in Model B. See the results in the computer printout in Appendix C.

traditional areas of the wet zone where the farms are small, tenancy could be said to have its effect on smaller farms, as suggested by a correlation coefficient of -0.66 between farm size and land rented (Table 6.2).

The experiences of other regions confirms the relationship. In West Pakistan a land owner is reported to have been instrumental in introducing high-yielding varieties to traditional farmers (5, p. 62). This study also quotes the results of a field study in the Philippines,[1] according to which the pattern of spread of high-yielding varieties in Gapan owed much to the fact that three major landowners had sufficient political or economic power to secure IR-8 seed and cause it to be planted by selected tenants. The study of the Recife area in Northeast Brazil also found that farmers who worked rented holdings were more innovative than their owner-operator counterparts (3, pp. 214-16).[2] Peacock reports:

> . . . the percentage of tenants using tractors and insecticides seems to more closely resemble his landlord rather than his owner-operator counterparts. . . . If any generalization may be made, it appears that landlords and tenants are more innovative than owner-operators.

---

[1] Rochin quotes R. E. Huke and J. Duncan, "Spatial Aspects of HYV Diffusion," Philippines, International Rice Research Institute, 1970. (Mimeographed.)

[2] In Brazil the institutional relationships between landlords and tenants may be different from those prevalent in South Asia in terms of degree of coercion, etc.

It appears, therefore, that tenancy has the effect of reducing information costs to tenant farmers through the practice of input provision by landlord. When landlords provide inputs like new seed, fertilizer, weedicides, and pesticides, they introduce tenant farmers to new technology and thereby perform an information cost-reducing extension function. This hastens the adoption process for tenant farmers, and probably accounts for the appreciable size of the regression coefficient that exists for the tenancy variable.

But the yield-increasing influence of tenancy seems to be an essentially short-run phenomenon. Although the (information) cost-reducing effect of the institution of input provision by landlords may initially result in adoption levels for tenants that are higher than for owner-operators, over the longer run the concomitant crop-sharing arrangement could be expected to cause maximum profitability to be reached at a lower level of output than for owner-operators. These relationships are illustrated in Figure 4. As indicated, the diffusion curve for owner operators is OBCD, and for tenant operators, OECF. At time Ot_i tenant farmers have a relatively higher level of adoption ($OM_2 > OM_1$), which is however overtaken at the point in time t_k due to the inherently yield-limiting effect of crop sharing. Sri Lanka has apparently yet to reach such a point in time.

Figure 5 shows why the yield-increasing effect of input provision is offset by the yield-limiting effect of crop sharing in time t_k. For the owner-operator the marginal value product curve MVP_0 makes it worthwhile to apply $0x_2$ units of input, given marginal factor costs MFC. However, the marginal value product curve MVP_t facing the crop-sharing tenant does not make it worthwhile for him to increase the number of units of inputs applied to greater than x_1.

Moreover, higher levels of adoption (and yields) by tenants do not mean that tenants are necessarily better off than their owner-operator counterparts; the landlord may not permit a sufficient proportion of the benefits of innovation to accrue to tenants.

The importance of this "tenancy" variable therefore lies not in its justification of tenancy but in its ability to reinforce the case already made in support of the crucial role that information can play in reducing adoption lags and in accelerating the adoption process.

Risk.--The statistical analysis revealed that the "risk" variable X_9 was highly significant (at the 1 percent level of confidence) in its effect on inter-district paddy yields in Sri Lanka. This variable takes the 10-year average difference between the area sown and

the area harvested. This and other aspects have already been examined in fair detail in Chapter V.

The objective here is to examine how the risk factor influences equity--the receptivity to new technology of small farmers with holdings below 4 acres in size. The risk variable is potentially if not actually congruent. It is significant for productivity, and its reduction (measured here as an increase in the area harvested as a percentage of area sown) will benefit small farmers more than large farmers (since small farmers who are nearer the margin of subsistence have to pay a higher price for error, they tend to be bigger risk averters). Also, there is evidence that in Sri Lanka crop failure (risks) affects smaller farms more than larger farms. The Central Bank reports that, "There was a steep reduction in the percentage area of crop failure to cultivated area as the size of area cultivated increased."[1]

The following analysis attempts to examine two of the components in "risk" which cause crops on small farms to be more prone to crop failure. These factors are (a) the pest control factor and (b) the water control factor.

Although on an overall basis only 10 percent of risk from crop failure can be attributed to inadequate

---

[1]Central Bank of Ceylon, Survey of Defaults, op. cit., p. 30.

pest control (Table 5.2), the data indicate that a reduction in cultivation risks through better pest control will benefit small farmers more than large farmers. As Table 5.2 evidences, crop failure attributed to pests is more than twice as high in the wet zone (18 percent) where the average size of farm is less than 1 acre, than in the dry zone (7 percent) where the average size of farm is over 2.5 acres. Information from the recent Central Bank Survey is in conformity with the view that the pest factor affects small farmers more than large Farmers. The report states:[1]

> Lower income groups are adversely affected by their inability to purchase these pest killers in adequate quantities . . . they (also) considered it less important to use such weedicides and pesticides than the large cultivators and high income earners who had better knowledge of cultivation.

Apart from a lack of cash capital resources and technical knowledge, there are other possible reasons for the inadequacy of pesticide use by small farmers. One such reason is the probable inadequacy of credit (Rs. 25) allotted for this purpose. Yet another reason can be traced to externalities associated with pest control efforts. Due to the large number of small holdings within a given area, the efforts of one farmer to control pests is likely to involve higher costs than if all farmers made concurrent efforts. Conversely, a farmer using

---

[1] Ibid., p. 32. The word in parentheses is the author's.

pesticide on his farm may confer uncompensated (external) benefits on contiguous farms. In either case, the externalities factor causing a divergence between private and "social" benefits/costs must, on the assumption of economic rationality, result in an under-application of pesticides. In short, it appears that pest control has considerable "public good" characteristics, and should therefore be treated as such. This matter will be dealt with when policy alternatives are proposed for improving the productivity of small farms in the following chapter.

Floods and drought account for as much as 70 percent of crop failure (Table 5.2). Also, since they influence both zones equally, and there are twice as many farmers in a given area in the wet zone, more small farmers than large farmers are affected. Although weather is an exogenous factor, improvements in infrastructure could minimize its adverse effects. For instance, water conservation in tanks (an ancient means of ensuring an even supply of water over the spectrum of one year), irrigation, and improved drainage can reduce the crop failure resulting from floods and drought. A positive correlation coefficient of .39 (Table 6.2) between farm size and irrigated acreage suggests that large farmers have some advantage in access to irrigation water.

In the wet zone, where smaller farmers predominate, "unsuitability of land for paddy cultivation (arises) from excessive water logging and drainage facilities."[1] This points to a need for the emphasis on minor irrigation works in traditional areas rather than the major works in new areas. The latter have tended to be favored in the past. As the ILO Report points out,[2] a long series of reports has questioned the economic viability of major colonization. Minor works in traditional areas are congruent in that besides favorably influencing productivity and cropping intensity, such works would also benefit more households for a given acreage, and tend to be more employment generating. Moreover, the money costs of minor works are considerably lower than for major works. The ILO[3] estimates that 1 acre of land is brought under irrigation under minor works at Rs. 300 per acre, whereas major works (including colonization) cost about ten times as much; namely, Rs. 3,000 per acre.

The Significance of Techniques

At the beginning of this subsection it was proposed that two conditions need to be fulfilled if the

---

[1]Central Bank of Ceylon, Survey on Default, op. cit. The word in parentheses is the writer's.

[2]ILO, Report, op. cit., p. 90.

[3]International Labor Organization, "Matching Employment Opportunities and Expectations," Technical Papers (Geneva: ILO, 1971), pp. 109-110.

biological input package is to be regarded as being optimally applied: (1) The seed, fertilizers, pesticides, water, and other components of the input package should be applied in prescribed dosage, and (2) the appropriate techniques corresponding to the technological package should be fully applied. For instance, seed should be planted in a manner (in rows) that will permit maximum fertilization and weed control. If not, a sub-optimal condition may be said to exist.

Congruence in techniques.--The evidence indicates that techniques important for optimality are highly congruent. The statistical analysis indicated that row planting was a technique that was statistically significant (at the 10 percent level of confidence) in explaining interdistrict paddy yields. It was also previously stated that the variable for row transplanting (X_4) represented the concomitant techniques of hand weeding and rotary weeding.[1]

Not only is row planting (and hand weeding) significant for yields, it (they) is (are) also more suited to small farms, and is (are) highly labor intensive. The existence of "divisibility" in row planting is suggested by the negative coefficient -.14 (Table 6.2) for the linear

[1]To have included additional variables for hand weeding and rotary weeding in the econometric model would have resulted in less reliable coefficients due to multicollinearity.

relationship between farm size and area row planted. This is in conformity with a prior belief that row transplanting and hand weeding are operations that are more suited to small farms.[1]

Besides being "divisible," row planting and hand weeding are also highly employment generating. This employment potential exists in the performance of the operations described below.

(a) To replace broadcasting of seed with row transplanting increases the demand of labor for the planting operation itself. For instance in Minipé (Sri Lanka), the extra man-days required for transplanting the IR-8 rice variety is 17 to 25 days if complementary practices are adopted, and an extra 15 to 18 man-days otherwise.[2]

(b) Row (trans)planting facilitates access to weeds with a minimum of soil and plant disturbance, and hence enables hand weeding to take place. The average increase in the demand for labor for hand weeding is reported to be as high as 20 man-days per acre for all varieties together.[3]

(c) To the extent that row transplanting increases yields (it has been found to be statistically significant

---

[1] The ILO Technical Papers make a cursory reference to this. ILO, Technical Papers, op. cit., p. 101.

[2] Ibid., p. 202.

[3] Ibid.

in this connection), it also increases the man-days needed for harvesting and post-harvest operations. Transplanting reportedly increases yields from 15 to 20 percent, and this increase requires an extra 20 to 25 man-days per acre for harvesting.[1] This information is supported by the Central Bank's findings in 1969,[2] according to which the average yield for transplanting was 65 percent higher than for broadcasting. The national average man-days required for transplanting was 79.6 per acre, but only 34.4 for broadcasting.[3]

It may be concluded generally that a considerable employment potential exists in this area. The dimensions of this potential can be gauged from the fact that only about 20 percent of paddy land in Sri Lanka is hand weeded, while only 55 percent of all paddy land is subject to any sort of weeding.[4]

The employment benefits from row (trans)planting can be partially negated, however, if the rotary weeder is used. The use of this machine reduces the employment

---

[1] Ibid.

[2] Central Bank of Ceylon, Cost of Production of Paddy, op. cit., pp. 21-27.

[3] It needs to be emphasized, however, that each of these operations will be adopted only if the added perceived returns justify the added felt costs. No information is available with regard to this crucial aspect.

[4] Ministry of Agriculture and Lands, Implementation Programme, loc. cit.

created from hand weeding by almost 5 man-days per acre and even more (25 man-days) if a rotary weeder is used in conjunction with a seeding machine.

Farmer receptivity to techniques.--It seems important to distinguish between technology and technique because farmer response differs between the two; farmers tend to be relatively more receptive to technology than to techniques. In Sri Lanka only 3.5 percent of paddy acreage is subject to row transplanting despite its statistical significance for yields, while only 20 percent of the acreage is subject to hand weeding. On the other hand, the S-F package has been applied to 75 percent of paddy lands[1] though not necessarily in optimal dosages. The ILO Report states: "For a country with severe unemployment it is surprising to what extent tried and tested labor-intensive techniques in agriculture are . . . ignored."[2]

Evidence of increased farmer resistance to techniques is also observed in the experiences of other areas researched. For instance, evidence from Western Uttar Pradesh in North India indicates that farmers growing wheat were more prepared to change the physical input than the methods that were associated with them (9, pp. 51-52).

---

[1] Ibid.

[2] ILO, Report, op. cit., p. 91.

There were very few changes in regular crop operation in the survey farms, and even the basic irrigation technique was unchanged in spite of the use of purchased water.

Given the definition of optimum adoption made earlier in the subsection, the effect of farmer resistance to techniques on the diffusion process is illustrated in Figure 4. Such resistance has the effect of flattening the diffusion curve, so that it moves downward from OBCD to OBCG.

Do row transplanting and hand weeding generate significantly greater returns through increased yields than chemical weeding? If so, are these benefits recognized by farmers? What factors on the cost side of farmer calculus offset the benefits in returns from row planting (hand weeding) and thereby cause such techniques to be rejected in favor of chemical spraying? This would appear to be an important area for research and possible extension emphasis.

The information already available suggests that although the private (and social) returns from row planting and hand weeding may be higher than from chemical weeding, cost factors tend to offset these benefits. The "row transplanted" variable (which represented unincluded variables for rotary weeding and hand weeding) was found to be statistically significant at a 10 percent level of probability, while the "chemical weeded" was not. While the

coefficient β_3 for chemical weeding was .12, the coefficient β_4 for row transplanting was .60. The cost factors that probably operate to render chemical weeding preferable to row planting are as follows.

(a) The tax allowances specified for spray equipment such as the 80 percent development rebates, together with low interest rates and over-valued foreign exchange rates, must influence the cost of random planting and chemical weeding relative to that of row planting and hand weeding.

(b) Changes involving organization and routine must have high felt costs, especially for small farmers who are more tradition bound. For instance, in Sri Lanka it is a strong tradition that consanguineous farmers work each others' fields. Hence labor application may be limited by the size of the extended family. As the West Pakistan study indicates, so long as new technology fits into the existing cultural routine and agricultural calendar, they will be more readily accepted (5, p. 72).

(c) The farmer appears to have to incur high search and organization costs in labor utilization. The ILO Report[1] recognizes a need to "improve the accessibility

---

[1] ILO, Report, op. cit., p. 21.

of information concerning seasonal and casual employment." The Report states: "The dry zone is still short of labor at certain seasons when workers have nothing to do in other parts of the country."[1]

(d) The credit scheme fails to distinguish between traditional and new varieties in its allocation of cash for row planting and hand weeding. The sum allocated is only Rs. 50 (Table 5.5) whereas about 40 extra man-days are required for these operations, according to the ILO.[2]

(e) Techniques make demands on the entrepreneurial (organizational) abilities of farmers, which abilities may be latent or inadequate.

(f) There may be extension biases in favor of the (statistically) more visible changes in output than in the (statistically) less visible changes in employment.

Summary

The chapter sought to assess the variables from the standpoint of equity. Two criteria were suggested for making this assessment: (a) scale neutrality, and (b) employment generation. In evaluating scale neutrality, the correlation coefficient between farm size and each of the other independent

---

[1] Ibid., p. 127.

[2] ILO, Technical Papers, op. cit., p. 202.

variables was regarded as a weak but nevertheless useful indicator. It was used to either confirm or raise questions regarding the prior information available with regard to the degree of scale neutrality in a variable. Major sources of this prior information were the regional and Sri Lanka primary-data-based micro studies listed in Appendix A. If variables that were employment generating and/or divisible were found to be significant from the standpoint of paddy productivity, the variable was then said to possess the desirable quality of congruence between equity and output.

The variables that were important from the standpoint of paddy revenue in Sri Lanka were yields and cropping intensity. It appeared prima facie that there was a contradiction between the prior knowledge of a negative relationship between yields and farm size and the posterior knowledge of a statistically significant positive relationship between them. It was shown, however, that this conflict may be more apparent than real, because mixing adoptors and non-adoptors at an aggregated national level, particularly in a situation where early innovators are large farmers, makes it possible to observe a significant positive relationship between yields and farm size, without refuting the prior belief held. The results with regard to the relationship between cropping intensity and farm size indicated that there may be more income-increasing

potential on small farms from increasing cropping intensity than is generally presumed to be the case.

It appears there is a considerable degree of consistency and congruence between output and equity variables. It transpired that tractorization, which was antagonistic to equity because of its employment-limiting or labor-displacing effects, was also unimportant from the standpoint of both yields and cropping intensity, although the latter may not continue to be the case. The practice of chemical weeding through the use of spray equipment, which was not statistically significant for yields (although there was evidence that it did have some appreciable positive effect), was also found to be unimportant for employment. In fact, chemical weeding was found to be associated with techniques that were comparatively weak with respect to both output and equity. On the other hand, row planting, which was statistically significant for yields, also has considerable employment generation potential.

The general conclusion that emerged from the analysis of agricultural mechanization was that although application of mechanical technology resulted in a clear discrepancy between private and social benefits, no general verdict on agricultural mechanization was possible. The variables determining the desirability of specific machines in specific situations are so numerous that

policy measures taken at a macro level need to leave room for technical flexibility.

Notwithstanding the scale neutrality in the physical seed-fertilizer package, its applicability to small farms was found to be limited. The positive relationship between farm size and adoption was partly attributed to small farmer lags. Small farmers were found to be later adoptors, and the only discernible reason why small farmers adopted later rather than sooner (ceteris paribus) was due to the reduced risk from later adoption. The reduced risk in turn stems mainly from improved information that reaches small farmers from the demonstration effects of early adoptors, the development of informal local channels, and formal extension contact. Since technical information flowed unevenly through the farm size structure, time (adoption lags) is a proxy variable for information costs to the farmer.

Informal local channels may be a substitute for deficient extension. Early adoptors seem to confer an external benefit on laggards which tends to make the diffusion process inherently sub-optimal.

Possible factors inhibiting small farmer access to technical information (thus in effect increasing the average cost of adoption for small farmers) were indivisibility in the time needed to learn how to use new inputs, extension biases against small farmers, the lower

receptivity to new information on the part of small farmers, and control over some multipurpose cooperatives by non-peer groups.

Indirect proof that improved channels of information have the capacity for accelerating the adoption process was found in the influence of the perceptibility of benefits and tenancy on adoption and productivity.

Acquisition costs of inputs were also found to be higher for small farmers.

Production credit was discounted as a factor entering into the perceived positive relationship between farm size and adoption of biological technology. This conclusion did not, however, extend to the effect of credit on the positive relationship between farm size and mechanical technology. It is conceivable that unless the credit disbursement rules are changed, small farmers who were bigger defaulters in the past may be prevented from adopting despite a desire to do so in the future.

Contrary to theoretical presumptions, tenants seemed to have a higher level of adoption than their owner-operator counterparts. But this factor justified extension rather than tenancy because it served to underline the importance of the information factor, and reveal limited productivity potentials in concomitant crop-sharing arrangements.

The risk factor was found to be statistically significant for interdistrict paddy yields, and there was

evidence that small farmers were affected more by crop failure than large farmers. Crop failure due to pests and plant disease affected small farmers more than large farmers due to the limited sum allotted for pesticide use under the credit scheme, the lack of savings and technical knowledge, and possible externalities in pesticide use.

There is no evidence that small farmers are particularly disadvantaged in their access to irrigated water. However, minor irrigation works seem to be more congruent than the major works that tend to be presently emphasized.

There is considerable congruency in the techniques of row transplanting and hand weeding, but their relatively greater revenue benefits vis-a-vis chemical weeding seem to be offset by probable higher relative costs. This was identified as an important area for research and extension emphasis.

CHAPTER VII

ALTERNATIVE POLICY SUGGESTIONS FOR SRI LANKA

Introduction

Policy options cannot be separated from policy goals. The broad goals of growth and equity were condensed to the more specific objective of increasing the productivity of paddy farmers with holdings below 4 acres in size in a manner that will adequately increase employment for surplus agricultural labor. This objective was narrowed still further to focus on specific variables that were seen to be important for increasing paddy productivity on small farms and increasing employment opportunities.

The analysis indicated that the use of tractors, and perhaps the use of spray equipment for weeding, should be de-emphasized (although there is a clear need for technical flexibility), and that less reliance should be placed on the disbursement of credit as a major means of increasing small farmer productivity. At the same time it is necessary that factors that encourage a more optimal and widespread application of the seed-fertilizer package and congruent techniques (chiefly row transplanting/

hand weeding) be emphasized. The constricting institutional variables here were the high cost of information to small farmers (mainly due to evident extension weaknesses), the high real cost of acquiring fertilizers and other inputs, and the technical risks in production from lack of pest control and water control.

The objective of this chapter is to suggest policy options that will cause those variables that are unfavorable to growth and equity to be de-emphasized, and those variables that are congruent or potentially congruent to be emphasized.

It needs to be expressly stated, however, that actual acceptance of the biological package and associated techniques depends not on the characteristic of congruency, but on profitability--whether the added perceived benefits to the farmer are worth the added felt costs. Therefore no specific extent of adoption of congruent techniques or technologies can be determined in the absence of information with regard to relative prices and costs at the community and farm level. Hence no blueprint for action will be suggested.

Nevertheless, a number of alternative suggestions for economic, institutional, and organizational modifications came into view as the analysis proceeded. Since these suggestions are tentative in nature, they need to be examined and defined more specifically within relevant

agencies. They should be implemented so as to reduce certain existing limitations to production expansion and income improvements on small farms and to create programs and emphases which stimulate expansion in production and employment on small farms, and thereby improve income distribution. Such changes would be consistent with the economic movement and performances desired in the Five Year Plan.

Policy Alternatives

Fiscal Changes

Fiscal changes have the ability to change relative prices so as to bring social and private benefits/costs into closer alignment. Appropriate changes in relative prices can discourage the use of those technologies and techniques considered less desirable for the productivity of small farmers and employment generation (income disparities), vis-a-vis those considered more desirable for these purposes.

The quantitative effect theoretically depends on relative prices and cross elasticity of demand factors. The strategy proposed will in effect rearrange the manner in which the chips fall so that the resultant performance contributes more to the growth and equity objectives of the Five Year Plan.

It may be advisable to apply the higher of the two exchange rates to imports of tractors and (power)

spraying machines, so that the c.i.f. value of imports will reflect the prevalent acute foreign exchange scarcity. Consideration may be given to reducing or abolishing some or all of the capital allowances (tax concessions) with regard to these types of agricultural machinery. This recommendation would specifically apply to the lump sum depreciation of 80 percent of the cost on "short-lived" equipment and 66 2/3 percent on "normal" machinery, the exemption from business turnover tax given agricultural machinery, and the development rebates of 40 percent of the cost of the assets that are allowed in addition to lump sum depreciation allowances. In the interests of improving the income distribution, it may also be advisable to eliminate the tax holidays to large farmers who engage in food production on jungle land.

Consideration may be given to increasing the commercial borrowing and lending interest rates to reflect both the scarcity of capital and the rate of inflation, and to replace the tax concessions for machinery with tax concessions for labor costs (or change in labor costs) incurred in agricultural production.

These changes will increase the price of agricultural machinery to reflect their social valuation and require that the present value of added future output from

the use of machines exceed the discounted cost of investment valued shadow input prices, before their use is considered worthwhile. As the foregoing implies, these changes permit the chips to fall where they may with regard to mechanical technology thus facilitating technical flexibility (although not ensuring it--see below).

Elimination of Market Controls on Machinery Supply

Concurrently with fiscal changes, steps may be taken to make machinery and spare parts freely available at the new (higher) price in order to ensure maximum technical flexibility in their use. This involves abolishing or reducing or changing physical import and exchange controls on machinery and spare parts imports, which presently operate in a cumbersome manner due to inevitable bureaucratic rigidities. There is evidence that over half the tractors in Sri Lanka are not used at any one time due to the nonavailability of spare parts,[1] thus keeping farmers from attaining the very flexibility that is the most desirable attribute of tractors.

The ready availability of mechanical equipment and spare parts is also likely to eliminate wastes in the use of energy by reducing the uncertainties associated with tractor use. Since many farmers retain traditional sources of power (draught animals) in reserve for

---

[1] ILO, Report, op. cit., p. 15.

use in case of mechanical failure, the free availability of spare parts would reduce duplication and wastes, besides making available to society the social benefits from the release of fodder land.

The existing marketing structure can be retained. The private sector has well developed distribution channels that may be used. In addition, quasi public channels which have been recently established in the Tractor Corporation could be expanded to deal with all types of agricultural machinery importation and distribution in competition with private sector channels. The payment of commissions on sales to quasi public employees, and the use of public pricing policies to ensure reasonable private pricing, are expected to contribute to efficiency in the marketing of machinery and spare parts.

Production Credit

Production credit, it was shown, plays a largely facilitative role. There was also evidence that small farmers were bigger defaulters and that the availability of credit to them *per se* has not induced them to innovate to the same extent as large farmers.

Provision may be made to reactiviate the credit scheme without writing off loans outstanding (and thereby encouraging even greater default in the future). The recovery of outstanding loans to date may be spread over five to six seasons, or even ten, in order to make past

defaulters re-eligible to receive credit. Recovery should be a less important problem now that the government-owned Paddy Marketing Board is the sole legal outlet for paddy. However the repayment rate would cease to be an index of productivity increases.

Loans may be confined to small farmers with holdings below 4 acres in size. If subsidized inputs are also confined to these target groups then the credit may take the form of physical input provision. When cash payments are called for, they could be made in the form of vouchers which would be encashable only by the recipient at a local bank or coop. For instance, if labor is paid in the form of vouchers, encashment at the local cooperative or bank may be confined to the person who offered his services. This procedure may reduce the possibility that credit would be put to nonproductive uses, although not ensuring it. This suggestion could, however, lead to results that are counterproductive. It is possible that labor will tend to show a preference for the more affluent who pay in cash and this could result in higher wages (either in terms of the money wage rate or only being able to attract less efficient workers) for the smaller farmers who pay in the form of vouchers.

It seems necessary to considerably increase the credit allotment for row planting and hand weeding (and perhaps pesticide use).

It may be advisable to tie the production credit scheme to a supplementary scheme providing credit for the settlement of accumulated past loans owing to private money lenders. These accumulated debts may be settled by the state, and amortized by farmers in small installments from the sale of proceeds of future paddy output. Specific loans for ceremonial needs would need to be provided to prevent future indebtedness to private money lenders.

Improved extension discussed below should help considerably in increasing the efficacy of the credit scheme by increasing the farmer's ability to repay.

Extension

The wider application of the congruent variables of the S-F package, row transplanting, hand weeding, water control (through minor irrigation works and improved drainage), and pest control can contribute much to the specified goals, given the planning horizon of five years. To do so two broad institutional-organizational variables need to be made operationally more effective. Input supply channels need to ensure timely and adequate supplies, and the extension service should be able to provide the conconitant technical information that will reduce information costs sufficiently to accelerate the adoption process. The expanded use of the techniques of row transplanting, hand weeding, minor irrigation, and

dranage also require an intensive extension effort, besides the other measures recommended.

The information with regard to the extension service in Chapter V indicated that the service was deficient, while Chapter VI drew attention to its crucial role for the adoption of new technology by small farmers who tend to be laggards.

Steps are already underway to use more streamlined methods of extension program planning and evaluation.[1] This is to be accomplished through the provision of a cadre of "Extension Specialists" (who will act as liaison between research agencies and extension staff), in-service training in extension work for university graduates, and an increase in the number of demonstration plots and the use of the radio medium.

Other measures need to be considered for speedily increasing the presently deficient extension ratio. One means for doing this may be by a large-scale recruitment of unemployed or underemployed science graduates with farm backgrounds and providing them with a crash course in extension and subsequent employment in the service. Another alternative that may be explored is to concentrate a majority of the present extension cadre in each of the administrative divisions for a period of one (or two) years, so as to improve the extension ratio in the

---

[1]Director of Agriculture, op. cit., pp. 191-95.

short run. Particular attention may be paid to the target groups.

The success of this strategy to intensify extension depends greatly on the enthusiasm and efficacy of the extension personnel. The successful mobilization of extension workers appears to be a prerequisite to the mobilization of farmers. Extension workers may need to be adequately compensated for the inconvenience costs of temporary relocation. This compensation may be composed of a fixed component and a variable component, the latter being tied to output increases in a given area. Output information would be readily available at the local offices of the Paddy Marketing Board, which is the sole legal outlet for paddy.

An alternative strategy that is more experimental and flexible may be adopted. Within one division it may be possible to intensify extension contact to a ratio of perhaps 1:250; in another, the existing structure and ratios may be retained, but have extension personnel concentrate on small farmers with holdings less than 4 acres; in a third division, it may be possible to increase the number of personnel through additional recruitment, and confine the efforts of the new staff to target group farmers. This strategy would be less disruptive to individuals in their living conditions, and thereby be conducive to stimulating innovative extension projects.

Studies would be needed to determine the best extension strategy. For instance, reluctant farmers may be mobilized by putting a small fraction of their land under new varieties, and assuring them of at least the income foregone from traditional varieties. Those who have already adopted may be shown how to move toward optimum adoption. Risk reductions may be possible through a diversification of (new) varieties applied, so as to balance at the margin the utility of added returns against the disutility of added uncertainty.[1]

---

[1]Such diversification is very similar to the portfolio strategy that investors in developed countries adopt with regard to their investments. The concept of a "portfolio" is taken from liquidity preference theory in macroeconomics and qualifies for transfer to a traditional context because traditional farmers are risk averters, and there is similarity in the direction of the relationship between uncertainty and prospective yields. The various types of new seed varieties in a traditional economy have the identical attribute of an inverse relationship between yield and uncertainty as do securities in a developed money economy. Thus a new improved variety (NIV) like BG11 may have high expected return but a relatively low probability that this return will be realized; an old improved variety (OIV) like H4 or IR-8 may have a comparatively lower yield potential than the NIVs, but because they are more robust have less yield variability; the expected return from traditional varieties (TV) may be even lower, but there is greater certainty about its realizability. Hence it would be possible to arrange the "portfolios" of traditional farmers in such a way as to balance at the margin the utility of additional return against the disutility of additional uncertainty. This concept can be traced to J. Tobin's "Liquidity Preference as Behaviour Towards Risk," Review of Economic Studies, 25(2):65-86, 1958.

Input (Acquisition) Costs

It is necessary to reduce input acquisition costs which are higher for small farmers. As was indicated in Chapter V, the input supply problem has two dimensions to it: the lack of timeliness in supplies affects all farmers in a given location while the supply procedures impose greater burdens on small farmers. In either case, the costs of acquisition must be higher than otherwise would be the case and must consequently have an effect on productivity and incomes.

As argued in Chapter V, input subsidies are more likely to encourage innovations than price supports, and they tie government expenditures to the degree of innovation, unlike price supports. As was stated in Chapter VI, input subsidies constitute a large regressive transfer from taxpayers to large farmers because large farmers use more subsidized inputs than small farmers. Hence measures are needed to ensure that input subsidies continue to have their expected favorable effect on innovation, without being regressive and thus inimical to the distribution of income.

An alternative to be considered is to make unsubsidized fertilizer and other inputs easily available through private outlets, while confining subsidized seed and fertilizer to farmers with holdings below 4 acres, irrespective of crop. Such an innovation in fertilizer

marketing is expected to yield three major benefits. It would firstly reduce the regressive element in the present scheme; secondly, reduce the acquisition costs for small farmers; and thirdly, contribute substantially to input marketing efficiency.

If the subsidized fertilizer is made available purely on the basis of farm size regardless of the type of crop, it would remove much of the time-consuming procedures presently in operation to ensure that fertilizer utilization is crop-specific. These reforms do not, however, safeguard against the resale of subsidized fertilizer by eligible farmers. This danger may be reduced by limiting a small farmer's eligibility to receive subsidized fertilizer to a specified number of seasons (two or perhaps four). Such limitation would have the further benefit of compensating early adoptors for the greater risks of early adoption.

Another alternative would be to provide subsidized fertilizer to all innovators irrespective of size for a specified number of years.

Yet another alternative is to reduce the subsidy considerably (e.g., from 50 percent to 10 or 20 percent) but make fertilizer easily available through both private and public sources.

As a supplementary measure, cooperative employees may be paid a commission on subsidized or unsubsidized input sales.

The upshot of these measures would be to increase the efficiency and efficacy of input market channels. The development of private channels would introduce a competitive element into input supply channels that would operate to the advantage of farmers by increasing their bargaining power vis-a-vis input suppliers. It would also strengthen the local market system in terms of timeliness and adequacy of supplies, and hence be conducive to optimum levels of adoption (where the MVP of an input equals its price).

The financial savings from confining the fertilizer subsidy to small farmers (amounting to about Rs. 18 million) could be diverted to agricultural research, minor irrigation works, and improving extension. An idea of the potential in this area can be gauged from the fact that if only half the present fertilizer subsidy savings (Rs. 9 million) is applied to minor irrigation works, 25,000 additional acres can be brought under improved irrigation and drainage per annum.[1]

Labor Utilization Costs

There is a need to reduce search costs of labor not so much to reduce costs of labor hiring for the large farmers, but rather to facilitate an expansion in their

[1]The cost of minor irrigation averages Rs. 300 per acre, while annual maintenance costs average around Rs. 60 per acre, according to the ILO, Technical Papers, op. cit., p. 110.

use of hired labor, thus stimulating employment. The present local-level network of multipurpose cooperatives may establish an employment exchange division, supplemented by a notice board, to bring together the suppliers and demanders of labor.

An alternative proposal suggested by the ILO Report[1] is to create a network of labor cooperatives at the district level rather than at the local level that could match up the job seekers and jobs, and also pass on requests which could not be met to neighboring (district) cooperatives.

No matter which alternative is finally adopted, it would be necessary to provide incentives to officials who perform these functions that will cause them to operate in the general social interest. It may be necessary to make the head of the employment division an elected official so as to ensure his responsiveness to the needs of (local) job seekers and employers.

Pest and Disease Control

It was seen earlier that crop failure attributable to plant disease and pests accounted for between 12 to 15 percent of "risk" and that this factor affected small farmers more than large farmers.

---

[1] ILO, Report, op. cit.

A solution may be to increase the credit allotted for pesticide use. However, this does not solve the problem of externalities associated with pesticide application.

Since pesticide use has public goods characteristics, it may be advisable to leave pest and disease control under extension aegis where the costs would be socialized. But the success of program implementation measured in terms of adequacy and timeliness in pesticide application will depend on the extent to which extension interests coincide with farmer interests. If extension incentives are tied to changes in output (as suggested earlier) success is more likely to be achieved than otherwise.

If the pest and disease control program is effectively administered, the credit allotment for pesticide use may be withdrawn. But it is suggested that the credit allotment be maintained for use by farmers in the event of extension deficiencies in program implementation.

The alternative of leaving pest and disease control to cooperatives may be examined, although the existing cooperative structure would need to be reformed before success can be expected.

Research Needs

There is an important and pervasive need for continuous, relevant and adaptive research.

In the area of mechanical technology there is a clear need for task specific machines and a need to develop simple water control system in the wet zone. The lack of task-specificity in machines causes fixed costs to be higher than otherwise, and this in turn results in more labor being displaced than otherwise would be the case. In Sri Lanka tractors make possible the plowing of hard dry soil in the dry zone for which draught animals would lack the power intensity. But the purchase of tractors needed for the specific task of breaking up hard soil introduced into the production function a fixed cost that necessitates the use of tractors for other tasks like puddling, threshing, hauling, etc., for which the use of tractor power would otherwise not be warranted.

Alternatives to tractor use for plowing may also be explored. Instead of using tractors for this purpose, it may be worthwhile for instance to simply divert for a few days the power from the engines of ordinary diesel trucks used for transport to the task of plowing, by developing appropriate attachments such as pulleys and cables that permit the power source itself (truck) to be positioned outside the field.[1] Water also is a substitute for tractor power in the sense that it may be possible to use water from the existing network of tanks

[1]That this may be technically feasible was communicated by an agricultural engineer who further said that similar devices had been used in the U.S. at one time.

to soften the ground sufficiently to permit plowing by draught animals. The benefit-cost ratio of using tubewells for this purpose might also be explored.

With regard to biological technology, it is necessary to know which of the 22 varieties are suited to which ecological locality, how pests and diseases could be better controlled, and how weed control by water can be replaced by weed control by correct methods of planting and mechanical and hand weeding.

This study has also delineated the major areas for economic research. More information is required on the relative costs and elasticity of substitution between the more labor-intensive and capital-intensive technologies and techniques, particularly in planting and weeding, and on the benefit-cost ratio of simple water control systems utilizing pumps, lift irrigation, and tubewells as against the capital-intensive large-scale irrigation projects that are now emphasized.

In order that these and other alternatives may be researched, adequate funding and appropriate directives need to be given to research agencies. The funds may be raised from foreign aid, and expansion of the regional research agency in Central India may be considered due to the considerable economies of scale and externalities involved. This admittedly is a long-range solution.

CHAPTER VIII

SUMMARY

This study sought to identify policies that would contribute to increasing paddy output in a manner contributory to the growth and equity objectives of Sri Lanka's Five Year Plan. This required the identification and assessment of technological and institutional variables, and an investigation of how they could be made to interact to increase paddy productivity among small farmers and significantly generate employment opportunities in the rural sector.

Technology constituted a link between growth and income distribution. The primary source of growth is not through the reallocation of traditional factors or greater application of such factors; rather, it is through the application of new off-farm purchased inputs embodying modern scientific knowledge. But the actual nature of the impact of technological change on income distribution is determined by the socio-political milieu in which it occurs. Technology is not neutral with respect to its effect on personal and functional income distribution; it implicitly influences both.

Since technology has an inevitable impact on income distribution, policies designed to achieve equity should be explicitly incorporated into policies designed to increase productivity. If the redistributive impact of technology can be harnessed and directed toward desired equity goals, it reduces the reliance that needs to be placed on fiscal and welfare policies for income redistribution.

Redistributing income sources rather than income streams has several advantages over conventional methods. First, it minimizes the effect of a probable trade-off between growth and equity ensuing from the transfer of (potential) savings for consumption. It involves instead a substitution of investment by low income groups for investment or consumption by high income groups. Since the transfer is of investment goods, it also contributes toward a socially desirable pattern of production. Second, it reduces the possible adverse effect that the transfer of income flows may have on incentives of potential investors, since it provides capital to persons who presumably have a greater marginal utility for the incremental income subsequently generated. Third, since a redistribution of income sources changes the pre-tax distribution, it preempts possible obstacles to subsequent redistribution by fiscal means that may arise from the existence of fixed assets and the resistance of their

political manifestation (vested interests). Fourth, the transfer of income sources (new agricultural technology) increases the supply of goods (food) for which income elasticity of demand is high, and at the same time arranges for its sale at fairly stable prices by increasing rural incomes and actuating an outward shift in the demand curve. Fifth, since in a traditional economy significant output increases must occur along a new (higher) production function, the activation of a consumption multiplier through a redistribution of income streams rather than income sources (by the transfer of income from persons with a relatively high marginal propensity to save to those with a relatively low marginal propensity to save) is likely, due to supply inelasticity, to stimulate inflation rather than generate output and employment.

The conceptual framework developed demonstrated that the interaction of the primary variables of technology and institutions determined output and the manner in which the resultant income was distributed. Resource endowments influence the interaction of technology with institutions but only to the extent that the political process chooses to discover shadow price signals and, once discovered, chooses to be guided by them. The distribution of political power ultimately determines who should gain or lose by the interaction of the primary variables.

Program (policy) benefits (direction) in Sri Lanka cannot be determined without reference to the social welfare function as embodied in the Objectives of Sri Lanka's Five Year Plan. Moreover, only when these program benefits (outputs) are determined can the variables (inputs) needed to achieve them be identified. An inference was drawn that the Five Year Plan sought to reduce disparities but not to the point that they disappear altogether. Such an inference made the concentration area of the Lorenz curve relevant because it deprived the line of equal distribution of normative significance, and made the Lorenz curve a normative outer bound. The concept of the poverty rate, in conjunction with the notion of the economic size of farm, was used to identify target groups (those with holdings below 4 acres in size) which were to be the focus of programs. Those farm households with incomes above the poverty line were to be outside the general scope of agricultural development programs providing access to subsidized income sources (like fertilizer and seed), although they were to have access to the benefits of specific projects or schemes to which market alternatives were not available (like the guaranteed price scheme).

With the focus established, it becomes possible to determine program objectives, and therefore to identify the variables relevant for achieving them. These objectives

called for the identification and assessment of variables from the standpoint of both growth and equity. Accordingly, variables that were significant for paddy productivity and the cropping index in Sri Lanka were identified, and thereafter their applicability to small farms and their employment generation potential were evaluated.

A regression of five technical and five institutional variables on interdistrict paddy yields revealed that for policy purposes, the seed-fertilizer package was (as expected) highly significant for yields. Other variables that were significant were row transplanting, rotary weeding and hand weeding, the risk factor in production, and farm size. It was concluded that chemical weeding and the renting of holdings (the tenancy factor) had a positive and important, though statistically insignificant, effect on yields. For tractor use and production credit, the statistical analysis indicated that they were not important for interdistrict differences in paddy productivity. An $\bar{R}^2$ of .76 indicated that 24 percent of paddy yield was not explained by the included variables (and the excluded variables for which they were proxy). Since most of the variables relating to technology (and techniques) were included in the regression analysis (either expressly or by proxy), much of the unexplained variation was attributed to omitted institutional, infrastructural, and resource endowment factors.

The major excluded objective institutions were identified as technical information (mainly extension) and input supply differences between districts. The subjective institutions were religious, cultural, and social factors.

The relation between farm size and output indicated more scope for yield increases and double cropping among small farmers than is generally supposed. Tractorization, which was found to be not significant for yields, was also found to be antagonistic to equity. Despite the general conclusion that emerged that the application of mechanical technology resulted in a clear discrepancy between private and social benefits in Sri Lanka, no blanket condemnation of tractorization and the use of power spray equipment was possible because of a need to ensure technical flexibility with regard to the use of such equipment.

Notwithstanding the scale neutrality in the physical seed-fertilizer package, its applicability to smal farms was found to be limited. The positive relationship between farm size and adoption was partly attributed to small farmer lags--small farmers were later adoptors. The only discernible reason why small farmers adopted later rather than sooner (ceteris paribus) was the reduced risk from later adoption. Since technical information flowed unevenly through the farm size structure, small farmers postpone innovation until perceived risks are

reduced through adequate information from the demonstration effects of early adoptors, the development of informal local channels, and formal extension contact. Hence time (adoption lags) is a proxy variable for information costs to the farmer.

Possible factors inhibiting small farmer access to technical information (thus in effect increasing the average cost of adoption for small farmers) were indivisibility in the time to learn how to use new inputs, extension biases against small farmers, the lower receptivity to new information on the part of small farmers, and control over some multipurpose cooperatives by non-peer groups.

Indirect proof that improved channels of information have the capacity for accelerating the adoption process was found in the influence of the perceptibility of benefits of technological change and tenancy on adoption and productivity.

Perceived input costs were found to be higher for small farmers due to high fixed costs in input acquisition.

Production credit was discounted as a factor entering into the perceived positive relationship between farm size and adoption of biological technology. The existence of this positive relationship despite the availability of credit for small farmers indicated that less reliance should be placed on credit as a means of inducing technological change in agriculture. It is likely,

however, that the credit factor did enter into the positive relationship between farm size and mechanical technology due to inadequacy of loan allotments for the utilization of mechanical equipment. Conceivably, unless credit disbursement rules are changed, small farmers who are ineligible to receive further credit because they were bigger defaulters in the past, may be prevented from adopting despite a desire to do so in the future.

Contrary to theoretical presumptions, tenants seemed to have a higher level of adoption than their owner-operator counterparts. But this factor justified extension rather than tenancy because it served to underline the importance of the information factor, and revealed limited productivity potential in concomitant crop-sharing arrangements.

The risk factor was found to be statistically significant for interdistrict paddy yields, and there was evidence that small farmers were affected more by crop failure than large farmers for several possible reasons: the limited sum allotted for pesticide use for those participating in the credit scheme, the inadequate amount of operating capital, the limited technical knowledge, and externalities in pesticide use.

There is no evidence that small farmers are particularly disadvantaged in their access to irrigated water.

However, minor irrigation works seem to be more congruent than the major works that tend to be presently emphasized.

There is considerable congruency in the techniques of row transplanting and hand weeding, but their relatively greater revenue benefits vis-a-vis chemical weeding seem to be offset by probable higher relative costs. This was identified as an important area for research and extension emphasis.

The policy suggestions made sought to de-emphasize variables that were antagonistic to the objectives of the Five Year Plan with regard to paddy, and to emphasize those that were contributory to those objectives. The limitations of the study were expressly recognized. The recommendations were tentative in nature; they sought in the main to indicate general directions, and suggest alternatives for further exploration and empirical study --not a blueprint for action. No specific extent of adoption of congruent techniques or technologies can be determined in the absence of information with regard to relative prices and costs at the community and farm level.

Fiscal changes were proposed that would change relative prices in a manner that will bring social and private benefits/costs into closer alignment. It was suggested that foreign exchange and interest rates applicable to agricultural machinery imports and purchases have market prices that reflect their true cost to the

economy. Tax concessions applicable to machinery should be reduced or abolished, and replaced with tax concessions for (changes in) labor utilization. Concurrently, physical market controls over machinery and spare parts utilization may be eliminated so as to ensure maximum technical flexibility in their use. The use of both public and private channels for machinery distribution is likely to contribute to marketing efficiency.

Provision may be made to reactivate the production credit scheme by staggering recovery of outstanding loans, confining loans to small farmers, increasing the credit allotment for row planting, hand weeding (and perhaps pesticide use), amortizing past loans to private lenders, and providing loans for specific ceremonial needs (to safeguard against future indebtedness to private sources).

The analysis revealed that extension is a key variable that needs to receive greater emphasis. It may need to be applied regionally (intensively) in order that the externalities and economies in the adoption process may be captured, and the time span needed for a given level of adoption may be telescoped. Such levels of intensity may be achieved over a longer period by recruitment of trained extension personnel into the service. Reforms are needed that will tie extension incentives to desired performance.

It is imperative that the high (fixed) costs of input acquisition be reduced for small farmers by confining subsidized inputs to small farmers, perhaps for a specified number of seasons (while making unsubsidized fertilizer freely available through private channels), and eliminating the crop-specific character of the fertilizer subsidy that presently necessitates intricate bureaucratic checks. Another possible alternative is to provide inputs at reduced levels of input subsidy to all farmers, through both public and private channels. These measures would reduce input acquisition costs for small farmers, reduce the regressive element in the input subsidy, and contribute to marketing efficiency by increasing outlet options for farmers.

Search and organization costs of labor utilization may be reduced by setting up employment exchanges at the local or district level. Costs of pest and disease control need to be socialized due to externalities in pesticide application. But success in such a program (measured in terms of timeliness and adequacy of pesticide application) can be expected only if incentive mechanisms are devised that tie the motivations of program administrators to desired performance.

An important and pervasive need exists for continuous, relevant and adoptive research, particularly for

developing simple water control systems in the wet zone, task-specific machines, and examining the relative costs of labor-intensive as against capital-intensive techniques.

APPENDICES

APPENDIX A

SOURCES OF PRIOR BELIEF FOR THE EVALUATION OF STATISTICAL RESULTS

APPENDIX A

SOURCES OF PRIOR BELIEF FOR THE EVALUATION OF STATISTICAL RESULTS

Regional Studies

1. Ahmad, Bashir. "Farm Mechanization and Agricultural Development: A Case Study of the Pakistan Punjab." Ph.D. dissertation, Michigan State University, 1970.

2. Naseem, M. "Small Farms and Agricultural Transformation in Pakistan Punjab." Ph.D. dissertation, University of California, 1972.

3. Peacock, D. L. "The Adoption of New Agricultural Practices in Northeast Brazil: An Examination of Farmer Decision-Making." Ph.D. dissertation, Michigan State University, 1972.

4. Rebello, N. S. "Agricultural Program Planning to Reflect Potentials of Small Farms, with Application to Mysore State, India." Ph.D. dissertation, University of Tennessee, 1972.

5. Rochin, R. I. "Microeconomic Analysis of Smallholder Response to High-Yielding Varieties of Wheat in West Pakistan." Ph.D. dissertation, Michigan State University, 1972.

6. Schluter, M., and Mellor, John W. "New Seed Varieties and the Small Farm," Cornell International Agricultural Development Reprint 52. Department of Agricultural Economics, Cornell University, Ithaca, New York, June, 1972.

7. Singh, R., and Leagans, J. P. Communication and Socio-Economic Variables Related to Fertilizer Use by Indian Farmers. Department of Education, New York State College of Agriculture, Cornell, 1972.

8. Stevens, Robert D. "Rural Development Programs for Adaption from Comilla, Bangladesh, Agricultural Economics Report No. 215. Michigan State University, June, 1972.

9. Willis, I. R. "The Implications of the Green Revolution for Future Production Income and Employment in Agriculture in W. Uttar Pradesh, India." Ph.D. dissertation, University of Illinois, 1970.

Sri Lanka Studies

10. Bartsch, William H. Employment Effects of Alternative Technologies and Techniques in Agriculture. Unpublished draft copy, 1972. (Mimeographed.)

11. Central Bank of Ceylon, Survey on the Cost of Production of Paddy. Department of Economic Research, Colombo, 1969.

12. Central Bank of Ceylon. Survey on Defaults in the Repayment of New Agricultural Loans. Department of Economic Research, Colombo, 1962.

13. Department of Census and Statistics. Census of Agriculture. Colombo, 1962.

14. International Labor Organization. "Matching Employment Opportunities and Expectations," Report. Geneva, 1971.

15. International Labor Organization. "Matching Employment Opportunities and Expectations," Technical Papers. Geneva, 1971.

16. Ministry of Agriculture and Lands, Implementation Programme 1973. Colombo, 1972.

17. Moomaw, J. C., and Curfs, H. P. Some General and Special Aspects of Rice Soil Tillage. AGS:MRP/71/11-1, FAO, Netherlands, July, 1971.

18. Raj, K. N. "Mechanization of Agriculture in India and Sri Lanka." International Labor Review, Vol. 106, No. 4 (Oct. 12), pp. 315-34.

19. Samuel S. N. "An Analysis of Institutional Modifications for Effective Farmer Credit in Ceylon." Unpublished M.S. thesis, Department of Agricultural Economics, Michigan State University, 1971.

APPENDIX B

RESULTS OF REGRESSION REGARDING INTER-DISTRICT PADDY YIELDS--MODEL A

```
LS
1=P(2...7,9,10,12,13) RES

   SAMUEL-- REGRESSION ANALYSIS.
DOUBLE PREC MATRIX FOR     22 CASES AND  13 VARS. CREATED ON 012/H06/73
```

DEPENDENT VARIABLE--X(1) YIELD

ANOV FOR OVERALL REGRESSION

	SUM OF SQUARES	DEG OF FREEDOM	MEAN SQUARE	F	SIG
REGRESSION (ADJUST MEAN)	3141.12899633	10	314.11289963	7.7016	.001
ERROR	446.63691276	11	40.78517389		
TOTAL (ADJUST MEAN)	3583.76590909	21			

CASES	MULTIPLE CORR COEFS R2	R	R BAR 2	R BAR	S STANDARD ERROR OF ESTIMATE
22	.8750	.9354	.7614	.8726	6.38632710

	VAR	REGRESSION COEFFICIENTS	STD. ERRORS OF COEFFICIENTS	BETA WEIGHTS	STD. ERRS OF BETAS	TB	FB	SIG	PARTIAL CORR COEFS	R2 DELETES
CONSTANT	0	-127.55392362								
TRACTOR	2	.02111151	.10033568	.05745	.27318	.2103	.0442	.837	.05328	.87452
WEEDED	3	.11443718	.13.33446	.16362	.18721	.8740	.7638	.401	.25462	.85554
TRANSPLD	4	.09953869	.31314027	.29362	.13560	1.8734	3.4984	.088	.48122	.83523
SEED	5	.30112971	.09479175	.48750	.15341	3.1777	10.0979	.009	.69182	.78663
IRRIGATD	6	-.02463470	.08933454	-.05511	.19722	-.2794	.0781	.785	-.08395	.87414
RENTED	7	.17002295	.13.70570	.24908	.19441	1.2812	1.6415	.226	.36035	.85637
RISK	9	1.73754344	.56412549	.43619	.14513	3.0356	9.0335	.012	.67151	.77233
DUMMY	10	-.07126527	8.89194365	-.02627	.34305	-.0755	.0057	.941	-.02270	.87495
SIZE	12	-.27672134	.11747404	-.37257	.15816	-2.3556	5.5488	.033	-.57935	.81193
DEFAULT	13	.05753567	.06514139	.11586	.13118	.8832	.7801	.396	.29734	.86016

APPENDIX C

RESULTS OF REGRESSION REGARDING INTER-DISTRICT PADDY YIELDS--MODEL B

SAMUEL-- REGRESSION ANALYSIS.

APPENDIX C

TIME 13.23.34 PAGE 5
ELAPSED 2.440 05/15/73

```
LS
1=P(2...10)     PES
```

SAMUEL-- REGRESSION ANALYSIS.
DOUBLE PREC MATRIX FOR 22 CASES AND 10 VARS. CREATED ON D15/M05/73

DEPENDENT VARIABLE--X(1) YIELD

ANOV FOR OVERALL REGRESSION

	SUM OF SQUARES	DEG OF FREEDOM	MEAN SQUARE	F	SIG
REGRESSION (ABOUT MEAN)	2906.36448145	9	322.92939683	5.6734	.003
ERROR	683.40142764	12	56.95011897		
TOTAL (ABOUT MEAN)	3589.76590909	21			

CASES	MULTIPLE CORR COEFS R2	R	R BAR 2	R BAR	S STANDARD ERROR OF ESTIMATE
22	.8096	.8998	.6668	.8166	7.54553026

	VAR	REGRESSION COEFFICIENTS	STD. ERRORS OF COEFFICIENTS	BETA WEIGHTS	STD. ERRS OF BETAS	TB	FB	SIG	PARTIAL CORR COEFS	R2 DELETES
CONSTANT	0	-125.71642445								
TRACTOR	2	-.04206525	.11686732	-.11430	.31800	-.3594	.1292	.726	-.10320	.80758
WEEDED	3	.14078673	.14151604	.21306	.20224	1.0535	1.1093	.313	.29096	.79202
TRANSPLD	4	.57677670	.37438351	.24583	.15357	1.5406	2.3734	.149	.40635	.77197
SEED	5	.23219664	.12194777	.47305	.13726	2.3390	5.7306	.034	.56318	.71833
IRRIGATD	6	.06339943	.10023226	.14149	.22198	.6374	.4063	.536	.18096	.80318
RENTED	7	.17037218	.14815163	.24916	.21411	1.1537	1.3541	.267	.31344	.78814
SIZE	8	.59427512	2.26494734	.09765	.23739	.2403	.0579	.814	.06921	.80871
RISK	9	1.54723382	.67834979	.39524	.17329	2.2939	5.2324	.042	.54393	.72709
DUMMY	10	-4.22976375	10.19336344	-.16556	.39839	-.4150	.1722	.685	-.11894	.80689

APPENDIX D

RESULTS OF REGRESSION REGARDING CROPPING INDEX--MODEL C

SAMUEL-- REGRESSION ANALYSIS.

11=P(2,6,7,9,10,12) RES

APPENDIX D

TIME 18.08.02 PAGE 8
ELAPSED 3.557 06/11/73

SAMUEL-- REGRESSION ANALYSIS.
DOUBLE PREC MATRIX FOR 22 CASES AND 13 VARS. CREATED ON 011/M06/73

DEPENDENT VARIABLE--X(11) CROPINOX

AOV FOR OVERALL REGRESSION

	SUM OF SQUARES	DEG OF FREEDOM	MEAN SQUARE	F	SIG
REGRESSION (ABOUT MEAN)	10450.43931607	6	1741.73988601	5.7848	.003
ERROR	4516.33341120	15	301.08889408		
TOTAL (ABOUT MEAN)	14966.77272727	21			

CASES	MULTIPLE CORR COEFS R2	R	R BAR 2	R BAR	S STANDARD ERROR OF ESTIMATE
22	.6982	.8356	.5775	.7600	17.35191327

	VAR	REGRESSION COEFFICIENTS	STD. ERRORS OF COEFFICIENTS	BETA WEIGHTS	STD. ERRS OF BETAS	TB	FB	SIG	PARTIAL CORR COEFS	R2 DELETES
CONSTANT	0	92.64994667								
TRACTOR	2	-.22679965	.23080763	-.30222	.30758	-.9826	.9655	.341	-.24591	.67882
IRRIGATD	6	-.55245209	.19632437	-.59919	.21293	-2.8140	7.9185	.013	-.58780	.53499
RENTED	7	.76275463	.30160808	.54728	.21640	2.5291	6.3961	.023	.54675	.56957
RISK	9	1.27353254	1.37953065	.15932	.17259	.9232	.8522	.371	.23186	.68110
DUMMY	10	-13.41811156	18.33220399	-.25722	.35142	-.7319	.5357	.475	-.18570	.68747
SIZE	12	-.46989430	.30411449	-.30984	.20053	-1.5451	2.3874	.143	-.37055	.65021

APPENDIX E

CORRELATION MATRIX

SAMUEL-- REGRESSION ANALYSIS. TIME 16.34.55 PAGE 3

ICMATRIX,SSCP ELAPSED 1.623 06/12/73

APPENDIX E

SAMUEL-- REGRESSION ANALYSIS.
SINGLE PRECISION FILE OF 22 CASES AND 13 VARS. CREATED ON 012/M06/73

1ST CASE RETAINED

YIELD 1	TRACTOR 2	WEEDED 3	TRANSPLD 4	SEED 5	IRRIGATD 6	RENTED 7	SIZE 8	RISK 9
50.000000	23.100000	25.600000	.600000	68.000000	15.300000	37.700000	.600000	97.700000

DUMMY 10	CROPINDX 11	SIZE 12	DEFAULT 13
1.000000	164.050000	76.000000	53.000000

NUMBER OF CASES READ 22 DROPPED 0 AND RETAINED 22

TABLE A -- STATISTICS ON TRANSFORMED VARIABLES

VARIABLE LABEL	NO.	MINIMUM VALUE	MAXIMUM VALUE	MEAN	STANDARD DEVIATION	SUM	SUM OF SQUARES	SUM, SQUARED DEVIATIONS FROM MEAN
YIELD	1	34.00000	83.40000	54.78636	13.07445	1205.30000	69623.77000	3589.76591
TRACTOR	2	0.00000	97.10000	45.82727	35.57620	1008.20000	72782.04000	26578.98364
WEEDED	3	.70000	62.00000	30.91818	18.65502	680.20000	28362.28000	7331.73273
TRANSPLD	4	0.00000	23.40000	3.48182	5.57252	76.60000	918.82000	652.11273
SEED	5	24.40000	99.10000	75.37727	21.16675	1658.30000	134406.79000	9408.95864
IRRIGATD	6	10.50000	97.80000	65.04545	28.95454	1453.00000	113570.08000	17606.03455
RENTED	7	0.00000	57.30000	25.52273	19.15409	561.50000	22035.47000	7704.45864
SIZE	8	.50000	5.20000	1.59091	1.37040	35.00000	95.12000	39.43818
RISK	9	89.50000	98.70000	94.66818	3.33986	2082.70000	197399.67000	234.24773
DUMMY	10	0.00000	1.00000	.50000	.51177	11.00000	11.00000	5.50000
CROPINDX	11	113.00000	133.00000	155.68182	26.69651	3425.00000	548177.00000	14966.77273
SIZE	12	13.00000	77.00000	49.81818	17.60313	1096.00000	61108.00000	6507.27273
DEFAULT	13	0.00000	86.00000	49.31818	26.32831	1085.00000	68067.00000	14556.77273

SIMPLE CORRELATIONS

VAR	NO.	1 YIELD	2 TRACTOR	3 WEEDED	4 TRANSPLD	5 SEED	6 IRRIGATD	7 RENTED	8 SIZE	9 RISK	10 DUMMY	11 CROPINDX
YIELD	1	1.00000										
TRACTOR	2	[illegible]	1.00000									
WEEDED	3	.14157	.54593	1.00000								
TRANSPLD	4	[illegible]	-.25938	[illegible]	1.00000							
SEED	5	[illegible]	.44593	[illegible]	.26130	1.00000						
IRRIGATD	6	[illegible]	.45224	[illegible]	.28336	.55163	1.00000					
RENTED	7	[illegible]	-.66344	-.25373	.12337	-.24211	-.39258	1.00000				
SIZE	8	[illegible]	.74719	.45972	-.14425	.54295	.39076	-.65542	1.00000			
RISK	9	[illegible]	-.43039	[illegible]	.37779	.14134	.06495	.03322	-.30062	1.00000		
DUMMY	10	[illegible]	-.34323	[illegible]	.14851	-.41523	-.64271	.73415	-.73330	.23263	1.00000	
CROPINDX	11	[illegible]	-.65061	-.15935	.03521	-.36521	-.57799	.67533	[illegible]	.18152	.51518	1.00000
SIZE	12	[illegible]	[illegible]	[illegible]	-.37025	[illegible]	-.65019	.42536	[illegible]	.05489	.61316	.24335
DEFAULT	13	[illegible]	-.32227	-.27352	[illegible]	-.15263	[illegible]	.42405	-.55173	.03996	.24916	.20272

APPENDIX F

TABULATED DATA

Tabulated Data APPENDIX F

	X_1 YIELD	X_2 TRACTOR	X_3 WEEDED	X_4 TRANSPD	X_5 SEED	X_6 IRRIGATED 1/	X_7 RENTED 2/	X_8 ASSIZE 3/	X_9 RISK	X_{10}	X_{11} CROPIND	X_{12} FARMSIZE 3/	X_{13} DEFAULT 4/	
1	50.0	29.1	25.6	10.6	68.0	15.3	37.7	0.6	97.7	1	164	76	53	Colombo
2	35.5	4.7	15.4	10.1	24.4	12.4	31.2	0.7	94.2	1	193	66	53	Kalutara
3	34.0	8.6	33.8	10.3	36.2	10.5	36.3	0.7	94.1	1	192	67	29	Galle
4	45.0	29.7	55.0	0.9	72.5	37.3	49.7	0.6	95.5	1	190	57	60	Matara
5	40.0	66.7	26.4	0.2	69.2	92.7	29.0	4.0	89.5	0	125	55	70	Hattalna
6	44.7	50.8	4.0	4.1	65.6	57.5	31.4	0.6	91.2	1	154	43	65	Kurunegala
7	60.4	3.9	10.4	5.9	89.7	23.4	38.4	0.5	98.2	1	181	61	64	Kegalle
8	42.1	6.5	18.0	11.0	43.6	68.2	46.4	1.0	97.3	1	187	53	33	Ratnapura
9	69.8	0.10	32.6	3.5	90.4	59.5	51.7	0.5	98.7	1	173	68	69	Kandy
10	57.9	33.3	6.9	0.5	66.7	65.2	89.3	0.5	96.2	1	158	50	73	Matale
11	60.9	0.2	0.7	6.9	84.7	97.8	26.6	0.5	98.7	1	156	58	61	Nuwara Eliya
12	64.3	14.9	6.4	23.4	87.2	85.4	35.1	0.5	97.9	1	136	63	53	Badulla
13	54.5	53.8	58.5	6.5	57.7	85.1	0.0	1.0	95.0	0	126	28	36	Moneragala
14	37.2	92.7	27.0	0.1	62.5	66.6	11.1	1.4	92.2	0	120	77	86	Jaffana
15	46.1	97.1	44.8	0.1	95.5	82.5	2.5	3.1	91.1	0	113	25	0	Vavuniya
16	66.2	92.3	45.4	0.2	98.1	91.2	0.0	2.9	95.3	0	114	38	0	Mannar
17	60.6	30.5	46.6	1.1	73.2	97.4	20.4	1.3	94.3	0	141	21	79	Anuradhapura
18	83.4	48.7	27.4	12.8	91.2	94.3	9.2	3.6	97.5	0	177	19	34	Polonnaruwa
19	62.4	84.1	46.1	0.0	98.9	80.9	16.3	3.5	95.8	0	153	32	86	Trincomalee
20	49.5	92.8	36.8	0.0	99.1	64.5	0.0	5.2	93.1	0	128	58	0	Batticaloa
21	62.0	88.3	50.4	1.5	84.4	81.8	0.0	3.3	96.3	0	167	40	28	Amparai
22	73.8	79.5	62.0	6.9	94.5	89.5	57.3	2.0	92.6	0	172	41	53	Hambantota

Sources: All the data is from the Implementation Programme, 1973 (Ministry of Agriculture and Lands) unless otherwise indiacted

1/ Statistical Abstract of Ceylon, 1969, Department of Cencus and Statistics 1970

2/ Survey on Cost of Production of Paddy, Central Bank of Ceylon, 1969.

3/ Census of Agriculture, 1962

4/ Central Bank Annual Reports 1969-71.

BIBLIOGRAPHY

BIBLIOGRAPHY

Adelman, I., and Taft, M. Society, Politics and Economic Development. Baltimore, Md.: 1967.

Adelman, I., and Morris, I. "An Anatomy of Income Distribution Patterns." Development Digest, Vol. IX (October, 1971).

Ahmed, Bashir. "Farm Mechanization and Agricultural Development: A Case Study of the Pakistan Punjab." Ph.D. dissertation, Michigan State University, 1970.

Barber, W. J. "A Critique of Aggregate Accounting Concepts in Underdeveloped Areas." Bulletin of the Oxford University Institute of Economics and Statistics (November, 1963).

Bartsch, William H. Employment Effects of Alternative Technologies and Techniques in Agriculture. Unpublished draft copy, 1972. (Mimeographed.)

Bator, F. The Question of Government Spending. Collier, 1960.

Becker, Gary S. Human Capital. New York: Columbia University Press, 1964.

Becker, Gary S., and Chiswick, Barry R. "Education and the Distribution of Earnings." American Economic Review (May, 1960).

Boulding, Kenneth. The Image. Ann Arbor, Mich.: Ann Arbor Paperback, 1956.

Boulding, Kenneth, and Singh, Pritam. "The Role of the Prize Structure in Economic Development." Ameri- Economic Review (May, 1962).

Bowley, A. L. "The National Income in the U.K." Economica, 1933.

Brown, Lester. The Social Impact of the Green Revolution. International Conciliation, 1971.

Byerlee, D., and Eicher, Carl K. Rural Employment, Migration, and Economic Development: Theoretical Issues and Empirical Evidence from Africa. East Lansing: Department of Agricultural Economics, Michigan State University, 1972.

Cannon, E. "Division of Income." Quarterly Journal of Economics (1905).

Castle, Emery, and Youmans, Russel. "Economics in Regional Water Research and Policy. American Journal of Agricultural Economics, Vol. 50 (December, 1968).

Central Bank of Ceylon. Annual Reports. Colombo: Central Bank.

_____. Bulletins. Colombo: Central Bank.

_____. Survey on Cost of Production of Paddy. Colombo: Economic Research Department, Central Bank, 1969.

_____. Survey of Defaults in the Repayment of New Agricultural Loans. Colombo: Department of Economic Research, Central Bank, 1972.

Clower, R. W., et. al. Growth Without Development. Evanston, Ill.: 1966.

Coward, Walter E., and Schutjer, Wayne. "The Green Revolution: Initiating and Sustaining Change." Civilizations, Vol. 20, No. 4 (1970).

Department of Census and Statistics. Socio-Economic Survey, 1969-70, First Round. Colombo: 1971.

_____. Socio-Economic Survey. Colombo: 1972.

_____. Census of Agriculture. Colombo: 1962.

_____. Statistical Abstract of Ceylon, 1969. Colombo: 1970.

_____. Statistical Pocketbook of Ceylon. Colombo: 1971.

Department of Inland Revenue. Tax Concessions for Agriculture. Colombo: 1966.

Director of Agriculture. Administration Report 1967-8. Colombo: Department of Agriculture, 1970.

Dorner, Peter. "Discussions on Equity and Productivity." American Journal of Agricultural Economics (December, 1970).

Duesenberry, J. S. Income, Savings and the Theory of Consumer Behavior. Cambridge, Mass.: Harvard University Press, 1949.

Eicher, Carl K., et. al. Employment Generation in African Agriculture. East Lansing: Institute of International Agriculture, Research Report No. 9, Department of Agricultural Economics, Michigan State University, 1970.

Falcon, Walter. "The Green Revolution: Generations of Problems." American Journal of Agricultural Economics (December, 1970).

Fisher, Irvin. Elementary Principles of Economics. New York: Macmillan, 1912.

Food and Agriculture Organization. Production Yearbook 1971. Rome: FAO.

_____. The State of Food and Agriculture. Rome: FAO, 1970.

_____. "Tea Trends and Prospects." Commodity Bulletin Series. Rome: FAO, 1960.

Friedman, Milton. A Theory of the Consumption Function. New York: National Bureau of Economic Research, Inc., 1955.

_____. "Choice, Chance and Personal Distribution of Income." Journal of Political Economy (August, 1953).

Galbraith, John K. The New Industrial State. Boston: Houghton Mifflin, 1967.

Gotsch, D. H. "Technical Change and the Distribution of Income in Rural Areas." Economic Development Report, No. 205. Cambridge, Mass.: Centre for International Affairs, Harvard University, 1971.

Griliches, Zvi. "Hybrid Corn and the Economics of Innovation." Science, Vol. 132, No. 3422 (July 29, 1960).

Haq, M. "Employment in the 1970's: A New Perspective." International Development Review. Ottawa: Society for International Development, December, 1971.

Havens, Eugene A., and Rogers, Everett M. "Adoption of Hybrid Corn: Profitability and Interaction Effect." Rural Sociology, Vol. 26, No. 4 (December, 1961).

Hayami, Yujiro, and Ruttan, Vernon W. "Sources of Agricultural Productivity Differences Among Countries." Agricultural Development: An International Perspective. Baltimore: John Hopkins Press, 1971.

Heady, E. O. Economics of Agricultural Production and Resource Use. New York: Prentice Hall, Inc., 1952.

_____. "Changes in Income Distribution in Agriculture with Special Reference to Technological Change." Journal of Farm Economics, XXVI (3).

Hicks, J. R. "Distribution and Economic Progress: A Revised Version." The Review of Economic Studies, Vol. IV (1).

Hill, E. F., and Mosher, A. T. Organizing for Agricultural Development. New York: Agricultural Development Council, 1963. (Mimeographed.)

International Labor Organization. "Matching Employment Opportunities and Expectations." Report. Geneva: ILO, 1971.

_____. "Matching Employment Opportunities and Expectations." Technical Papers. Geneva: ILO, 1971.

_____. Towards Full Employment: A Programme for Columbia. Geneva: ILO, 1970.

Jogaratnam, T., and Schickele, Rainer. Practical Guidelines to Agricultural Development Policies in Ceylon. Peradeniya: Agricultural Economics Research Unit (AERU), University of Sri Lanka, 1970.

Johnston, B. F., and Mellor, J. W. "The Role of Agriculture in Economic Development." American Economic Review, Vol. 51, No. 4 (September, 1961).

Krishna, Raj. "Agricultural Price Policy and Economic Development." Agricultural Development and Economic Growth. Edited by Herman M. Southworth and Bruce F. Johnston. Ithaca, N.Y.: Cornell University Press, 1967.

Kuznets, Simon. Modern Economic Growth. New Haven, Conn.: Yale University Press, 1966.

_____. Six Lectures on Economic Growth. New York: The Free Press, 1959.

Kwok, Min-hsioh. "Farmer's Associations and Their Contributions toward Agricultural and Rural Development in Taiwan." Bangkok: FAO, ECAFE, 1966.

Leff, N. H. "Marginal Savings Rates in the Development Process: The Brazilian Experience." Economic Journal (September, 1968).

Lewis, W. A. "Is Economic Growth Desirable?" Theory of Economic Growth. Homewood, Ill.: Richard D. Irwin, Inc.

MacNamara, Robert S. "The Environmental Dilemma." War on Hunger. Washington, D.C.: U.S. Department of State, December, 1971.

Marchal, J., and Ducros, eds. The Distribution of National Income. New York: Macmillan, 1968.

Marshall, Alfred, Principles of Economics. 8th ed. New York: Macmillan, 1961.

McHale, Thomas R. "Ecological Analysis and Differential Economic Growth Rate." Human Organization, Vol. 21, No. 1 (Spring, 1962).

McKean, R. N. Public Spending. New York: McGraw Hill, 1968.

Mellor, John. The Economics of Agricultural Development. Ithaca, N.Y.: Cornell University Press, 1970.

_____. "The Functions of Agricultural Prices in Economic Development." Indian Journal of Agricultural Economics, Vol. XXIII, No. 1 (Jan.-Mar., 1968).

Ministry of Agriculture and Lands. Implementation Programme 1973. Colombo: The Ministry, 1972.

Ministry of Planning and Employment. The Five Year Plan. Colombo: The Ministry, 1971.

Moomaw, J. C., and Curfs, H. P. Some General and Special Aspects of Rice Soil Tillage. (AGS/71/11-1). Netherlands: FAO, July, 1971.

Mosher, Arthur T. Getting Agriculture Moving. New York: Fredrick A. Praeger, 1966.

_____. Creating a Progressive Rural Structure. New York: Agricultural Development Council, 1969.

Myrdal, G. Asian Drama. New York: 1968.

_____. "The Inequality Issue." The Challenge of World Poverty. New York: 1970.

Nair, Kusum. The Lonely Furrow. Ann Arbor: University of Michigan Press, 1969.

Naseem, M. "Small Farms and Agricultural Transformation in Pakistan Punjab." Ph.D. dissertation, University of California, 1972.

National Planning Council. The Ten Year Plan. Colombo: Planning Secretariat, 1959.

Niehoff, Arthur H. A Casebook of Social Change. Chicago: Aldine Publishing Co., 1966.

Nulty, Leslie. The Green Revolution in West Pakistan: Implications of Technological Change. New York: Fredrick A. Praeger, 1972.

Oshima, Harry T. "The International Comparison of Size Distribution of Family Incomes with Special Reference to Asia." Review of Economics and Statistics (November, 1962).

Owen, Wyn F. "The Double Development Squeeze on Agriculture." American Economic Review, Vol. LVI, No. 1 (March, 1966).

Pathirana, W. Administration Report of the Cooperative Movement in Ceylon, 1968-69. Colombo: Ceylon Government Press, 1970.

Peacock, D. L. "The Adoption of New Agricultural Practices in Northeast Brazil: An Examination of Farmer Decision-Making." Ph.D. dissertation, Michigan State University, 1972.

Pen, Jan. Income Distribution. London: Allen Lane Penguin Press, 1971.

Perkins, M., and Witt, Lawrence. "Capital Formation: Past and Present." Journal of Farm Economics, Vol. 43, No. 2 (May, 1961).

Raj, K. N. "Some Questions Concerning Growth, Transformation and Planning of Agriculture in Developing Countries." Journal of Development Planning, No. 1 (1969).

_____. "Mechanization of Agriculture in India and Sri Lanka. International Labor Review, Vol. 106, No. 6 (October 12).

Rao, V. K. R. V. "Redistribution of Income and Economic Growth in Underdeveloped Countries." Income and Wealth, Series X (1964).

Rebello, N. S. "Agricultural Program Planning to Reflect Potentials of Small Farms, with Application to Mysore State, India." Ph.D. dissertation, University of Tennessee, 1972.

Robbins, Lionel. An Essay on the Nature and Significance of Economic Science. 2nd ed. (1952). London: Macmillan, 1935.

Rochin, R. I. "Microeconomic Analysis of Smallholder Response to High-Yielding Varieties of Wheat in West Pakistan." Ph.D. dissertation, Michigan State University, 1972.

Rogers, Carl. "Client-Centered Therapy." Theories of Personality. Edited by H. S. Hall and G. Lindzey. New York: John Wiley and Sons, 1970.

Samuel, S. N. "An Analysis of Institutional Modifications for Effective Farmer Credit in Ceylon." Unpublished M.S. thesis, Department of Agricultural Economics, Michigan State University, 1971.

Samuels, Warren. Welfare Economics, Power and Property. East Lansing: Department of Economics, Michigan State University. (Mimeographed.)

Schickele, Rainer. "Improving Income Distribution as a Development Goal." Staff Paper P72-17. Department of Agricultural Economics, University of Minnesota, 1972.

Schickele, Rainer. Ceylon Papers 1967-70. New York: A/D/C, 1972.

_____. Agrarian Revolution and Economic Progress. New York: Fredrick A. Praeger, 1968.

Schluter, M., and Mellor, John W. New Seed Varieties and the Small Farm, Cornell International Agricultural Development Reprint 52. Ithaca, N.Y.: Department of Agricultural Economics, Cornell University, June, 1972.

Schmid, A. Allan. "Economic Analysis of Water Resource Problems." American Economic Review (May, 1967).

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

Schultze, Charles L. The Politics and Economics of Public Spending. Washington, D.C.: The Brookings Institution, 1968.

Scitovsky, Tibor. "The State of Welfare Economics." American Economic Review, No. 41.

Seers, Dudley. "The Meaning of Development." Communications Series, Br. 44. Sussex: Institute of Development, 1970.

_____. "Income Distribution and Employment: Some Issues Raised by the Columbia Report." Bulletin of the Institute of Development Studies, Vol. 2, No. 4 (1970), Brighton England.

_____. "New Approaches Suggested by the Columbia Employment Programme." International Labor Review (October, 1970).

Shaffer, James D. Property, Market Structure and Efficiency. East Lansing: Agricultural Economics Miscellaneous Report 1966-9, Department of Agricultural Economics, Michigan State University.

Shaw, Robert A. "Jobs and Agricultural Development." Development Digest, Vol. IX, No. 1 (January, 1971).

Singh, R., and Leagans, J.P. Communication and Socio-Economic Variables Related to Fertilizer Use by Indian Farmers. Department of Education, New York State College of Agriculture, 1972.

Staehle, H. "Short Period Variations in the Distribution of Incomes." Reveiw of Economic Statistics (1937).

Stevens, Robert D. "Rural Development Programs for Adaption from Comilla, Bangladesh. Agricultural Economics Report No. 215. East Lansing: Michigan State University, June, 1972.

Thambyahpillay, George. "Climatological Research and Agricultural Development in the Dry Zone." Development of Dry Zone Agriculture. Edited by O. S. Perera. Colombo: Ceylon Association for the Advancement of Science, 1967.

Thiesenhusen, William C. "Latin America's Employment Problem." Science, Vol. 171 (March 5, 1971).

Tobin, J. "Liquidity Preference as Behavior Towards Risk." Review of Economic Studies, 25(2):65-86 (1958).

Tweeten, Luther. Foundations of Farm Policy. Lincoln: University of Nebraska Press, 1970.

United Nations. Report on the Second Development Decade. U.N. Sales No. E71, 11, A.2.

United Nations Research Institute for Social Development (UNRISD). Cooperatives and Planned Change in Asian Rural Communities. Edited by Inayatullah. Geneva: 1970.

U.S. Department of Agriculture. Rice Situation. USDA, ERS RS-15 (March, 1970).

Weeks, John. Employment and the Distribution of Income. Ms. IDS. Brighton: 1972. (Mimeographed.)

Wharton, C. R. "The Green Revolution: Cornucopia or Pandora's Box." Foreign Affairs (April, 1969).

_____. "Risk, Uncertainty and the Subsistence Farmer." Development Digest, Vol. III, No. 2. Washington, D.C.: Agency for International Development, U.S. Department of State, April, 1969.

Willis, I. R. "The Implications of the Green Revolution for Future Production Income and Employment in Agriculture in W. Uttar Pradesh, India." Ph.D. dissertation, University of Illinois, 1970.

Wonnacott, Ronald J., and Thomas H. Econometrics. Toronto: John Wiley and Sons, 1970.