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Agriculture in Economic Development, 1940s to 1990s

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PART TWO. Agriculture in Economic Development: Theories, Findings, and Challenges in an Asian Context

Agriculture in Economic Development: Theories, Findings, and Challenges in an Asian Context

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Chapter I. Introduction

Since World War II and the end of colonialism in Asia, there has been a substantial evolution in thought about the role of agriculture in economic development and the processes by which agriculture develops. That evolution has been reflected not only in the substance of the literature but also in the relative weight given to different areas of analysis.

Also, the proportion of research and literature from the developing world has increased. Western economists had a large, perhaps even dominant, influence on published thought about agriculture and development in the early postwar period. The remains of the colonial legacy and the flow of foreign capital and technical assistance from the West contributed to that influence. With the sharp decline of U.S. foreign assistance and increase in the number of economists and research institutions in Asian countries, that influence has declined. As a result, the perceptions that shape research and its ultimate use have changed. A relatively smaller proportion of research on agricultural development in Asia is reported or even reflected in Western journals today. And American and Asian scholars interact less, so that knowledge of agricultural development has declined in America.

Modern thought about what is now called economic development began in the 1930s and 1940s, when Europeans were concerned about what they perceived to be the backwardness of Eastern and Southeastern Europe. They generally emphasized industrialization [e.g., Rosenstein-Rodan, 1943], an emphasis that has

been consistently reflected in the mainstream of thought on economic development.

It was recognized early that the shift of labor from rural to urban areas was an important aspect of industrialization. Initially, the literature on that subject was concerned with the use of surplus rural labor to facilitate capital formation in a nonagricultural sector which, with the transfer of labor to industry along with the food that it was already consuming, made the social cost of labor almost zero. Most of the approaches of that time did not call for the diversion of scarce resources to develop agriculture.

Agriculture was given a positive role in development in Johnston and Mellor [1961]. They used a labor surplus approach, and recognized that industrialization was essential to modernization, a view later elaborated in Mellor [1966, 1976], Johnston and Kilby [1975], and an update by Mellor and Johnston [1984]. In addition to agriculture's supply of labor, Johnston and Mellor [1961] emphasized the need to increase agricultural production to supply wage goods in support of labor transfers, the ability of agriculture to provide industrial capital through foreign trade, and the stimulus that demand for industrial goods emanating from rising rural incomes would give to growth of the nonagricultural sector.

The ideas of Johnston and Mellor [1961] were not in the mainstream of thought on economic development in Asia at that time, however. The idea was more widely accepted that the basic limitation to economic growth was capital and that resources should, therefore, be concentrated in the capital goods industry. This implied that resource allocations to consumer goods industries, including the principal one, agriculture, should be minimized. That strategy was carefully delineated and quantified over the following decade. It culminated in highly sophisticated, multisectoral, mathematical growth models based solely on capital, giving a dynamic role neither to agriculture nor to labor [Chakravarty, 1969]. The results were similar to the results of import displacement models used for Latin America at the same time.

By the late 1960s, it was recognized that growth from the development strategy was slow and that its benefits were distributed narrowly. The latter problem was expected and was to have been solved by rapid growth that would increase consumption and distribute benefits more broadly. Slow growth was an unpleasant surprise. It led thought in the 1970s in two directions: to supplementary programs that would try to abate poverty directly, and to alternative strategies of growth that emphasized agriculture and developed growth linkages between agriculture and other sectors of the economy.

Alleviating poverty through social welfare schemes was consistent with an orientation toward capital and industrialization. Many adherents of these schemes began to view agriculture as a place to hold the poor and underemployed. They recognized the need for social welfare programs to mitigate rural poverty, to re-

tain the poor in rural areas, and to avoid disturbing the urban economic and political processes as industrialization and urbanization proceeded. Others envisaged social welfare in a basically rural society and rejected an emphasis on industrialization. During the 1970s, the basic human needs approach found a wide following in western countries. But most leaders of Asian developing countries presumed that the benefits of such an approach would be wiped out by population growth; that it would not benefit large, politically important urban constituencies and large farmers; and that it would leave their countries in permanently weak positions in international power politics. Nevertheless, much thought continues to be given to such strategies.

A contrasting approach that emphasized agricultural production as a way to raise incomes in agriculture through vigorous development processes and as a way of fostering linkage and multiplier effects elsewhere in the economy became attractive in the 1980s as the deficiencies of capital-intensive approaches became apparent. Mellor [1976, 1986] and Mellor and Johnston [1984] provided an integrated statement of the strategy as a means of accelerating growth and modernization. It is an approach, however, which is not yet fully conceptualized or described using sound empirical research. During the 1980s, progress was made in both conceptualizing and quantifying the key relationships. Not surprisingly, as that process proceeded, increasing emphasis was given to expanded rural infrastructure investment as the means of bringing about the rural specialization and integration essential to modernization, technological change, and rising productivity [Ahmed and Hossain, 1987]. This interest in rural linkages was fostered by recognition of the failure of older approaches to industrialization, and social welfare to provide for the rising expectations of a rapidly growing rural population.

Thought about how to develop agriculture has evolved more consistently than thought about the role of agriculture. In the 1950s, the view was widely held that farmers in developing countries were ignorant, inefficient, and exploited. It was believed that if exploitation could be stopped by removing the rapacious landlord and money lender, if leadership could be provided through local government bodies, and if ignorance could be removed through extension and community development programs, then agriculture would grow and prosper.

It became apparent, however, that while these measures were important to political development, they had little effect on production. A view developed, with T. W. Schultz [1964] as the most articulate spokesman, that farmers were indeed intelligent and sensible optimizers but that their environment and lack of incentives discouraged increases in output. Specifically, many believed that fertilizer, water, pesticides, and credit were not reaching the farmer. Development programs were redesigned to provide these inputs. Again, success was only modest.

The next step in the evolution of agricultural development came with the reminder that modern agriculture in developed countries had grown and developed

largely because of the application of science. By the mid-1960s, many recognized that in developing countries, production increases and greater use of inputs were impeded by limitations of technology. Subsequently, much effort was devoted to increasing the ability to develop new high-yielding crop varieties and associated practices [Dalrymple 1986a, b]. Signs of accelerated growth then became apparent. But progress from the new high-yield technologies tended to be more rapid where there had already been a major effort to inform farmers, to develop extension services, and to develop input distribution systems. New technology was indeed the key to the puzzle, but many other parts had to be put in place as well. A slowly building body of analysis came to recognize the critical role for physical infrastructure investment—a matter of major importance because of massive resource requirements.

Growth in the knowledge of how to develop agriculture has increased the attention given to problems of implementation. This is an important new direction that leads past the traditional boundaries of economic thought and empirical techniques. Increasing agricultural production has also brought greater attention to other development questions such as what are the determinants of effective demand for agricultural output, how resources to agricultural research and modern inputs are to be allocated, what patterns of income distribution are emerging, and what processes broaden participation in economic growth. It is recognized that small farmers and the landless have difficulty manipulating and, in turn, benefiting from, the institutions that are critical to growth and development. Concern with broadening participation in such institutions is growing.

Following the outline of the preceding overview, we begin with a brief description of the characteristics and role of Asian agriculture, followed by a review of agriculture's place in the dominant theories of economic growth. In these discussions the bias is, of course, towards the Asian context. The theme is that of a major, positive role for agriculture in the process of economic development. Given that context, we proceed to discuss the process of modernizing agriculture so as to contribute to overall economic growth. The discussion is followed by further treatment of two particularly important aspects of modernization—technology and market development, leading to a treatment of the thorny issues of income distribution and welfare in the context of agricultural growth. The story then reverts to the issue of overall economic growth—how contribution to real national income arising from technological change in agriculture can stimulate growth in other sectors. This is a view that sees overall economic growth rising from the multipliers that result from agricultural growth. A brief treatment of the vast subject of trade and aid is presented before a discussion of implementation issues is taken up. The question of how to achieve implementation is presented in the earlier sections.

The subject is vast, the literature immense. We have included only a small fraction of an increasingly diverse and specialized literature, selecting those studies that fit into the progression outlined above. Many important works are not mentioned in the text, but are included in the references. We no doubt have missed important contributions—in the interest of keeping at least the vestiges of a theme and due to space constraints. This problem of a massive body of literature is much more substantial for the literature on Asia than for Africa and Latin America. For the latter two, the literature is large but at least a pretense can be made at a comprehensive survey. For Asia, India alone has an overwhelming literature. Our solution is to have a theme we believe is particularly relevant to contemporary problems in Asia, to stay with it, and to keep the total presentation brief.

Chapter II. Agriculture's Characteristics and Role

1. Stages of Agricultural Development

Following Rostow [1960], the growth of agriculture in developing countries can be divided into three stages: traditional (static), transitional, and modern (dynamic).[1] These stages and their major attributes are summarized in Table 1. The contribution of agriculture to economic development increases as it develops from the static stage to the dynamic.[2] The value of this classification into stages is severely limited by the lack of characteristics unique to any one stage and clear-cut demarcations between stages. Nevertheless, it still delineates the changing characteristics of agriculture and the implications of these changes for agriculture's relationships with other sectors in the economy. It also emphasizes the changing objectives and instruments of agricultural development. These insights are essential for policymakers to understand not only the role of agriculture in economic development but also the processes by which agriculture develops.

2. Special Characteristics of Asian Agriculture

The role of agriculture varies from one stage of economic development to another and from one country to another. The importance of agriculture in Asia's economic development comes from its relative and absolute size, as shown by the comparative agricultural development indicators (Table 2). There are, however, large variations within Asia. In 1985, the contribution of agriculture to gross domestic product ranged from 25 percent (Pakistan) to 62 percent (Nepal) in South Asia; 17 percent (Thailand) to 48 percent (Burma) in Southeast Asia; and 3 percent (Japan) to 33 percent (China) in East Asia (Table 3). More strikingly, the proportion of the labor force employed in agriculture in 1980 ranged from 53 percent (Sri Lanka) to 93 percent (Nepal) in South Asia; 42 percent (Malaysia) to 71 per-

Table 1. Summary of major characteristics of agricultural development from stage I through stage II and into stage III

General characteristic	Stage I (static)	Stage II (transitional)	Stage III (dynamic)
1. Values, attitudes, motivations	Negative or resistant (does *not* imply non-national)		Positive or receptive
2. Goals of production	Family consumption and survival		Income and net profit
3. Technology or state of arts	Static or traditional with no or slow innovation		Dynamic or rapid innovation
4. Degree of commercialization of farm production	Subsistence or semisubsistence		Commercial
5. Degree of commercialization of farm inputs	Family labor and farm produced		Commercial
6. Factor proportions and rates of return	High labor/capital ratio, low labor return		Low labor/capital ratio, high labor return
7. Institutions affecting or serving agricultural and rural areas	Deficient and imperfect		Efficient and well developed
8. Availability of unused agricultural resources	Available		Unavailable
9. Share of agricultural sector in total economy	Large		Small

Source: Hayami and Ruttan [1971, 1985], originally from Wharton [1963a].

cent (Thailand) in Southeast Asia; and 11 percent (Japan) to 74 percent (China) in East Asia.

In noting that the relative size of the agricultural sector suggests major attention to that sector, two important points should be kept in mind. First, even at best, the maximum growth rates in agriculture tend to be low relative to those achievable in nonagriculture. Thus, a nonagricultural sector may achieve, even for rather sustained periods of time, growth rates of 10-15 percent. In agriculture, one is doing well to get above the range of 3-6 percent. This leads to the implication that agriculture's potential can only be realized if the development process occurs broadly throughout the agricultural sector.

Table 2. Selected comparative agricultural development indicators for Asia, Africa, Latin America, and the rest of the world[a]

	Year[b]	Unit	World	Percent share in Asia[c]	Africa[c]	Latin America[c]	The rest of the world
Population	1984–86	Million	4,838.8	58	11	8	22
Agricultural population	1984–86	Million	2,220.0	74	16	5	5
Arable land and permanent crops	1983–85	Million ha	1,475.0	31	12	12	45
Irrigated land	1983–85	Million ha	217.8	63	4	7	26
Nitrogen consumption	1983/84–1985/86	Million mt	69.2	39	3	4	54
Phosphate consumption	1983/84–1985/86	Million mt	33.2	27	4	7	63
Potassium consumption	1983/84–1985/86	Million mt	25.6	12	2	6	80
Total nutrient consumption	1983/84–1985/86	Million mt	128.1	30	3	5	62
Agricultural tractors	1983–85	Million	24.0	18	2	6	74
Harvesters/threshers	1983–85	Million	3.8	30	1	3	65
Total cereal production	1984–86	Million mt	1,839.3	42	4	6	48
Paddy rice production	1984–86	Million mt	473.5	92	2	4	2
Wheat production	1984–86	Million mt	519.4	35	2	4	59
Maize production	1984–86	Million mt	473.9	21	6	11	62
Other cereal production[d]	1984–86	Million mt	372.5	16	8	4	72
Total pulses production	1984–86	Million mt	51.7	46	12	10	32
Total roots and tubers production	1984–86	Million mt	590.3	38	17	8	37
Fruit production[e]	1984–86	Million mt	315.6	30	12	20	38
Vegetable production[f]	1984–86	Million mt	404.6	55	7	5	33
Meat production	1984–86	Million mt	150.2	24	5	11	60
Milk production[g]	1984–86	Million mt	511.8	16	3	7	73
Egg production[h]	1984–86	Million mt	31.1	33	4	10	53
Tea production	1984–86	Million mt	2.3	78	12	3	7
Coffee (green) production	1984–86	Million mt	5.4	13	23	63	1
Sugarcane production	1984–86	Million mt	928.0	38	8	49	6
Seed cotton production	1984–86	Million mt	50.1	49	7	10	33

[a] Derived from data obtained from the annual publications (and various previous issues) of FAO [1989a] and FAO [1989b]. The percent share is approximate due to rounding.
[b] Three-year average for the years shown.
[c] Refers to FAO's definition of continental Asia (including China, Israel, and Japan); continental Africa (including South Africa); and Latin America.
[d] Includes barley, rye, oats, millet, sorghum, and other minor cereals.
[e] Excludes melons.
[f] Includes melons.
[g] Includes milk from cows, buffaloes, sheep, and goats.
[h] Includes hen eggs and other eggs.

The broadly participatory growth in the agricultural sector means not only bringing in the bulk of geographic regions, but the bulk of the people within those regions. This latter process has two dimensions. The first, particularly in the context of smallholder agriculture, is that one must have institutions that

bring most of the small farmers into the process. This requires not only complex and intricate institutional development, but also full geographic participation. This is the major argument for a well-developed rural infrastructure. Urban-based officials may have the impression that all rural people have good roads because that is the only kind they know. However, the fact of the matter is that in developing countries road systems are much less developed than they were at the same stage of development in modern developed countries; and it follows that a high proportion of rural people are located too far from roads to enter fully into the exchange and specialization economy. One of the important benefits of physical infrastructure is to distribute the educated people who run modern institutions broadly throughout the economy. Pioneering work by Raisuddin Ahmed and Mahabub Hossain has brought out these relationships [Ahmed and Hossain, 1987].

It can also be seen from Table 3 that South, Southeast, and East Asia (excluding China) represent successively higher levels of economic growth. Our review is biased towards discussion of the earlier stages of growth and problems of take-off in growth, both for agriculture and the economy generally. Thus, the emphasis is largely on South and Southeast Asia. We draw heavily on the historical literature for East Asia.

Agriculture also demands attention in economic development because of the peculiar nature of its production conditions. It is seasonal and heterogenous in nature; subject to large agroclimatic, environmental, and economic risks; highly unorganized and nonunionized; and involves a large number of decision-makers. Limited awareness of knowledge about the transformation of agriculture, and the complexity of technology and technological change in it, has baffled many development economists and administrators and turned them away from agriculture as an engine of employment-oriented economic growth.

Agriculture is the only sector of the economy that comes close to meeting the conditions of atomistic competition. Yet, agriculture has often been regarded as an impenetrable mystery, not yielding to the tools of economic analysis and incapable of being integrated with other sectors of the economy. Furthermore, the common view that the farmer is bounded by tradition, irrational, and unresponsive to economic stimuli has prevented agriculture from receiving adequate attention and resources from planners and policymakers.

This erroneous view of the farmer arose from the failure to understand the complex relations between the farmer's business world and his household life; the economic implications of the high risks farmers face; the effect of the heterogeneity of physical, economic, and institutional conditions on innovations; and the burden that the limited land base places on the ability of technological change to increase agricultural production. In the complex decisionmaking environment of

Table 3. Comparative economic development indicators for selected countries in Asia

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Region/country	Population mid-1985	GNP per capita 1985	Average annual real growth rate (1980–85)				Agriculture as percent of GDP (1985)[b]	Percent of total expenditure on agriculture (1981)	Infant mortality rate per thousand of live births (1985)
			Population	Gross domestic product (GDP)	GDP per capita	Gross agricultural production			
	(millions)	(US$)		(percent)					
South Asia									
Bangladesh	100.6	150	2.6	3.6	1.0	2.8	50	12[d]	123
India	765.1	270	2.2	5.2	3.0	2.7	31	7[c]	89
Nepal	16.5	160	2.4	3.4	1.0	—	62[c]	18	133
Pakistan	96.2	380	3.1	6.0	2.9	2.1	25	2[c]	115
Sri Lanka	15.8	380	1.4	5.1	3.7	4.0	27	8[f]	36
Southeast Asia									
Burma	36.9	190	2.0	5.5	3.5	5.4	48	24[c]	66
Indonesia	162.2	530	2.1	3.5	1.4	3.1	24	10[c]	96
Malaysia	15.6	2000	2.5	5.5	3.0	3.0	—	7[g]	28
Philippines	54.7	580	2.5	−0.5	−3.0	1.7	27	6[c]	48
Thailand	51.7	800	2.1	5.1	3.0	3.4	17	10	43
East Asia									
Japan	120.8	11300	0.7	3.8	3.1	1.6	3	—	6
South Korea	41.1	2150	1.5	7.9	6.4	6.3	14	6[c]	27
China[a]	1040.3	310	1.2	9.8	8.6	9.4	33	—	35

Region/Country	Years of life expected at birth (1985)	Population per square kilometer of agricultural area (1980)	Rural population as a percent of total (1985)[h]	Percent of labor force in agriculture (1980)	Percent of national income received by lowest 20% (1981)	Percent of calorie requirements supplied per capita (1980)	Percent of adults who are literate (1981)
South Asia							
Bangladesh	51	908	82	75	7[i]	84	26[f]
India	56	373	75	70	7[j]	88	36
Nepal	47	356	93	93	5[f]	86	19[c]
Pakistan	51	324	71	55	8[k]	106	24[g]
Sri Lanka	70	570	79	53	7[l]	102	85[g]
Southeast Asia							
Burma	59	321	76	53	8[m]	113	66[c]
Indonesia	55	461	75	57	7[n]	110	62[d]
Malaysia	68	320	62	42	4[l]	121	60[c]
Philippines	63	442	61	52	5[k]	116	75[g]
Thailand	64	257	82	71	6[n]	105	86[c]
East Asia							
Japan	77	2,139	24	11	8[o]	124	99[c]
South Korea	69	1,702	36	36	6[n]	128	93[d]
China[a]	69	308	78	74	7[g]	107	69[p]

Source: Compiled from World Bank [1983a, 1987c].

[a] Excluding Taiwan.
[b] At current prices.
[c] 1984.
[d] 1978.
[e] 1980.
[f] 1977.
[g] 1979.
[h] 100 minus urban population as a percent of total.
[i] 1974.
[j] 1975.
[k] 1970.
[l] 1973.
[m] 1972.
[n] 1976.
[o] 1969.
[p] 1982.

the farmer, the welfare of his family must be improved if innovations are to raise agricultural output.

3. Contributions of Agriculture

According to Kuznets [1961], agriculture makes product, market, and factor contributions to economic development. According to Johnston and Mellor [1961], agriculture increases food supplies, enlarges agricultural exports, transfers manpower, forms capital, and stimulates industrialization through increased rural net cash income. These two approaches have been synthesized in Figure 1 to describe the contribution of agriculture to economic development. The capital-oriented development strategies attach little importance to these contributions, and so, either ignore agriculture entirely or include it only marginally. According to the World Bank [1982b], economic growth has been rapid in virtually all those countries where agricultural development has been strong. Faster agricultural growth in low-income countries can also reduce rural poverty since over 90 percent of the absolute poor are rural people. The different elements of this powerful role of agriculture are discussed below.

4. Structural Change and Growth Patterns

The process of economic growth consists of growth in economic variables and structural change in the economy. Of particular importance is the secular growth in the absolute size of agriculture, its secular decline in relative importance, and the concurrent increase in the relative importance of the industrial sector.[3] In an empirical study of fifty-one countries, Chenery [1960] showed that the share of industrial output increased from 17 percent when per capita income was $100 to 38 percent when it was $1,000 while the share of primary production (agriculture) declined from 45 percent to 15 percent, the share of transportation and communication doubled, and the share of other services did not change.

Goreux [1959] and Houthakker [1957] demonstrated that as development takes place, the composition of demand changes in favor of industrial goods, and the share of food in the household budget declines. This is consistent with the well-known Engel effects. Chenery [1960], on the other hand, argued that the factor supply conditions lead to a systematic change in the structure of industrial growth as incomes rise.

In noting the inelastic demand for most basic food staples, one should not ignore the fact that there is a substantial set of agricultural commodities, including livestock and horticultural products, for which the demand is elastic. These commodities, particularly livestock, have a significant initial base and a rapid growth in effective demand as incomes rise. Indeed, this set of factors explains why agriculture can play quite an important role even in relatively late stages of devel-

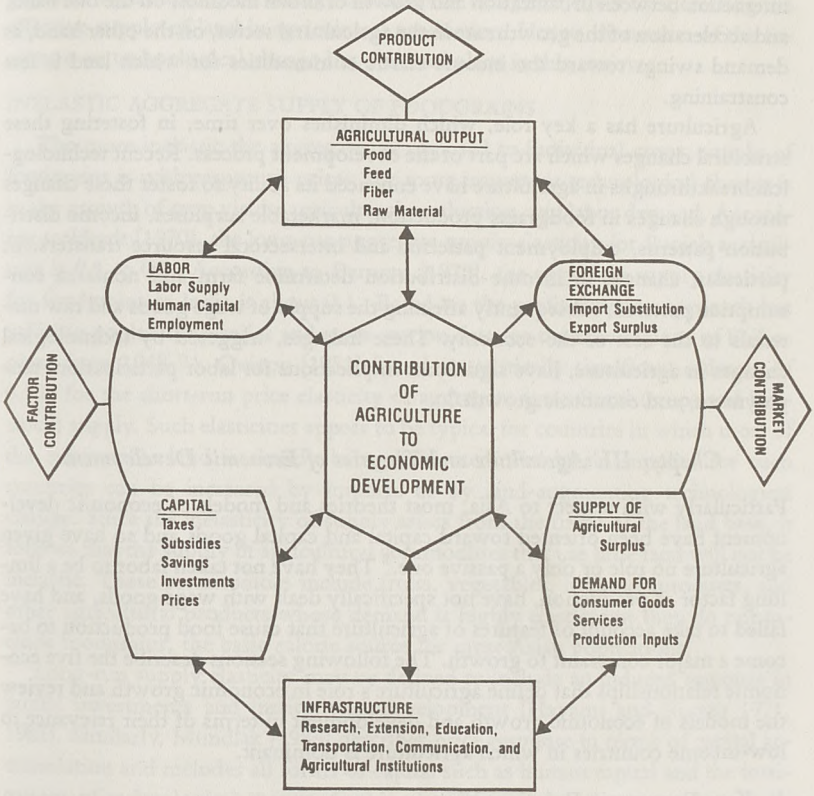

Figure 1. Sectoral linkages and contribution of agriculture to economic development.

opment. The income-elastic sectors become more and more important, and because they are not constrained as much by land area as the basic staples, they can provide a more substantial supply response as well. Thus, one has an important interaction between urbanization and growth of urban incomes, on the one hand, and acceleration of the growth rate in the agricultural sector, on the other hand, as demand swings toward the income-elastic commodities for which land is less constraining.

Agriculture has a key role, which diminishes over time, in fostering these structural changes which are part of the development process. Recent technological breakthroughs in agriculture have enhanced its ability to foster these changes through changes in foodgrains production, marketable surpluses, income distribution patterns, employment patterns, and intersectoral resource transfers. In particular, changes in income distribution determine farm and nonfarm consumption patterns, subsequently affecting the supply of wage goods and raw materials to the rest of the economy. These linkages, triggered by technological changes in agriculture, have significant implications for labor participation, employment, and economic growth.[4]

Chapter III. Agriculture and Theories of Economic Development

Particularly with respect to Asia, most theories and models of economic development have been oriented toward capital and capital goods and so have given agriculture no role or only a passive one.[5] They have not taken labor to be a limiting factor of production, have not specifically dealt with wage goods, and have failed to take account of features of agriculture that cause food production to become a major constraint to growth. The following sections describe the five economic relationships that define agriculture's role in economic growth and review the models of economic growth and development in terms of their relevance to low-income countries in which agriculture is dominant.

1. Key Economic Relationships

LAND AND LAND-AUGMENTING TECHNOLOGICAL CHANGE

Recognizing land as a factor of production leads to diminishing returns to variable inputs because land is assumed to be fixed in supply. Diminishing returns ultimately lead an economic system into a stationary state as was amply demonstrated by Ricardo. Although this paper deals with post-World War II literature, it should be noted that the classical economists, e.g., Petty, Smith, and Ricardo, had much to say about agriculture's role in economic development and anticipated much of the contemporary discussion.

Most Asian countries encompass a high proportion of the population in areas of high density, a substantial fraction of the population is underemployed or em-

ployed at extraordinarily low levels of productivity, and agriculture—for which land accounts for a major factor share—contributes significantly to GNP. As a result, the effect of diminishing returns on national output can be large. Land-augmenting technological change can offset or delay that effect by increasing the effective supply of land in agricultural production. Hence, discussion of the literature on technological change has a central place in this review.

INELASTIC AGGREGATE SUPPLY OF FOODGRAINS

The more inelastic the aggregate, as opposed to individual crops, supply of foodgrains is with respect to prices, the more important technological change is to the growth of crop yields, agricultural production, and labor demand. According to Herdt [1970], the long-run aggregate supply elasticity for Punjab agriculture is 0.1 to 0.2. According to Barnum [1973], the aggregate supply elasticity for foodgrains in India is about 0.1. Based on the profit-function approach but utilizing pooled time-series and cross-section data for the nine regions of Philippines from 1948-74, Quizon [1981] found a statistically significant estimate of 0.104 for the short-run price elasticity of aggregate agricultural (crops and livestock) supply. Such elasticities appear to be typical for countries in which most of the cultivatable land is already being cultivated. Foodgrain supplies for such countries can be increased by imports or by land-augmenting technological change. Since the inelasticity of supply arises from the fixity of the land base, it follows that the supply of agricultural commodities that use little land will not be inelastic. These commodities include fruits, vegetables, livestock products, and other agricultural products whose demand is highly elastic; but they do not include foodgrains, the basic calorie source for most Asian populations.

Long-run supply elasticity may be defined to include an induced response in public investments and institutional development [Hayami and Ruttan 1971, 1985]. Similarly, Mundlak [1988] describes price response in terms of capital accumulation and includes all forms of capital such as human capital and the institutions of technological change. In this view, long-term price response may be quite elastic. However, Mundlak is explicit that such response is conditional on the realization of a substantial pace of technological change. In this review, we treat the processes of technological change separately in later sections as more appropriately dealt with by explicit public policy. This is because of the long lags in developing such measures and the consequent need to abstract from short-run processes of market price formation.

HIGH MARGINAL PROPENSITY OF LABORERS TO CONSUME FOODGRAINS

The low elasticity of the aggregate supply of foodgrains will not limit additional employment if labor's marginal propensity to consume foodgrain is low.

However, empirical evidence has shown that low-income consumers spend most of any additional income on food, a major part of it going to foodgrains and other staples. For India, the lower 20 percent of the income distribution which can be defined as the laboring class, spend 59 percent of their incremental income on foodgrains alone and 79 percent on all food commodities [Mellor and Lele, 1973; Mellor, 1978].

ELASTIC SUPPLY OF LABOR

In most low-income Asian countries, the supply of labor to the nonagricultural sector seems to be highly elastic. This is because population growth is rapid and employment conditions in the agricultural sector are poor. Increasing employment opportunities in the nonagricultural sector, with only a small increase in the real wage rates, will elicit a large increase in labor supply to that sector. The elasticity of aggregate labor supply from agriculture depends on the relative size of the agricultural sector, on technical conditions of agricultural production, and on the family labor-leisure choice function.[6] Much work has been done in this area to determine whether or not the marginal product of labor in agriculture is zero.

The marginal product of labor in agriculture need not be zero to provide a highly elastic labor supply [Mellor, 1963]. It is likely that agricultural labor is fully employed seasonally and that small expenditures on selective mechanization or on reorganizing production could save large amounts of labor at seasonal peaks and make the labor supply elastic. The empirical evidence is generally consistent that the supply of labor to the nonagricultural sector is highly elastic with little increase in real wage rate [Nabi, 1984; T. H. Lee, 1971; Ohkawa and Rosovsky, 1960; Umemura, 1969].

Thus, despite a complex set of determinants, it appears that the labor supply can increase rapidly if jobs and wage goods are made available. Note that a constraint on wage goods is effectively a constraint on labor supply. Lele and Mellor [1981] underline this connection with a two sector model which presents and achieves a general equilibrium with two separate, interacting markets, for labor and for wage goods.

LESS-THAN-PERFECT SUBSTITUTABILITY OF CAPITAL FOR LABOR

To the extent that capital and labor are less than perfect substitutes, restraints on the labor supply (or wage goods supply) will require increasingly high rates of savings simply to maintain a given rate of growth. Although growth models may assume fixed factor proportions, in reality, there is always more than one process to produce the same commodity, each with a different capital-labor ratio. Depending on the factor-price ratio, capital and labor can be combined in different proportions by using different production techniques. And, at an aggregate level

with trade, the choices of production can change capital-labor ratios substantially. Changes in income distribution may change the structure of demand and consequently the average capital-labor ratio. The technological data indicate that the possibilities of capital-labor substitution vary considerably among sectors, are greater in agriculture than in industry, and are particularly so in rural activities for which rural people have a high marginal propensity to consume. As a result, it is possible to increase employment without a corresponding increase in capital.

2. Aggregate Theories of Economic Growth

The aggregate economic growth models that form the basis of modern growth theory were developed in Harrod [1948] and Domar [1957]. The Harrod-Domar model provides a conceptual framework for analyzing the growth process by focusing on a few crucial economic variables and their relations. One of the major assumptions of the Harrod-Domar formulation is a production function with fixed factor proportions. The steady-state growth rate is determined by the average productivity of capital and the average propensity to save. This approach is elegant in its simplicity. The models of Solow [1956] and Swan [1956] eliminate the knife-edge property of the Harrod-Domar model by allowing substitution between capital and labor and introducing technological change.

However, investment plays a dominant role in determining economic growth in these models. While the frameworks were designed essentially for high-income countries, they form the intellectual basis for a wide range of models that are applied to developing countries. They are particularly important in understanding inattention to agriculture. In particular, aggregate models are inappropriate for analyzing the sectoral linkages, structural changes, and market feedbacks in the process of economic growth. Since these models generally have ignored technological change, growth is achieved mainly by increasing the use of capital, which is relatively scarce in most low-income countries. Furthermore, these models may also be inappropriate when labor supply is highly elastic and the supply of wage goods seriously constrains employment.[7]

3. Multisector Models of Economic Growth

The neoclassical two-sector model is an elaboration of the single-sector neoclassical growth model.[8] But despite all the efforts made to make the two-sector models more realistic, "they do not represent any great advance in realism over one-sector models," according to Hahn and Matthews [1965, p. 39]. Two-sector models appear to disregard low-income economies that have elastic supplies of labor and in which wage goods constrain both employment and the rate of growth. Because these models assume full employment they are even less suitable for analyzing the growth process in labor surplus economies. However, the con-

cepts behind such models have been important to development theory and practice in Asia and explain much of the early inattention to agriculture.

In the two-sector model of Mahalanobis [1953, 1955], which guided Indian planning for a decade or two commencing in the mid-1960s, labor is assumed to be perfectly elastic and the growth rate of the system is determined asymptotically by the proportion of investment going to the capital-goods sector and the ratio of incremental income to investment in that sector. Mahalanobis maintained that the main constraint to employment is the scarcity of capital goods. In general, however, Mahalanobis's framework ignored demand considerations for both consumer and capital goods. The main paradox of the Mahalanobis model in fact is that income will eventually be higher if a large proportion of investment goes to the capital-goods sector even though capital may be more productive if invested in the consumption-goods sector.

The Fel'dman [1957] model, developed for the Soviet Union in the 1920s, is similar to the Mahalanobis model. It emphasizes investment in heavy industry as a source of economic growth. Agriculture, as a source of wage goods and as a source of employment and economic growth, is virtually ignored in both the Mahalanobis and the Fel'dman models. Despite obvious shortcomings, the Mahalanobis model formed the basis of the Second Five-Year Plan in India.

Chinese leaders, including Mao, explicitly recognized agriculture's role as a source of wage goods and eventually, through bitter experience, the central importance to overall economic growth of a dynamic, healthy agricultural sector. They did not, however, appreciate the investment requirements necessary to achieve this dynamism on an appropriate scale, and thus China's sectoral allocation of state investment bore striking similarity to that of India's in its overwhelming emphasis on heavy industry [Tang and Stone, 1980; Lardy, 1983a; Stone, 1985], while various mechanisms were employed to channel rural savings to the greatest extent possible through the public sector [Stone, 1988a; Ishikawa, 1982, 1988].

The multisector model developed in Chakravarty and Lefeber [1965] is an intertemporal optimizing planning model. It assumes that the labor supply is perfectly elastic and that capital is the only bottleneck to economic growth. The objective of the model is to maximize the discounted sum of composite consumption bundles over the planning period subject to technological, market, and political constraints and to the terminal conditions. Land, labor, and natural resources are assumed to have no limits and are not included in the model. As Srinivasan [1965] pointed out, the model has many shortcomings. Since technology is assumed to be constant, the projections of supply and demand of inputs and hence, the investment patterns, are not realistic. Despite surplus labor, the objective of the model can only be achieved if capital-intensive techniques are adopted. Eckaus and Parikh [1968] tried to make this model more realistic by

adding sectors, by incorporating nonlinear relationships and technological change, and by dividing the economy into different regions.

The consistency models developed in Manne and Rudra [1965] and Bergsman and Manne [1966] are multisectoral, intertemporal, and use dynamic Leontief input-output frameworks, but treat agriculture superficially. They are designed to analyze the implications that alternative paths of economic growth have for the balance of trade by postulating different aggregate growth targets and import substitution targets. They were tested by using data from India. Their main conclusions are that investment in import substitution and export promotion of capital goods industries relieves foreign exchange bottlenecks in the long run. Von Neumann's [1945-46] general equilibrium multisector model of a uniform expanding economy was highly abstract but was a major step in the development of multisector planning models. Specifically, it allowed incorporation of labor and wage goods into the formulation.

None of the models described above had a place for a dynamic agriculture in economic growth. Nor did they have a place for accelerating growth by mobilizing labor. They led, in practice, to a capital-intensive, low-employment strategy, with little investment in agriculture. The theory behind the Mahalanobis plan for India was simple, internally consistent, and suitable for an economy presumed to have poor prospects for growth of agriculture and exports.

4. Dualistic Development Models

The dualistic models focus on the transfer of labor from the agricultural sector to more productive employment in the industrial sector and the supply of wage goods as a constraint to economic growth.

POPULATION GROWTH AND LABOR TRANSFER

W. Arthur Lewis [1954], in an original formulation of a dualistic model, emphasizes the potential for capital formation of a transfer of low-productivity labor from the agricultural to the industrial sector without a corresponding decline in agricultural output. Lewis's model is termed "classical" because it assumes that some agricultural labor is redundant and that labor is paid a constant, institutionally determined wage. The Lewis model was more formally elaborated and generalized in Ranis and Fei [1961]. They assumed no technological change and showed that the agricultural sector passes through three distinct phases as labor is transferred to the industrial sector.

In phase I, some labor in the agricultural sector is redundant. The average product of labor in the agricultural sector is assumed to equal wages in the industrial sector. Hence, labor can be transferred from the agricultural to the industrial sector without affecting either agricultural output or the terms of trade between the two sectors. In phase II, the marginal product of labor in agriculture is posi-

tive but less than industry's institutionally determined wage. As a result, labor cannot be transferred to industry without decreasing agricultural output. This implies that the terms of trade go against industry and that the industrial real wage measured in industrial goods rises. When all agricultural labor with a marginal product less than industry's wage has been transferred, the agricultural sector enters into phase III where labor becomes a scarce factor and wages are no longer fixed. Both the agricultural and industrial sectors become competitive and wages are determined by marginal labor productivity. In this phase, the agricultural surplus falls rapidly because total output falls and the wage rate rises. In phases II and III, the industrial sector faces a rising labor supply curve.

In both the Lewis and Ranis-Fei models, the demand for labor in the industrial sector was determined by capital accumulation. In their later work, Fei and Ranis [1963, 1964] made labor absorption in the industrial sector a function of capital, innovational intensity and its labor-using bias, growth in real wages, and the elasticity of labor demand. On the other hand, Jorgenson [1961] assumed that agricultural labor has a positive marginal product, that labor leaves the agricul tural sector when the wage rate in the nonagricultural sector provides an income equal to the average income in agriculture, and that the wage rate in the nonagricultural sector is equal to the marginal product of its labor.[9] Population growth is determined endogenously in the Jorgenson model and exogenously in the Lewis and Ranis-Fei models. None of these models incorporates other factors that determine labor supply. If intersectoral labor transfers and changes in labor participation rates are an important part of growth in low-income countries, then models must deal with the real complexities of the labor markets in such economies. Mellor and Stevens [1956], Mellor [1963, 1976], A. K. Sen [1966], Todaro [1969], and Hymer and Resnick [1969] shed some light on labor supply questions.

WAGE GOODS PRODUCTION

Because of the high marginal propensity of laborers to spend on food, the supply of a marketable surplus of wage goods is important in determining labor transfer and capital accumulation in the industrial sector. In classical dualistic models, since land is fixed and capital is not included, productivity can only be raised through improved production techniques. Fei and Ranis [1964] assume that technical change is neutral, which raises the marginal productivity of labor and hence total agricultural output. Since wages are fixed, an increase in total output increases the marketable surplus which, in turn, changes the terms of trade against the agricultural sector and lowers the labor supply curve in the industrial sector.

A. K. Dixit [1969] and Hornby [1968] examined the question of how to increase the production of wage goods in response to a change in relative prices and a favorable public investment policy using a classical framework. In the absence

of technological change, this approach inferred that returns would diminish and the prices of wage goods would rise, which would increase labor costs and cause capital to be substituted for labor. In the Jorgenson model, since capital is excluded, land is fixed, and labor is fully employed, production can only be maintained and labor transferred through technological change in the agricultural sector.

Since technological change is critical to the growth of agricultural production and tends to be biased, normally land-augmenting, it is important to incorporate these elements in a dualistic model. Lele and Mellor [1981] presented a dualistic model that examines the relationships between increased foodgrain production, achieved through alternative technologies, and the rates of growth of nonagricultural employment, the nonagricultural sector capital-labor ratios, relationships of the prices of agricultural and nonagricultural commodities, and changes in the per capita incomes of the labor force. The model clarifies that land-augmenting technological change plays a critical role in release of labor to the industrial sector; is accompanied by declining terms of trade for agriculture; and that factor bias is an important determinant of the pace of labor transfer. In a further extension, Mellor and Ranade [1988] show how, under the conditions of developing countries, technological change in agriculture does not depress agricultural income.

WAGE GOODS TRANSFER

Dualistic development models have assumed that the amount and pattern of consumption per capita does not change and that the potential marketable surplus will automatically be transferred to the industrial sector without cost. These are highly simplifying assumptions. In fact, because of leakages in the system, not all the marketable surplus gets transferred. In the classical model [W. A. Lewis, 1954] the capitalist landlord, responsive institutions, and the government make sure that all the potential surplus is properly channeled to the industrial sector. The "neoclassical" models have not really addressed this question.

The Lewis, Ranis-Fei, and Jorgensen models assume that consumption per capita does not change as growth rates in the economy rise. Consequently, these models ignore the effects of both price and income on the level and pattern of consumption. Kelley, Williamson, and Cheetham [1972], however, analyzed consumption using a linear expenditure system. This added a realistic component to the dualistic models. Zarembka [1970] also focused on the problem of marketable surplus by assuming that income and price elasticities of demand are not zero. Lele and Mellor [1981] explored this relationship in the context of technological change and changed distribution of income, showing that it is the factor bias of technology which is key to a substantial transfer of wage goods to support a high growth rate of nonagricultural employment which, in turn, requires either accelerated capital formation or lower capital-labor ratios. The factor bias to-

wards land distributes incremental income to relatively higher income people who market additional agricultural commodities to purchase nonagricultural goods and services. The factor bias not only supplies wage goods, but provides demand for the goods produced by added employment. The added employment, of course, requires at least some added capital to combine with the added labor.

CAPITAL FORMATION AND TRANSFER

Except for the Kelley-Williamson-Cheetham model, the "classical" and "neoclassical" dualistic models incorporate capital only in the nonagricultural sector. This is a significant shortcoming, especially since technological change is often the main source of increases in labor productivity in the agricultural sector and since technological change normally is either embodied in new capital goods or requires a large amount of working capital to purchase modern farm inputs produced in the nonagricultural sector. Furthermore, technological change itself is determined by capital formation because it requires large initial investments [Hayami and Ruttan 1971, 1985; Mundlak, 1988]. On the other hand, employment and hence, growth in the nonagricultural sector, depends on capital accumulation. Mellor [1974] delineated the attributes of a model for a country with a dominant and dynamic agricultural sector. The appropriate model would have much in common with the models of A. K. Sen [1968] and Von Neumann [1945/1946], particularly with reference to the role of wage goods.

5. Market Orientation

We should not leave this discussion on theories of economic development without discussing market orientation, though briefly. The essence of a market orientation is substantial decentralization of decisionmaking, with the guidance for that decisionmaking coming from market prices. As economies become more and more complex, it becomes less and less possible for governments to allocate resources in an effective way. Thus, as development proceeds, it drives toward a market orientation that becomes stronger and stronger. It should be noted that, in an agriculturally oriented development strategy, market orientation is particularly important. On the one hand, a myriad of small farmers can hardly be managed by fiat from a central government; on the other hand, the activities generated by the rising incomes of small farmers tend themselves to be labor-intensive and hence, suited to small-scale production, again leading to large numbers of entrepreneurs pursuing diverse activities. Thus, a market orientation is critical to an agriculturally led development strategy.

Having made the basic case for a market orientation, one should recognize that in the early stages of development when relatively labor-intensive activities are most productive and efficient, there is a substantial need for public sector activities in support of the small firms that tend to go along with a high degree of

labor intensity. Thus, agriculture itself requires substantial support from public sector research and educational institutions; it may require an initial impetus even in areas like fertilizer distribution and credit. Thus, striking the correct balance between public and private sector activities and, within each of those, between larger-scale centralized activities and small-scale decentralized activities is one of the most important sets of decisions in an agriculture-oriented development strategy.

In the 1980s, a large number of developing countries undertook reforms that involved substantial increases in market orientation. These changes were required in part because of major structural maladjustments, which in many cases were postponed by taking on massive amounts of debt. The maladjustments rose significantly from the large increases in oil import bills which represented a decline in real incomes for the large importers, the effect of which was hidden by large borrowings. But constant pressure to increase public expenditure for developmental and welfare reasons, combined with fixed exchange rates, also created major and growing distortions. The transition from the one set of policies to the other tends to be politically difficult and often disruptive. Foreign assistance can play a major role in such processes, but its instability has often added to the problems rather than decreasing them [Lele and Nabi, eds., 1990].

Chapter IV. Agricultural Production Behavior, Technology, and Policy

1. Technology and Agricultural Productivity

GREEN REVOLUTION AND SOURCES OF GROWTH

Agricultural production is affected by farm inputs, weather, government programs, and technological change. In many Asian countries, however, the most important factor in the substantial increase of agricultural productivity of recent years has been the introduction of land-augmenting farm technology. These farm innovations have set into motion events which have had important multiplier effects.

Since land-augmenting agricultural technology (often referred to as the "Green Revolution") was introduced in Asian countries, many studies have appeared describing its various implications for growth and income distribution.[10] These studies have acknowledged that the Green Revolution has contributed positively to agricultural growth. But they have also warned about its negative effects, at least on the distribution of income.

Rice is a staple food crop for much of Asia's population. The results reported in Table 4 indicate that, except for Thailand, the major source of increases in rice production in major Asian countries has been increases in yield per acre. Expansion of area with controlled irrigation accounted for a significant part of the increase in production attributed to the growth in area planted to rice. Increased

Table 4. Estimated relative contributions to growth in rice production in selected Asian countries at the height of the Green Revolution

			Percentage of total increased production					
		annual	attributed to area			attributed to yield		
	Year[a]	growth (in %)	Irrigated land	Rainfed & upland	Total	Fertilizer[b]	Others[c]	Total
Burma	1965–73	0.8	35.8	−23.3	12.5	47.8	39.7	87.5
India	1965–70	3.2	19.2	5.8	25.0	47.3	27.7	75.0
Indonesia	1965–72	4.8	46.4	−6.8	39.6	25.2	35.2	60.4
Philippines	1965–73	3.4	33.1	−7.7	25.4	44.5	30.1	74.6
Sri Lanka	1960–68	4.8	34.7	11.1	45.8	31.9	22.3	54.2
Thailand	1965–72	2.1	10.8	82.2	93.0	13.6	−6.6	7.0

Source: Asian Development Bank [1977].

[a] Five-year average centered on the years sown.

[b] One additional kilogram of nutrients ($N + P_2O_5 + K_2O$) is assumed to produce ten kilograms of paddy.

[c] Includes increased factor productivity resulting from new technology.

yield accounted for approximately 75 percent of the increase of rice production in India and the Philippines. The performance of high-yielding varieties of wheat was even more spectacular.[11] This is partly because the growing season of wheat and the geographical regions suitable for wheat cultivation are drier and hence subject to fewer environmental hazards than those for rice [Barker and Mangahas 1971].

A comparative analysis of the adoption of new rice technology and changes in rice farming for selected Asian countries is available in IRRI [1975, 1978b]. This study presents summary results based on farm-level research from 1971 to 1973 in thirty-six villages, fourteen study areas in six countries in Asia.[12] According to Duff [1978], there is little evidence to indicate a causal relationship between the adoption of modern rice varieties and mechanization, particularly tractors. However, water control, through the establishment of pumping units, has increased the use of modern rice varieties. According to Parthasarathy and Prasad [1978], there was significant association between farm size and adoption of modern rice varieties in both wet and dry seasons in Andhra Pradesh, an important rice growing province in India. Barker, Herdt, and Rose [1985] provided a classic survey of *The Rice Economy of Asia*, with a particularly full picture of technological change.

Wheat has also been an important component in the Green Revolution. The increase in wheat production illustrates what an outstanding research breakthrough can do when applied in a locale where there is an impressive experimental system, room to expand irrigated area rapidly, a well-developed set of institutions and facilities that can efficiently transmit knowledge, and a marketing system that can deliver production inputs and outputs. Wheat production grew rapidly primarily because of a sharp increase in yields following the widespread application of dwarf wheat varieties. This growth increased the profitability of irrigated wheat production, which in turn accelerated investment to expand cropped area. The rate of growth in irrigated area sown with wheat was dramatic. This is attributable to large, cheaply developed groundwater resources which facilitated development of private tube wells. The investment in tube wells became highly profitable after the new varieties were introduced. The rapid expansion of rural electrification further aided this growth in irrigated area. It is also significant that the infrastructure, including transportation and communication systems, were highly developed in the wheat regions of Asia; and that the wheat area had a more developed infrastructure of public services than many other regions of India.[13]

The belief that technological change helps to expand agricultural production is further corroborated by the empirical results reported in Hayami and Ruttan [1971, 1985]. These results are based on a cross-sectional analysis of thirty-eight developed and developing countries. Chemical, biological, and mechanical innovations, the use of which is determined by domestic resource endowments and

factor price ratios, are clearly important in determining growth in agricultural productivity. The study also found that the contribution of general and technical education, as a major part of the embodiment of human capital in labor, was quite large.

CONTRIBUTION AND DEMAND OF FERTILIZER

The input analysis reported in Table 5 emphasizes the dramatic change in the sources of growth of foodgrain production in India. The increased contribution of fertilizer to foodgrain production has been startling. From 1949/50 and 1960/61, the use of additional fertilizer accounted for less than 10 percent of increased foodgrain output in India, while from 1960/61 to 1973/74 it was responsible for 53 percent. Much of this increase came after fertilizer responsive crop varieties were introduced in the late 1960s and began to increase the productivity of fertilizer.[14] Increased use of fertilizer has been the single most important indicator of technological change in agriculture. It reflects increases in irrigation and the development of new crop varieties, since they raise the productivity and the profitability of using greater quantities of fertilizer.[15] However, yield response to applied fertilizer varies across soils and crops, and under different technological, management, and climatic conditions. The rice yield response to applied nitrogen, for example, varies considerably from one location to another and over time, but generally it is higher in dry season than in wet season because of greater solar energy and lower damage due to weather and insect infestation.

In India, fertilizer use is concentrated in a few districts. In northern India, fertilizer use grew at a compound annual growth rate of 38 percent from 1960-61 to 1970-71. The rapid rise in fertilizer consumption in the region in the early 1960s was associated with improvements in price ratio between fertilizer and wheat, but increases in the adoption of high-yielding wheat varieties and in controlled irrigation were probably far more important.[16] Increases in domestic fertilizer production require large capital outlays and place a heavy burden on foreign-exchange supplies, thus restricting the expansion of fertilizer supply. This and other fertilizer related policy issues and their national and farm-level implications in developing countries are discussed in Mudahar and Pinstrup-Andersen [1977] and Mudahar [1978].

The available cross-country empirical evidence on price elasticity of fertilizer demand is presented in Table 6. The large variation in elasticity estimates is partly due to differences in data, time period, methodology, definition of fertilizer, and domestic policies related to fertilizer prices. However, the tremendous variability in elasticities in Table 6 suggests highly imperfect knowledge of the relationship between fertilizer price and use. The elasticities computed vary so much because farmers typically use much less fertilizer than would be profitable in perfectly functioning markets. Hence, price may easily pick up a move toward

Table 5. Estimated contribution of agricultural inputs as a percentage of total and incremental foodgrain production in India for selected years[a]

Crop years	Unirrigated land and labor on it		Irrigated land and labor on it		Intensification of labor		Inorganic fertilizer	
	Total	Incremental	Total	Incremental	Total	Incremental	Total	Incremental
1956-57	73	–	22	–	4	–	1	–
1960-61	68	20	21	14	9	55	2	11
1964-65	63	6	21	21	11	34	5	38
1970-71	51	−5	22	29	12	16	15	59
1973-74	47	−5	22	22	13	30	18	53
1978-79[b]	38	10	19	6	13	10	30	76
1983-84[b]	31	0	17	10	12	9	40	79

Source: Mellor [1976, Appendix Table 9].

[a] The percentages of incremental contribution have been taken from the increments to foodgrain production from one selected year to the next. The 1978-79 and 1983-84 data are extrapolations. New technology played a key role in determining the levels of factor productivity, particularly for fertilizer, that lie behind the numbers presented.

[b] Extrapolations.

Table 6. Summary of fertilizer demand studies and price elasticity of demand for fertilizer[a]

Country/region	Fertilizer	Time period	Elasticity of demand		Adjustment coefficient	Source
			Short run	Long run		
Asia						
India	N	1953/54–1967/68	−0.31[b]	-0.34	0.92	M. S. Rao [1974]
India	N	1953/54–1967/68	−0.53[c]	−6.63	0.08	M. S. Rao [1974]
India	N	1958/59–1963/64	−1.20[b]	−2.50	0.50	Parikh [1966]
Japan	NPK	1883–1937	–	−0.74[d]	–	Hayami [1964]
Korea	NPK	1960–72	−0.17	−0.88	0.20	Sung, Dahl, and Shim [1973]
Korea	NPK	1971	−0.70[d]	–	–	Shim, Dahl, and Sung [1974]
Pakistan	N	1959/60–1972/73	−0.52[d]	–	–	Salam [1975]
Philippines	N	1958–72	−0.59[d]	–	–	Rodriguez [1974]
Taiwan	N	1950–66	−0.55[c]	–	–	Hsu [1972]
Taiwan	N	1950–66	−2.03[d]	−2.99	0.68	Hsu [1972]
Thailand	NPK	1954–72	−0.29[c]	–	–	Puapanichaya [1976]
Thailand	NPK	1954–72	−0.27[c]	−0.37	0.72	Puapanichaya [1976]
Other countries						
Brazil	NPK	1949–71	−1.12[d]	–	–	Larson and Cibautos [1974]
Brazil	NPK	1949–71	−0.33	−1.94	0.17	Larson and Cibautos [1974]
United States	NPK	1911–56	−0.53	−2.99	0.23	Griliches [1958a]

[a] Many of these studies have also been summarized in Mudahar [1978] and Timmer [1974c]. Short-run elasticity = adjustment coefficient × long-run elasticity.

[b] Denotes significance between 0.7 and 0.8.

[c] Denotes significance between 0.8 and 0.9.

[d] Denotes significance at 0.9 or higher.

"equilibrium" involved in improved policies, distribution networks or even technology, depending on the specification of the model.

ROLE OF IRRIGATION AND WATER MANAGEMENT

A comprehensive list of publications dealing with social and economic aspects of irrigation systems in Asia was compiled by IRRI [1976]. This bibliography covers materials up to mid-1970s and includes a total of 689 publications. It is divided into eight categories: economic analysis of design and construction of irrigation and drainage systems; operation and management of irrigation systems; irrigation policy and planning; economic analysis of irrigation performance; water rates; social and institutional factors in irrigation; interaction of irrigation systems with their environments; and selected technical issues in the design and operation of irrigation systems. About 75 percent of the publications covered in this bibliography dealt with three topics: irrigation policy and planning, economic analysis of irrigation performance, and social and institutional factors in irrigation.

Irrigation and water management reduce risk and increase agricultural production. Irrigation increases crop yields at existing levels of inputs, allows application of higher levels of inputs, increases cropping intensity through multiple cropping and makes it possible to grow modern crop varieties and high value cash crops. According to Bagi [1981c], irrigated farms used much larger amounts of labor per unit of land as compared to unirrigated farms in crop production in Haryana, India. The availability of irrigation and efficient water management can substantially increase agricultural production, farm employment and farm income. Increased farm income, in turn, increases farm investment as well as backward and forward linkages between production and consumption.

Irrigation and water management have contributed significantly to agricultural development in Asia by increasing crop production and reducing production risks. However, the analysis of irrigation projects, allocation of water and water use efficiency, water pricing policies, and equity effects of irrigation has received growing attention from economists only in the last few years. According to Kikuchi and Hayami [1978a], the efforts to develop irrigation systems in the Philippines were induced largely by an increase in the social rates of return to investment in irrigation [also see Feeny 1983a]. The increase in social profitability to investment in irrigation was due to the introduction of modern rice varieties, changes in the world price of rice, and a rise in the cost of bringing new land under cultivation. The desire to become self-sufficient in food production and to improve food security has motivated many governments in Asia to make large investments in irrigation.

A research seminar on irrigation systems in Southeast Asia was held at IRRI during 1976 and the papers are published in the proceedings [IRRI, 1978c].[17]

Some of the key conclusions of this seminar were: the development of irrigation systems in areas where farmers are small and poor would promote equity; since large-scale irrigation projects are always subsidized, landowners receive windfall gains through an increased value of their lands; and higher water charges alone may not provide incentives for more efficient use of irrigation water.

A series of studies commissioned by IFPRI, however, shows that participation in the benefits from irrigation has a broad base and includes small farmers and landless laborers. Much of the gain from the increased value of land accrues directly to small owner-operators [Mongkolsmai, 1985; Paris and Pascual, 1984; Prabowo, 1985; Sriswasdilek and Wattanutchariya, 1985].

The relative success of a number of Asian countries in achieving at least short-term self-sufficiency in rice, combined with increasing investment costs for irrigation and declining real rice prices, has rekindled debate on the efficiency of irrigation investment. In a number of countries, there has been a substantial shift of resources from new construction to rehabilitation and upgrading of infrastructure and management of existing systems. There is much debate about the benefits of these investments. Chambers [1987] suggests that the payoffs to improved main system management in South Asia could be very large. However, other recent analyses indicate that the returns to rehabilitation and management improvement may be lower in general than the returns to investment in small and medium scale new irrigation systems in the Philippines [Rosegrant, 1985; Rosegrant, Gonzales, *et al.*, 1987] and in Indonesia [Rosegrant, Kasryno, *et al.*, 1987]. Weaver [in Mellor, Weaver, Lele, and Simon, 1968] in an earlier work reports similarly on the failure to develop tertiary channels and management as deriving from basic flaws in management and design upstream.

No one denies the large direct and indirect contributions of irrigation and water management to agricultural development in Asia. However, this should not lead planners and policymakers to ignore other investment opportunities in agriculture which may have the potential of even higher rates of return. For example, modern rice technology is most suitable for irrigated rice, yet a large share of rice in Asia is still rainfed. Barker and Herdt [1979, p. 29] concluded:

> Asian governments, particularly among the rice-importing countries, are likely to emphasize irrigation as a fairly sure but costly means of increasing rice production and achieving price and political stability. However, if the estimates of the potential for yield increase in rainfed rice are correct, the total benefits for the Asian economies may be greater if more emphasis is given to research on rainfed rice problems.

Clearly, this calls for greater efforts in determining economic returns from alter-

native investment opportunities for different technology regimes for a specific crop.

CONSTRAINTS TO HIGHER CROP YIELDS

The Green Revolution has been concentrated in wheat and rice areas with well developed irrigation systems and institutional networks. The arid and semiarid areas in Asia are still experiencing little technological change in agriculture. This is due to limited technological possibilities, high risk, and serious socioeconomic constraints [ICRISAT, 1980]. Binswanger, Jodha, and Barah [1980], based on a survey of sample farms in the semiarid tropics of India, concluded that income risk is high and it is primarily due to production rather than price risk, virtually all farmers are risk-averse; high-risk and risk-averse attitudes of farmers lead to underinvestment in agriculture in the semiarid tropics. However, the extent of underinvestment relative to socially optimal levels may prove to be quite small.

Despite large increases in average rice yields in Asia, the gap between the potential and actual rice yields is still quite large. In recognition of this yield gap, IRRI initiated a yield constraints project in 1974 to determine the role of biological and socioeconomic constraints in explaining yield gaps.[18] The results of these country studies are summarized in IRRI [1977], and IRRI [1979a]. According to Barker [1979], the maximum rice yields on experiment stations were between 4.5 to 5.5 mt/ha in wet season and between 5.5 to 6.5 mt/ha in dry season. The actual national average rice yield of about 2 mt/ha was much lower than potential yield. Lack of control over water, low levels of fertilizer use and high risk appear to be important constraints to expanded rice yields. Herdt [1979] concluded that, given various constraints, the available technology is being used to its potential. For future growth, the development of technology must be accompanied by institutional reforms that make current technology more attractive to farmers. This was further emphasized by Ruttan [1978].

The policy and institutionally related questions of technological advance were addressed in the "Stanford Project on the Political Economy of Rice in Asia." The purpose of this project was to trace the history of rice policies in several Asian countries and to understand the causal mechanisms in formulating national rice policy. These comparative rice policy studies go beyond the narrow economic factors in understanding the formulation and implementation of national rice policies and in understanding the behavior of policymakers. The overall methodology and results are summarized in Timmer [1975a, c]; and the results of individual country studies are summarized in Timmer [1975b] for Indonesia; Siamwalla [1975] for Thailand; R. H. Goldman [1975] for Malaysia; Mangahas [1975] for Philippines; Hayami [1975a] for Japan; Moon [1975] for South Korea; and Chen, Hsu, and Mao [1975] for Taiwan. A related set of studies on comparative advantage, government policies, and international trade in rice, covering

Indonesia, Philippines, Taiwan, and Thailand, is reported in Pearson, Akrasanee, and Nelson [1976], and Monke, Pearson, and Akrasanee [1976]. A more recent set of papers on rice price policy in China, Indonesia, Nepal, Philippines, South Korea, and Thailand can be found in Sicular [1989a].

VARIABILITY IN CEREAL PRODUCTION

As has been discussed in the previous sections, the introduction of modern agricultural technology (including modern seeds, fertilizer, and irrigation) has resulted in impressive growth in food production, particularly cereal production, in many developing countries, especially Asian countries. However, as cereal production has grown so has year-to-year variability in cereal production. The primary source of cereal production variability has been variability in cereal yields. These issues have been addressed in a series of studies carried out at IFPRI which include J. R. Anderson, Hazell, and Evans [1987], J. R. Anderson and Hazell, eds. [1989], Hazell [1982, 1984, 1985, 1986], and Mehra [1981]. The variability in cereal yields has been attributed to biological, climatic, and economic factors. Any strategy designed to minimize fluctuations and variability in crop yields has important implications for agricultural research and agricultural policies such as crop insurance, crop diversification, marketing, and buffer stock arrangements.

Several other follow-up studies, including Sahn, ed. [1989] and Sahn and von Braun [1987], examine the relationship between food production and consumption variability. An analysis of data from thirty-eight countries by Sahn and von Braun [1987] indicates that increased production variability does translate into increased variability in consumption; year-to-year consumption variability has declined during the past twenty-five years, mainly due to stocking operations and trade practices; and food insecurity, as measured in terms of fluctuations around trend levels of consumption, does remain a problem, especially for the poor. Consumption variability can be reduced through appropriate technology, trade, storage, and pricing policies.

2. Farm Size, Productivity, and Resource Allocation

INVERSE RELATIONSHIP BETWEEN FARM SIZE AND PRODUCTIVITY

The empirical relationship between farm size and productivity in land scarce Asian countries has important policy implications for agricultural development strategy, land reforms, and agricultural taxation.

Studies based mainly on "Farm Management Data" collected in the 1950s from selected districts in India show that farm size and productivity are inversely related in traditional agriculture.[19] This relationship has important implications for policies affecting land reform and farm organization, as it implies that output could be increased simply by dividing large farms into small ones. In other words, land reform can improve both equity and efficiency. The controversy on

the farm-size issue has been argued at great lengths for India and that controversy illuminates the issue well, hence we report it in some detail.

A. K. Sen [1962, 1964] hypothesized that high labor input and low labor costs were responsible for higher productivity on small farms. This explanation was later questioned by P. K. Bardhan [1973] on the grounds that dual labor markets cannot exist.[20] However, empirical support for A. K. Sen's explanation can still be found by explicitly incorporating differences between the quality of hired and family labor. Family, as compared to hired, labor is relatively more productive, works harder and longer, and requires less supervision.

Khusro [1964] hypothesized that the inverse relationship between farm size and productivity is explained by differences in soil fer tility. Small farms may be more fertile either because the soil is managed better or because the quality of land is better [Bardhan, 1973]. According to Khusro [1964] for India and Roumasset [1976] for rice in the Philippines, if land quality is accounted for, the inverse relationship disappears. It might also be true that higher irrigation and cropping intensities on small farms make them more productive than large ones.

Rudra [1968a, b], on the other hand, questioned the statistical validity of the inverse relationship. According to Rudra, this relationship is partly the result of aggregation and might disappear if ungrouped data were used. Most of the Indian studies, which verify the inverse relationship statistically, use data from the 1950s. At that time, Indian agriculture was characterized by the absence of technological change and little use of modern inputs. On the other hand, during the 1960s and 1970s, the major sources of growth in agricultural production were capital and such modern farm inputs as high-yielding crop varieties, fertilizer, insecticides, and controlled water.

The inverse relationship between farm size and productivity does not exist for crops characterized by improved production technologies [Ghosh, 1986; and A. Sen, 1981]. In modern agriculture, the role of purchased farm inputs becomes crucial, with limited possibilities of substitution between labor and purchased farm inputs. It is well established that the small farmers, as compared to large farmers, have relatively limited access to credit and purchased inputs. As a result, the small farmers may not be able to apply optimal amounts of purchased modern farm inputs and the relationship between farm size and productivity may eventually become positive. In a detailed survey of small farmers in South Asia, I. J. Singh [1988a] has summarized the empirical evidence which shows that the inverse relationship between farm size and productivity held during the pre-HYV period but does not hold during the post-HYV period.

Based on a large sample of farmers in Punjab, S. S. Sidhu [1974a] found that the technical efficiency of small and large farmers producing wheat was about the same. Johl [1973a], on the other hand, observed a positive relationship between farm size and productivity in Punjab, as did Utami and Ihalauw [1973] in a sam-

ple survey of rice farmers in central Java, Indonesia (where farm size is small even by Asian standards) during 1971. This positive relationship can be explained by the better access large farmers have to scientific information, modern farm technology, and financial institutions or by their ability to use fertilizers and mechanization to overcome land quality and labor constraints.

It has been suggested that small farmers achieve higher crop yields at higher cost of production per unit of land by using relatively more labor and animal draft power. Consequently, economic efficiency on small farms is likely to be lower than on large farms. In the absence of gainful off-farm employment for family labor, however, the opportunity cost is lower than the market wage rate paid to hired labor [Bagi, 1983a; and A. K. Sen, 1962, 1964, 1966]. As a result, the use of market wage rate tends to overestimate labor and hence production costs. Yotopoulos and Lau [1973] estimated the relative economic efficiency of small and large farms in India using the concept of restricted profit function and concluded that small farms had higher relative economic efficiency than that of large farms. S. S. Sidhu [1974a] used farm level data for wheat production in Punjab to estimate a similar model and concluded that there was no difference in the economic efficiency of small and large farms.

Economic efficiency is a combination of technical and allocative efficiency [Yotopoulos and Lau, 1973]. Technical efficiency refers to the ability to produce maximum output from a given set of inputs; whereas, allocative efficiency refers to the ability to choose an optimal combination of inputs for a given set of input and output prices. More recent analysis based on farm level data in India found no definite superiority in economic efficiency, or its technical and allocative efficiency components, for either group of farms [Huang and Bagi, 1984; and Huang, Tang, and Bagi, 1986]. These results indicate that there is no convincing economic case for land redistribution or land ceiling, except for socio-political considerations.

The major policy question remains unsettled. Can rural unemployment and mass poverty be reduced by redistributing land and reducing farm size? Ladejinsky [1972] observed that an emphasis on a land ceiling in India can lead a government to neglect land reform measures such as increasing security for tenants, regulating land rents and farm wages, and consolidating land. C. H. H. Rao [1970] emphasized the need for more responsive credit institutions to serve small farmers in their efforts to modernize agriculture. C. H. H. Rao and Subbarao [1976] concluded that market imperfections do not put small farmers in India at as great a disadvantage in marketing rice as is generally believed. Instead, the lack of a well-developed infrastructure reduces the marketing efficiency of both small and large farmers.

Two other important questions need to be addressed. What farm size is optimal, taking both efficiency and equity into consideration? And, is there a rela-

tionship between farm size and the adoption of modern farm technology, including farm machinery? According to Schultz [1964, p. 111], "The size of farms may change as a consequence of the transformation, . . . but changes in size are not the source of the economic growth to be had from the modernization process." Barraclough [1967, p. 264] added that "when a society's institutional parameters are in flux and the kinds of activities carried out by the farm unit are themselves changing, there is no possibility of identifying optimum-size farms."

A related concept is the relationship between farm size and returns to scale in agricultural production. In order to formulate appropriate policies on farm organization, information on the economies and diseconomies of scale is needed. Empirical investigations carried out in Asia, most of which used the standard Cobb-Douglas production function in log-linear form, indicate that agricultural production is generally ruled by constant returns to scale.[21] The obvious inconsistency between the inverse relationship of farm size and productivity and constant returns to scale can be explained by the law of variable proportions.

In real farm situations, not all inputs increase in the same proportion. In determining optimum farm size, "an appeal to the concept of 'returns to scale' is, as a rule, barren because the transformation of traditional agriculture always entails the introduction of one or more new agricultural factors" [Schultz, 1964, p. 111]. In most Asian countries, agricultural land is becoming a serious constraint on the expansion of agricultural production. This implies that if agriculture is to be modernized, some inputs are needed more than others, new inputs should be brought into the production process, and input substitution possibilities should be explored.

EFFICIENCY OF RESOURCE ALLOCATION IN AGRICULTURE

To transform traditional agriculture and to expand the contributions of agriculture to economic development, there is a need both to determine the efficiency of resource allocation in agriculture and to formulate public policies that would remove inefficiencies in agricultural production. Schultz [1964, p. 27], in his classic book *Transforming Traditional Agriculture*, maintained that "there are comparatively few significant inefficiencies in the allocation of the factors of production in traditional agriculture." Consequently, agriculture cannot be modernized merely by altering the prevailing pattern of resource allocation in the absence of technological change.

In Asia, a high proportion of the empirical studies evaluating the efficiency of resource allocation in agriculture have been conducted in India.[22] The major impetus for most of these studies came from the "Farm Management Data" collected in different states of India during the 1950s. Resource allocation was evaluated by estimating agricultural production functions (usually of the Cobb-Douglas type) and then comparing the computed marginal value products for

different factors with their corresponding market prices. Equality between the marginal value product and market price of different inputs implied that resources were allocated efficiently.

The main conclusions of aggregate studies using "Farm Management Data" are that the variable factors of production are allocated and used efficiently but that bullocks, fixed factors, and the main source of draft power, are not. Bullocks are used uneconomically mainly because of resource fixity and because of diseconomies of scale. This puts into question the relevance of an approach that, in analyzing the efficiency of resource allocation for a particular enterprise, measures capital input as a flow. Econometric studies indicate that resources in India are allocated with no significant inefficiencies. On the other hand, D. K. Desai [1963], in a linear programming study of resource use in Maharashtra, showed that resources are allocated inefficiently, as gaps between actual and potential agriculture output indicate.[23] This raises a question about the relevance and ability of different methodological approaches to analyze the efficiency of resource allocation. Also, one can always question the appropriateness of prevailing factor prices in evaluating the efficiency of resource allocation in agriculture, using an aggregate production function.

Most of these studies deal with the period before the Green Revolution in India. Not only has the use of modern factors of production, especially fertilizer, become popular but bullocks are being replaced gradually by tractors. The Government of India [1976] study concludes that "the studies available so far could not be considered adequate enough in coverage to provide guidance in policy formulation" for tractorization [vol. I, p. 445]. Similarly, A. K. Sen [1975a, p. 164] observed that "the factual picture is unclear, e.g., the extent of the yield impact of tractorization has not yet been isolated from variations in other factors not complementary to tractor use for a sufficiently large number of cases." Because tractors are indivisible, used for several purposes, and used in all enterprises, how to measure their economic efficiency and their contribution to agricultural production presents serious analytical questions. Furthermore, a farmer does not have to own a tractor to make use of it. In many Asian countries, farmers hire the services of tractors in order to perform specific farm operations on time and more efficiently.

Finally, most of the studies discussed were based on the standard neoclassical approach. Day and I. J. Singh [1977, p. ix] argued that agricultural development theory based on neoclassical economics "underplays the complexity of technology, overplays the rationality and information content of decisions, and exaggerates the equilibrium and efficiency of market." Consequently, where reality contradicts the underlying key assumptions of studies, their results may be of little relevance (or may even be misleading) to policymakers.

3. Tenancy, Productivity, and Resource Allocation

TENANCY ARRANGEMENT

Most of the studies that used "Farm Management Data" deal with the owner-operated farms, yet tenancy is prevalent all over Asia, including India. According to traditional theory, resources are allocated inefficiently under share tenancy mainly because of a lack of incentives.[24] However, Cheung [1969, pp. 3-4], based on Taiwan's experience, rejected the inefficiency argument and concluded that

> resource allocation under private property rights is the same whether the landowner cultivates the land himself, hires farm hands to do the tilling, leases his holding on a fixed-rent basis, or shares the actual yield with his tenant. In other words, different contractual arrangements do not imply different efficiencies of resource use as long as these arrangements are themselves aspects of private property rights.

Sharecropping exists for several reasons. First, sharecropping helps tenants share the risk and uncertainty in crop production, since tenants may not have risk-bearing ability to rent-in land for cash. Second, tenants may not have the necessary cash or ability to borrow in order to rent-in land and purchase modern farm inputs. Third, tenants may be able to borrow from landlords and may even be able to share the cost of inputs. Fourth, landowners will feel safe to lend to tenants since they will be able to recover their loan with interest at the time of harvest. Fifth, landowners have the opportunity to participate in decisions related to farm operations, crop selection, and input use. Sixth, if tenants are faced with the challenge of making a subsistence living from sharecropping, they will have the incentive to produce the maximum possible output from available inputs and do a better job at managing farm operations. In this case, landowners may be able to share higher crop output due to tenant's hard work.

The sharecropping contracts, however, may vary in different parts of the world and even within small geographical areas. The neo-marxian explanation for this variation is based on the degree of economic dominance of the landowner relative to the economic deprivation of the tenant. Since the relative bargaining power of the two parties varies in individual cases, the prevailing sharecropping contracts can also vary. On the other hand, the neo-classical explanation for this variation is based on the degree of contribution of landowner relative to tenant. According to this view, the output and input shares of the two parties may seem to be uniform in sharecropping contracts in a small geographical area. The actual contribution and reciprocal obligations, however, may vary in every case.

According to the Marxian view, landowners exploit the tenant and the extent of this exploitation will depend on the relative economic and hence the bargain-

ing power of the two parties [Bhaduri, 1983]. On the other hand, the neo-classical view denies the possibility of exploitation since the actual shares in crop output represents the return to monetary as well as nonmonetary favors and reciprocal obligations. In many densely populated developing Asian countries, there are large number of small and marginal farmers who must depend on sharecropping for their subsistence. Land available for sharecropping is limited and it gives enormous bargaining advantage to landowners. This can create a strong temptation for the landowners to exploit tenants. Whether such exploitation actually happens may vary from one case to another.

RELATIVE EFFICIENCY OF SHARECROPPING

There has been a debate on the relative efficiency of sharecropping as compared to owner-operated and other forms of tenancy arrangements [Byres, 1983]. In case landowners exploit tenants, tenants will not have the incentive to apply optimal level of inputs and perform various farm operations efficiently. As a result, suboptimal application of inputs will lead to economic inefficiency. This view is represented by P. K. Bardhan and Srinivasan [1971]. On the other hand, when off-farm gainful employment opportunities are limited and there is excess demand for rented land, sharecropping can be as efficient as other forms of tenancy, even if tenants receive less than their fair share. When there is competition for limited rental land, landowners have the opportunity to choose the most efficient sharecroppers. The challenge of making a living and competition among sharecroppers forces the tenants to apply optimal levels of farm inputs and be efficient producers [D. G. Johnson, 1950].

On the other hand, if the neo-classical view is correct and the output shares received by the landowner and the tenant truly reflect their contributions, the efficiency on sharecropped land may not be any different from that on cash rented and owner-operated land. Furthermore, if owner-operated or cash rented farms do not have necessary resources to apply optimal levels of inputs, whereas the sharecropping farms are able to do so, the efficiency of sharecropping may actually be higher than owner-operator and other forms of tenancy. According to Bagi [1981b], there was no significant difference in the technical efficiency of the owner-operated and sharecropped farms when both irrigated and unirrigated farms were aggregated. However, when irrigated farms were analyzed separately, technical efficiency was significantly higher on sharecropped farms than on owner-operated farms. Furthermore, sharecropped farms made more intensive use of labor than owner-operated farms, thereby having positive implications for employment in labor-abundant Asian countries.

Sharecropping may be more prevalent in traditional agriculture when agricultural production is primarily nonmechanized and highly labor intensive. As the agricultural sector modernizes, it may become possible for most of the large

landowners to purchase farm machinery and cultivate the entire land by themselves [A. Sen, 1981]. The supply and use of modern farm inputs such as disease-resistant high-yielding crop varieties, fertilizers, pesticides, herbicides, and irrigation increase crop output; increase net farm income per unit of land; and reduce risk in crop production. All these factors tend to reduce the need for sharecropping arrangements. The incidence of sharecropping may decline with general economic development of a region or country, but it may not totally disappear, as long as there are sound economic reasons for its existence.

In analyzing fertilizer use behavior, Minhas and Srinivasan [1966] assumed that the greater the share of the crop a share tenant has, the more fertilizer he will use. C. H. H. Rao [1971] argued that sharecropping is more prevalent for those crops and areas with little entrepreneurship, little substitution between crops, and a negligible amount of uncertainty. According to C. H. H. Rao, fixed contractual arrangements may be more prevalent where uncertainty is high. He also speculated that fixed contractual arrangements may be preferred to crop-sharing arrangements after modern farm technology is adopted. P. K. Bardhan and Srinivasan [1971] also rejected Cheung's argument that resource allocation under share tenancy is efficient.

More recently, Reid [1976, p. 576], using theoretical analysis, argued that "gain from the joining of tenant and landlord interests, not gain from the dispersion of agriculture risk, is the impetus to share tenancy, and that sharecropping is chosen for its efficiency, not in spite of its inefficiency or efficiency." As C. H. H. Rao [1971] and Day [1967] argued, the efficiency of a sharecropping arrangement depends on the farm technology used and on how risk and management tasks are shared. Most of these issues were discussed in detail in Roumasset [1976]. He also argued, in contrast to the prevailing view, that risk aversion does not inhibit the use of modern farm inputs. This conclusion was based on a sample of Filipino rice farmers and his analysis of the decision to use nitrogen fertilizer.

The empirical evidence on the efficiency of share tenancy remains inconclusive. If share tenancy is as efficient as owner-operator arrangements, and if efficiency is the only objective, then the case for land reforms is weakened.[25] Since existing agricultural institutions tend to be geared to serve the interests of landlords, there is a need to analyze the access tenants have to these services and its implications for resource use and agricultural output.[26]

4. Rationality, Incentives, and Price Policy

SUPPLY RESPONSE AND PRICE POLICY

Relative prices have a significant role to play in transforming a traditional agricultural sector into a modern and dynamic sector. That, of course, presumes that farmers and others respond to changing price incentives. The rationality of

farmers in traditional agriculture was once a controversial issue. In view of this, a large number of supply response studies were undertaken with a principal aim of demonstrating a farmer response to price as a means of demonstrating farmer rationality. Tables 7 and 8 report results from a substantial number of those studies. They clearly show response and contribute to T. W. Schultz's [1964] finding of farmer rationality.

Having once established farmer rationality, more complex problems remain. The term supply response has often been used vaguely. There are important empirical distinctions between the response to price changes of area sown with individual crops, of total cropped area, of crop yields, and of aggregate agricultural production. Furthermore, the price in question could be the price of a specific output, the price of one output relative to another, or the relative price of inputs and outputs. Most empirical supply response studies, however, deal with acreage (as opposed to production) response of individual crops to changes in relative output prices.[27]

The differences in the size of the price elasticities, even for the same crop in the same region, are large [Tables 7 and 8]. These differences are caused by differences in the time period and length of time series data; the nature of dependent variables: for instance, area can be irrigated, unirrigated, total, standardized, change over time, or a ratio; the price variable used, such as the specific output price, the price index, the relative output price, and the competing crop used to obtain relative output price; and the nature of the model, its specification, and the techniques used to estimate it.[28]

The voluminous literature on acreage response has left several questions unsettled. There are still large gaps in our knowledge about aggregate production behavior, though the limited evidence available, for example, from Herdt [1970], Barnum [1973], and Bapna [1980], indicates that the price elasticity of aggregate agricultural output is low at between 0.1 and 0.2. The price elasticity for cash crops is presumed to be higher than for food crops, perhaps because they tend to occupy a smaller area. It has become routine to estimate short-term elasticity, long-term elasticity, and coefficient of adjustment. Little is known, however, about what determines a coefficient of adjustment. The meaning and relevance to policymakers of long-term elasticity remain uncertain. We still know little of how the farmer allocates nonland production resources in response to price policy and what effect price policy has on technological change in agriculture.[29] Mellor and Ahmed, eds. [1988], in a compendium of papers, specifically address price policy in the context of technological change. They conclude that technological change introduces substantial problems of instability and potential secular decline in prices that price policy must address but it does so in a favorable environment of declining costs of production.

Table 7. Summary of selected acreage response studies for food crops in Asia

Table 7. Summary of selected acreage response studies for food crops in Asia

Crop	Country/region	Time period	Price elasticity[a]		Dependent variable	Source
			Short run	Long run		
Rice	India-Pakistan/Punjab	1914/15-1945/46	0.31	0.59	Standard irrigation area	R. Krishna [1963]
	India/Punjab	1951-64	0.24	0.40	Area	Kaul [1967]
	India/Punjab	1948/49-1965/66	0.33	0.38	Standard irrigated area	Maji, *et al.* [1971]
	Bangladesh (9 districts)[b]	1948/49-1962/63	0.12	–	Rice area relative to rice and jute area	Hussain [1964]
	Philippines/Central Luzon	1953/54-1963/64	0.13-0.27	0.62-2.15	Area	Mangahas, *et al.* [1966]
	Indonesia	1951-62	0.30	–	Area	Fletcher and Mubyarto [1966]
	Thailand	1940-64	0.18	0.31	Area	Behrman [1968]
Wheat	India-Pakistan/Punjab	1914/15-1943/44	0.08	0.14	Standard irrigated area	R. Krishna [1963]
	India/Punjab	1951-64	0.08	0.09	Area	Kaul [1967]
	India/Punjab	1948/49-1965/66	0.67	0.67	Standard irrigated area	Maji, *et al.* [1971]
	India/Uttar Pradesh	1950/51-1962/63	0.21	0.64	Area	J. Krishna and M.S. Rao [1967]
	Pakistan (7 districts)	1933/34-1958/59	0.10-0.20	–	Percent change in irrigated area	Falcon [1964]
Corn[c]	India-Pakistan/Punjab	1914/15-1943/44	0.23	0.56	Standard irrigated area	R. Krishna [1963]
	India/Punjab	1948/49-1965/66	0.49	0.54	Standard irrigated area	Maji, *et al.* [1971]
	Philippines	1946/47-1963/64	0.07	0.42	Area	Mangahas, *et al.* [1966]
	Thailand (8 corn regions)	1950-63	1.03	2.29	Area	Behrman [1968]
Sorghum	India-Pakistan/Punjab	1914/15-1943/44	–	−0.58	Unirrigated area	R. Krishna [1963]
	India/Tamil Nadu	1947-65	0.20	0.28	Area	Madhavan [1972]
Bajra[d]	India-Pakistan/Punjab	1914/15-1945/46	0.09	0.36	Unirrigated area	R. Krishna [1963]
	India/Punjab	1951-64	0.05	0.06	Area	Kaul [1967]
	India/Tamil Nadu	1942-66	0.03	0.15	Area	Madhavan [1972]
Barley	India-Pakistan/Punjab	1914/15-1945/46	0.39	0.50	Unirrigated area	R. Krishna [1963]
	India/Punjab	1951-64	0.53	0.60	Area	Kaul [1967]
Gram[e]	India-Pakistan/Punjab	1914/15-1945/46	–	−0.33	Unirrigated area	R. Krishna [1963]
	India/Punjab	1951-64	−0.30	−0.65	Area	Kaul [1967]

[a] Short-run elasticity = coefficient of adjustment × long-run elasticity.
[b] Summer rice only.
[c] Maize.
[d] Millet.
[e] Chickpeas.

Table 8. Summary of selected acreage response studies for cash crops in Asia

Crop	Country/region	Time period	Price elasticity[a]		Dependent variable	Source
			Short run	Long run		
Cotton	India-Pakistan/Punjab (American cotton)	1922/23-1941/42	0.72	1.62	Standard irrigated area	R. Krishna [1963]
	India-Punjab (American cotton)	1951-64	0.34	2.84	Area	Kaul [1967]
	India-Pakistan/Punjab (Desi cotton)	1922/23-1943/44	0.59	1.08	Standard irrigated area	R. Krishna [1963]
	India/Punjab (Desi cotton)	1951-64	0.29	1.19	Area	Kaul [1967]
	Pakistan (8 districts)	1933/34-1958/59	0.41	–	Percent change in area	Falcon [1964]
Sugarcane	India-Pakistan/Punjab	1915/16-1943/44	0.34	0.60	Standard irrigated area	R. Krishna [1963]
	India/Punjab	1951-64	0.09	0.73	Area	Kaul [1967]
	India/North Bihar	1950/51-1964/65	0.66	0.79	Area	D. Jha [1970]
	India/Tamil Nadu	1947-65	0.63	0.76	Area	Madhavan [1972]
Groundnuts	India/Tamil Nadu	1947-65	0.34	0.65	Area	Madhavan [1972]
	India/Andhra Pradesh	1930/31-1943/43	0.76	–	Area	Reddy [1970]
Jute	India-Pakistan	1911-38	0.46	0.73	Area	Venkataramanan [1958]
	Bangladesh (9 districts)	1948/49-1962/63	0.42	–	Jute area relative to rice and jute area	Hussain [1964]

[a] Short-run elasticity = coefficient of adjustment × long-run elasticity.

The role of price and nonprice factors in raising agricultural output has also been reviewed by Chhibber [1988]. The available evidence indicates that in developing countries the long-run aggregate supply elasticity of agriculture with respect to price is in the range of 0.3 to 0.9. The elasticity is not greater than 1.0, as is sometimes claimed by those who ascribe primacy to price policy. On the other hand, elasticity is not as low as zero, as claimed by those who view price policy effects as insignificant. The price elasticity is in the range of 0.6 and 0.9 in relatively advanced and land-abundant countries, and around 0.2 to 0.5 in developing countries with inadequate infrastructure. The supply elasticity with respect to nonprice factors (public goods and services) tends to be much higher. It is around 1.0 in countries with inadequate infrastructure, imperfect markets, limited capital, and lack of private research organization. On the other hand, the supply elasticity to nonprice factors in developing countries with better developed infrastructure is smaller.

The available empirical evidence indicates that there is a need for a judicious blend of improvements in price incentives and nonprice factors such as infrastructure, technology, delivery systems, and services. These results have also been supported by a study conducted by Binswanger, Khandker, and Rosenzweig [1989] on the impact of infrastructure and financial institutions on agricultural output and investment in India. The study covers 1960/61 to 1980/81 period and is based on panel data from eighty-five randomly selected districts from thirteen states in India. Based on detailed empirical analysis, they conclude that prices really do matter but so do infrastructure, markets, and banks.

From a policy point of view, it is important to recognize the conflicting roles of relative prices in allocating resources, in distributing incomes, and in capital formation [Mellor, 1968, 1969a, 1978]. These conflicts limit the scope for public policy in manipulating prices and raise complex welfare questions.[30] Finally, although a less researched issue in Asia, the effect of a broad macro policy on exchange rates and hence on relative prices of agricultural tradeables to nontradeables is still significant [Bautista, 1987]. In particular, pro-industry trade policies may result in unfavorable price relations for agriculture.

The distortions in price policy and lack of necessary incentives are quite common in most developing countries [Schultz, ed. 1978]. The empirical evidence, however, does confirm that prices play a significant role in achieving specific policy goals in economic development. Varying relative crop prices can induce a shift of area from one crop to another. But with technology stagnant and with few purchased inputs, such a shift cannot increase the aggregate foodgrain supply, as foodgrains already occupy the bulk of cultivated area. Agricultural prices influence the balance between agricultural and industrial development through labor and capital flows across sectors. But initial disequilibrium and many other forces are at work. Prices are important in distributing the benefits and losses of

growth. Yet, there are large gaps in our knowledge about the effects of price policy on irrigation and the use of fertilizers and about the relative merits of output price support and input subsidy programs.[31]

CROP PRICE SUPPORT AND INPUT SUBSIDY

The discussion related to crop price support and input subsidy programs is summarized in Barker and Hayami [1976], Mudahar and Pinstrup-Andersen [1977], Mudahar [1978], R. Ahmed [1978, 1979], Bagi [1984], Timmer [1986a], and Mellor and R. Ahmed, eds. [1988]. Both crop price support and input subsidy programs can increase the output of a specific crop but initially the main beneficiaries are those farmers who have positive marketable surplus of that crop. Input subsidies, on the other hand, can increase the output of all crops that use the subsidized input, provided there is enough supply to satisfy increased demand for that input due to the price subsidy. In a regime of input scarcity, however, large and influential farmers will be able to purchase more and the smaller farmers will be squeezed out of the market. Input subsidy programs targeted at a single crop often do not work due to leakages.

Crop price support and input subsidy programs are non-neutral to farm size because the gains to the producers from these policies are more or less directly related to the size of crop output sold or quantity of inputs purchased. Economic incentives provided through crop price supports and/or input price subsidies are essential to adopt modern technology and increase agricultural output. However, economic incentives must be accompanied by investment in infrastructure, agricultural research, irrigation systems, and technology transfer in order to have greater social rates of return and higher agricultural growth.

Both crop price support and input subsidies tend to be biased in favor of large farmers. The small and marginal farmer with no marketable surplus may actually end up spending more on consumption, if they are net buyers of that commodity. In the absence of technological change and increases in area for the target crop, an increase in output will be at a higher unit cost. Crop price support in such a case may benefit the producer but not the consumer of that commodity. Domestic production at a unit cost slightly higher than international price may be justified if it creates additional employment in the production and/or processing of that commodity and saves scarce foreign exchange which may have a higher opportunity cost and pressing national priorities elsewhere.

On the other hand, input subsidy policy assumes that farmers are applying sub-optimal levels of farm inputs due to depressed output prices. Some farmers, however, may not have the necessary resources to purchase adequate amount of inputs. Input subsidies can increase crop output with no increase in crop prices for the consumers. The small and marginal farmers also benefit from input subsidy, provided they have equal access to those subsidies. The supplies of agricultural

credit, fertilizer, chemicals, gasoline, and diesel fuel in most developing countries are generally scarce. Implementation of input subsidy programs generally increase demand. This results in an increase in market price and the small farmers, who may have only limited access to subsidized inputs, may end up paying even higher prices. Consequently, any input subsidy program must be accompanied by programs designed to increase input supply and remove marketing constraints.

According to Barker and Hayami [1976], the use of fertilizer subsidy is preferable to rice price support if the objective is to achieve rice self-sufficiency in Philippines. R. Ahmed [1979] also examined the relative efficiency of price support and fertilizer subsidy policies in increasing rice production by half a million tons in Bangladesh. The results indicate that fertilizer subsidy policy is superior to price support policy. Mudahar [1978] identifies and analyzes the information and economic analysis needed to design fertilizer subsidy and price policy in developing countries. Garcia [1981] provides a detailed Colombian case study which also has relevance to Asian countries. Based on the analysis of farm-level data from India, Bagi [1984] concluded that both crop price support and input subsidies can increase crop output. The former increases output of the targeted crop while the latter increases the output of all crops that use the subsidized input. The choice between those two policies will depend on the objective and their economic implications with respect to efficiency, equity, and cost to achieve that objective.

According to Rosegrant *et al.* [1987] fertilizer subsidy has been employed as a key instrument to stimulate rice production in Indonesia. It has led to rapid growth in fertilizer use, rice production, and subsidy expenditure. Any reduction or elimination of fertilizer subsidy would achieve significant financial gains for the government. However, the results indicate that fertilizer subsidy remains a powerful policy instrument for accelerating domestic agricultural production. Farmers remain highly responsive to changes in fertilizer price. Complete elimination of fertilizer subsidy has a large negative impact on production because net imports, hence import costs, increase significantly. Depending on rice price strategies, removal of subsidies causes either consumers or producers to suffer significant welfare losses. As a result, fertilizer subsidy should be reduced only in pace with improvements in quality of irrigation, expansion of credit program, dissemination of improved crop technology, improved pest management practices, higher efficiency in fertilizer use, and improved fertilizer production and distribution systems.

One of the main reason for fertilizer subsidies is the prevalence of inefficient fertilizer production and distribution systems in many developing countries [Mudahar, 1978]. The issue of fertilizer production pricing policies was discussed in a seminar organized by the World Bank and the papers are published in the con-

ference proceedings by Segura, Shetty, and Nishimizu [1986]. According to them, economically optimal fertilizer pricing policy—whether determined by the free market or by an official agency—must perform the following functions: provision of stimulus to mobilize and allocate adequate resources for fertilizer capacity expansion; optimal choice of production processes; effective control of feedstock and other operating costs; satisfactory level of capacity utilization; and when necessary, closure of obsolete, high cost fertilizer plants.

ECONOMIC INCENTIVES AND AGRICULTURAL POLICIES

Agricultural growth and farmer incentives are influenced not only by direct sectoral agricultural policies, but also by developments in other sectors of the economy, particularly trade, exchange rate, and other macroeconomic policies. There are at least four stylized facts about the agricultural policies of developing countries, the interactions among which are not fully appreciated or analyzed. These are: promotion of industry through policies of import substitution and protection against imports competing with domestic production; maintenance of overvalued exchange rates through exchange-control regimes and import licensing mechanisms; suppression of producer prices of agricultural commodities through government procurement policies, agricultural marketing boards, export taxes, and/or export quotas; and compensation of various disincentive effects on producers through subsidization of agricultural inputs and capital investment in irrigation and other inputs. The net effect of these direct and indirect policies leads to a tax on agriculture and transfer of substantial resources from agricultural to nonagricultural sectors.

Several years ago, the World Bank initiated a research project entitled "A Comparative Study of the Political Economy of Agricultural Pricing Policies." The purpose of the project was to provide a detailed history of pricing policies; to measure the degree of intervention affecting agriculture; and to analyze their effects on output, consumption, trade, the budget, intersectoral resource transfers, and income distribution. In other words, the study provides a systematic comparative analysis of the impact of government intervention and measures discrimination against agriculture. The study was carried out for eighteen countries for the 1975-84 period. All the country studies used a common methodology which facilitated a comparative analysis. The initial results of these studies are reported in Krueger, Schiff, and Valdes [1988]. The detailed findings of country studies and synthesis will be published in four volumes; the country studies from Asia—which includes Korea, Malaysia, Pakistan, the Philippines, Sri Lanka, and Thailand—are reported in Krueger, Schiff, Valdes, eds. [1990].

The study measures the impact of sector-specific (direct) and economy-wide (indirect) policies on agricultural incentives for both exportable and importable agricultural commodities. The direct effect is measured by the proportional dif-

ference between the producer price and the border price with appropriate adjustments for distribution, storage, transportation, and other marketing costs. The indirect effect has two components. The first is the impact of the unsustainable portion of the current account deficit and of industrial protection policies on the real exchange rate, and thus on the price of agricultural commodities relative to nonagricultural nontradeables. The second is the impact of industrial protection policies on the relative price of agricultural commodities to that of nonagricultural tradeable goods. The initial results for two time periods (1975-79 and 1980-84) for selected exportable and importable agricultural commodities are reported in Table 9. These results provide estimates for the direct and total (direct and indirect) impact of government policies on agriculture.

The results show that for exportables there is a high degree of discrimination; in many cases, discrimination increased over time and the indirect discrimination is much stronger than the direct discrimination. On the other hand, importables are subsidized directly but are taxed indirectly; the net effect being discrimination on importables also. In other words, the findings indicate that in almost all cases the direct effect is equivalent to a tax on exportables (-11 percent on average) and to a subsidy on importables (20 percent on average); the indirect effect also taxes agriculture (−27 percent on average) and dominates the direct effect. There are, of course, variations across different countries depending on their respective stages of development. Two other impacts of these policies are annual transfer of substantial resources from agriculture to government and nonagricultural sectors in most countries, and stabilization of domestic producer prices for both exportables and importables. However, these intervention policies may not be the most appropriate effective mechanisms to achieve price stabilization.

The World Bank also analyzed trade and pricing policies in world agriculture in *1986 World Development Report* [World Bank, 1986a]. One of the conclusions was that economic growth and stability would be greatly enhanced if pricing and trade policies were improved in developing countries. Unfavorable economic policies have discouraged agricultural production and hindered agricultural development in many of these countries. Some of these policies include overvalued exchange rates, protection of industrial activities, taxation of agricultural exports, and import-competing food crops. In addition, public policies designed to subsidize consumers and farm inputs and policies designed to stabilize consumer and producer prices have led to significant losses in the real national income of developing countries.

The available evidence indicates that the developing countries discriminate against their farmers, even though agriculture accounts for a larger share of gross domestic product, employment, and export earnings. On the other hand, the industrial countries provide subsidies to farmers, even though agriculture accounts for a small share of gross domestic product and employment. Elimination

Table 9. Direct and total nominal rate of protection for export and import commodities in selected developing countries[a]

	Exports					Imports				
		1975/79		1980/84			1975/79		1980/84	
Region/country	Commodity[b]	Direct	Total	Direct	Total	Commodity[b]	Direct	Total	Direct	Total
		percent					percent			
Asia										
Korea	–	–	–	–	–	Rice	91	73	86	74
Malaysia	Rubber	−25	−29	−18	−28	Rice	38	34	68	58
Pakistan	Cotton	−12	−60	−7	−42	Wheat	−13	−61	−21	−56
Philippines	Copra	−11	−38	−26	−54	Corn	18	−9	26	−2
Sri Lanka	Rubber	−29	−64	−31	−62	Rice	18	−17	11	−20
Thailand	Rice	−28	−43	−15	−34	–	–	–	–	–
Africa										
Côte d'Ivoire	Cocoa	−31	−64	−21	−47	Rice	8	−25	16	−10
Egypt	Cotton	−36	−54	−22	−36	Wheat	−19	−37	−21	−35
Ghana	Cocoa	26	−40	34	−55	Rice	79	13	118	29
Morocco	–	–	–	–	–	Wheat	−7	−19	0	−8
Zambia	Tobacco	1	−41	7	−50	Corn	−13	−55	−9	−66
Latin America										
Argentina	Wheat	−25	−41	−13	−50	–	–	–	–	–
Brazil	Soybeans	−8	−40	−19	−33	Wheat	35	3	−7	−21
Chile	Grapes	1	23	0	−7	Wheat	11	33	9	2
Colombia	Coffee	−7	−32	−5	−39	Wheat	5	−20	9	−25
Dominican Republic	Coffee	−15	−33	−32	−51	Rice	20	2	26	7
Others										
Portugal	Tomatoes	17	12	17	4	Wheat	15	10	26	13
Turkey	Tobacco	2	−38	−28	−63	Wheat	28	−12	−3	−38
Average (simple unweighted)		−11	−36	−11	−40		20	−5	21	−6

Source: Krueger, Schiff, and Valdes [1988]

[a] The direct nominal protection rate is defined as the difference between the total and the indirect nominal protection rates, or equivalently, as the ratio of (1) the difference between the relative producer price and the relative border price, and (2) the relative adjusted border price measured at the equilibrium exchange rate and in the absence of all trade policies.

[b] The commodities for which the results are reported are considered fairly representative of government policy toward exportables or import-competing food crops.

of these distortions can result in large potential gains to the world economy. A summary of national and international aspects of agricultural policies in developing countries and their potential economic consequences are also provided in A. Ray [1988].

The economic impact of various agricultural, tax, and trade policies can be analyzed through various programming, simulation, and econometric models. Braverman and Hammer [1988] have provided an overview of multi-market simulation models which have been designed and applied to evaluate the economic consequences of proposed agricultural policy reforms in several developing countries in Asia, Africa, and Latin America. Bautista [1987] has analyzed the effects of trade and exchange rate policies on production incentives in Philippine agriculture for the thirty-year period from 1950 to 1980. The empirical findings indicate an existence of persistent and significant bias in relative incentives against agricultural export production and in favor of nontraditional (mainly industrial) exports, and most strongly in favor of import-competing industrial consumer goods. The use of such policies has been, and still continues to be, widespread in most developing countries in Asia.

PRICE STABILIZATION AND INTERVENTION POLICIES

Producer and consumer price stability for agricultural commodities remains one of the important national objectives of policymakers in most Asian countries. Price stability can be achieved indirectly through policies affecting demand and/or supply or directly through price controls. Different policies, individually or as a policy package, have different economic implications with respect to agricultural growth and welfare. An important recent study by R. Ahmed and Bernard [1989] examines rice price fluctuations and an approach to price stabilization in Bangladesh.

Rice is a staple commodity in Bangladesh and other Asian countries. The rice sector is also subject to various kinds of government intervention policies. According to Ahmed and Bernard [1989], actual rice price fluctuations have increased in the post-independence period (1970s onward) in Bangladesh. In the past, government used ration distribution, open-market sales, and post-harvest procurement to stabilize prices. These policy interventions were based on quantity targets. In the absence of a consistent approach based on price targets, the government's efforts to stabilize rice price have been relatively ineffective and wasteful.

Ahmed and Bernard [1989] propose an alternative framework for rice price stabilization which involves a shift from quantity-targeted approach to price-targeted approach. Policy framework includes specification of price band in annual prices, linking price band to seasonal prices, coordinating ration prices for priority groups with market prices, maintaining optimal stocks in the public sector,

import-competing food crops.

developing flexible procurement and open-market sales programs, and careful monitoring of crop production levels. The framework accommodates private traders as principal actors in consonance with a complementary public intervention in foodgrain markets. The results based on a simulation model indicate that the proposed alternative program would increase rice price stability, both annual and seasonal, and reduce pressure on the rationing system.

Two other major studies dealing with price policy in selected Asian countries were initiated in the mid-1980s. The first study deals with a comparative analysis of food price policy and government intervention programs in China, Indonesia, Philippines, Nepal, Republic of Korea, and Thailand [Sicular, ed., 1989a]. The second study deals with evaluation of rice market intervention policies in Bangladesh, India, Republic of Korea, and Malaysia [ADB, 1988]. Timmer [1988a] has examined four country case studies commissioned by the ADB and has drawn lessons which may be of particular relevance to policymakers in other Asian countries. First, it is important to make a clear distinction between short-run and long-run objectives and the analyst must provide a bridge between expediency and long-run efficiency. Second, global cost of production information does not provide an appropriate reference for determining domestic support prices. Third, there is frequently a wide gap between the first-best policy prescription based on border price paradigm and the outcome of events in reality. Fourth, certain type of interventions may be impractical when borders are permeable to unauthorized trade.

5. Rural Credit

Rural credit[32] is an extraordinarily complex and contentious subject that includes the broad issues of financial market development, overall economic growth, agricultural growth, and equity. The basic controversy at the macro level is whether intervention in financial markets, including direct credit allocation and interest rate regulation, accelerates development or misallocates resources and slows development. [Fry, 1988]. McKinnon [1988], generally counted on the "liberalization" side of the controversy, has delineated a number of problems of liberalization, particularly a tendency to indiscriminate lending at high rates with inadequate assessment of risk, leading to a policy recommendation of some regulation of interest rates and to some use of credit quotas [McKinnon, 1988; see also de Macedo, 1988]. A similar debate has occurred as to whether credit "leads" supply-creating activities, playing either a proactive or a neutral role. Patrick [1966] reviews these arguments and Mellor [1966, 1976] suggests a synthesis with particular reference to agriculture.

A debate parallel to that in the broad macro area has occurred in the area of rural credit. This debate is summarized in relation to expansion of rural banking

as well as interest rates and their determination, with the latter leading back into issues of scale economies and expansion of the credit system.

In developing countries, the rural sector—and even the smaller commercialized portion of that sector—includes a major portion of the economy's real and financial resources. The fragmentation of the rural sector due to its spatial dispersion, poor communication system, and consequent high transaction costs results initially in a low degree of integration of rural financial markets into the national and global systems. Although opening of rural credit branches is discussed largely, if not exclusively, in terms of credit extension, it is of perhaps greater importance in deposit mobilization and market integration. In general, deposit mobilization of rural branches of the commercial credit system are far larger than credit extended, and those net deposits are readily moved to other regions and sectors in response to opening of dispersed rural branches.

In countries, such as India, that have expanded rural banking rapidly, a dilemma has been exposed. The same political forces that have led to rapid expansion of the system for deposit mobilization have brought high overdues on loans and high bad debt ratios. Deposit mobilization is facilitated by convenience, which requires a multiplicity of branches and loss of scale economies. Such expansion tends to occur only slowly without political pressure. New branches inevitably make initial losses while scale economies are built up. The fact of expansion under political pressure may bring the fact of political pressure on lending and the excuse as well for poor loan recoveries and gross overdues.

The issue of poor loan recovery in the context of rapid expansion of rural credit systems has led to a major controversy on the role of institutional credit—indeed, whether it even has an important role—and the issue of subsidized interest rates. See Adams [1980], and Adams, Graham, and von Pischke, eds., [1984] for an exposition of this issue. The interest rate issue is complex because of the role of interest rates in influencing the savings rate, mobilization of savings, and investment rates. The "high interest rate" school emphasizes the elasticity of savings and deposit mobilization with respect to interest rates and the misallocation of resources attendant on low interest rates (see, for example, Adams [1980] and Adams, Graham, and von Pischke, eds. [1984]).

The empirical record on interest rate elasticities is sparse and provides mixed results, but the weight is more on the side of relatively lower elasticity of savings than of investment with respect to interest rates. This is not surprising, since rural saving may be heavily weighted by a drive to save specific sums for specifically calculated future events, including the possibility of major economic reverses. This issue is even more complex because deposits mobilized by higher interest rates are drawn not only from hoarding in nonproductive forms but also from investment in productive activities—especially in a dispersed small-scale sector such as agriculture and allied activities. Such a conversion into financial assets

from directly productive instruments may be, in net, production- and employment-depressing, given the high employment content of rural activities.

Much of the interest rate controversy revolves around the issue of lending margins, itself a complex issue. Liberalization is often interpreted to mean interest rate spreads between borrowing and lending costs that cover margins. But start-up margins are always high in new branches and should be viewed in part as a capital cost to be spread over several years of income—not just the year in which the cost is incurred. Besides, scale economies are substantial in rural branches and proximity is important to enlarging business. Thus, initial large spreads between borrowing and lending interest rates may themselves lead to low volume, and conversely, initial apparent subsidies may lead to a rise in volume that will eventually reduce margins. These are complex processes in which political forces may well push rates too low.

A further complication with respect to margins and efficiency of rural banking operations arises from the interaction of the dispersed nature of the rural sector, the need for convenience and hence proximity, and scale economies. All of these argue for single institutional monopolies in a particular area, while other efficiency-based arguments favor proliferation of institutions to provide competition. Competition between a cooperative system and commercial branch banking, plus access to urban-based finances through low-cost transport, represents a solution to this dilemma by offering different systems that can tap somewhat different markets through somewhat different modes of operations and still overlap sufficiently to provide competition.

The problem of massive overdues is the overriding issue in rapidly expanding rural credit systems. In this complex area, several shibboleths need to be disposed of: overdues are generally not greater with small borrowers than large ones, in poverty-oriented programs than others, in one type of institution compared with others, or now compared to several years ago; overdues are not the same as bad debts (inappropriate dates for including repayment and lack of certainty about reborrowing in the future are due to inappropriate definition and accounting practices); the issue is not simple, to be dealt with by a rule or two (rather it is more like line losses in electricity distribution, to be brought down slowly by many complex steps).

Finally, there is an issue of whether special banks should be created for the poor. The arguments against such actions are of course clear: reduction of scale economies by fractionating the institutional credit market; high costs incident to small-scale borrowers with little opportunity for cross-subsidization; the political attraction of large-scale subsidies when they can be targeted to such institutions; and the general argument that markets work well and should not be tampered with. In practice, a number of examples exist of successful credit programs targeted to low-income people. The Grameen Bank of Bangladesh is a prime ex-

ample [Hossain, 1988a]. Its borrowing rates were subsidized, but margins were kept within reasonable bounds and lending rates were high enough to cover them. Loans are to the poor and particularly to poor rural women.

Chapter V. Agricultural Research and Transfer of Technology

1. Investment in Agricultural Research

Modern agricultural technology, the result of agricultural research, has been the major source of agricultural growth gained through increases in the efficiency of resource use. Despite this contribution, developing countries usually underinvest in agricultural research.[33]

Many developing countries still accord low priority to agricultural research as reflected by budget allocation to agricultural research. According to Yadav [1987], agricultural research expenditure as a proportion of the agricultural budget in Nepal declined from 32 percent in 1970-71 to 14 percent in 1980-81. The real expenditure on agricultural research increased by about 4 percent per year from 1970-71 to 1980-81 as compared to expenditures on agricultural extension and agricultural support services which increased by 7 percent and 14 percent per year, respectively. Even what is allocated to agricultural research is not really used for this purpose. For example, annual agricultural research expenditure in Nepal during 1979/80 (based on 3-year average) was Rs 35.4 million. Out of this, only 35 percent was spent on actual research and the remaining 65 percent was spent on nonresearch activities.

Estimated expenditures on agricultural research and extension are reported in Table 10. Asia, which has 72 percent of the world's agricultural population, 57 percent of its total population, and 32 percent of its arable land, contributed only 17 percent of the world's expenditure on agricultural research and 20 percent of the world's expenditures on agricultural extension.[34]

Despite the importance of agricultural research, there has been only limited economic analysis of the optimum amount of investment in agricultural research. Nor has much work been done to provide guidelines for the allocation of research resources among projects, crops, and regions.[35] Most of the studies on agricultural research have been limited to measuring the rates of return to investment in agricultural research.

A systematic conceptualization of the process of allocating resources to agricultural research was developed in Pinstrup-Andersen and Franklin [1977]. Binswanger and Ryan [1977] proposed that agricultural research resources should be allocated according to the share a particular crop has in the gross value of agricultural output. Research resources need to be allocated on the basis of efficiency and equity. In labor-surplus agrarian economies, it is also important to evaluate the impact of research resource allocation on employment. Research resource al

Table 10. Estimated land, population, and expenditure on agricultural research and extension in Asia

Region	Expenditure on agricultural research, 1974 Amount	Expenditure on agricultural research, 1974 Percent	Expenditure on agricultural extension, 1974 Amount	Expenditure on agricultural extension, 1974 Percent	Ratio of research to extension expenditure	Arable land 1975 (%)	Total population, 1975 (%)	Agricultural population, 1975 (%)
	(US$ millions, constant 1971)	(US$ millions, constant 1971)						
North America and Oceania	1,289	34	288	22	4.5	21	7	1
Asia	646	17	259	20	2.5	32	57	72
World	3,841	100	1,326	100	2.9	100	100	100

Source: Boyce and Evenson [1975] for expenditure and FAO [1989a] for land and population estimates.

location designed to help the poorest consumers should emphasize commodities with low income and price elasticities of demand [Pinstrup-Anderson, de Londono, and Hoover, 1976].

As argued in Mellor [1977], several factors make market prices inappropriate for allocating agricultural research resources optimally. The relationship between research expenditure and economic returns are poorly understood. Market prices might not include externalities of agricultural research, such as its effect on health and nutritional status, and thus understate their true value to society. Finally, new technology affects the distribution of income by changing both the relative returns to owners of productive resources and the prices of goods consumed in unequal proportions by different income classes. Research resources could be allocated by taking into consideration their effects on the supply of wages goods, on the demand for labor, on the nutritional composition of food supply, and on the size of and variation in producers' net income. But, because little is known about them, the allocation of research resources remains ripe for research. Hayami and Ruttan [1971, 1985] explore the complex institutional aspects of the question.

2. Contribution of Agricultural Research

Pinstrup-Andersen and Franklin [1977] name three contributions that are the direct result of agricultural research. These are increases in the technical efficiency of at least one resource; changes in the characteristics and composition of existing products and development of new ones, and reductions in production risk. These contributions result in changes in the composition, quantity and quality of agricultural supply, in aggregate resource demand, and in domestic farm income.

Estimates—from selected empirical studies—of the internal rates of return on investment in agricultural research for a number of commodities are given in Table 11.[36] The estimated rates of return in Asian countries are 35 to 63 percent for aggregate output, 25 to 75 percent for rice in Japan, 32 to 78 percent for rice in Asia, 25 percent for rubber in Malaysia, and 60 percent for sugarcane in India.[37] The evidence is limited to only a few crops and a few countries in Asia. However, the internal rates of return estimated for other crops and other regions of the world confirm its general order of magnitude. Agricultural research in Asia has made a major contribution to agricultural growth by relaxing constraints imposed by the inelastic supply of cultivable land.[38]

3. The Transfer of Agricultural Technology and Research

Agricultural research requires large investments, particularly in human capital, which, in developing and developed countries, requires time and economic resources. And, the agricultural problems for each set of agroclimatic and socioeconomic conditions are unique; this situation limits the transfer of research results. Therefore, the developing countries need to emphasize adaptive research so

Table 11. Estimated annual internal rates of return on investment in agricultural research for different commodities[a]

Country/region	Commodity	Time-period	Rate of return (%)	Source
Asia				
Japan	Aggregate	1880-1938	35	Tang [1963]
India	Aggregate	1953-71	40	Evenson and Jha [1973]
India	Aggregate	1960/61-1972/73	63	Kahlon *et al.* [1977]
Japan	Rice	1915-50	25-27	Hayami and Akino [1977]
Japan	Rice	1930-61	73-75	Hayami and Akino [1977]
Philippines	Rice	1966-75	27	Flores-Moya, Evenson, and Hayami [1978]
Asia	Rice	1950-65	32-39	Evenson and Flores [1978]
Asia	Rice	1966-75	73-78	Evenson and Flores [1978]
Tropics	Rice	1966-75	46-71	Flores-Moya, Evenson, and Hayami [1978]
Bangladesh	Rice and wheat	1961-77	30-35	Pray [1979]
Malaysia	Rubber	1932-73	25	Pee [1977]
India	Sugarcane	1945-58	60	Evenson [1976]
Other Countries				
United States	Aggregate	1949-59	35-40	Griliches [1964]
United States	Aggregate	1949-59	47	Evenson [1968]
United States	Hybrid corn	1940-55	35-40	Griliches [1958b]
United States	Hybrid sorghum	1940-57	20	Griliches [1958b]
Mexico	Wheat	1943-63	90	Ardito-Barletta [1970]
Mexico	Maize	1943-63	35	Ardito-Barletta [1970]
Peru	Maize	1954-67	35-40	Hines [1972]
Colombia	Rice	1957-72	60-82	Hertford *et al.* [1977]
Colombia	Rice	1957-74	79-96	Scobie and Posada-Torres [1978]
Brazil	Cotton	1924-67	77+	Ayer [1970]
Brazil	Cotton	1924-67	77-110	Ayer and Schuh [1972]
Colombia	Soybeans	1960-71	79-96	Hertford *et al.* [1977]
Canada	Rapeseed	1960-75	95-110	Nagy and Furtan [1978]
South Africa	Sugarcane	1945-62	40	Evenson [1976]
Australia	Sugarcane	1945-58	50	Evenson [1976]
Australia	Pastures	1948-69	58-68	Duncan [1972]
United States	Poultry	1915-60	21-25	Peterson [1967]

[a] Many of these results have also been summarized in Arndt, Dalrymple, and Ruttan, eds. [1977]; Boyce and Evenson [1975]; Evenson, Waggoner, and Ruttan [1979]; Pinstrup-Andersen [1982]; and Ruttan [1982].

that they can maximize the benefits of research results by increasing the transferability of technology from whatever source.

A particular need is for research on how to increase the effectiveness of agricultural research systems. It is clear that returns to research success are high and

that success requires an effective national research system. The national research systems in many countries are relatively ineffective.[39]

That constraint can be erased by borrowing research results. The ability of high-income countries to generate the bases for technological change is well developed. Hence, that capacity is one of the most coveted elements that these countries have to offer the low-income countries. Substantial analysis is needed on the appropriate technology, on the way education and training helps or hinders technology transfer, and on how the transfer of technology relates to national systems. Technology transfer requires highly effective national systems.

An excellent overview of the performance and prospects of international transfer of agricultural technology is provided by Evenson [1988]. There are four channels of technology transfer, including direct, adaptive or indirect, pretechnology science, and capacity. Based on an examination of large volumes of data, Evenson concludes that direct transfer between countries is very limited for most technology fields. Even within most countries, direct transfer between regions for most technology areas is limited. Indirect transfer is probably more important. However, indirect transfer does not take place without research capacity in the destination country. Pretechnology science transfer has become an increasingly important form of transfer as research systems throughout the world have expanded capacity. Capacity transfer has also been important. United States' assistance and training have facilitated the development of this capacity, especially in several Asian countries.

The development of domestic technology transfer capacity depends on at least three factors, including investment in agricultural research, investment in agricultural extension, and creation of scientific manpower. The available evidence, as reflected by the above three factors, shows a significant growth in technology transfer capacity in the last twenty years in the developing countries, particularly in Asia (Table 12). In the 1950s and 1960s, most Asian countries (except East Asia) were spending more on agricultural extension than on agricultural research. This strategy was reversed in the 1970s and 1980s. A rapid growth in spending in agricultural research, combined with little or no growth in expenditure on agricultural extension, produced roughly equal spending intensities (public expenditure in research or extension as percent of the value of agricultural product) in research and extension in most developing countries, particularly in Asia.

The World Bank (through its lending) and CGIAR (through its agricultural research programs) provided major stimulus for the development of national agricultural research and extension capacity. For example, the World Bank initiated and funded the development of Training and Visit System (T&V) of agricultural extension in the 1970s [Benor and Harrison, 1977; and Benor and Baxter, 1984]. The T&V system emphasizes simplicity, flexibility, and continuous feedback from farmers to extension and research. Central aspect of the system is the role of

Table 12. Expenditure on agricultural research and extension and estimated agricultural scientific manpower in world regions

Region	Agr. research expenditure, 1980[a]		Public expenditure as % of the value of agr. product						Scientific manpower[c]	
			Agricultural research			Agricultural extension			Number	
	Mill. US$	Growth[b]	1959	1970	1980	1959	1970	1980	1980	Growth[d]
Northern Europe	410	4.3	0.55	1.05	1.60	0.65	0.85	0.84	8,027	4.4
Central Europe	871	6.2	0.39	1.20	1.54	0.29	0.42	0.45	8,827	3.1
Southern Europe	209	5.3	0.24	0.61	0.74	0.11	0.35	0.28	2,686	1.7
Eastern Europe	553	2.8	0.50	0.81	0.78	0.32	0.36	0.40	20,220	3.5
USSR	939	2.5	0.43	0.73	0.70	0.28	0.32	0.35	31,394	2.6
Oceania	387	4.2	0.99	2.24	2.83	0.42	0.76	0.98	3,302	1.9
North America	1336	2.0	0.84	1.27	1.09	0.42	0.53	0.56	10,305	1.5
Temperate S. America	80	2.6	0.39	0.64	0.70	0.07	0.50	0.43	1,527	4.2
Tropical S. America	269	7.7	0.25	0.67	0.98	0.34	0.71	1.19	4,840	8.5
Caribbean & C. America	113	8.3	0.15	0.22	0.63	0.09	0.18	0.33	2,167	4.4
North Africa	62	3.0	0.31	0.62	0.59	1.27	2.21	1.71	2,340	4.4
West Africa	206	4.6	0.37	0.61	1.19	0.58	1.24	1.13	2,466	6.0
East Africa	71	5.9	0.19	0.53	0.81	0.67	0.88	1.16	1,632	7.4
Southern Africa	82	2.0	1.13	1.10	1.23	1.64	0.67	0.46	1,650	2.4
West Asia	125	5.1	0.18	0.37	0.47	0.25	0.57	0.51	2,329	5.1
South Asia	191	6.0	0.12	0.19	0.43	0.20	0.23	0.20	5,691	4.0
Southeast Asia	103	11.4	0.10	0.28	0.52	0.24	0.37	0.36	4,102	9.3
East Asia	735	5.2	0.69	2.01	2.44	0.19	0.67	0.85	17,262	2.2
China	644	11.9	0.09	0.68	0.56	n.a.	n.a.	n.a.	17,272	13.8

Source: Evenson [1988]; originally from Judd, Boyce, and Evenson [1986].

n.a. = not available.

[a] In constant 1980 U.S. dollars

[b] Growth expressed as a ratio of expenditure in 1980 over 1959.

[c] In terms of scientist man-years.

[d] Growth expressed as a ratio of scientific manpower in 1980 over 1959.

contract farmers and subject matter specialists and the primacy of field work. Similarly, the CGIAR system had a significant impact on the development of national agricultural research systems, allocation of needed resources, and the training of scientific manpower.

Evenson [1988] also provided an overview of emerging agricultural technologies based on both the conventional methods and biotechnology. The development of biotechnology has been stimulated by institutional developments enabling private firms to capture more returns from their research. According to Evenson, the 1990s will be dominated by technologies emerging from the conventional systems, with some shift from public sector to private sector. By year 2000, the biotechnology sector will produce a number of significant technologies but the developments will be volatile, including failures, bankruptcies, and mergers. United States, Japan, and Western Europe will play dominant roles and most of these technologies will emerge from the private sector. Direct transfer and multinational firms will play increasingly important roles in the development and transfer of agricultural technology.

4. International Agricultural Research Centers

In this context, the international agricultural research centers (IARCs), under the auspices of Consultative Group on International Agricultural Research (CGIAR), have made significant contributions to agricultural growth in Asia not only through research results but also by facilitating the transfer of appropriate agricultural technology (Table 13). All of these programs will affect the nature and level of employment generated by transfers of technology and the competitiveness of domestic production employing imported technology.[40] The initial emphasis of the IARCs was on individual crops mandated for respective centers. However, over time farming systems research (FSR) became an increasingly important component of research programs of the IARCs as well as national research programs and agricultural development projects. A comprehensive review of FSR is provided by Simmonds [1985].

CGIAR, which was established in 1971, is an association of countries, international and regional organizations, and private foundations dedicated to supporting a system of international agricultural research centers around the world. The number of both CGIAR members and international agricultural research centers has grown over time. During 1986, CGIAR had fifty-one members, of which thirty-nine were donors [CGIAR, 1987b]. Total contributions have grown from US$12.0 million in 1972 to US$235.5 million in 1986.

In 1987, W. David Hopper, then CGIAR chairman, outlined two broad challenges for the CGIAR [CGIAR, 1987b]. First, policies and programs: how the CGIAR can best contribute to the enhancement of income and the enhancement of food availability for poor people throughout the developing world. Second,

Table 13. International agricultural research centers with implications for agricultural development in Asia

Center	Location	Primary research mandate	Year of establishment
IRRI (International Rice Research Institute)	Philippines	Rice, farming systems	1960
CIMMYT (International Maize and Wheat Improvement Center)	Mexico	Wheat, maize, and farming systems	1966
CIAT (Centro Internacional de Agricultura Tropical)	Colombia	Cassava and beans	1967
AVRDC (Asian Vegetable Research and Development Center)	Taiwan	Vegetables	1971
CIP (International Potato Center)	Peru	Potatoes	1972
ICRISAT (International Crops Research Institute for the Semi-Arid Tropics)	India	Sorghum, pearl millet, pigeon peas, chickpeas, groundnuts, and farming systems	1972
IBPGR (International Board for Plant Genetic Resources)	Italy	Plant genetic material	1973
IFDC (International Fertilizer Development Center)	United States	Fertilizer	1975
IFPRI (International Food Policy Research Institute)	United States	Food policy	1975
ICARDA (International Center for Agricultural Research in the Dry Areas)	Syria	Barley, wheat, broad beans, lentils, and farming systems	1976
ISNAR (International Service for National Agricultural Research)	Netherlands	National agricultural research systems	1980
IIMI (International Irrigation Management Institute)	Sri Lanka	Irrigation	1984

technologies: how best to maintain the research drive to find and exploit new technologies of producing basic food materials for growing world demand, especially in the light of the accelerating revolution in biological research fundings and methodologies.

The CGIAR was initially an agricultural production research system. In the mid-1970s, a need was felt to increase the effectiveness of production science research both in increasing production and distributing benefits to the poor by adding a policy research center. In that context, the International Food Policy Research Institute (IFPRI) was formed to generate new knowledge of policy, to stimulate the building of similar capacity in developing countries, and finally to have a policy impact in collaborations with sister institutions in the national systems of developing countries. One result of this activity has been to give a substantial boost to the attention paid to policy-oriented research relating to agricultural development, with a particular emphasis on field research that elicits facts at the farm and family level and pyramids those to policy conclusions.

Chapter VI. Marketable Surplus and Marketing Behavior

The generation of a marketable surplus and its transfer from the agricultural to the nonagricultural sector are crucial to the achievement of self-sustaining economic growth in dualistic development models. With the exception of A. K. Dixit [1969], Hornby [1968], Lele and Mellor [1981], and Zarembka [1970], these models do not deal with changes in marketable surplus caused by changes in technology, prices, and output. These issues have been analyzed in theoretical and empirical studies that are specifically about marketable surplus. Knowledge about how a marketable surplus responds to changes in price, output, and the size of land holdings has important implications for the design of agricultural policy.

1. Price, Output, and Marketable Surplus

Knowledge of the price elasticity of a marketable surplus is of paramount importance as a guide to the formulation of appropriate price policy for output. Most of the studies on marketable surplus have estimated the price elasticities of marketable surpluses for different crops from different regions at different time periods. Mathur and Ezekiel [1961] argued that the cash obligations of farmers in subsistence agriculture are relatively fixed. Consequently, a rise in output prices would result in a fall in the marketable surplus, implying that the price elasticity is negative. This would lead to an increase in the amount of crop produce retained for home consumption, which is determined as a residual.[41] But this study assumed that the income elasticity of demand for nonfoodgrains was zero and that there were no substitution effects. Neither of these assumptions is supported by the empirical evidence.[42]

Based on data from 1959/60 to 1962/63, T. N. Krishnan [1965] estimated the price elasticity of marketable surplus for foodgrains in India to be −0.03. The underlying logic is that as price goes up, real income also goes up, and the consumption demand for farm produce increases, which leads to a reduction of the marketable surplus. The whole analysis assumed that farm output is fixed at a certain level. If the effect of price on output is explicitly incorporated, however, the price elasticity of the marketable surplus may become positive.

R. Krishna [1962] developed a conceptual framework to determine the relationship between the price and marketable surplus of a single crop by incorporating positive price elasticities of both output and consumption. He found the price elasticity of marketable surplus for subsistence crops in India to be positive. According to Nowshirvani [1967b], however, R. Krishna [1962] ignored the income effect of a change in the value of initial consumption caused by changes in price. Once this is incorporated, a negative price elasticity of the marketable surplus must be considered a possibility. Khusro [1967] was more affirmative, saying that farmers would retain more of the foodgrains they produce if the market price was lower. This implies that the price elasticity for marketable surplus is positive.

K. Bardhan [1970] estimated the price and output elasticities of marketable surplus of foodgrains in North India.[43] The study was based on a cross-sectional survey of twenty-seven villages in Punjab and Uttar Pradesh. The price elasticity of marketable surplus was estimated to be −0.6 and the output elasticity was estimated to be 1.8. In Thamarajakshi [1971], the price elasticity for marketable surplus of foodgrains was −0.6 and the output elasticity 1.01. These two studies clearly imply that if the marketable surplus is to be expanded, then foodgrain prices should be reduced and foodgrain output expanded through technological change. But, since the price elasticity of output is usually positive, a reduction in the price of foodgrains alone will reduce the marketable surplus.

Many of the empirical analyses of marketable surplus have dealt with India, but a few have analyzed the behavior of marketable surplus in other Asian countries.[44] Mangahas, Recto, and Ruttan [1966], using a time series analysis for Philippines, found the price elasticities of marketable surplus for rice and corn generally to be positive, with the price elasticities for rice higher than for corn. Furthermore, the price elasticities for marketable surplus were higher than the corresponding elasticities for production. The price elasticities of marketable surplus for rice were found to be positive in Taiwan by Chinn [1976], in Indonesia by Mubyarto [1965] and Mubyarto and Fletcher [1966], and in Thailand by Behrman [1966]. Using a 1972-74 sample survey of rice farmers in central and south Luzon in the Philippines, Toquero, Duff, Lacsina, and Hayami [1975] estimated the price elasticities to be 0.0, partial output elasticity to be 1.37, and the total price elasticity to be 0.41. Output has a strong, positive effect on marketable sur-

plus. Price influences marketable surplus positively through its indirect effect on output. Therefore, the findings were consistent with the indirect inference of others that price elasticities are positive.

2. Farm Size and Marketable Surplus

Knowledge of the relationship between farm size and marketable surplus is relevant to the design of land tenure policies. The most detailed analysis of the distribution of the marketable surplus of agricultural production was done by Narain [1961] who found that there is a nonlinear relationship between farm size and marketed surplus. Marketed surplus as a proportion of the value of agricultural output first drops from 20.7 percent for 0.5 acre size group to 9.7 percent for 10-15 acre size group and then rises rapidly thereafter. According to Narain, the drop in the proportion of marketable surplus is due to distress sales.

Using twenty-three samples drawn from eight states in India, R. Krishna [1965a] found a linear relationship with a negative intercept between output and marketable surplus.[45] The output elasticities of marketable surplus were between 1.04 and 1.60 for wheat and between 1.04 and 1.36 for rice. These results imply that land reform policy should try to reduce fragmentation and increase farm size if its objective is to increase marketable surplus. This analysis dealt with a single crop. The linear relationship observed for a single crop may not hold for aggregate agricultural production.

Muthiah [1964], using a sample survey of six villages in Punjab and western Uttar Pradesh in India, found a positive relationship between marketable surplus and the size of agricultural holdings. Dandekar [1964] provided empirical evidence that the relationships between farm size and the marketable surpluses of wheat, jowar, and other cereals are positive.[46] Other studies that show positive relationships between farm size and marketable surplus, and between production and marketable surplus, are Parthasarathy and Subbarao [1964] for rice in south India; Bhargawa and Rustogi [1972] for rice in West Bengal; and Dayal [1963] for cereals in Uttar Pradesh.[47] These studies indicated that the marketable surplus is concentrated in the hands of large farmers who control large parts of total production and sell larger shares of their produce than smaller farmers because their income elasticity for foodgrain consumption is lower. There appear to be no studies that analyze the effect of farm size on marketable surplus after the Green Revolution.

3. Sectoral Terms of Trade and Marketable Surplus

In addition to its positive impact on foodgrain production and marketable surplus, an increase in foodgrain prices also determines changes in the distribution of income and the transfer of resources between sectors, the distribution of income between classes, and the growth of the economy.[48] As reported in Parthasarathy

and Mudahar [1976], policies based on the observed empirical relationship often ignore the unfavorable consequences that higher foodgrain prices have for economic growth and the distribution of income, effects that sometimes outweigh the positive effects of higher foodgrain prices.

Changes in the terms-of-trade in favor of foodgrains relative to manufactured goods were found to reduce aggregate savings in India through their effect on wage rates and nonagricultural sector profits [Parthasarathy and Mudahar, 1976; Mellor, 1976]. Shifting the terms of trade in favor of foodgrains is only one instrument available to policymakers. Its efficacy when compared to other instruments, such as a direct public investment in agriculture, continues to be in doubt.[49] However, major distortions in relative prices arising from macro policy, including public investment policy, and their effects on exchange rates have been shown in other parts of the world to have a substantial deleterious effect on agriculture [see, for example, Garcia 1981]. Bautista [1987] documents these exchange rate relationships for the Philippines, showing a strong negative effect on agriculture of a whole set of macro policies.

4. Agricultural Marketing and Its Efficiency

In regions experiencing the Green Revolution, marketed surplus has increased faster than production; this increase has resulted in postharvest gluts and wastage where marketing facilities are inadequate. As reported in Gill [1972] and Mudahar [1974], the proportion of total wheat production marketed increased from 33 percent in 1967/68 to 57 percent in 1970/71 in the Indian Punjab. Furthermore, the postharvest (April 15 to July 15) market arrivals, as a percentage of the total marketed surplus for wheat, increased from 55 percent in 1967/68 to 84 percent in 1970/71. Markets were not able to cope with this sudden increase in arrivals because of deficiencies in storage, communication, and transportation facilities.

In India, policies for the system of marketing agricultural commodities have been particularly complex. It was widely believed that private trade was exploitative and discouraged production, there was concern with the free market's inequity in allocating food, and there was a stated belief that cooperative structure would have social advantages. Lele [1971], however, showed that the shortcomings in the efficiency and productivity of the private marketing system stem largely from deficiencies in transportation, communications, and information.[50] The study concluded that these inadequacies were aggravated by haphazard government policies that were usually made in reaction to short-term crises without consideration of long-term production and welfare. The Indian experience is typical of the experience of many developing Asian countries.

It is difficult to argue that cooperatives have social advantages as long as they are controlled by the wealthier rural people. In periods of scarcity and rising prices, market forces reduce the consumption of the poor disproportionately be-

cause their low incomes and the high proportion of those incomes spent on food offer few alternatives. It is doubtful that cooperative marketing can alleviate a problem rooted in income inequality and scarcity. Lacking viable solutions to this politically explosive problem, politicians usually resort to displacing private trade.

The environment for the development of cooperatives improves as technological change increases the demand for new forms of purchased inputs and market outlets and as the infrastructure develops. In the long-run, trade organized by cooperatives may have a useful social and economic role to play. For a full discussion of these issues as they relate to equity, see Lele [1974, 1981].

Chapter VII. Modernizing Agriculture and Rural Welfare

1. Food, Nutrition, and Consumption Patterns

INCIDENCE OF MALNUTRITION

The literature on the economic aspects of human nutrition has attempted to estimate the incidence of malnutrition by determining the size and importance of deficiencies in calorie and protein consumption, and to understand how the Green Revolution affects nutrition by affecting food supply.

It was generally believed in the 1960s that there existed a serious protein gap that was responsible for malnutrition in developing countries. But, empirical evidence suggests that protein deficiency is less important than calorie deficiency.[51] Sukhatme [1977, p. 1] argued that there is "no evidence to support that our diet is seriously deficient in protein. . . . The protein deficiency undoubtedly prevails but it appears to be the indirect result of inadequate energy in the diet. It is only right therefore that research workers should turn their attention to estimating the size of the calorie gap and its incidence in the population."

It is important to use an appropriate procedure to determine energy requirements and the number of the malnourished. Dandekar and Rath [1971a, b] estimated the incidence of poverty in India and Reutlinger and Selowsky [1976] estimated it in Brazil by using the "average" amount of energy for the "reference" individual required to lead a healthy active life. Sukhatme [1977], however, argued that this procedure overestimates the incidence of poverty because "average" requirements are higher than the "minimum" requirements. Using National Sample Survey data for 1971/72, Sukhatme [1977] estimated that the incidence of malnutrition is 25 percent in urban India and 20 percent in rural India.[52]

The incidence of energy-deficient diets in eighty-seven developing countries (excluding China) during 1980 is reported in Table 14. About 16 percent of the population (340 million) did not have adequate calories to prevent stunted growth and serious health risk. Out of 340 millions of affected population, 65

Table 14. Prevalence of energy-deficient diets in eighty-seven developing countries, 1980[a]

Region	No. of countries	Not enough calories for an active working life[b]		Not enough calories to prevent stunted growth and serious health risks[c]	
		Share in population (%)	Population (million)	Share in population (%)	Population (million)
South Asia	7	50	470	21	200
East Asia and Pacific	8	14	40	7	20
Sub-Saharan Africa	37	44	150	25	90
Middle East and North Africa	11	10	20	4	10
Latin America and the Caribbean	24	13	50	6	20
Developing countries	87	34	730	16	340

Source: World Bank [1986b].

[a] The eighty-seven countries accounted for 92 percent of the population in developing countries in 1980, excluding China.

[b] Below 90 percent of FAO/WHO requirements. This category includes population described in footnote C.

[c] Below 80 percent of FAO/WHO requirements.

percent was in Asia—59 percent in South Asia alone. On the other hand, 34 percent of the population (730 million) did not have adequate calories for an active working life. Out of 730 million affected population, 70 percent was in Asia—64 percent in South Asia alone. Over time, there has been a small reduction in the relative shares of affected population, but not in the absolute numbers.

According to the World Bank [1980c], the number of people in absolute poverty in eighty-seven developing countries (excluding China and other centrally planned economies) is estimated at about 780 million. Absolute poverty refers to a condition of life characterized by malnutrition, illiteracy, and disease as to be beneath any reasonable definition of human decency. The problem is relatively more serious in Asia. These malnutrition problems exist even when the world has ample food. The growth in global food production has been faster than population growth in the last forty years [World Bank, 1986b]. Despite this, many poor countries and millions of poor people do not share in this abundance. They suffer from both chronic and transitory food insecurity, caused mainly by lack of purchasing power. Based on research in India, Binswanger and Quizon [1984] concluded that an increase in domestic food production will not reduce food insecurity unless it reduces food prices.

GREEN REVOLUTION, NUTRITION, AND PRICES

The studies that implicitly assumed a serious protein gap exists in developing countries concluded that the Green Revolution has reinforced this problem by replacing area under pulses, which are rich in protein, with cereals. However, Ryan and Asokan [1977], using empirical data from the wheat region of India, argued that the yield-oriented strategy for breeding wheat did not adversely affect nutrition. Furthermore, one could argue that a yield-oriented strategy and the Green Revolution increased the food supply, and thus reduced the calorie gap, increased the income of farmers, and even increased the real income of consumers by reducing prices. Lele [1972] reported a positive relationship between the Green Revolution, income distribution, and nutrition. Pinstrup-Andersen, *et al.* [1976] argued that an increase in the total supply of nutrients is a poor indicator of relative nutritional impact because both the wastage of nutrients and adjustments by consumers of their food consumption are functions of the commodity from which the additional food nutrients are obtained.

In analyzing the impact of CGIAR, J. R. Anderson, Herdt, and Scobie [1988] provide an overview of the impact of Green Revolution on food production, nutrition, and prices. Since food accounts for the largest share of expenditure by low-income groups, any reduction in food prices leads to about twice the relative increase in real income for poor households than for rich households (Table 15). Modern crop varieties have helped to keep real food prices from rising. If modern varieties of rice and wheat had not replaced traditional varieties (with other inputs

Table 15. Estimated impact of a decrease in price of food on the real income of low-income and high-income consumer groups

	Increase in real per capita income due to 10% decrease in the price of food (in %)		
Country	Lowest 10%	Highest 10%	Source
Egypt	5.6	1.0	Alderman and von Braun [1984]
India[a]	5.3[b]	1.2[c]	Mellor [1978]
India	7.3	2.9	Murty [1983]
Sri Lanka	8.5	4.1	Sahn [1988a, b]
Thailand	6.0	2.0	Trairatvorakul [1984]

[a] Foodgrains only.
[b] Lowest 20 percent.
[c] Highest 5 percent.

unchanged) in the early 1980s, annual rice output would have been ten to thirty million tons less and wheat output ten to twenty million tons less. Modern varieties of other crops have added at least three to five million tons to available food supplies.

However, consumption gains of the poor may be limited due to several factors. First, increased food output may be absorbed by the rich if income growth favors them and the poor lack the purchasing power. Second, added domestic food production may merely displace food imports. Third, in response to a slow increase in prices of staples, employers may hold wages down and the real purchasing power of the poor may not improve much. However, the available evidence indicates that introduction of modern varieties, by moderating food prices, has been the main factor in improving the nutrition of the poor in developing countries. In most of Asia, modern varieties of rice and wheat have prevented mass starvation, and improved nutrition of urban residents, farm households, *and* landless rural poor.

A. K. Sen [1981a, b, 1987] has provided very perceptive insights into the ingredients of famine analysis and the role of food production, poverty and entitlements in famines. According to him, decline in food production and availability is not necessarily the primary cause of famine, rather a series of factors may converge to reduce the exchange entitlement of households, precipitating reduced consumption. These factors include redistribution of available food, inflation, reduction in income due to unemployment and lower farm profits. Governments often pay excessive attention to aggregate food supplies, failing to recognize the other key elements that result in the decline of food consumption of

population segments which, at the extreme, result in famine. The policymakers must also be cognizant of the fact that the proportion of poor in a population may not change over time but this does not mean that it is the same households [Srinivasan, 1985]. It is important to generate such information since it is essential in designing and implementing effective poverty alleviation and nutrition programs.

TARGETED NUTRITION AND SUBSIDY PROGRAMS

A series of studies undertaken by Behrman [1988], Behrman and Deolalikar [1987], and Behrman, Deolalikar, and Wolfe [1988] in several developing countries, including India, analyze the influence of prices, income, and schooling on the nutrient intake and the effect of nutrition on health, productivity, wages, and fertility. The studies suggest strong impact of food prices on nutrition, particularly for the poor; growth in income may be less likely to improve nutrition than has been suggested by others; women's schooling is important in improving nutrition; nutrition exerts positive influence on productivity, wages, and fertility; and direct association between nutrition and health is not shown.

Such information is essential in designing effective nutrition and food subsidy programs as a mechanism to improve nutrition and keep the cost of food subsidy as low as possible. Food subsidy programs are popular in many developing countries, particularly in Asia [Pinstrup-Andersen, ed., 1988]. The blanket subsidy program in Sri Lanka became too expensive for government to sustain and was replaced in 1979 with targeted food stamp scheme [Edirisinghe, 1987]. In the long run, it is essential to promote welfare through policies designed to promote economic growth, as was argued for Sri Lanka by S. S. Bhalla and Glewwe [1986]. However, these policies need to be complemented with targeted nutrition and food subsidy programs in order to improve the welfare of low-income households who may not benefit from economic growth.

As has been shown by Garcia and Pinstrup-Andersen [1987] for a sample survey of a pilot project area in the Philippines, targeted food subsidy schemes could be very effective in reducing malnutrition. The pilot project was implemented in three provinces for one year during 1983/84. Prior to the implementation of pilot program, the survey showed that the distribution of food within household was biased in favor of adults, about one-fourth of preschoolers were malnourished, and malnutrition decreased with an increase in income. Food (rice and cooking oil) subsidies had positive impact on household food expenditure, calories acquired and consumed, and average weight of preschoolers. It was shown that consumers are more likely to increase food consumption if foods are subsidized than if incomes are raised directly. The total cost of the scheme was attributed to food subsidy (84 percent), administrative cost (9 percent), and incentive payments to private retailers to assure efficient distribution of subsidized food (7 per-

cent). The annual cost of eliminating calorie deficiencies in the sample was estimated to be about twenty-five dollars per adult equivalent unit. The food subsidy scheme was based on geographical targeting rather than targeting based on household income—which is relatively more difficult to administer, implement, and monitor. However, there was a strong relationship between poverty and malnutrition, indicating that any long-term solution to the nutrition problem must focus on poverty alleviation. Overall, the scheme was considered efficient and cost effective. Blanket subsidy programs, like urban food subsidies in China, become too expensive to sustain in the long run and even lead to wastage of food by the high-income households.

INCOME AND CONSUMPTION PATTERNS

There is a direct relationship between income and consumption behavior. The Green Revolution has been responsible for increases in income levels and for changes in the distribution of income. As a result, the Green Revolution has important implications for food consumption patterns.[53] Mellor and Lele [1973] argued that, particularly for the peasant farming classes, the incremental share of budget spent on foodgrains declines with the income increases associated with improved agricultural technology; and the incremental share spent on goods and services produced by nonfoodgrains agriculture and industrial sectors increases. This can increase economic growth by increasing the marketable surplus of foodgrains to the nonagricultural sector; increasing the incremental demand for the consumption of those consumer goods that can be produced by labor-intensive techniques; increasing labor demand and employment; and increasing demand for foodgrains, which keeps foodgrain prices from falling below the incentive price levels that are important for continuing growth in agricultural production.

There are sharp contrasts between rural and urban expenditure patterns [Government of India, 1986] in Asia as well as in other developing and even developed countries. However, all these differences cannot be explained by differences in income alone. This suggests that short-term development patterns in different sectors are dissimilar. The expenditure elasticities for foodgrains, milk, and milk products are consistently greater in rural than in urban areas [Harrison, Hitchings, and Wall, 1981]. In rural compared to urban areas, expenditure elasticities for clothing are higher in the low-expenditure groups and fall much less rapidly as expenditures rise but are lower in the upper expenditure groups. C. H. H. Rao [1969] showed that foodgrains may be as much as 19 percent cheaper and urban goods 34 percent more expensive in rural than in urban areas. Apparent elasticities may change substantially as rural markets are integrated more fully into the national centers. Consumers' tastes may also change over time, especially as income increases rapidly, markets grow and become integrated, and income distribution changes. In order to shift the structure of domestic production, so that

employment is increased, taxes and subsidies may be used to channel consumption toward more labor-intensive commodities.

2. Labor, Employment, and Wages

THE NATURE OF RURAL LABOR SUPPLY

Surprisingly little is known about the rural labor supply.[54] The rural labor force in much of South Asia appears to be overemployed at seasonal peaks and underemployed in slack seasons. Yet contrary to commonly held views that labor is chronically in surplus, it seems likely that there is an active and pervasive labor market that adjusts to interseasonal equilibria.[55] The labor market is probably in equilibrium at all seasons, but with sharply different wage rates. During slack seasons, the supply may be so elastic that a modest increase in wages will draw a large increase in labor supply. The labor supply may be highly inelastic during seasonal peaks. Farm operators would then try to reduce labor requirements during peak season by mechanizing, that is, by substituting more elastic supplies of capital. Thus, a combina tion of inelastic supply of labor during seasonal peaks and an inability to mechanize may reduce employment in slack seasons. Most mechanization in India seems to have been suitable for resolving this problem.[56]

Low-income households provide disproportionately large numbers of women in the rural labor force. According to Mellor [1976], among landless and near landless families in India, 43 percent of the workers are female, compared to 33 percent of the workers among families with holdings of over five acres. This suggests that women withdraw from the rural labor force as incomes rise. This result is corroborated for India in Agarwal [1984], for Indonesia in B. White [1984], and for rural Egypt in B. Hansen [1969]. Child labor responds similarly to rising incomes. There is also a high degree of substitution between women's and children's labor [Yotopoulos and Mergos, 1986].

There are about three times as many households of landowners as there are of landless laborers in India. While most landowners do farm work, little is known of their need for labor. It seems logical, given the low wage rate, that well-to-do landowners would hire much of the labor needed for arduous physical work and spend most of their own time on supervisory, managerial, and marketing activities. On the other hand, it is possible that the introduction of machinery, rising wage rates, and declining seasonality of employment raise direct labor participation rates of landowners.[57]

Rapid population growth prevents the increased demand for labor from tightening the labor market and raising per capita employment. No group has a greater stake in reducing the rates of population growth than the landless laborers.[58] Unfortunately, there is probably no better example of a divergence between individual and group interests. If the poor participate in economic growth,

however, then mortality rates decline, the potential income of the poor goes up, and the opportunity to invest in education expands. A strategy of growth that increases the demand for labor may reduce the long-run supply of labor by reducing fertility, thereby improving employment and the wage rates of the laboring class.

THE DEMAND FOR RURAL LABOR

The major forces affecting the demand for agricultural labor are modern farm technology, mechanization, changes in crop acreage, structure of demand for agricultural products, and the pattern of cultivation. Again, surprisingly little is known about the effects these forces have on the demand for labor. In the few areas that have undergone major technological changes, it is clear that wages, employment, and mechanization have all increased substantially.[59] These developments are, however, the product of complex interactions between unusually successful, geographically localized innovations.[60]

Based on 1967/68 sample data for the Indian Punjab, S. S. Sidhu [1974b] estimated that the per acre labor demand function increased by 25 percent as a result of a shift to modern wheat varieties. For Rajasthan, Acharya [1973] estimated that labor demand increased by 32 percent as a result of the same kind of shift. Barker and Cordova [1978] reported that for rice production in the Philippines the introduction of modern varieties of rice increased labor input per hectare, but decreased labor input per ton of rice production.

Johl [1973b], in a careful analysis of agriculture in the Indian Punjab, concluded that mechanization, along with elements of improved farm technology, has directly and indirectly increased not only employment and labor productivity but also the returns to various factors of production. On the other hand, Billings and A. Singh [1969] reported that labor demand declines marginally as a farm shifts completely from traditional to mechanized cultivation methods. Kahlon and Grewal [1972] concluded that the use of tractors in the agriculture of the Indian Punjab decreased labor demand slightly but increased the productivity of land and off-farm employment. Donovan [1974], using a linear programming model for a group of villages in the state of Mysore (now Karnataka) in India, showed that mechanization can break labor bottlenecks and increase production.[61]

Binswanger [1978] in a comprehensive review for South Asia concludes that there is no convincing evidence that tractors are responsible for substantial increases in intensity, yields, timeliness, and gross returns. There is no evidence that tractors have high benefit-cost ratios in semiarid zones or even in the eastern rice belt of the subcontinent. A comparative historical perspective of agricultural mechanization is provided by Binswanger [1984]. Policy issues and options

related to agricultural mechanization in the context of economic development are discussed in detail by Binswanger and Donovan [1987].

A concern for the laboring classes should not lead automatically to the simplistic solution of not mechanizing. And there is not a dichotomy between labor-saving and land-saving mechanization. Mechanization, which pays for itself in increased crop yields and larger supply of wage goods necessary to increase employment, may also displace labor that has little alternative use in agriculture and for which provision has not been made elsewhere in the economy.[62] Given the complexity and variability of these relationships, one can well argue that such decisions about mechanization are necessarily best left to the marketplace which in turn requires that there be no direct or indirect (e.g., through credit) subsidies.

The difficulty of the employment problem and the natural desire for simple answers lend substantial support to increased use of rural public works programs.[63] While the returns to rural infrastructure are potentially high, however, rural public works created solely for employment creation with inadequate complementary resources may be less useful for long-term poverty reduction than alternative programs. In those areas where there is little apparent prospect for future development, there is a difficult tradeoff between public works as a means of distributing welfare to such regions, or to invest elsewhere and expect migration to solve the problem.[64] Finally, one of the most important determinants of the real wages of the poor is foodgrain prices [Mellor and Desai, 1985]. If food production increases, the poor can benefit whether or not rural public works projects are effective. If such projects do not increase food production, the poor will lose much of their gain from higher employment through higher prices.[65]

3. Poverty, Equity, and Technology

POVERTY PROBLEM

Any definition of poverty is bound to be arbitrary. Dandekar and Rath [1971a, b] set the poverty line for India at 20 rupees or $4.19 per person per month according to 1960/61 prices and exchange rates, on the ground that persons with less than that income do not obtain enough calories for normal health and activity. According to this definition, 40 percent of India's rural population and 50 percent of its urban population were below the poverty line during 1960/61. Since urban employment has grown consistently faster than the natural increase in urban population, poverty in the cities largely reflects rural poverty and the migration of the unemployed to urban areas.

Although there is controversy on this point, the real incomes of the people in the lower 40 percent of the income distribution scale probably have not increased in the past two decades.[66] A particularly important finding by Narain, reported in Mellor and Desai, eds. [1985], is that in India underlying structural changes

have reduced poverty secularly with that effect more than balanced by rising food prices and declining food availability per capita. The implication is that insufficient Green Revolution and population growth are the culprits behind lack of progress in reducing poverty. These results are corroborated by Alamgir [1975a, b] for Bangladesh, and T. Alauddin [1975] for Pakistan.[67]

According to a World Bank [1975] study, 40 percent of the Asian population was below the poverty line set at fifty dollars per capita annual income during 1969, with 85 percent of the Asian poor in the rural areas. Time series data show large swings in the proportion of the Indian rural population in poverty—from 40 percent to 60 percent. Some of these swings lasted for several years. The nature of these swings and their causes are discussed by several authors in Mellor and Desai, eds. [1985]. The authors put special emphasis on food prices and food production.

The income of landless or almost landless laborers depends on the demand for their labor by the owners of land and capital. Virtually all of them fall into the Dandekar and Rath [1971a, b] poverty class. Only a massive increase in employment can change this. The rural landless labor class is larger in India than in most other low-income countries, which makes the problem more difficult, economically and politically. India, however, offers particularly timely and instructive lessons because population growth and the diminishing availability of uncultivated lands are bringing increases in the size of the landless class in many other Asian countries.

TECHNOLOGY, GROWTH, AND EQUITY

The possible trade-offs between growth and equity in agricultural development and strategies for their improvement were discussed at the Eighteenth International Conference of Agricultural Economists, held in Jakarta, Indonesia, August 24 to September 2, 1982. The deliberations were published in Maunder and Ohkawa, eds. [1983] and Greenshields and Bellamy, eds. [1983]. According to Vyas [1983a, b], the pattern of agricultural growth in South and Southeast Asian countries during the 1970s did not favor the small farmers and the landless laborers who continued to be marginal producers and consumers. Hayami [1983], however, argued that technology does not promote inequity in the rural sector, and concludes that there is no trade-off between growth and equity in the long run. Narain and Roy [1980] showed the very powerful effects of irrigation, as a proxy for technology, on increasing employment.

Though it is ironic that a solution to the problem of rural poverty is provided by the spread of yield-increasing technological innovations that may raise the incomes of the landowning classes markedly, increased food supplies are essential if the welfare of the poor is to be improved. The nature of the new technology, the extent of its application, and the physical environment within which it is applied

determine the size of the increase in yield, the quantity of inputs purchased, and the amount of employment created. These forces, in combination with the distribution of production resources, are responsible for the initial allocation of benefits among different income classes.

Although the use of modern technology has certainly increased average per capita income, there is controversy about how it affects the distribution of income. Some claim that the income distribution is becoming much more inequitable.[68] Using a sample of 126 representative farm holdings during 1967/68 to 1969/70, K. Singh [1973] argued that farm income inequality declined in the Aligarh district of Uttar Pradesh in India from 1963/64 to 1968/69. Based on an empirical study in Gujarat (India), Schluter [1974] concluded that much of the incremental income from high-yielding varieties is a residual return to landowners; only a small proportion comes from a greater use of labor.

In a farm-level analysis of rice farms in selected Asian countries, Barker and Herdt [1978] concluded that the adoption of modern rice varieties has been accompanied by an increase in labor use per hectare, small farmers have lagged significantly behind large farmers in the adoption of labor-saving innovations but not in the adoption of technology that would increase yields and income, and in the survey villages in India, Indonesia, and Pakistan, large farmers consistently used higher levels of fertilizer and obtained higher yields.

The proportion of the additional income paid to labor is nevertheless smaller than the proportion paid to each of the other inputs. This has confused many appraisers of the Green Revolution. According to R. S. Dixit and P. P. Singh [1970] actual imputed payments to labor in Uttar Pradesh (India) absorbed only 10 percent of the increased income from high-yielding varieties of wheat, while other purchased inputs absorbed 23 percent, leaving 67 percent as a reimbursement to the owners of land and capital. Similarly, in thirteen of the fifteen cases in Table 16, the proportion of increased output attributable to labor was between 5 and 15 percent. The percentage gain in income to labor was large, more than 25 percent in seven of the fifteen cases, because of the large rise in production.

In a study based on survey data of rice farmers for 1966, 1970, and 1974 for Laguna and Central Luzon/Laguna in the Philippines, Ranade and Herdt [1978] concluded that even though relative share of total labor declines, and because employment of hired labor increases, hired laborers became relatively "better-off" and new technologies were not landlord biased. Commenting on this study, Sinaga and Sinaga [1978] indicated that in Indonesia the benefit from the use of modern varieties of rice went to the operators and landlords, despite the fact that the labor requirement for rice production did not decline. The decline in labor share was because of a decline in real wages in the rural areas of Indonesia.

In a comprehensive study of crop diversification, Schuh and Barghouti [1988] argue that the rice industry in Asia in recent years has the found itself in a para-

Table 16. Division of increased agricultural production between labor and other farm inputs in Asia

Location	Increase in gross value of output		Increase in labor "payments"		Percent of increased output to labor[b]	Percent of increased output to other Inputs[c]	Source
	Rupees per acre[a]	Percent increase	Rupees per acre[a]	Percent increase			
				Wheat			
Aligarh, U.P., India[d]	462	71	46	58	10	90	Dixit and Singh [1970]
Varanasi, U.P., India[d]	620	65	11	15	2	98	Misra and Shukla [1969]
Udaipur, Rajasthan, India	343	43	18	13	5	95	Acharya [1969]
Punjab, India	450	100	56	42	12	88	Government of India [1967/68]
				Kharif Paddy			
West Godavari, Andhra Pradesh, India	269	38	32	17	12	88	Agro-Economic Research Center [1968/69]
East Godavari, Andhra Pradesh, India	216	33	20	13	10	90	Agro-Economic Research Center [1968/69]
Uttar Pradesh, India	1,100	200	67	92	6	94	Misra and Shukla [1969]
Tamil Nadu, India	550	100	33	20	6	94	Government of India [1968/69]
Laguna, Philippines	374	72	3	3	1	99	Crisostomo *et al.* [1971]
Sambulpur, Orissa, India	404	95	36	28	11	89	Tripathy and Samal [1969]
				Rabi Paddy			
West Godavari, Andhra Pradesh, India	562	86	39	16	7	93	Agro-Economic Research Center [1968/69]
East Godavari, Andhra Pradesh, India	761	153	39	30	5	95	Agro-Economic Research Center [1968/69]
Tamil Nadu, India	625	100	46	21	7	93	Government of India [1968/69]
Gumai Bil, Bangladesh	948	208	302	125	32	68	Masud and Underwood [1970]
				Bajra[e]			
Kaira, Gujarat, India	300	85	39	27	13	87	B. M. Desai and M. D. Desai [1969]

Source: Mellor and Lele [1973].

[a] Peso in the case of Philippines and Taka in the case of Bangladesh.

[b] Labor "payment" is defined as physical labor input (family and hired) in man-days at a constant wage.

[c] Other inputs "payments" are defined as gross value of output minus share to labor.

[d] U.P. refers to state of Uttar Pradesh in India.

[e] Millet.

doxical situation of "immiserizing growth," under which rice producers and workers are actually worse off than they were before the new rice production technology was adopted. Rice, which is a staple food in Asia, has limited international trade prospects. Domestic demand for rice has relatively low income and price elasticity. Improved varieties and use of modern inputs has increased rice supply faster than demand, pushing the price of rice down and leading to lower income for rice producers. Public policies that facilitate the transfer of resources to other productive activities can alleviate the problem. As a result, there is a need for rational agricultural diversification out of rice, and development of nonagricultural activities that will shift labor out of the agricultural sector. Some of these issues have also been addressed by Gonzales [1987] in the context of rice production and regional crop diversification in the Philippines.

Quizon and Binswanger [1986] analyzed the impact of agricultural growth and government policy on income distribution in India. The study is based on a limited general equilibrium model and deals with all-India data for a twenty-year period from 1961 to 1981. Based on an empirical analysis, they conclude that income gains from the Green Revolution initially accrued to the wealthier rural groups, but after 1972/73 they were transferred to urban consumers. By 1980/81 the per capita income of poor and wealthier rural groups alike were barely above their respective 1960/61 levels. They propose a reduction in population growth and an increase in nonagricultural employment and income to convert agricultural growth into reduced poverty.

POVERTY ALLEVIATION STRATEGY

Programs for alleviating rural poverty logically should emphasize helping low-income small farmers gain access to new production technology and inducing expenditures from the increased incomes of the landowning classes that would stimulate the demand for labor.[69] If access to goods and services is to be broadened, the incomes of low-income families must be increased. Most of such increases must occur by increasing employment and labor productivity, particularly in countries with the lowest per capita incomes.

Experience shows, however, that development and investment strategies that raise production do not necessarily cause a commensurate increase in the employment or incomes of low-income people. An increase in foodgrain production may not provide enough direct increase in employment to create adequate demand to maintain price ratios, even though grain is an important staple of low-income families in many countries. Conversely, a large increase in the income of the lower income majority caused by an increase in employment cannot be sustained in low-income countries unless there is a commensurate increase in the production of food and other goods to meet the greater demand allowed by higher incomes. A practical strategy that increases the productivity and incomes

of low-income families is complex and must be adapted to the different factor endowments and levels of development of countries.

The critical point to keep in mind in assessing the effect of new technology on poverty is that growth in population and hence of the labor force is a major force increasing poverty. The principal offset is migration to nonfarm employment. The combination of the high rate of population growth and little growth in nonfarm employment is too powerful a negative factor for technological change to offset. But if the multiplier effects of new agricultural technology on nonfarm employment are strong, a major reduction in poverty can occur. It is for policy to encourage those nonfarm employment multipliers.

Major inequalities in the ownership or control of land and other productive assets impose significant obstacles to economic development. Programs that expand production in such an environment tend to exclude many of the poor from production and consumption. This holds back growth, does little or nothing to alleviate poverty, and aggravates economic and social inequalities.

To enable the poor to participate in the growth process, low-income countries may need either to redirect public expenditures or to redistribute land. Either choice is likely to be viewed as an unacceptable short-run sacrifice by powerful urban and rural elite groups. Appeals to a long-run concern for the existing system may not be able to overcome or modify these views.

A major set of problems facing the landless and the poor is the lack of their own capital and their inability to obtain institutional credit for any productive activities. Banks often discriminate against them because they do not have land or any other assets for collateral. In this context, the experience of the Grameen Bank in Bangladesh—which provides credit to alleviate rural poverty for the landless—is very instructive for other developing countries as well as Bangladesh [Hossain, 1988a]. The Grameen Bank was established as a specialized financial institution in 1983 in order to provide credit to the rural poor. In 1987, there were 298 branches, and women accounted for 74 percent of total membership. Loans are given for noncrop activities. Out of all the loans granted in 1986, 46 percent were for livestock and poultry, 25 percent were for processing and manufacturing, and 23 percent were for training and shopkeeping. The loan recovery rate was excellent since less than 1 percent of the loans were overdue. The Grameen Bank has significantly contributed to the generation of employment (especially for women) and the alleviation of rural poverty. However, the cost of operations is considered rather high due to the low rate of interest and high cost of intense supervision. The cost may be high compared with commercial bank operations, but, for an objective comparative analysis this cost needs to be compared instead with the cost of other national programs that are designed to provide employment and alleviate rural poverty, particularly for rural women.

The World Bank has provided leadership in financing projects designed to alleviate rural poverty. At present, one of the major thrusts of the World Bank is gradually to alleviate poverty in low-income developing countries. The World Bank experience in rural development from 1965 to 1986 is summarized in World Bank [1988b]. The Bank defined rural development projects as those projects in the agricultural sector where 50 percent or more of the direct benefits were intended to go to poverty target groups. The operational goals of rural development projects were to improve productivity, employment, and income for the target groups as well as to provide a minimum acceptable levels of food, shelter, education, and health. In broader terms, the rural development strategy was appropriate and effective. Millions of rural people benefited from investment in rural infrastructure and food production. However, many often-ambitious targets have not always been met. Many valuable lessons have been learned and applied to later operations. The program continues to evolve and the challenge to alleviate rural poverty in developing countries remains undiminished.

4. Health and Education

IMPROVED HEALTH

Health epitomizes the complex interaction between production, employment, consumption, and human well-being.[70] But, the surplus labor in many countries lessens the importance of the argument that improving the health of the labor force would make it larger and more productive.

Wyon and Gordon [1971] found the death rate nearly twice as high among low-caste agricultural laborers as among high-caste owner-cultivators in a set of villages in relatively prosperous Indian Punjab. Levinson [1974], in another Punjab study—this one of infants aged six to twenty-four months—frequently found significant malnutrition in all income and caste groups, reflecting a lack of knowledge as well as resources. But malnutrition was much more widespread among the laboring classes than among the landowning classes. According to Chowdhury, Alauddin, and Chen [1977], during the 1971 and 1974 famines in Bangladesh, the population which was affected more than others included the young, elderly, poor, and the disadvantaged.

The children of the poor frequently suffer from poor health and high mortality rates because they lack proper care. Minkler [1970] noted that in both rural and urban India the need to supplement low incomes forces the majority of women from low-income households to seek jobs outside the home. As a result, their children may not receive proper attention. This leads to high infant mortality, which encourages a large number of births [Kocher, 1973]. Research by S. Kumar [1979] indicates that large-scale food subsidies improve substantially the food consumption of low-income households and the health of infants. Recent

research on this subject has corroborated these early results [Kennedy and Alderman, 1987]. The research results suggest various ways to reduce the cost of food subsidies, including targeting them towards the poorest households, inferior commodities, and low-income regions.

There is increasing evidence that public activities, including education and public health measures, are necessary if improved health is to follow quickly after rising incomes and increased food consumption. There is a particular need for research on the factors that affect the relationship between increased food intake, nutrition, and health; on the extent to which these factors are subject to public intervention; and on the extent to which private actions may be encouraged by increased education. On the education factor, there is evidence that, at the very lowest levels of incomes, education has little effect on nutritional status and health [Bouis, 1990]. That may be because, at the lowest income level, there is simply not the resource flexibility to take advantage of improved education with respect to health and nutrition. However, as incomes rise, the impact of education on nutrition also rises.

RURAL EDUCATION

No effective poverty program can ignore education. Education increases access to jobs, production resources, and power. By improving labor productivity and the efficiency with which resources are used, it contributes to higher national income. As a rule, the poor are the least educated and get the fewest benefits from their schooling. They also fail to attend school, particularly in rural areas, largely because jobs requiring education are not readily available and the opportunity cost of the labor hours of family members is relatively high even in very poor families.[71] A review of literature in the past twenty years and discussion of issues dealing with education and development is provided by Psacharopoulos [1988a].

The relative costs of education are much higher for the needy because the income foregone for education is more important to them than for the upper-income classes. A number of studies show that the rates of return from investment in primary education are considerably higher than from investment in other levels of schooling.[72] These studies, however, are based largely on urban areas, where a much larger percentage of children attend primary schools that are substantially superior to those in rural districts.

It is likely, as analyses of educational processes proceed, that the returns to secondary education in the dynamic context of a modernized agriculture will turn out to be quite high. We already see in studies of management-intensive modernization practices, such as use of cross-bred dairy animals, that the returns to upper levels of education are high [Alderman, 1987]. One could make a reasonable generalization that, as technology advances, it becomes more complex and therefore it requires higher levels of education. It stands to reason that in developing coun-

tries where at any given level of education, instruction is relatively poor, it will take more years of such education to achieve a given result. In these circumstances, primary education may largely provide the tools for further learning, and it is at the secondary school level that one acquires the ability to make the judgments necessary for modernizing agriculture.

The contrasts in the enrollment of different economic classes in universities are similarly associated with greater costs and lower rewards for the poor. Full participation of the poor in education cannot be achieved simply by adding primary school facilities in rural areas suffering from economic stagnation and extreme poverty. Fundamental economic and, possibly, social changes are needed.[73]

5. Environmental Considerations

As agriculture modernizes, incomes rise and rural welfare increases. There is scope for improving the environment in which rural people live. It must be kept in mind that the bulk of rural environmental destruction, including deforestation and destruction of perennial grasses in arid lands, takes place as a result of growing populations of increasingly poor people [Mellor, 1988c]. Increasing poverty forces people onto land of lower and lower productivity.

S. Kumar and Hotchkiss [1988] analyze the consequences of deforestation for women's time allocation, agricultural production, and nutrition in hill areas of Nepal. The main causes of deforestation in Nepal are found to be the need for more land to grow food to sustain growing population, and fuelwood consumption. The main consequences of deforestation are found to be low agricultural productivity on existing cultivated land since more time is spent on collecting essential forest products, and rapid environmental degradation. Clearly, any strategy to deal with environmental concerns needs to be analyzed in the context of growth in population and poverty.

It is also important to keep in mind, when looking at environmental issues in the context of modernization and rural welfare, that values with respect to the environment probably differ little between low and high income people, whether located in developed or developing countries. Most people are quite risk-averse with respect to ill-understood changes in the circumstances in which they live. This leads to an environmental conservatism. Most poeple are concerned with intergenerational income transfers. They are concerned about their children and their grandchildren. This concern leads them away from practicing a discounted rate of return in their day-to-day life. Some of these issues, in the context of population policy and individual choice, are analyzed by Nerlove, Razin, and Sadka [1987].

There are three basic reasons why destruction of environmental resources is more rapid in rural areas of developing countries. First, intense poverty, which as indicated above, drives people onto marginal resources and leads to destructive

land use patterns. Second, the low level of education in rural areas makes it difficult for people to apply complex modern practices. For example, there is a clear close relationship between adoption of integrated pest management with its requirement for careful insect population counts, and for quick response to changes in insect populations. And fertilizer-conserving practices include scientific soil testing, variation in fertilizer use from year to year according to the findings of those tests, and precise timing and placement in the application of fertilizer. All of these practices, which are important from an environmental preservation point of view, require widespread education through the secondary-school level.

Finally, an intricate grid of rural infrastructure is essential to sound environmental practices. This is because land and water resources vary in the rural sector over small geographic areas. Optimal use of these resources calls for variations in agricultural production systems, which may not be tuned precisely to the narrow demand in a small region defined by lack of infrastructure. To put the case simply, in an area of subsistence agriculture with a small amount of flat valley land and a considerable amount of steeply sloping land, annual grain crops such as maize are likely to be grown on both. As the potential opens up for specialization in trade, which accompanies good infrastructure, the level lands in the valley may be used for annual crops, but the hillsides can be planted to perennial crops, including fruit trees and grasses. This steep land may even be used quite intensively in combination with the flat valley lands. That is possible, however, only if the surplus production for the local area can be exported and other goods brought in.

Thus, we can expect environmental destruction to occur as long as rural populations are exceedingly poor, ill-educated, and without basic means of transportation and communication. Modernization of agriculture increases rural welfare generally and has substantial externalities with respect to the environment.

These theories of environment and sustainable agriculture, which propound that farming practices can and should be designed to maintain optimal crop yields indefinitely, has received a great deal of attention from scholars and policymakers in the last few years [Bunting, ed., 1987; Conable, 1989; FAO, 1988b; Grimshaw, 1989; Mellor, 1988c; Oram, 1988; Pimentel *et al.*, 1987; Tisdell, 1988; York, 1988; Warford and Partow, 1989; T. J. Davis and Schirmer, eds., 1987; and World Commission on Environment and Development, 1987a, b]. However, the concept of sustainability is not precise and has different meanings for different people. As has been emphasized by Oram [1988], the causes and effects of major environmental concerns—such as deforestation, acid rain, eutrophication of water resources, ozone depletion, and the greenhouse effect—transcend economic, social, and geographic boundaries. Agriculture is both a contributor to the erosion of sustainability and a victim of other environmental abuses caused by industry, rapid population growth, and urbanization.

Agricultural resource management, especially of agricultural land and water, is extremely important and must be included in any strategy of agricultural development. This is particularly important for developing Asian countries with high population pressure and limited supplies of agricultural land and water. According to the results reported in Pimentel *et al.* [1987], in the United States, for example, soil erosion averages about eighteen tons per hectare per year. About half of the forty-five million tons of fertilizer applied annually in the United States are replacing the soil nutrients lost by erosion. Pimentel *et al.* [1987] find that soil erosion and associated water runoff cost the United States about $43.5 billion dollars annually in direct and indirect effects. The long-term environmental and social costs may be several times this level. Clearly, it would pay society to invest in soil and water conservation. These problems in tropical Asia are even more serious, and the poor developing countries can ill afford such physical and economic losses. Both conventional and unconventional strategies for soil and water conservation need to be promoted. For example, according to Grimshaw [1989], the use of vetiver grass has proved to be an effective vegetative alternative for reducing soil erosion and preserving soil moisture. It is also environmentally sound, less expensive, and has the potential to make a large contribution to sustainable agriculture.

6. Women in Development

The influence of women is, of course, pervasive in the household and rural development context. Women provide a major part of the labor force in the rural sector, participate in a wide range of household decision-making activities, and play a particularly critical role in family welfare circumstances. Presumably, no aspect of rural development fails to have a female component. For that reason, instead of drawing attention to women's roles as we proceed, we refer the reader to a particularly perceptive discussion on women and structural transformation by Lele [1986]. Specific guidelines to help policymakers and development institutions bring women into the economic mainstream are outlined in Herz [1989].

Having emphasized the pervasiveness of the role of women in the modernization process, one should pay specific attention to critical aspects of the process from which they may be excluded, either accidentally or by design. For example, the importance of education increases in the process of modernization. Education rapidly becomes the most important asset, particularly for lower income people. If women are systematically excluded from formal education, they are excluded from ownership of one of the key assets in the development process. It is not uncommon for the opportunity cost of young girls' time to be higher than that of boys, primarily because of their role in child rearing of siblings, and therefore, girls are often withdrawn from school at an early age. This has major repercus-

sions not only for their own development, but also in generational terms because of the critical role of women in molding the next generation.

Women may also have problems with respect to ownership and control of assets, including land. This again may inhibit women, particularly those who are single either by choice or due to the deaths of male family members. Because of the critical role of women in the family and household, they may be more restricted in their geographic movement. This means that, if women and young girls are to be included in the processes of education and of development generally, particular attention may have to be given to how they can be integrated into complex institutions while still fulfilling heavy household responsibilities. Such considerations are particularly important because unthinking male domination of institutional structures may in fact exclude women, even when movement out of the household and related factors are not at work. Thus, it is often necessary to consider the role of women explicitly.

Chapter VIII. Growth Linkages and Agricultural Development

Poor performance of agriculture is widely regarded as a retardant to economic growth, but the fact that rural areas can stimulate growth is rarely recognized. According to Hirschman [1958, pp. 109-110]: "Agriculture certainly stands convicted on the count of its lack of direct stimulus to the setting up of new activities through linkage effects—the superiority of manufacturing in this respect is crushing."[74] Traditional agriculture may have diminishing returns and increasing costs, but the conclusion that increased agricultural production must become a drain on the productivity of other sectors ignores the potential and the implications of modernizing agriculture more rapidly through technological change. Increases in the efficiency of technologically advanced farming make possible large net increases in national income, which provide growth with positive consumption as well as production multiplier and linkage effects.

1. Sectoral Linkages and Development Strategy

Hirschman [1958] operationalized the linkage approach to economic development. In Hirschman's framework, investment dominated economic development. The economic development strategy he proposed relied primarily on linkages to induce and facilitate investment. More recently, Hirschman [1977, p. 80] provided a broader definition of linkages: "development is essentially the record of how one thing leads to another, and the linkages are that record, from a specific point of view. They focus on certain characteristics inherent in the productive activities already in process at a certain time. These ongoing activities, because of their characteristics, push, or more modestly, invite some operators to take up

new activities. Whenever that is the case, a linkage exists between the ongoing and the new activity."[75]

The linkage theory of economic development has been operationalized to measure the forward and backward linkages, and provide guidelines to policymakers to induce investment in those industries with strong linkages and remove obstacles from industries with potentially strong but existing weak linkages. The Leontief input-output framework is the basis for measuring alternative linkage indexes and sectoral interdependence.[76] The direct backward linkage index measures the amount of intermediate inputs required from different sectors in the economy to produce one unit of output in any one sector. The direct forward linkage index measures the amount of output from any one sector supplied for intermediate use to different sectors of the economy as a proportion of its total demand.

Hirschman [1958] argued that backward linkages are better guides to the design of economic development strategies than forward linkages, since increased demand for intermediate inputs is a better stimulus than increased supply. In Hirschman's framework, sectors with high forward *and* backward or high backward linkages should be preferred to agriculture, which, according to Chenery and Watanabe [1958], possesses high forward and low backward linkages. Modernized agriculture, however, promises higher potential linkages than traditional agriculture. Furthermore, the empirical evidence generated by Yotopoulos and Nugent [1973] from cross-country time-series data does not support the extreme version of the linkage hypothesis, according to which countries that give high priority to high-linkage industries have higher rates of growth than those that give low priority to them. According to Mudahar [1982], however, since the linkage indexes are calculated from input-output tables based on highly aggregated data, one should be very careful in interpreting these indexes and using them to guide sectoral planning.

2. Growth Linkages and Agricultural Development

Mudahar [1982] classified sectoral growth linkages in agriculture into four categories: production linkages, consumption linkages, investment linkages, and employment linkages.[77] The Asian Development Bank [1977] estimated production linkage coefficients for India and found that crop and animal husbandry has "weak" backward and "medium-strong" forward linkages, and that agroprocessing sector has "strong" backward and "medium-weak" forward linkages. Experience since the Green Revolution demonstrates that modernizing agriculture possesses strong backward and forward linkages.[78] This is corroborated empirically in an econometric model of the Indian economy by Rangarajan [1982]. Critical to the assessment of agricultural sector linkages is the role of technolog-

ical change in making a *net* addition to income which may provide its stimulus through increased *consumption* expenditure.

It is common to think of a pattern of demand either as fixed or as malleable only as a welfare measure. The contrasting view, presented in Mellor [1976], is that demand can be manipulated to increase production—for example, by investment policy, including emphasis on peasant agriculture and by taxation policy. That is, it can be manipulated to accommodate capital shortages (by structural changes towards a labor-intensive product mix) and other obstacles to expansion, to increase the productive use of land, and to increase the consumption of foodgrains enough to sustain the price in the face of an increase in agricultural production. Crucial to this view of growth is the potential for a major increase in the national income through efficiency-increasing technological change in agriculture and the mobilization of underutilized labor by the expansion of effective demand, particularly in the service and small-scale manufacturing sectors. The growth of such activities has important locational implications—what activities occur where and in what order—which a facilitating policy needs to grasp [Wanmali, 1983, 1985].

To plan effectively to meet increased demand and to correct imbalances between the production and consumption of different goods, the patterns of expenditure of additional income must be known. Increased expenditures on production inputs and capital goods for agriculture may have strong domestic growth linkages. Such investments are largely for fertilizer, pesticides, improved seeds, irrigation works, and labor-saving machinery. Fertilizer and pesticides tend to have a large import content. Many mechanical items can be produced in small-scale enterprises with low capital-labor ratios.[79] In the long run, however, 60 to 80 percent of additional rural income is spent on consumer goods. A comparative analysis by Hazell and Röell [1983] brings out the strong linkages of middle peasants in Asia with growth in other sectors. The nature of new foodgrain technologies and the availability of resources determine the distribution of the additional income.

Increases in per capita income and growing disparities in income distribution have important implications for households in different expenditure classes and for growth linkages. They cause marketable surplus of the higher expenditure classes to increase, which increases the proportion of incremental income they spend on nonfoodgrains, processed foods, and nonagricultural goods and services.[80] The production processes of most of these goods and services are highly labor intensive, and so can create large increases in the demand for labor.

The linkages from increased foodgrain production cannot have their full stimulative effect on growth unless restraints on production in the domestic consumer goods sector are removed. Growth in industrial production may be constrained by institutional barriers, particularly within capital, input, and output markets.

Public policy must analyze these barriers and make appropriate adjustments. The nonfoodgrain agricultural sector (dairy, vegetable, and fruit production) is the most important beneficiary of demand increased by rising incomes. It is in many respects the most attractive sector for expansion because it is labor intensive and has a geographically dispersed pattern of demand and production. As the process of economic development gathers momentum, the rapid growth in demand for this subsector of agriculture and its lack of land constraint allows an acceleration in growth well beyond what the land-bound basic food staples sector could sustain—four to six percent growth rates, rather than two to three percent.

While demand generated by agricultural expansion allows shifts in the composition of industry, shifts that reduce the capital required for each employee, and other elements of the process, can greatly increase savings and investment. Added savings may not only finance much of the larger capital needs of agriculture but may also finance part of an expansion of the nonagricultural sector.[81] The extent to which agriculture supports investment in other sectors depends on the net capital requirements for agriculture's own increased production, the development of institutions for transferring agricultural savings within agriculture or to the other sectors in the economy, the economic returns from capital in those sectors, and the form of institutional growth in those sectors.

The basic components of the rural-led employment-oriented strategy of growth were developed fully in Mellor [1976]. The most important principle in the argument was that the supply of foodgrains as wage goods is a major constraint on employment growth, but that attainable increases of foodgrain production can allow employment to grow significantly faster than in the past. The analytical framework for the strategy was developed in Lele and Mellor [1981]. The test of key quantitative relationships of rural-led growth strategy was provided in Mellor and Mudahar [1974a, b]. The simulation confirms that foodgrain production is a constraint to employment, that a demand-derived expansion of nonfoodgrain agriculture is important, and that the choice of technology is significant in determining these forces.

Chapter IX. International Trade and Resource Transfers

1. Resources for Economic Development

The ability of low-income countries to develop rapidly with broad participation in that development is strongly influenced by their international trade performance, the flow of capital resources, and other elements of the international environment. Trade based on comparative advantage makes productivity increases possible through specialization. In low-income countries, this tends to increase employment opportunities by encouraging them to produce labor-intensive goods and to import capital-intensive goods. Specialization according to

comparative advantage conserves the scarce capital resources of low-income countries, making them available for employment-oriented production. For the developed countries, it expands markets for capital-intensive goods and raw materials. Thus trade policies interact with other elements of the development strategy, including an emphasis on agriculture, the structure of industry, and the growth of employment. All too often, developing countries have misallocated resources to capital-intensive industries, even to the point of subsidizing substantial exports of such commodities [Mellor and Johnston, 1984; Mellor and Lele, 1975].

Foreign resource transfers may facilitate a participatory growth strategy by allowing an increase of the rate of investment without a commensurate reduction in consumption [Mellor, 1976]. Similarly, foreign transfers may facilitate development programs that increase employment and raise the consumption of necessities by low-income people. Simultaneously, they add to the amount of foreign exchange available and thus facilitate the adjustments most developing countries have to make in their internal structures before they can realize their trade potential. On the other hand, developed countries that are unable to make the adjustment needed to allow an increased volume of low-income countries' imports in their markets, can transfer resources which, because they add foreign exchange available to low-income countries, are often a convenient, if second best, alternative.

There are significant differences in the nature and mix of the resource transfers appropriate or possible for low-income countries. If trade and resource transfers are to succeed in influencing the choice and pattern of development, the nature of the relationships, the relative advantages of trade and different resource transfer instruments, and how these instruments can be used to achieve particular objectives must be clearly understood.

2. Agricultural Trade and Economic Development

Low-income countries are emphasizing their trade needs even more than resource transfers, because trade is far more important than foreign aid as a source of foreign exchange, and because foreign exchange obtained through trade carries fewer of the conditions commonly associated with aid or private capital. This increases the relevance of a number of trade issues for research and development policy. Most important, trade and development strategies are so closely related that any consideration of aid when choosing strategies must also incude a look at trade.

AGRICULTURAL TRADE PATTERNS AND GROWTH STRATEGY

Tolley and Gwyer [1967] reported that the shares of agricultural products in the exports of developing countries are higher than those of developed countries.[82] Furthermore, in some countries one or two crops account for most of the

earnings from agricultural exports. India's exports in the 1950s were weighted heavily toward such agricultural commodities as jute and tea [Mellor, 1976]. The belief that the prospects for the growth of these commodities were poor led to an import displacement policy, in spite of the rising capital intensity of such a strategy. Initially displaced imports may be produced domestically by labor-intensive techniques,[83] but over time the imported goods to be displaced are increasingly capital intensive. However, in contrast to India's first two plans, subsequent plans emphasized exports explicitly.[84] Generally, however, export promotion is still done in the context of a foreign exchange regime that discriminates strongly against agriculture [see, for example, Bautista, 1987].

The large demand for imports of raw materials and capital goods and the uncertainties of foreign aid for financing them indefinitely led to many policy changes in developing countries, but the progress towards more liberal trade regimes has been slow. For example, in the 1960s, India instituted a variety of export subsidies and licensing preferences, the complexity and inefficiency of which precipitated the 1966 devaluation. Following that, exports reversed the declining trend of the 1950s. However overall, during the 1950s, India's imports grew at a rate comparable to Taiwan, the Philippines, and Hong Kong. The sharp contrast between the imports of India and the other countries occurred in the 1960s. While most countries rapidly increased the growth rate of their imports in the 1960s, India's actually declined. This represented a loss of comparative advantage, reflected in poorer growth and poorer export performance [Mellor, 1976].

To provide the means of payment for imports, exports must be at the core of a strategy to support increased employment with imports of necessary capital-intensive goods. In India, one of the primary arguments for the capital-intensive approach to development is based on pessimism about export prospects. According to Bhagwati and P. Desai [1970], this is usually grounded on the expectations that demand for primary commodities will grow poorly and that barriers against imports of manufactured goods by high-income countries will rise.[85] According to Mellor [1976], however, the evidence, particularly of the 1960s, does not support the gloomy view of exports of low-income countries generally or of India specifically. More recently, Bhagwati [1988] discusses issues and provides evidence in support of "export-promotion" as opposed to "import-substituting" strategy.

The efforts of less developed countries to industrialize seem to have paid off by rapid advancement of exports of manufactured goods. The emphasis on manufacturing may also have resulted in temporary neglect of the primary commodity categories and a consequent loss of productive output and export potential. This neglect has probably been most evident in agriculture and has taken the form of underinvestment in cost-reducing technological change.[86] Most impor-

tantly, the trade policies favoring capital-intensive industry resulted in an overvalued exchange rate that was deleterious to agriculture.

A set of research studies which were conducted under the umbrella of the "Stanford Project on the Political Economy of Rice in Asia" dealt specifically with the comparative advantage of rice production in Thailand, Philippines, and Taiwan.[87] The results are summarized in Monke, Pearson, and Akrasanee [1976]. Akrasanee and Wattanaukit [1976] concluded that Thailand had a strong comparative advantage in rice production but the taxation system discriminated against its expansion. Herdt and Lacsina [1976] concluded that in the Philippines rice production would be preferable to importation if the long-term price of rice is $600 per mt and input prices remain at their 1974 level. On the other hand, if the long-run price of rice is below $280 per mt and the input prices remain at their 1974 level, the country would be better off to import additional rice requirements. Similarly, Wu and Mao [1976] concluded that for Taiwan, self-sufficiency in rice may be justified if the world price of rice remains high. K. Anderson and Ahn [1984] found that South Korea's advantage in food production is declining, and the cost of protection policy is increasing. K. Anderson and Hayami [1986] provide a comprehensive review of protectionist agricultural policies in East Asia, emphasizing the very high levels of agricultural protection and its relation to declining comparative advantage in agriculture as industrial productivity rises very rapidly.

The lessons for India on exports are similar to those of most Asian, African, and Latin American countries. Trade relations with a richer and more powerful partner had to be laboriously changed before trade could have a vigorous role in development. According to Hecksher [1919] and Ohlin [1933], trade between countries with unlike proportions of factors of production reflects one of the more plausible patterns of trade. According to this view, however, India would produce labor-intensive commodities. In practice, however, India's pattern of industrial growth has been highly capital intensive.[88] There is also a tendency for industries with greater capital intensity to expand exports faster, although the average increase in the capital intensity of exports was somewhat less than for the economy as a whole.[89]

Agricultural trade and protection policies in Asia are reviewed by DeRosa [1988]. During 1985, the Asian countries accounted for about 15 percent of world trade in agricultural commodities (Table 17). China, India, Indonesia, and Malaysia account for the major share of the region's agricultural exports. Overall, Asia's imports of agricultural commodities are much more than exports. Japan alone accounts for over 40 percent of the region's agricultural imports. Other major importers are Hong Kong, the Republic of Korea, Singapore, and Taiwan. The existing patterns of trade indicate that Asia's strongest trading relationship in agriculture is with industrial countries outside the region.

Table 17. Agricultural trade of Asian countries by commodity groups, 1985[a]

Commodity division	World exports	Asian countries		Direction of trade (in %)[b]		
		Exports	Imports	Japan	Other Asia	Other industrial countries[c]
		BillionUS$				
Food	146.6	19.7	24.3	11	31	46
Meats, fish, dairy products	42.3	5.5	7.7	24	29	40
Cereals	32.5	2.2	6.9	2	24	47
Fruits, vegetables	25.2	3.6	2.5	13	45	41
Sugar	5.8	0.8	0.9	8	52	26
Seeds, oils	19.8	4.4	4.6	5	39	47
Beverages, spices	21.1	3.3	1.9	4	31	31
Raw materials	49.2	9.1	13.4	15	30	46
Tobacco	3.8	0.3	0.7	2	6	79
Rubber	6.7	3.7	1.7	12	49	31
Wood	14.4	2.9	4.5	27	33	34
Natural fibers	11.1	1.9	3.7	12	33	46
Others (hides, pulp)	13.1	0.3	2.8	8	26	60
All commodities	195.8	28.8	37.8	13	31	46

Source: DeRosa [1988]; originally from World Bank's Trade, Analysis, and Reporting System.

[a] The data cover the trade of fifteen major Asian economies, including China and Taiwan Province of China. The underlying data for China are for 1984.

[b] Average percentage share in Asian countries' exports and imports.

[c] Consists of Australia, Canada, New Zealand, the United States, and the industrial countries of western Europe.

AGRICULTURAL PROTECTIONISM AND ECONOMIC DEVELOPMENT

According to DeRosa [1988], *ad valorem* tariffs are the most common form of restriction imposed against imports of food commodities and agricultural raw materials. Hong Kong and Singapore impose virtually no tariffs. On the other hand, the highest tariffs in the region are imposed by South Asian countries. Furthermore, tariff rates are generally higher for food than for agricultural raw materials, indicating a strong desire for national food self-sufficiency.

However, agricultural protection policies are much more prevalent in the developed industrialized countries of the world. This area has been extensively researched, and the literature is immense. Selected studies that deal with Asia or have trade implications for Asian countries include K. Anderson [1981, 1983a, b, 1989b]; K. Anderson and Ahn [1984]; K. Anderson and Tyers [1985a, b, c, 1987b]; K. Anderson and Warr [1987]; K. Anderson, Hayami, *et al.* [1986]; Binswanger and Scandizzo [1983]; Fitchett [1988]; Koester [1985]; T. C. Miller [1986]; Tyers and K. Anderson [1986, 1987, 1990]; Winglee [1989]; and the World Bank [1987c].

The empirical evidence developed by Binswanger and Scandizzo [1983] and reviewed by D. Gale Johnson [1988] indicates that there is a systematic relationship between the level of protection (positive, which implies subsidy; or negative, which implies tax) and the characteristics of countries, commodities, and the structure of farming. The protection coefficients are positively related to the level of per capita income, and commodities produced on the larger or more specialized farms. On the other hand, the protection coefficients are negatively related to the percentage of the countries' labor force engaged in agriculture or, alternatively, the percentage of GNP produced by agriculture; the amount of agricultural land per capita; the value of agricultural exports per capita; and the products classified as tropical beverages. Demand for agricultural protection increases as the share of agriculture in GNP declines and per capita income increases. However, at high levels of per capita income, agricultural protection becomes affordable. Asia, Japan, and now the Republic of Korea fall in this category. On the other hand, at low levels of per capita income, agriculture is an important source of revenue for government.

A survey of agricultural trade and protection policies in Japan is available in Fitchett [1988]. Japan has emerged as one of the major importers of agricultural commodities in the last two decades. Japanese farmers have benefited from various protection policies. The reasons cited for these protection policies include food security, rural-urban income parity, and smoothing of the sectoral adjustment process. The nominal rates of protection (as measured by the nominal protection coefficient, NPC) for seven selected agricultural commodities in Japan, EC-10, and EFTA member countries are provided in Table 18. The results indicate that during 1980-82 the weighted average rates of protection were 133 per-

Table 18. Nominal rates of protection for selected agricultural commodities in Japan, EC-10, and EFTA, 1980-82 (in %)

Commodity	Nominal rate of protection		
	Japan	EC-10	EFTA[a]
Rice	235	40	0
Wheat	290	40	65
Coarse grains	330	40	55
Beef and lamb	180	25	130
Pork and chicken	50	25	40
Dairy products	190	75	145
Sugar	200	50	55
Weighted average	133	55	90

Source: Fitchett [1988]; originally from K. Anderson and Tyers [1987b].
[a] European Free Trade Association member countries.

cent, 90 percent, and 55 percent in Japan, EFTA, and EC-10 member countries, respectively. Earlier, K. Anderson [1983a] reported that during the period 1960-64 to 1980-82 the weighted average level of NPC for seven principal agricultural commodities in Japan increased from 68 percent to 151 percent. On the other hand, the average rate of protection for these commodities in the United States was about 16 percent [Tyers and K. Anderson, 1986].

Such protection policies discourage structural transformation of the economy into more efficient production systems. Furthermore, the financial and economic costs of agricultural protection policies are enormous both to taxpayers (in the form of budgetary subsidies to farmers) and to consumers (in the form of higher food prices). The average annual cost of agricultural support and protection policies for selected industrial countries during 1984-85 are summarized in Table 19. The direct costs to taxpayers are the highest in the United States (US$ 49 billion) and the European Community (US$ 25 billion). On the other hand, direct costs to consumers are highest in the European Community (US$ 42 billion) and Japan (US$ 35 billion). Direct costs to taxpayers and consumers of agricultural support and protection policies were about US$ 185 billion per year in 1984-86, which is equivalent to about 40 percent of the gross value to agricultural producers. These results indicate that in the industrialized, developed countries there is a transfer of substantial resources from the government and consumers to producers. On the other hand, in the developing countries of the world, there is a transfer from producers to the government and to consumers [Krueger, Schiff, and Valdes, 1988].

Table 19. Costs of agricultural support policies for selected industrial countries (annual average for 1984–86)

Country	Direct cost to			Producer subsidy equivalent (in %)[b]
	Taxpayers[a]	Consumers	Total	
		BillionUS$		
United States	49.1	17.1	66.3	28.3
Canada	3.0	2.7	5.7	39.1
Australia	0.6	0.7	1.3	14.5
New Zealand	0.4	0.1	0.5	22.5
Japan	7.4	34.9	42.3	68.9
Austria[c]	0.6	1.0	1.6	35.3
European community	25.2	42.2	67.2	40.1
Total	86.3	98.5	184.9	38.4

Source: Winglee [1989]. Originally from M. Kelly *et al.* [1988], based on data from the OECD.

[a] Net of budgetary receipts from tariffs.

[b] The subsidy that would be required to maintain producers' income at the current level if all support policies were removed; measured as a percent of the gross value to agricultural producers.

[c] Refers to 1984–85.

A comprehensive analysis of international trade issues, trade policy reforms, and protectionism in the context of industrialization is provided by the World Bank [1987c]. According to the World Bank [1988a], protectionism broadly declined up to 1974 as tariffs were cut under successive agreements of the GATT. Average import tariffs on manufactures declined from about 40 percent in the early 1950s to less than 10 percent in 1974. However, agricultural products and textiles—two major exports from the developing countries—remained the biggest exception to the trend towards more liberal trade. Furthermore, liberal trade has been seriously threatened since the mid-1970s.

TRADE BARRIERS AND INTERNATIONAL TRADE NEGOTIATIONS

There is great potential for exporting labor-intensive manufactured commodities from low-income, labor-surplus countries. But, realization of this potential depends on the effects the trade policies have on the efforts of industrialized countries, the efforts of low-income countries to expand labor-intensive exports, and on the attitude of industrialized countries toward low-income countries' policies to expand manufactured exports by using subsidies. Limits placed by industrialized countries on labor-intensive exports by low-income countries obviously have adverse implications for employment in low-income countries, for an employment-oriented strategy of growth, and hence on the domestic demand for food.

The concerns of producers in high-income countries should be addressed in ways that take into account low-income countries' interests. The objective is to obtain economic efficiency by encouraging low-income countries to adopt outward-looking growth strategies that support participatory development. The problem was less urgent for high-income countries when only a few low-income countries chose an export-oriented growth strategy. Now that more low-income countries are adopting such a strategy, it is important that the full implications be analyzed.[90]

Most high-income countries have a generalized system of trade preferences. In the multilateral trade negotiations, special attention is being paid to tropical products of interest to low-income countries. High-income countries have also made political commitments to insure that tariff-cutting formulas and other negotiating schemes to reduce nontariff barriers cover products of interest to low-income countries. It is important to analyze the effects such policies have on trade and to determine how effective these measures would be in promoting low-income countries' exports of labor-intensive manufactures, especially since many low-income countries' exports are produced by capital-intensive processes.[91] As rural modernization occurs, the comparative advantage of developing countries in labor-intensive agricultural commodities is bound to increase. Thus it is important

that GATT negotiations in the late 1980s and 1990s open trade to these commodities.

As developed countries increase factor productivity in their agriculture and cease to expand domestic demand for cereals, the rapidly expanding export markets to developing countries become increasingly attractive. If those markets are to expand, the developed countries must be open to labor-intensive imports, including labor-intensive agricultural commodities.[92]

A basic instrument of the export promotion policies of low-income countries is subsidization of export industries. There is evidence that indiscriminate use of export subsidies tends to be inefficient. On the other hand, undiscriminating opposition by developed countries overlooks the legitimate needs for subsidies to offset the costs of entry into foreign markets, particularly when a low-income country is diversifying the legitimate needs for subsidies to offset the costs of entry into foreign markets, particularly when diversifying exports. The problem is how to devise international guidelines that discourage economically wasteful subsidies and encourage policies promoting labor-intensive exports from low-income countries.

Tariff and nontariff barriers to agricultural imports and possibilities for bilateral trade negotiation in Asia are summarized in Table 20. Tariff rates are among the highest in South Asia. Nontariff barriers, generally regarded as more trade-distorting than tariffs, are applied widely but more selectively by most of the Asian countries. The nontariff barriers include restrictive licensing, prohibitions, state trading, quotas and entry regulations on health and product standards. There are possibilities for achieving economic gains from liberalizing agricultural trade in Asia through bilateral or multilateral trade negotiations. The World Bank [1986a] has also suggested that liberalization of trade should be a high priority for international action in agriculture.

According to Valdes [1988] and Zietz and Valdes [1988], much of the trade in agriculture is not covered by the spirit or letter of the Generalized Agreement on Tariffs and Trade (GATT) rules. Nontariff barriers proliferate, export subsidies increasingly substitute for a natural competitive advantage and trade wars erupt with frightening regularity. There is some hope that the Uruguay round of multilateral trade negotiations can achieve more for agricultural trade than prior GATT rounds. Sharply rising budgetary costs of support and protection policies have made the United States, the European Community, and other industrial countries more open to the idea of agricultural trade reform than ever before. Lack of a reasonable agreement in the Uruguay round could be detrimental to agriculture in developing countries.

Finger and Olechowski, eds. [1987] have published a handbook on multilateral trade negotiations for the Uruguay round that provides needed information base for participating developing countries. Jalali, ed. [1989] has completed a

Table 20. Barriers to agricultural imports and possibilities for bilateral trade negotiations in Asia

Table 20. Barriers to agricultural imports and possibilities for bilateral trade negotiations in Asia

Region/country	Commodity division	Tariffs[a]			Nontariff barriers					
					Quantitative restrictions					
		Frequency	Av. level	Bilateral negotiation possibilities[b]	Restrictive licensing	Quotas	Prohibitions	Bilateral negotiation possibilities[b]	State trading	Entry regulations
			(percent)							
Japan (JA)[c]	All	–	11		24	12	3	KO	–	–
	Foods		15		31	15	2			
	Raw materials		7		1		6			
South Asia										
Bangladesh (BA)	All	97	62	PA, IO, MA, PH, TH	36		37	PA, KO, SI	1	2
	Foods	98	66		44		30		1	3
	Raw materials	94	57		18		56		3	
India (IN)	All	99	106	MA, PH, TH	40		71	IO, PH	19	3
	Foods	99	119		47		65		20	4
	Raw materials	98	92		26		83		18	
Pakistan (PA)	All	93	59	BA, MA, PH, TH	43	2	39	BA, MA	5	
	Foods	93	75		33	3	55		7	
	Raw materials	94	43		70		5			
Sri Lanka (SR)	All	95	34	IO, MA	9			KO	4	
	Foods	95	48		9				4	
	Raw materials	94	21		9				1	
Southeast Asia										
Indonesia (IO)	All	80	14	BA, SR, KO	26	23	50	IN, MA	2	4
	Foods	75	19		8	29	63		3	5
	Raw materials	100	10		98					
Malaysia (MA)	All	77	9	BA, IN, PA, SR	8		1	PA, IO, PH, TH		20
	Foods	68	8		8		2			29
	Raw materials	97	9		10					1

(continued on next page)

Table 20. Barriers to agricultural imports and possibilities for bilateral trade negotiations in Asia [continued]

Region/country	Commodity division	Tariffs[a]			Nontariff barriers					
					Quantitative restrictions					
		Frequency	Av. level	Bilateral negotiation possibilities[b]	Restrictive licensing	Quotas	Prohibitions	Bilateral negotiation possibilities[b]	State trading	Entry regulations
		(percent)								
Philippines (PH)	All	100	28	BA, IN, PA, KO	49	6	9	IN, MA, TH	3	71
	Foods	100	35		53	4	13		5	96
	Raw materials	100	21		39	10				11
Thailand (TH)	All	88	29	BA, IN, PA, KO	35	1	24	MA, PH	1	20
	Foods	86	36		40	0	32		1	24
	Raw materials	95	22		23	1				7
East Asia										
Hong Kong (HK)	All				8	1		KO		3
	Foods				8	2				4
	Raw materials				7					
Korea (KO)	All	100	21	IO, TH	30			JA, BA, SR, HK		
	Foods	100	29		38					
	Raw materials	100	13		7					
Singapore(SI)[d]	All				22			BA		9
	Foods				26					12
	Raw materials				13					

Sources: DeRosa [1988]; originally from United Nations Conference on Trade and Development's Trade Information System and the World Bank.

Notes: The data refer to the following years: 1985 (Pakistan, Thailand), 1986 (Bangladesh, Japan, Korea, Singapore, Sri Lanka), and 1987 (Hong Kong, India, Indonesia, Malaysia, the Philippines).

[a] The data refer to general or statutory *ad valorem* tariff rates.

[b] Possibilities for bilateral negotiations for main agricultural commodities are based on correlations relating indices of comparative advantage to average tariff levels and on frequency ratios of quantitative restrictions between all pairs of countries.

[c] The tariff data for Japan refer to Tokyo Round-bound rates. The nontariff barriers data do not include information about Japan's state trading and entry regulations.

[d] Singapore is grouped with the East Asian countries for analytical purposes.

second volume to follow the volume published in 1988 on research inventory for the multilateral trade negotiations for the Uruguay round. This research inventory provides a guide to recent and ongoing economics research relevant to the issues under multilateral trade negotiations.[93]

COMMODITY PRICES, MARKET INSTABILITY, AND TRADE

An employment-oriented strategy of growth can expand total production and exports steadily if labor supply is elastic. But, such a strategy implies substantial increases of imports under most circumstances. Therefore, low-income countries may become more vulnerable to fluctuations in export earnings caused by cyclical fluctuations in high-income countries or by other factors, especially since the low-income countries' exports tend to be concentrated by commodity or by market. Fluctuations in the demand of high-income countries tend to be reflected in export commodity prices and in the instability of low-income countries' net foreign exchange earnings. In the more developed low-income countries, instability is also reflected in changes in demand, volume, and earnings of manufactured exports.[94] The efforts of developed countries to stabilize their domestic food markets increases instability in international markets [Josling, 1980; Koester, 1982]. And, this is in the context of increasing food production instability in both developed and developing countries [Mellor, 1981; Hazell, 1982].

According to the World Bank [1986a], international market prices of major agricultural products vary more than the prices of industrial products (Table 21). The price instability indices for major agricultural products were over 10 and as high as 90 for sugar during 1964–84. On the other hand, the price instability indices for the majority of manufactured products were lower than 10 for the same period. The high variability in agricultural commodity prices explains, to some extent, why developing countries adopt various kinds of stabilization schemes to protect farmers from large price falls and consumers from large price increases.

In a recent study, Grilli and Yang [1988] find that from 1900 to 1986 relative prices of all primary commodities, relative to those of traded manufactured goods, declined on trend by 0.5 percent a year and those of nonfuel primary commodities by 0.6 percent a year. Morrison and Wattleworth [1988] analyze the relative contribution of supply and demand factors to sharp declines in the prices of primary commodities. The results indicate that rising supplies of food and larger production capacity of agricultural raw materials were the major factors responsible for depressing primary commodity markets in the 1980s, and particularly during 1984–86. Relatively low economic growth during this period in the industrial countries was another factor.

The effects of the instability of export earnings on the economic growth of low-income countries and on employment have often been explored. Yet there is little understanding of how instability of export or import prices and significant

Table 21. Price instability indices for world market prices of major agricultural commodities[a]

Commodity	International price instability index (%)	
	1964–84	1974–84
Sugar	90.8	51.5
Cocoa	37.3	34.1
Rice	33.0	21.9
Coffee	32.0	37.7
Palm kernels	27.5	32.5
Wheat	24.3	16.9
Tea	21.7	23.6
Jute	21.2	26.8
Soybeans	20.8	9.9
Beef	16.7	11.3
Corn	16.6	15.6
Rubber	16.1	14.0
Sorghum	15.6	13.6
Cotton	14.3	10.7

Source: World Bank [1986a].

[a] Price instability index measures the average deviation from the price trend in any particular year. Prices are mainly from the London and New York markets, and they are deflated by the manufacturing unit value (MUV) index (1984 = 100).

shifts in a country's terms of trade are transmitted within low-income countries; or of how they affect aggregate employment, employment in specific sectors, economic growth, and diversification.[95] These questions are of special importance when low-income countries try to increase employment and improve income distribution through concerted rural development efforts. Heavy dependence on earnings from commodity exports and major fluctuations in commodity prices may have major long-run effects on the ability of the country to mount and pursue a participatory strategy. These problems are particularly severe for thinly traded commodities such as rice [Siamwalla and Haykin, 1983].

Recent strong fluctuations in the prices of the export commodities of low-income countries and of crucial raw material and food imports, such as fertilizer and grains, dramatize the effect that commodity market fluctuations have on the development objectives of low-income countries. Rising food and fertilizer prices and scarcity have reduced the availability of food, especially in countries dependent on food aid. Wildly fluctuating fertilizer prices have adversely affected incentives for food production and posed complex problems of food pricing for the producers and consumers of low-income countries. But, one must be aware that many developing countries have tariff policies to protect their fertilizer industry [Mudahar, 1978]. Such policies can raise fertilizer prices and thus slow the process of agricultural modernization. M. S. Rao [1974], in a detailed analysis of

the implications that implicit tariffs have for fertilizer in India, estimated that the cost of protection was large both in the form of additional production costs and in the form of lost agricultural output.[96]

TRADE ISSUES, INFORMATION NEEDS, AND POLICY

Analytical work on the role of agricultural trade in economic development and the interaction between trade and development strategy needs to focus on the following issues: first, internal adjustment mechanisms and low-income country policies, including policies on reserve holdings of food and commodities or financial assets, that can effectively cushion the effects of external shocks on internal growth and employment objectives; second, international actions such as buffer stocks that promote stability of trade in commodities and foodstuffs, and support policies of low-income countries to diversify production and adjust in response to abrupt changes in external demand and supply; third, domestic and international efforts to increase demand for the commodity exports of low-income countries, through appropriate institutional and promotional arrangements; fourth, existing market structures from the producer to the retailer to determine how to improve their performance; fifth, the implications that exploiting the resources of the sea have for internationally traded commodities of interest to low-income countries; finally, determination of the trade patterns for agricultural products.[97]

In addition, some of the concerns of high-income countries now receiving attention need further analysis of their implications for low-income countries. These include access to low-cost supply, the effects of instability in commodity prices on domestic consumers, and the usefulness of commodity arrangements. Several proposed schemes for international investment can also have important effects on supply, price, and aggregate export earnings. The policies high-income countries adopt to solve these problems will influence the prospects of low-income countries by affecting commodity export earnings and the rate and method of resource exploitation.

3. National and International Resource Transfers

FOREIGN ASSISTANCE AND DEVELOPMENT

Agriculture-based, high-employment strategies of growth are becoming more widely accepted. But, the changes needed in policy often require political decisions that can be taken more rapidly if some of the economic costs are absorbed by foreign resource transfer.[98] Foreign assistance includes food aid, loans, and grants from both bilateral and multilateral agencies. Resource transfers may also provide important investment resources to those sectors or activities that are responsible for developing crucial elements of the participatory strategy or that help meet basic human needs while domestic capabilities are being developed.

There is a need to analyze the most suitable amount, form, and terms of assistance.

It can be argued that foreign assistance given in support of a participatory development strategy should improve the long-term ability for raising domestic resources in the recipient country, encourage improvements in resource allocation, increase the employment and income of the lower-income majority, and help expand the provision of basic services to improve human well-being. Previous analyses of the volume of resource transfers needed to attain the objectives of low-income countries used the aggregate approach of the two-gap models.[99] These models suffer from serious deficiencies when used to forecast the long-term needs of low-income countries for resource transfers to achieve self-sustaining participatory growth.

Badly needed is an alternative to the two-gap analysis that would focus more on the distributive aspects of growth. Such an approach would need to take into account the investment needs of participatory strategies, the savings potential of a given distribution of income, the constraints to providing a posited amount of consumption by the low-income majority, and the effects aid and trade have on national savings under alternative international monetary and trade-policy regimes. This core of the proper methodology could then allow long-term resource needs to be quantified on the basis of an improved analytical framework.[100]

The source of resource transfers, their use, and the terms and conditions under which they are provided all bear on their effectiveness. Transfers have implications for employment growth and a country's long-term balance-of-payments position, and can directly influence the ability of the country to pursue its development strategy. Given the large resources available to private firms and the private capital market, questions must be asked about how they can contribute to development. These include how they affect overall growth, employment, the balance of payments and income distribution; how to obtain development resources; and what relationship such sources of finance have to the stage and strategy of development. Analysis is needed of the institutional and policy questions of access to private equity or bank capital and of those operations of the international monetary system that influence the supply of private capital to low-income countries.

TRENDS IN MULTILATERAL ASSISTANCE

The amount of assistance given as loans and grants, the relationship of present assistance to the servicing of past debt, and the relationship of these to the current stage of development of the recipient are changing rapidly and require current analysis. The effects of current assistance practices that tie procurement, commodity, or generalized sector loans to the development objectives of low-income countries should also be investigated. It is especially important to identify and

Table 22. Total World Bank lending for agriculture and rural development

Purpose	Allocation by Purpose	
	1975-79	1980-85
	(percent)	
Agricultural credit	14.2	17.5
Agricultural sector loan	1.4	6.2
Area development	25.2	20.4
Irrigation	32.1	30.6
Research and extension	5.1	4.3
Others (forestry)	21.9	20.9
Total	100.0	100.0
	(Billion US$)	
Total bank lending	38.02	81.17
Lending for agriculture	11.58	21.22
	(percent)	
Lending for agriculture	30.5	26.1

Source: World Bank [1986a].

analyze the distortions of development objectives introduced by assistance practices and to explore means of reducing or eliminating such distortions.

The World Bank is the principal donor and plays a leading role in providing development assistance to agriculture in developing countries. According to Lipton and Paarlberg [1989], the World Bank provided 29 percent of official resource flows to agriculture and rural development in 1980-83, and 36 percent in 1985, only slightly less than total bilateral resources for this purpose. During 1979-83, only 16 percent of bilateral aid reached agriculture as against 30 percent of Bank flows. In this context, the Bank provides a much needed corrective thrust against urban bias in national public investment and policy decisions prevalent in most developing countries, including Asia.

Agriculture and rural development has been, and continues to be, an important objective of the World Bank. World Bank lending for agriculture and rural development averaged about 27.5 percent of total Bank lending during 1975-85 (Table 22). The major focus of World Bank lending has been projects dealing with irrigation, drainage, area development, and agricultural credit. The Bank finances only part of the project costs. According to the World Bank [1986a], the $33 billion it lent for agriculture during 1975-85 has helped finance a total investment of about $87 billion. The Bank's experience has demonstrated that economic rates of return for agricultural projects are comparable to projects in other sectors. Furthermore, agricultural projects have been successful in raising agricultural productivity and food production, increasing rural employment, and im-

proving income of the rural poor. This has been particularly true for the Asian region which also accounts for the largest share of total lending for agriculture (Table 23). However, this is much smaller than Asia's share in total population, agricultural population, rural poor, and poverty [Lipton and Paarlberg, 1989].

In addition to project lending, the Bank has also been involved in supporting sectoral and structural adjustment programs since 1979. The sector adjustment loans (SECALs) and structural adjustment loans (SALs) are designed to address sector-specific policy issues and broad economy-wide policy reforms, respectively. The share of agricultural sector loans in total agricultural lending has increased from 1.4 percent in 1975-79 to 6.2 percent in 1980-85, and is even higher at present. The initial impact of SALs and SECALs has been positive. One must realize that restructuring the economies and reforming existing agricultural and economic policies can be a long and difficult process. However, it is essential to carry out needed economic and policy reforms in order to improve the overall economic environment for investment. Otherwise, investment in agricultural projects cannot be effective in achieving stated national goals. The policy issues that different SALs and SECALs address include reforming various pricing, subsidy, exchange rate, and trade policies as well as reduction in government intervention in various production, marketing, and trade activities. An evaluation of the Bank's adjustment lending is provided in World Bank [1988c].

As shown in Tables 22 and 23, the relative share of Bank lending for agriculture and rural development has declined over time. This declining trend in the share of agricultural lending, which does not appear to be deliberate, has become even more pronounced in recent years. However, the degree of observed decline in the relative share of lending for agriculture depends on the definition used in estimating agricultural and rural development lending. The issue of lending for agriculture—sources of decline, amount, share, components, and future allocations—is currently being debated within the Bank. As has been discussed earlier, the agricultural sector makes a substantial contribution to economic development in most developing countries, including Asia. Over three-fourths of the population lives in rural areas. Hence, any reduction in agricultural lending, unless it is compensated by other donors or by the national governments, can have an adverse impact on agricultural development and rural welfare. In order to address effectively the Bank's current initiatives of poverty alleviation, women in development, and the environment, there is need to reverse the declining trend in the relative share and increase Bank lending for agriculture and rural development.

FOOD AID TRENDS AND IMPACT

Food aid represents a particularly important basic issue. It provides real resources and public sector revenues and can particularly help employment growth

Table 23. Amount and regional shares of World Bank lending to agriculture[a]

	Bank lending[b] (millions US$)			Agriculture's share in total lending (in %)		Regional shares in narrow definition of agricultural lending (in %)				
		Lending for agriculture								
Fiscal year	Total	Broad definition[c]	Narrow definition[c]	Broad definition	Narrow definition	Africa	Asia	EMENA[d]	Latin America	Past borrowers
1970	2186.1	426.4	426.4	18.9	18.3	13.4	38.1	16.4	22.0	10.2
1971	2505.2	419.2	391.4	17.0	16.3	13.9	46.6	15.3	15.7	8.5
1972	2965.9	436.3	411.0	19.6	17.3	19.4	35.0	15.1	20.8	9.7
1973	3408.0	937.1	766.6	21.5	19.2	21.9	35.5	16.4	18.8	7.4
1974	4313.9	955.9	922.9	27.1	24.9	23.5	29.6	15.8	23.3	7.9
1975	5895.9	1857.6	1823.6	26.1	25.2	19.3	36.8	18.3	20.6	5.0
1976	6632.4	1927.6	1540.1	29.6	28.1	18.1	40.2	19.5	19.2	3.0
1977	7066.8	2307.9	2126.9	32.0	29.5	13.5	46.0	21.0	17.7	1.8
1978	8410.7	3269.7	2962.7	32.2	29.6	14.2	45.2	20.8	18.6	1.2
1979	10010.5	2521.8	2362.3	31.4	28.5	12.9	49.3	21.1	16.0	0.7
1980	11481.7	3468.4	3054.4	28.6	26.2	15.4	46.9	18.7	18.6	0.4
1981	12291.0	3763.0	3495.4	28.1	25.7	16.0	46.6	16.4	20.9	–
1982	13015.9	3078.4	2889.4	26.6	23.7	15.8	43.5	18.1	22.6	–
1983	14477.0	3698.3	2944.5	23.9	20.3	16.2	45.6	18.0	20.1	–
1984	15522.3	3472.9	2848.8	24.7	19.9	14.3	50.3	19.0	16.3	–
1985	14384.4	3749.3	3003.2	25.9	20.2	13.4	50.0	18.9	17.7	–
1986	16318.7	4777.4	3497.4	24.0	19.3	12.7	44.2	17.1	25.9	–
1987	17674.0	2930.3	2736.0	23.1	17.5	15.1	43.7	12.7	28.5	–

Source: Lipton and Paarlberg [1989]; originally from Agriculture and Rural Development Department of the World Bank.

[a] Agriculture here refers to agriculture and rural development.

[b] Three-year moving average, centered on the year shown.

[c] Broad definition corresponds to the World Bank definition of loans for agriculture. Narrow definition excludes both sector loans in agriculture and loans for agroindustry.

[d] Europe, Middle East, and North Africa region of the World Bank.

by assuring the supply of wage goods. The disincentive effects of food aid seem not to be significant for most countries.[101] Food aid represents a very low-cost source of resource transfer if it is seen as a means of price discrimination among markets with differing price elasticities [Mellor, 1983].

Food aid plays an important role in the economies of developing countries. During 1981-83, total food aid to developing countries was about $2.5 billion a year and accounted for about 9.4 percent of all official development assistance [Mellor, 1987]. The trends in food aid and cereal imports for developing world regions are summarized in Table 24. The results indicate that while cereal imports by developing countries have increased dramatically over the last twenty years, food aid has declined both absolutely and on a per capita basis. Furthermore, the share of food aid in total cereal imports has also declined over time. The decline has been particularly pronounced in Asia. Two other trends in food aid have emerged: sources of food aid have diversified, and over 25 percent of food aid is now being channeled through international agencies like the World Food Programme.

According to H. Ezekiel [1988], food aid can be classified into four categories: program food aid, project food aid, emergency food aid, and adjustment food aid. However, most of the analytical discussions on food aid do not make a clear distinction between different types of food aid. There appears to be a consensus that food aid has made an important contribution to food security, nutrition, employment, and economic growth in the developing world. Food aid can, and does, help provide the means needed to protect (and raise) the consumption status and labor productivity of the poor. This is particularly relevant in Asia. Using an applied general-equilibrium model, Srinivasan [1989] has shown that a well-designed and efficiently implemented food-for-work program can virtually eliminate abject poverty in India at a modest cost.

In many of the developing countries, especially in Asia, national food stocks tend to be very large and expensive because of food security concerns, partly due to the random occurrence of poor crop years and the potential for a sequence of bad years. Reutlinger and Bigman [1981] have estimated that a six million MT domestic food stock could cost between $59 and $82 million a year to operate. In this context, free trade and food aid represent a far more cost-effective approach to food security than large food stocking arrangements. Meeting such food security concerns of developing countries was the basic principle behind the creation in 1981 of a Cereal Import Facility at the International Monetary Fund (IMF). This facility was designed to provide financing to countries facing short-term problems of domestic food production shortfalls or high international prices. Between 1981 and 1985, a total of only seven developing nations made use of this facility. It has been suggested that, first, the facility needs to be broadened

Table 24. Cereal imports and food aid receipts by ninety-nine developing countries by region over time[a]

Table 24. Cereal imports and food aid receipts by ninety-nine developing countries by region over time[a]

Region	Year	Aggregate (million metric tons)			Per capita (kg)	
		Commercial cereal imports	Food aid[b]	Total cereal imports	Food aid[b]	Total cereal imports
Asia[c]	1961–63	11.4	5.7	17.1	3.82	11.54
	1976–78	22.2	4.2	26.4	2.06	12.98
	1981–83	36.9	2.7	39.6	1.18	17.14
Latin America	1961–63	3.7	1.9	5.6	8.31	25.00
	1976–78	14.2	0.4	14.6	1.17	43.26
	1981–83	21.6	0.9	22.5	2.30	60.80
North Africa/Middle East	1961–63	1.9	3.9	5.7	24.13	35.81
	1976–78	14.6	2.5	17.1	10.22	70.96
	1981–83	27.6	2.7	30.3	10.19	112.72
Sub-Saharan Africa	1961–63	1.5	0.1	1.6	0.62	7.87
	1976–78	4.1	0.9	4.9	2.89	16.21
	1981–83	6.4	2.1	8.5	5.85	23.29
Total developing countries	1961–63	18.5	11.6	30.0	5.59	14.49
	1976–78	55.1	8.0	63.0	2.74	21.59
	1981–83	92.5	8.4	100.9	2.55	30.50

Source: Mellor [1987]; originally from Huddleston [1984] and FAO [1985]. Information from FAO [1988a] and World Bank [1984b] was also used to obtain cereal imports and food aid estimates.

[a] The ninety-nine developing countries include those covered by the Huddleston study. Out of these ninety-nine developing countries, nineteen were in Asia, twenty-four in Latin America, seventeen in North Africa/Middle East, and thirty-nine in Sub-Saharan Africa.

[b] Food aid total for 1976–78 does not include approximately 0.7 million metric ton reported by FAO, most of which went to Indochina and Portugal.

[c] Including China.

to include noncereals, and, second, the rules regarding drawings from the facility need to be liberalized so as to make it accessible to more countries.

The potential benefits and costs of food aid programs are summarized by Srinivasan [1989]. Food aid "can" (not necessarily "will") further economic development through several channels: it adds resources that can be used for current consumption and accumulation; it provides balance-of-payments support by reducing the foreign exchange spent on imports; it augments the domestic availability of food; to the extent it is targeted to the poor, it can alleviate poverty and improve health and nutritional status of the poor; it promotes development if it is tied to development-oriented projects that would not have been undertaken otherwise; and to the extent it can be credibly tied to the initiation of growth-promoting policies and reform of policies detrimental to growth, it can promote development. Clearly, food aid has the potential to improve food security, nutrition, employment, and economic growth in the recipient countries. The potential costs of food aid include the following: it may provide disincentives to domestic food production and hence, increase the probability of long-run dependency on food aid; and by alleviating food shortages, it enables the regime in power to postpone politically costly economic reforms.

Any food aid program must accentuate the positive and eliminate the negative effects. In other words, for food aid to make the maximum contribution to economic development, a donor must provide reliable amounts of food aid so that long-term development programs can be designed and implemented, provide large amounts of food aid in order to make a significant impact on employment, and recognize the conditions of effective food aid use. On the other hand, the recipient country must give priority to agricultural development in order to minimize the disincentive effects of food aid, and pursue policies that spread capital supplies as evenly as possible over the labor force in order to maximize employment growth. Ultimately, the effectiveness of food aid depends on flexibility in its use, coordination of donor objectives with development objectives, and whether domestic, economic, political, and institutional environments in recipient countries are conductive to efficient utilization of food aid as a development tool.

Chapter X. Implementation and Assessment of Agricultural Strategy

1. Implementation of Agricultural Development Strategy

There is, at best, a fine line between analysis of the policies, programs, and projects that should be pursued and analysis of ways to implement those decisions. Each interacts with the other. Implementation deserves special attention because it has not been emphasized enough and is particularly poorly understood

in the context of participatory approaches to development, which take place under highly heterogenous conditions.

Problems of implementation arise both in poor countries and in developed ones. Policies or programs designed to obtain desired objectives may not be feasible because of sociopolitical constraints on the governments of developing countries and on the international institutions trying to assist them. Analysis of these problems is important in determining the policy and program mix that developing countries should adopt.

In developed and developing countries alike, the process of implementing policies and programs designed to use resources efficiently interacts with policies and programs designed to increase the availability of resources. This is especially true for financial resources. In the context of rural development in low-income countries, it is even more important for particularly scarce indigenous resources—personnel and institutions. The need to conserve and simultaneously expand the supply of these resources supports the need for inquiry to determine appropriate forms of implementation, including traditional institutions and private organizations.

Implementation must be analyzed with the methodology and perspective of other disciplines as well as economics. Research projects that integrate several disciplines and aspects of the problem are appropriate for analysis. Projects of separate disciplines are also appropriate, with policy advisors integrating the results of several of these projects into an action program. Little is known about how to conduct such research although it is especially necessary now. Because it is necessary to formulate sound policy and operations, a research program must be designed to address policy and operational questions and problems. There must be an explicit concern not only with how to use resources effectively to meet given objectives, but also on how to increase the supply of resources effectively.

Two aspects of implementation in poor countries deserve special attention—the political and social processes that affect the ability of the poor to participate in development, and the processes that determine how institutions function and grow.[102] Each set of processes develops from a particular cultural and historical framework that requires programs and analyses to be carefully adapted. Generalizing presents difficulties analogous to those presented by economic research on agricultural production policy. Each takes place in highly heterogenous physical, social, political, and economic environments.

Analysis of political processes should explore the range of means by which bureaucratic and other institutions are related to their clienteles.[103] These clienteles may include elected local and national legislators, traditional leaders, and even members of the bureaucracy itself. Such analysis could fruitfully focus on the competition of groups and interests and the implications that competition has

for the participation of low-income people in development. Analysis of the political determinants of success for policies or programs is also desirable. It must be recognized that the purpose of such analysis would not be just to provide insights into how to channel goods, services, and income to the lower income groups but also to explore the means of communication and feedback mechanisms that are essential for developing and operating the relevant institutions effectively.[104]

Analysis of institutional dynamics should address the problems of using resources effectively and of increasing the quality and quantity of financial, physical, human, and institutional resources. A range of questions about the interaction between formal technical knowledge and informal local, intuitive knowledge needs to be examined. Questions about the roles of traditional and commercial structures and of their desired degree of autonomy from the central government must also be examined.

The more research done on operational problems and on aspects of implementation, the more it merges into the very processes of project development and program evolution, and the more the distinctions between research, monitoring, and evaluation become blurred. However, because these processes are now in such an early stage of development, research can, if not generalize about these processes, then at least provide a sense of how they vary among countries and cultures. This would help create more flexible approaches to projects and improve techniques for project identification, development, implementation, monitoring, and evaluation.

One promising way to analyze the institutional aspects of project implementation and evaluation is to develop better ways of structuring and using participant observer micro research. Because such research focuses on the social organization of production and resource allocation—that is, on the institutional environment in which producers actually make decisions—it can be a useful source of information for project management.

The major challenges in pursuing this kind of micro research more effectively are: to develop more efficient ways of establishing how representative particular communities and situations are, to develop better ways of using micro research to identify reliable indicators that projects do or do not achieve their goals, and to develop more standardized methodologies to facilitate comparison and generalization from selected case studies.

2. Evaluation of Agricultural Development Strategy

One of the purposes of measuring progress is to judge the degree of national commitment to a particular strategy of growth. Such a judgment puts different weights on economic and social sectors and on the reallocation of national budgetary resources required to pursue a participatory growth strategy. An important element in such analyses is the distribution of revenues and expenditures. An

equally important element is an examination of a country's fiscal and monetary policies to determine how much they support and are consistent with a particular strategy. Such an analysis is difficult and technical. To be useful it must be comparative, since there are few absolute criteria. To be effective, such an analysis must take into account differences in budgeting procedures and practices and differences in how resources are allocated.

Consistent and effective assessment will often require that data on public finance be consolidated by the central government and, at times, at lower levels of government. A preliminary effort would require the evaluation of current sources of information, recommendations to improve information flows, and standards for judging performance. Experimentation is needed to see whether comparative analysis can help judge the commitment to particular strategies and perhaps to learn the size of resource commitments particular approaches imply.

Study is needed of how much improvement can be achieved on procedures for providing data to support policymaking and analysis and for improving the effectiveness of projects and programs. Most Asian countries are better off than other developing countries in their abilities to collect, disseminate, and analyze data relevant for food and agricultural analysis and planning [FAO, 1987]. Even in these countries, there are two problems: some countries do not have adequate and appropriate micro and macro data to carry out policy analysis, and/or data may be available but the country does not have capability for data processing and policy analysis. At a minimum, assessment is required of the data for a recursive approach to project design, implementation, and evaluation under a strategy of broadly participatory growth, and of the content and size of special surveys to measure the effects of programs and projects, the causes of those effects, and the means of improving programs and projects.[105]

Chapter XI. Summary, Conclusions, and Research Agenda

Conceptualization of the role of agriculture in economic development and the means of achieving agricultural development has improved immensely over the past few decades. Empirical knowledge of economic relationships has grown even faster. The number of studies carried out under different conditions and on a wide range of topics has grown at an accelerating rate. As a result, documentation has been achieved for a wide range of diverse conditions. Of course, there is also increasing difficulty in substantiating generalizations, but perhaps a diminishing need to do so. This growth in research is the product of public concern about the need to improve development policy and rapid growth in the stock of trained research personnel and the institutional capacity of developing countries.

The research needs of the future include refinement and replication of past research. A simple comparison of the number of agricultural economists in each

state in the United States, and the wide range of replicated studies done with the number of economists and studies in individual developing countries drives home the point that there is much further to go in expanding these capabilities. Similarly, as circumstances are constantly changing over time, research needs to be brought up-to-date. The research needs of the future require expansion of research capacity and will tax the ability of the scholarly community to digest such knowledge and to use it effectively.

Four areas of inquiry of particular importance are still inadequately conceptualized and lack a solid empirical base. These four areas are: the linkages by which a large, dynamic agriculture multiplies its effects on total economic growth through the other sectors of the economy—the role of technology, infrastructure, and education in those processes; the processes by which policy measures may be implemented quickly and efficiently; the links between improved income, food intake, nutrition and human well-being; and the interactions among the Third World countries, as their growth accelerates, as well as between the developing countries and the already industrialized countries.

The rationale for a strategy of growth based on agriculture is that a technologically dynamic agriculture stimulates accelerated growth in other sectors. That growth is not only faster and more broadly participatory than growth from other strategies of development, but it encourages a widely dispersed pattern of urbanization. The megalopolises that we see in many developing countries are quite contrary to the pattern of urbanization in present-day developed countries. That pattern is the product of growth without a broad rural base. It is the linkages from broadly based rural development that encourage development of a wide base of small urban centers that eventually, of course, may achieve a life of their own and grow to quite a large size.

Such linkages work through the demand for consumption goods and services, a demand which derives from the higher incomes that result from efficiency-increasing technological change in agriculture. But, the precise dimensions of these linkages and how public policy can encourage them is still poorly understood. Similarly, it is clear that these linkages are part of a commercialization process that depends on a large and expensive infrastructure of roads, other means of communication, and electrification. The size and composition of the needed investment and the principles by which it should be allocated have received little attention.

There is a continuous tendency for the academic community to understate the importance of rural education in these processes of growth. This underrating of the importance of education by the academic and intellectual communities follows from an inadequate understanding of the role that formal education plays in preparing people to deal with complex situations. The strong relation between the level of formal education and the acceptance of integrated pest management,

of high levels of feeding of livestock, and of efficient use of fertilizer, all three of which involve complex management interactions, is an illustration of these processes. Of course, rural people themselves understand the importance of such education and try to drive their political systems to provide it.

This statement of the importance of physical infrastructure and education to the process by which agricultural development drives accelerated development in other sectors of the economy underlines another *lacunae* in agricultural development research. Rural physical infrastructure and rural education both require vast quantities of resources. Raising these resources at the national government level, with the inevitable detachment of revenue raising from expenditure patterns, is apt to produce deleterious effects on incentives as marginal tax rates are pushed to high levels. It can be argued that the same taxation for local purposes that are fully understood and desired by the people will have a less strong negative incentive effect. Thus, we must confront a complex set of questions relating to the development of local government.

It is notable that local government is weaker, generally speaking, in developing countries than was the case in developed countries at a similar stage of development. This contrast may arise from the nature of colonial regimes and the freedom movements that ended colonialism. Both tended to be urban based and to favor centralized power structures. We need to understand these processes of development of local government and the role that local government plays in raising resources and allocating those resources effectively for broad-based rural development. This moves us into the complex areas of politics and political economy as well as economics.

Increasingly, agricultural practitioners have been frustrated by problems in implementing agreed upon policies. There has been little comparative analysis of development projects—analysis to determine what needs to be done to implement particular policies.

Growth in agricultural production has sometimes been accompanied by declining prices, rising stocks, and decreased imports or increased exports while the per capita consumption of food-deficient people has failed to increase. This problem has been partly met in the long run by effective linkages, and by stimulating employment and the incomes of low-income people with high income elasticities of demand for food. But, there is also a short-run problem that can be effectively dealt with by employment and food subsidies. There is still a lack of knowledge of the effect such policies have on public finance, food consumption, and nutrition.

A discussion of policies also relates to the complex areas of politics, political economy, and economics. There is an increasing recognition that this inadequate knowledge base must inevitably lead to more substantial research into health issues and particularly public health problems. It has become more and more clear

that increased productivity in agriculture does lead to rather broad-based participation in the income benefits of that increased productivity. The conversion of rising incomes into increased food consumption on the part of low-income people seems quite efficient. There is clear evidence, however, of a much lower level of efficiency in converting increased food consumption into improved health. A major expansion of research is necessary in order to understand these health problems. Undoubtedly, that research will lead back to issues of public expenditure and the development of rural local government. It seems likely that public health measures are important in these processes.

Even more, the importance of private aspects of health, including individual home sanitary systems, may require widespread acceptance before there is a measurable impact on the health of the population generally. Thus, economists, nutritionists, and public health practitioners must come together in order to understand these problems and to move toward a solution. It is also clear that the role of women in these processes is particularly important. A substantial body of research shows that income controlled by women has a more important effect on food consumption and nutritional status than income controlled by men. As understanding of health issues broadens, it seems highly likely that considerations of the role of women and women's education will expand.

Finally, large populations in Third World countries will enter periods of accelerated growth over the next few decades. We know little about the effects such growth will have on the aggregate demand for food and international trade, or on aid and food security relationships and the ways they interact with development strategy, breadth of political participation, and political systems. Yet we know that major changes in these relationships are likely, that they will affect all countries profoundly, and that the benefits from economically sound, long-run policies will be immense.

This quest for knowledge, with respect to relations among developing countries and between developing countries and developed countries, must, as a matter of course, include increasingly sophisticated trade analysis. We understand fully that open trading regimes can be favorable to economic growth. Given the restrictionism endemic in developing countries, the first round of policy from that knowledge has been to push toward freeing trade and drawing back from the stultifying effects of government interference. However, it is becoming increasingly clear that there are substantial scale economies, particularly for a wide range of agricultural commodities, and substantial institutional requirements that in effect act like scale economies. Thus, an effective horticultural export program requires research systems tuned to the specific horticultural commodities being exported and institutions specifically oriented to marketing those commodities. For most developing countries, such capacity cannot be built for a large number of commodities, and hence, the scale issues become important. This, in turn, re-

quires careful analysis of commodities to be emphasized, the result of that analysis in effect driving comparative advantage in an important way.

Thus, we face an exciting future world, growing out of nearly half a century of political and economic change in Asia. Agricultural economists have played a major role in providing the basic knowledge that has allowed these processes to move far more rapidly than they moved when the present-day developed countries were progressing through similar stages of development. This rapid growth is possible because increases in trained people and institutional capacity generate more new knowledge and that knowledge base can be applied more rapidly. There is a danger that we could lose our sense of strategy in the myriad details of process. Thus, we end our review on the note that it is a sense of strategy that has led to an emphasis on agriculture, allowing it to play a driving role in essentially all Asian countries where accelerated overall economic growth has been achieved. It is this sense of strategy that has allowed efficient allocation of both development resources and the analytical resources of our profession, thus forwarding accelerated growth and broad participation in those processes of growth.

Notes

1. For an early effort to categorize stages of agricultural development, see Johnston and Mellor [1961] and Mellor [1962a]; for a historical perspective on growth stage theories and their relevance for agricultural development, see Wharton [1963a, b], Ruttan [1965], and Hayami and Ruttan [1971, 1985].

2. Seminal efforts to articulate the process of agricultural development and strategies for economic development, especially in the Asian context, include Day [1963], Schultz [1964], Mellor [1966, 1976], Ishikawa [1967a], Hayami and Ruttan [1971, 1985], Johnston and Kilby [1975], and Binswanger and Ruttan, *et al.* [1978]. However, as has been argued by Kamarck [1976], most theories of economic development or agricultural development do not take into account the peculiar conditions faced by countries in the tropics.

3. For detailed discussion on structural change and patterns of development in relation to the agricultural sector, see Schultz [1953], Clark [1957], Chenery [1960, 1979], Kuznets [1971], Chenery and Syrquin [1975], and Chenery and Watanabe [1958].

4. These relations are spelled out more fully in Lele and Mellor [1981], Johnston and Kilby [1975], Mellor and Lele [1973], Mellor and Mudahar [1974a, b], Mellor [1976], and Mudahar [1982].

5. For analyses of the positive role of agriculture in economic development, see Johnston and Mellor [1961], Mellor and Johnston [1984], Kuznets [1961], Nicholls [1961, 1963, 1964], Eicher and Witt [1964], Witt [1965], Mellor [1966, 1967, 1974, 1976], Southworth and Johnston [1967], Thorbecke [1969], Hayami and Ruttan [1971, 1985], the World Bank [1982b], Hwa [1983], Ghatak and Ingersent [1984], and Eicher and Staatz, eds. [1984].

6. For further discussion and conceptualization of labor-leisure choice and its impact on labor supply, see Mellor [1962a, 1963], Nakajima [1969], and A. K. Sen [1966]; and, more recently, in the context of agricultural household models, see Barnum and Squire [1979b], and I. J. Singh, Squire, and Strauss, eds. [1986].

7. Unlike single-sector models where labor supply is exogenous, the models developed by Solow [1956], Buttrick [1958], Leibenstein [1957], and R. R. Nelson [1956] determine labor supply endogenously.

8. Two-sector models were developed by Meade [1962], Solow [1961], Stiglitz [1969], Takayama [1963], Uzawa [1961, 1963], and others.

9. The Jorgenson model is termed "neoclassical" in the literature. The "classical" and "neoclassical" theories of dualistic development were tested and contrasted in Jorgenson [1966, 1967] and A. K. Dixit [1970]. For a complete statement on generalized dualistic development models, see Kelley, Williamson, and Cheetham [1972]. The role of agriculture in dualistic development models has also been reviewed and summarized in Ghatak and Ingersent [1984].

10. Selected studies dealing with different aspects of the Green Revolution include L. R. Brown [1968], Wharton [1969b], Johnston and Cownie [1969], Ladejinsky [1969a, b, 1970], Falcon [1970], Griffin [1972], Lele and Mellor [1972], Collier, Soentoro, Wiradi, and Makali [1974], Evenson [1974], Mudahar [1974], Randhawa [1974], C. H. H. Rao [1975], M. H. Khan [1975], Mellor [1976], Day and I. J. Singh [1977], Narain [1977], Ruttan [1977], Farmer [1979], Farmer, ed. [1977], Hayami, Kikuchi, *et al.* [1978], Dahlberg, ed. [1979], Hayami and Kikuchi [1981], Feder and O'Mara [1981], IRRI [1978a], ICRISAT [1980], Pearse [1980], Chaudhury [1982], Barker and Herdt [1985], Mellor and Desai, eds. [1985], Lipton and Longhurst [1985, 1989], and Hossain [1988b].

11. For further discussion on the introduction and adoption of modern crop varieties, see Streeten [1969]; for wheat in India, Dalrymple [1974, 1986a, b]; for rice and wheat in developing countries, Bernsten, Siwi, and Beachell [1982]; for rice in Indonesia, Herdt and Capule [1983]; and Barker and Herdt [1985] for rice in Asia. More recently, CGIAR has provided a comprehensive survey of the development and transfer of modern crop technology and its impact on agricultural development, J. R. Anderson, Herdt, and Scobie [1988].

12. These six countries include India and Pakistan from South Asia and Indonesia, Malaysia, Philippines, and Thailand from Southeast Asia.

13. For a detailed discussion of the sources of productivity growth in Indian Punjab, the showcase of the Green Revolution in India, see I. J. Singh [1971], Mudahar [1974], Johl and Mudahar [1974], and Day and Singh [1977]. In addition to the factors mentioned, land consolidation was an important factor in expanding irrigated area by facilitating profitable capital investment in private tube wells operated by diesel engines or electric motors. The relative economics of prospective technologies for semiarid tropics (unlike wheat and rice varieties which were suited primarily for areas with assured irrigation) in India is discussed in Ryan, Sarin, and Pereira [1980]. A comparative analysis of the sources, nature and impact of Green Revolution in Bangladesh is provided by Hossain [1988b].

14. The role of modern rice varieties in raising fertilizer productivity was demonstrated by Herdt and Mellor [1964], and the complementarities among irrigation, fertilizer, and modern rice varieties in the Philippines are analyzed in Wickham, Barker, and Rosegrant [1978] and Herdt, Te, and Barker [1977/78, 1980]. Attribution of a large share of production growth to fertilizer arises partly by subsuming returns to various complementary inputs to fertilizer [Herdt and Capule, 1983]. However, such relatively raw analyses properly place the public policy focus on the need for developing infrastructure, distribution systems and incentive policies for massive increases in fertilizer use.

15. For a detailed analysis of fertilizer in agricultural development of India, see G. M. Desai [1969, 1973, 1978, 1979, 1982]; G. M. Desai and G. Singh [1973]; and G. M. Desai, Chary, and Bandyopadhyay [1972]. The role of fertilizer in the Asian rice economy is dis-

cussed in David [1976, 1978]; Barker [1978]; David and Barker [1978]; Herdt, Te, and Barker [1977/78]; Wickham, Barker, and Rosegrant [1978]; Pitt [1983b]; and Barker, Herdt, and Rose [1985]. Methodology to measure the contribution of fertilizer to food production and its application to estimate fertilizer's contribution to wheat and rice production in India is demonstrated in Mudahar [1987]. A comprehensive study dealing with the role of fertilizer in economic development in the United States was carried out by Sahota [1968b].

16. According to Hayami [1964], 70 percent of the increase in commercial fertilizer input in Japan is explained by technological progress in agriculture and 30 percent by decrease in price of fertilizer between 1883 and 1937. This conclusion is corroborated by the recent experience of rice growing in Asian countries by David [1976, 1978], Sidhu and Baanante [1981], and Rosegrant, Kasryno, Gonzales, Rasahan, and Saefudin [1987].

17. IRRI published the proceedings, *Irrigation Policy and Management in Southeast Asia*, during 1978. Among others, the proceedings include papers by Wickham and Valera [1978], D. C. Taylor [1978], Hafid and Hayami [1978], Dozina, Kikuchi, and Hayami [1978], Tagarino and Torres [1978], and Trung [1978].

18. The project was implemented in six Asian countries: Bangladesh, Indonesia, Philippines, Sri Lanka, Taiwan, and Thailand. The basic methodology used is summarized in De Datta, *et al.* [1978]. All the country studies used a common methodology which made it possible to compare the results across different countries. Furthermore, these studies were carried out by interdisciplinary teams of researchers both at the national and international levels.

19. The districts, from which farm management data were collected, were from selected Indian states, including Uttar Pradesh, Madhya Pradesh, Andhra Pradesh, Punjab, West Bengal, Bombay (now Maharashtra), and Madras (now Tamil Nadu). The empirical evidence on an inverse relationship between farm size and productivity was provided in P. K. Bardhan [1973]; Bharadwaj [1974]; Khusro [1964, 1969]; Lau and Yotopoulos [1971]; Mazumdar [1963, 1965]; A. P. Rao [1967]; C. H. H. Rao [1963, 1966]; Saini [1971]; A. K. Sen [1962, 1964]; and Yotopoulos and Lau [1973]. Some of these studies were summarized in Bachman and Christensen [1967], Kanel [1967], Bhagwati and Chakravarty [1969], and I. J. Singh [1988a]. More recently, the empirical evidence in support of an inverse relationship between farm size and productivity is provided in Bagi [1981a, 1983a, b, 1984]; Huang and Bagi [1984]; Deolalikar [1981]; Huang, Tang and Bagi [1986]; V. Rao and Chotigeat [1981]; and A. Sen [1981].

20. Based on the survey of six villages in South India (semiarid tropical area) Ryan, Ghodake, and Sarin [1980] found (a) no consistent evidence that small farmers use more labor per hectare than large farmers and (b) little evidence for the existence of dual labor markets.

21. The empirical evidence for India is provided in Khusro [1964], R. Krishna [1964], C. H. H. Rao [1965a], Saini [1969], and Yotopoulos and Lau [1973]. These studies are also based on "Farm Management Data" for the 1950s. Similar studies for other Asian countries include: Yotopoulos and Lau [1979] for the methodology and summary; Lau, Lin, and Yotopoulos [1979] for Taiwan; Kuroda [1979] for Japan; Adulavidhaya, *et. al* [1979] for Thailand; and Tamin [1979] for Malaysia. All these studies, except for Japan, confirm the hypothesis of constant returns to scale; Japanese agriculture has been found to experience increasing returns to scale.

22. These studies include P. K. Bardhan [1973], Chennareddy [1967], D. K. Desai [1963], Day and I. J. Singh [1977], Hopper [1965], Khusro [1964], R. Krishna [1964], C. H. H. Rao [1965a], Sahota [1968a], Saini [1969], S. S. Sidhu [1974a], Lau and Yotopoulos

[1971], and Yotopoulos and Lau [1973]. Some of these studies have been summarized in Bhagwati and Chakravarty [1969] and in Government of India [1976].

23. Based on the results of comprehensive linear programming model of agriculture in the Pakistan Punjab, Gotsch and Falcon [1975] concluded that there was scope to increase net revenue through optimal cropping patterns and cropping intensities. Further details of the model and its empirical analysis are available in Gotsch, B. Ahmed, *et al.* [1975]. A brief survey of literature on farm planning models with a focus on agriculture (both crop and livestock production) in the developed world is available in Glen [1987]. The survey concludes that although these models are used as research tools or teaching aids, few of them are used directly by farmers to improve their decisionmaking.

24. Among the studies that hold this view are Heady [1947], Georgescu-Roegen [1960], Issawi [1957], and Schickele [1941]. The notable exception is D. G. Johnson [1950].

25. Vyas [1970] and Ladejinsky [1972] argued that policy prescriptions which emphasize abolishing tenancy and setting ceilings on land ownership might overlook reforms that would make existing tenancy arrangements more effective and equitable. The empirical analysis carried out in three provinces in Thailand shows a statistically significant effect of ownership security on land prices [Chalamwong and Feder, 1988]. The risk of eviction on untitled land and the advantages in access to credit associated with titled land are shown to account for higher price of titled land. As a result, the authors conclude that granting full legal ownership to squatters can be a socially beneficial policy.

26. For related studies on the economic aspects of tenancy and land reforms, see Abdullah [1976] and Zaman [1973] for Bangladesh and Mangahas [1974] for the Philippines. Newbery [1977] and Newbery and Stiglitz [1979] discuss the theoretical issues; T. C. Smith [1959] and Feeny [1983a, b] discuss a broad range of issues related to tenancy.

27. A detailed survey of supply response studies is available in Askari and Cummings [1976].

28. The most popular model used for empirical acreage response studies has been the Nerlovian adjustment model, Nerlove [1958]. Multiple regression models, even though less elegant, are also widely used. Narain [1965], in his detailed and particularly insightful study on acreage response in India, used graphical analysis.

29. According to R. Krishna [1982], since elasticity of output with respect to technological change appears to be higher than price elasticity, a balanced policy should stress technology policy more than the price policy while maintaining price incentives.

30. For further discussion on price policy and economic development, see R. Krishna [1967a] and Mellor [1966, 1968] and for the price policy debate in India, see Dantwala [1967, 1972] and Lele [1969]. More recent literature on agricultural price policy includes ADB [1988], Bale and Lutz [1978, 1981], Bertrand [1980], Braverman, Ahn, and Hammer [1983], Byerlee and Sain [1986], Cheong and D'Silva [1984], de Janvry and Subbarao [1986], Krishna and Raychaudhuri [1980, 1981], Krueger, Schiff, and Valdes [1988], Meier, ed. [1983], Mellor and Ahmed, eds. [1988], Pinstrup-Andersen, ed. [1988], Scandizzo and Bruce [1980], Schultz, ed. [1978], Sicular, ed. [1989a], Timmer [1986a, b, c], and Timmer, Falcon, and Pearson [1983]. The evidence provided by various studies indicates that (1) the agricultural sector in developing countries is heavily taxed while that in the developed countries received substantial subsidies, and (2) there are large income transfers from the rural to the urban sector in developing countries and from the urban to the rural sector in developed countries.

31. The issue of choice between crop price support and input subsidy has become extremely important for policymakers. Both crop price support and input subsidy policies are widespread in developing countries. The issue is far from settled and the initial analysis is

provided in Barker and Hayami [1976], Mudahar [1978], R. Ahmed [1978, 1979, 1981], Bagi [1984], Timmer [1986a], and Mellor and R. Ahmed [1988].

32. We are particularly grateful for the input of Bupendra M. Desai in the development of this section.

33. For the evidence and detailed analysis of international data on agricultural research and extension, see Boyce and Evenson [1975]; Evenson and Kislev [1973, 1975a, b]; Evenson [1978a, 1986b, 1987, 1988]; Evenson, Pray, and Scobie [1985], Judd, Boyce, and Evenson [1986]; Oram and Bindlish [1981]; Oram [1985]; Pray [1979, 1983]; Ruttan [1982]; and Ruttan and Pray, eds. [1987].

34. According to Boyce and Evenson [1975], in Asia during 1974, 1.9 percent of the value of agricultural production was spent on research and 0.9 percent was spent on extension. Also, the expenditure on agricultural research was only about 26 percent of the total annual expenditure for research in Asia. More recent experience indicates that there has been a slight shift in public resource allocation in favor of agricultural research relative to agricultural extension.

35. These issues and problems were addressed carefully in many papers contained in Fishel, ed. [1971] and in Arndt, Dalrymple, and Ruttan, eds. [1977]. For a review of the models and methods used to allocate resources in agricultural research, see Shumway [1977]. Barker and Herdt [1979] analyzed different aspects of resource allocation for rice research in Asia and concluded that rainfed lowland rice needs to be given research priority in South and Southeast Asia since modern rice technology has largely bypassed the rainfed rice. The efficiency and equity issues in allocation of research resources and design of agricultural technology in developing countries are discussed in Binswanger and Ryan [1977] and Ryan [1984]. Resource allocation, structure, and incentives for agricultural research and its contribution to agricultural development in Nepal are analyzed by Yadav [1987].

36. Note the pioneering work using cost-benefit analysis to estimate the contribution of agricultural research by Griliches [1958b]—in the context of hybrid corn and related innovations.

37. For a description of the Indian agricultural research system and its contribution to agricultural production, see Mohan, Jha, and Evenson [1973]; Evenson and Jha [1973]; and Indian Society of Agricultural Economics [ISAE, 1977a]. Resource allocation, structure, and its contribution to agricultural development in Nepal are analyzed by Yadav [1987].

38. There is a growing realization of the need to estimate returns from investment in agricultural research. Pinstrup-Andersen [1982] deals with contribution of agricultural research to economic development; Ruttan [1982] and Ruttan and Pray, eds. [1987] deal with agricultural research policy. Other selected studies dealing with agricultural research are Andrew and Hildebrand [1982], Busch and Lacy [1983], Evenson [1978a], Evenson and Kislev [1973, 1975a, b], Evenson, Pray, and Quizon [1986], Evenson, Putnam, and Pray [1983], Evenson, Waggoner, and Ruttan [1979], Khan and Akbari [1976], Norton and Davis [1981], Pray [1979, 1983], Ruttan [1986a, 1986b, 1986d], and the World Bank [1985e].

39. For the problems and major issues in the development of agricultural research systems in developing countries, see Moseman [1970]. The influence of international research on national agricultural research systems is discussed in Evenson [1986b, 1987, 1988] and Evenson, Pray, and Scobie [1985]. Neglected dimensions and emerging alternatives in agricultural research are discussed in Dahlberg, ed. [1985].

40. Hillman and Monke [1983], after reviewing the literature on international transfer of agricultural technology, concluded that the greatest successes in technology transfer have been with technologies which are neutral with respect to the economic, biological, and in-

stitutional environment into which they are transferred. Technological opportunities and international technology transfer in agriculture are discussed in detail by Evenson [1988]. Evenson, Putnam, and Pray [1983] have analyzed the effects of international transfer of agricultural technology on the competitiveness of U.S. agriculture.

41. But in subsistence agriculture, household consumption requirements are more important and production patterns are adjusted according to consumption constraints. For detailed analysis along these lines, see Day and I. J. Singh [1977], I. J. Singh [1971], Mudahar [1973], and Mudahar and Day [1978]. More recently, household consumption and its implications for production decisions and related relationships in developing countries are evaluated in the context of agricultural household models by Barnum and Squire [1979a, b]; Binswanger, Evenson, Florencio, and White, eds. [1980]; I. J. Singh, Squire, and Strauss [1986a]; and I. J. Singh, Squire, and Strauss [1986b]. The agricultural households combine two fundamental units of microeconomic analysis: the household and the firm. The so-called new theory of agricultural households combines the producer and consumer behavior. These models have been applied in several Asian countries, including India, Indonesia, Japan, Korea, and Malaysia.

42. Khatkhate [1962] similarly argued that the marketable surplus will increase as the price falls because the farmer is interested in maintaining his money income at the same level. Dubey [1963] and Dandekar [1964] challenged these conclusions. For further discussion of the fixed-cash requirement theory of marketable surplus, see Nowshirvani [1967a].

43. For related studies on marketable surplus and marketing of cereals and foodgrains in India, see P. K. Bardhan and K. Bardhan [1969, 1971], Lele [1971], and Moore, Johl, and Khusro [1972].

44. Two other studies on marketable surplus of agricultural produce in South Asia include A. R. Khan and Chowdhury [1962] and Zaman [1966] for Pakistan.

45. A critical review and detailed comments on this study are available in Majumdar [1965], C. H. H. Rao [1965b], and R. Krishna [1965b].

46. Dandekar [1964], based on empirical evidence for jowar, wheat, and other cereals, also rejected the fixed-cash requirement theory of marketable surplus put forth by Mathur and H. Ezekiel [1961].

47. Additional studies on marketable surplus in other parts of India include Kahlon and Vashishtha [1968], Muthiah [1964], and Vyas and Maharaja [1966].

48. Mellor [1973a] has analyzed the impact of accelerated growth in agricultural production on intersectoral transfer of resources; and Mellor [1978] has discussed the impact of food price policy on income distribution in low-income countries, with particular reference to India.

49. T. H. Lee [1971] has provided a detailed empirical analysis of intersectoral resource transfers in Taiwan. Analyses of trends in foodgrain prices and the terms of trade in India and economic consequences for foodgrain production and economic growth are available in Mellor and Dar [1968] and Thamarajakshi [1969] for the period between 1952/53 and 1964/65, and Parthasarathy and Mudahar [1976] for the period between 1952/53 and 1973/74.

50. Related studies dealing with agricultural marketing and marketing efficiency in Asia and developing countries include J. C. Abbott [1962], Lele [1967, 1971, 1974]; Jasdanwalla [1966]; R. W. Cummings, Jr. [1968]; Farruk [1970]; Moore, Johl, and Khusro [1972]; Ruttan [1969]; Timmer [1972, 1974a]; Wharton [1962]; Harriss [1979, 1986]; von Oppen, Raju, and Bapna [1980]; and World Bank [1988d].

51. The empirical evidence from India that protein deficiency is not as widespread as has been believed, and that the calorie gap is more serious than the protein gap, is contained in the proceedings of the Indian Society of Agricultural Economics [ISAE, 1977b]. A de-

tailed assessment of energy and protein requirements conducted by a joint FAO/WHO Ad Hoc Expert Committee is available in FAO and WHO [1973]. The findings of this report also reject the simplistic view that the protein gap is widespread.

52. Further discussion on incidence of malnutrition and related issues is available in Berg [1973, 1981, 1987], Berg, Scrimshaw, and Call, eds. [1973], Caliendo [1979], Kalirajan [1976], Mitra [1973], L. Taylor [1977], FAO [1977], FAO and WHO [1973], Piazza [1983, 1986], Pitt [1983a], Knudsen and Scandizzo [1979], Poleman [1981], Srinivasan [1981], and World Bank [1986b]. Poleman [1981] points out disagreements among organizations, such as FAO, World Bank, and USDA, on the nature and extent of world food and nutrition problems, and hence their perceptions about appropriate remedial actions.

53. Consumer expenditure patterns and the implications of income growth are analyzed in Azizur Rahman [1963], M. I. Khan [1963], B. M. Desai [1972], Mellor and Lele [1973], and Mellor [1978]. The implications of industrialization for the demand for food in low-income countries are discussed in Stevens [1963]. The relation of income, expenditure patterns and food subsidies is extensively analyzed in R. Ahmed [1979, 1981]; J. M. Davis [1977]; George [1979]; Sarma, Roy, and George [1979]; Gavan and Chandrasekera [1979]; R. Krishna and Chhibber [1983]; Mateus [1983]; Trairatvorakul [1984]; Bienen and Gersovitz [1986]; and Pinstrup-Andersen, ed. [1988].

54. A critical review of issues dealing with contractual arrangements, employment, and wages in rural labor markets is available in P. K. Bardhan [1978, 1979, 1980, 1984a, b], P.K. Bardhan and Rudra [1978, 1981, 1983], and Binswanger and Rosenzweig, eds. [1984]. An excellent survey of labor market performance in developing countries was carried out by A. Berry and Sabot [1978].

55. Kao, Anschel, and Eicher [1964] found no consistent evidence that disguised unemployment exists in agriculture; also see I. J. Singh [1971] and Mudahar [1973]. The marginal productivity of labor may not be zero but Visaria and Visaria [1973] found that labor productivity in rural India was very low.

56. See, for example, C. H. H. Rao [1974], I. J. Singh [1971], Mudahar [1974], Johl [1973b], and Day and Singh [1977] for analysis dealing with Indian Punjab.

57. Theoretical discussion on some of these issues is available in N. Islam [1964], Mellor [1963], and Mellor and Stevens [1956].

58. In an excellent survey of landless poor in South Asia, I. J. Singh [1983] concludes that in the long run a reduction in population growth, an increase in agricultural growth and an increase in opportunities in the nonagricultural sector can benefit the landless through increased employment and can eradicate poverty. The relationship between the Green Revolution, prices, and poverty is discussed in several papers published in Mellor and Desai, eds. [1985], and in more recent papers by I. J. Singh [1988a, b, c].

59. Several case studies which discuss these issues are Billings and A. Singh [1970]; Kahlon [1976]; Lal [1976]; Mudahar [1974]; Johl and Mudahar [1974]; C. H. H. Rao [1972]; Visaria [1972]; Kahlon, Gupta, and Sondhi [1971]; Roy and Blase [1978]; and Barker and Cordova [1978].

60. Collier, Soentoro, Wiradi, and Makali [1974], in analyzing the impact of modern technology on institutional change in Java, concluded that there appears to be a significant relationship between the spread of modern rice varieties and the expansion of *tebasan* (a traditional method of selling a crop just before harvest), which is responsible for a reduction in employment opportunities for harvest labor. This is corroborated by Utami and Ihalauw [1978].

61. Other studies that analyze the interaction between modern farm technology, mechanization, and employment in agriculture include Acharya [1973], Agarwal [1980, 1984b],

Johnston and Cownie [1969], Mehra [1976], A. K. Sen [1975a, b], B. Ahmed [1975], Binswanger [1978, 1984], and Binswanger and Donovan [1987].

62. Johnston and Mellor [1961], Mellor [1966, 1976], Mellor and Johnston [1984], Mellor and Mudahar [1974a, b] argued that the major constraint to creating and sustaining increased employment in developing countries is wage goods supply. The Green Revolution and modernizing agricultural sectors have the potential for relaxing this constraint.

63. Rural works programs provide an alternative means of employment in areas facing large unemployment. This may be important since the proportion of landless laborers has gone up in the last decade or so. Several case studies, for example, include Abdullah, Hossain, and Nations [1976]; Booth and Sundrum [1976]; Raj [1976]; and Rath [1974].

64. Examples of rural works programs in India are provided in Apte [1973], Donovan [1973], and Dantwala [1975]. However, Dantwala [1975] seemed to conclude that the rural works program does not really benefit the poor. R. Krishna [1973, 1982] concluded that radical politicization of the poorest groups will be necessary if they are to obtain the share allocated to them.

65. Most of the studies on employment deal with the implications of modern farm technology on employment in the production process. Timmer [1972], however, analyzed the implications for employment of investment in rice marketing in Indonesia.

66. This controversy is reflected in several studies dealing with poverty in India, such as Dandekar and Rath [1971a, b], P. K. Bardhan [1970], Minhas [1970], and Vyas [1972]. A review of changes in income distribution and poverty in India is available in D. Kumar [1974].

67. Cross-country data on income distribution and incidence of poverty in the world are available in S. Jain [1975] and World Bank [1975].

68. See, for example, Frankel [1971], C. H. H. Rao [1975], Swenson [1976], and Shah [1976] for India, Hossain [1988b] for Bangladesh and Griffin [1974] for several developing countries. For a balanced view of the practices and attempts to increase equity in the context of agricultural growth, see Sarma [1981].

69. For further discussion on rural income distribution, especially the effects of technological change in agriculture, see Gotsch [1972], Hayami and Herdt [1977], Barker and Herdt [1978], and Barker, Herdt, and Rose [1985].

70. Some of the complex interactions between nutrition and health are discussed by Selowsky and L. Taylor [1973], C. E. Taylor [1976], McCord [1977], and Selowsky [1981b]; and the linkage between nutrition and labor productivity is discussed by Leibenstein [1957] and Deolalikar [1988]. Related studies that analyze nutrition, health, and labor productivity interactions include Behrman [1988], and Behrman, Deolalikar, and Wolfe [1988].

71. For discussion on school participation rates in India, see Blaug, Layard, and Woodhall [1969] and Shortlidge [1976].

72. See, for example, Harberger [1965] and Kothari [1967].

73. The importance of education in economic development and as an investment to develop human capital was well articulated in a pioneering effort by T. W. Schultz [1963]. The importance of investment in rural education and its effect on agricultural development was discussed in an excellent paper by Welch [1978].

74. In 1977, Hirschman clarified his earlier position on linkages in agriculture: "Perhaps the principal reason why it is difficult to establish backward and forward linkage industries around the staples is not so much that, as I argued originally, there are fewer linkage effects in agriculture than in industry, but that they largely point to industries whose technologies are alien to the grower of the staple" [p. 78].

75. According to Hirschman, this is an all-encompassing definition of linkages which includes the well known forward and backward linkages.

76. See Leontief [1951]. For definitions of alternative linkage indexes and their measurement, see Chenery and Watanabe [1958], Hirschman [1958], Rasmussen [1956], Yotopoulos and Nugent [1973], and Mudahar [1982].

77. The implications growth linkages have for agriculture development can best be analyzed by agricultural sector models that incorporate these linkages explicitly. Thorbecke [1973] discussed alternative approaches to agricultural sector analysis in developing countries. For a recursive programming approach, see Day [1963], Day and I. J. Singh [1977], Day and Cigno, eds. [1978], Mudahar and Day [1978], and Mudahar [1973]. For a simulation approach, see Manetsch *et al.* [1971] and Mellor and Mudahar [1974a, b].

78. A comprehensive analysis of modernizing agriculture and structural transformation was made in Johnston [1970], Johnston and Kilby [1975], and Mellor [1976]. The growth linkages of new foodgrain technologies in Asia were discussed in Mellor and Lele [1973] and Mudahar [1982]. Also see Flanders [1969], Hazell and Röell [1983], Krueger [1962], Lipton [1968a], and Nicholls [1963] for different aspects of linkages between agricultural and industrial sectors.

79. The growth of small-scale industry in response to agricultural development was discussed in Johl and Mudahar [1974] for the Indian Punjab and in van der Veen [1973] for Gujarat state in India.

80. According to D. W. Adams, Canh, and Chin [1975]: "Rural purchasing power in Taiwan during the past two decades (1952-72) has provided a major market for goods produced in the nonagricultural sector. These final demand linkages were especially important in the 1950s when rural residents made up a large part of the total population and when nonagricultural exports were relatively small. . . . The underutilized 'industrial islands' surrounded by seas of rural poverty in Northeast Brazil, Colombia, and Pakistan, for example, are vivid contrasts to the way development has evolved in Taiwan" [p. 141]. T. C. Smith [1959] sheds light on these important issues for pre-Meiji Japan.

81. Mellor [1973a] has reviewed this controversy and provided an elaboration of the basic case for net resource transfers from agriculture. For detailed analysis of intersectoral resource transfer in Taiwan, see T. H. Lee [1971].

82. Despite this, there are few analytical studies dealing with patterns of agricultural trade and the implications of alternative trade policies in determining these patterns. For discussion of agricultural trade issues and their interaction with economic development, see Ojala [1969], Sisler [1971], Mellor and Lele [1975], Tolley and Zadrozny, eds. [1975], Sorenson [1975], Mellor [1976], and Nagle [1976]. Taiwan was analyzed in Tang and Liang [1975] and Pakistan in S. R. Lewis, Jr. [1968].

83. This confirms the policy recommended for most of Latin America by Prebisch [1964].

84. A detailed account of India's trade policies is available in Bhagwati and P. Desai [1970]. Other studies that deal with different aspects of trade in India are R. Bharadwaj [1962], Mellor and Lele [1975], and M. Singh [1964].

85. The implications of agricultural protectiveness on distribution of gains from the dissemination of technology were analyzed by Josling [1975, 1980].

86. According to Evenson [1975], "There has been a significant decrease in the comparative productivity of cereal grain production in less developed regions of the world . . . the decline in relative productivity in most of these countries has diminished their export performance as well." Evenson attributed this to a lack of investment in agricultural research. For discussion on related issues and the interaction of technological change and in-

ternational trade, see Hayami and Ruttan [1971, 1985]; Evenson, Houck, and Ruttan [1970]; and Vernon, ed. [1970].

87. These studies used a domestic resource cost approach to determine the comparative advantage in rice production [Pearson, Akrasanee, and Nelson, 1976].

88. See Mellor and Lele [1975]. Also see R. Bharadwaj [1962], which maintains that the capital intensity of exports *vis à vis* import replacement rose in India in 1958/59 and 1953/54.

89. According to Mellor and Lele [1975], India's rank correlation coefficients between capital intensity and export growth from 1964 to 1969 were statistically significant at the 90 percent level.

90. D. Gale Johnson [1975] analyzed the effects of a hypothetical worldwide shift to free trade of agricultural products on the outputs and prices of those products. Tolley and Zadrozny, eds. [1975] paraphrased Johnson's conclusion: "that even though free trade would permit a more efficient allocation of resources in the long run, the immediate effect would be to lower food production for a decade, with the distribution of food consumption shifting toward high-income countries at the expense of the less developed countries" [1975]. Note the more recent work reaching similar conclusions by K. Anderson and Ahn [1984] and Hayami [1983]. The prospects for world demand for the agricultural exports of developing countries were analyzed in Rojko and Mackie [1970]. The structure, conduct, and performance of the international rice market and patterns of rice trade were analyzed in Falcon and Monke [1979/80], and Siamwalla and Haykin [1983].

91. A comprehensive discussion of some of these issues is available in H. G. Johnson [1967], which continued the work of the 1964 United Nations Conference on Trade and Development and provided background for the 1967 Conference. This work points out that the GATT system is discriminatory against developing countries. Also, see Perez and Benedick, eds. [1978] which deals with some of these issues in the context of multilateral trade negotiations. A number of more recent studies have analyzed the impact of developed country trade practices on developing country agriculture and the potential implications of trade liberalization. See, for example, Josling [1980], Koester [1982], Koester and Valdes [1984], OECD [1987], Tyers and Anderson [1986, 1987], and Valdes and Zietz [1980].

92. A number of studies indicate that rapid rates of agricultural growth in developing countries, facilitated by open trade regimes, produce a rapid growth in those countries' food imports, particularly cereals. See, for example, Bachman and Paulino [1979], de Janvry and Sadoulet [1986a, b], Houck [1986], and J. E. Lee, Jr. and Shane [1985].

93. The multilateral trade negotiations (MTN) for the Uruguay round are divided into fifteen negotiating groups, out of which fourteen are for goods and one for services. These fifteen negotiations groups are: (1) tariffs, (2) nontariff measures, (3) natural resource-based products, (4) textiles and clothing, (5) agriculture, (6) tropical products, (7) GATT articles, (8) MTN agreements and arrangements, (9) safeguards, (10) subsidies and countervailing measures, (11) trade-related aspects of intellectual property rights, including trade in counterfeit goods, (12) trade-related investment measures, (13) dispute settlement, (14) functioning of the GATT system, and (15) services.

94. Export earnings also depend on the terms of trade. It has been argued that there is a long-run tendency for the terms of trade to turn against primary commodities, the major source of export earnings for many of the developing countries. However, Morgan [1959, 1963] found no strong evidence of a consistent pattern to support this general conclusion.

95. Hayami and Ruttan [1971, 1985] indicated that a major source of disequilibrium in world agriculture since World War II has been agricultural protectionism in the developing

countries. They also analyzed the implications of the Green Revolution for agricultural trade.

96. Balassa *et al.* [1971] have provided a comprehensive theoretical and empirical discussion of the structure of protection in developing countries, including case studies for Malaysia, Pakistan, and the Philippines.

97. More recently, Timmer and Falcon [1975a, b] analyzed the determinants of rice trade in Asia and concluded that "differences in rice and fertilizer prices across countries (and over time) are an important determinant of levels and patterns of international trade in rice" [1975b, p. 89].

98. The political aspects of foreign aid, in the context of India, are discussed in Eldridge [1969].

99. A general discussion of the two-gap model approach is available in Chenery and Strout [1966] and Chenery and MacEwan [1966].

100. See Mellor [1976] for a general discussion on foreign aid along these lines. The needed volume of foreign assistance can be viewed as the difference between domestic financial resource requirements and their availability. Domestic resource availability can be manipulated through policies on taxes, savings, and international resource transfers. For discussion of agricultural taxation, see Gandhi [1966], Johl [1972], and Pathak and Patel [1970]; for savings, see Mikesell and Zinser [1973] and Pannikar [1961]; and for intersectoral resource transfers, see T. H. Lee [1971], Mellor [1973a], and C. H. H. Rao [1969].

101. These issues are summarized in Bhagwati and Chakravarty [1969] and are addressed in more detail in Clay and Singer [1984], Dantwala [1967], M. Ezekiel [1958], Fisher [1963], Huddleston [1984], Isenman and Singer [1977], Khatkhate [1962], J. S. Mann [1967], Mathur and H. Ezekiel [1961], Pinstrup-Andersen and Tweeten [1971], and S. R. Sen [1960]. Maxwell and Singer [1979] provide a survey of the issues surrounding the use of food aid. More recent work on food aid includes H. Ezekiel [1988], Hopkins [1984], Mellor [1987], Srinivasan [1989], Wallerstein [1980], and World Food Programme [1985, 1987].

102. Russell and Nicholson, eds. [1981] discuss a range of such issues related to collective action.

103. For example, it is known that large areas under irrigation in Pakistan are experiencing soil salinity problem due to water-logging and poor drainage. Yet, according to S. H. Johnson III [1982b], the government has not been able to find a long-term satisfactory solution due to lack of success in implementing salinity control and reclamation projects, and lack of positive response from the bureaucracy due to project-related conflicts between provincial and central government organizations.

104. A major effort at comparative analysis of agricultural development projects in order to elucidate elements of implementational strategy was made by Mosher [1966] and Lele [1975]. Because broad access to data and project knowledge is difficult except in large agencies such as the World Bank, the sponsor of the Lele study, such work has not been duplicated. Birowo [1983] discussed the problems associated with implementing rural development strategies in Indonesia.

105. Based on the evaluation of the Companiganj project on health, nutrition, and family planning in Bangladesh, McCord [1977] concluded that for successful implementation of a project there is need for a realistic assessment of what is likely to work outside the pilot project and evidence that the program will work before it is implemented nationally.

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