Chapter 8

THE AGRICULTURAL TRANSFORMATION

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Contents

*I would like to thank the participants at the authors' workshop for helpful reactions to my initial ideas for this chapter. Particular thanks go to Larry Westphal, Pranab K. Bardhan, David Dapice, and Scott Pearson for serious and critical readings of the first draft. As always, my deepest debt is to my wife and editor, Carol, for her patience and persistence in helping me make my manuscripts readable and for her mastery of the wonderful new technology that permits me to lose half the manuscript with the push of a button and for her to get it back after considerable effort and anguish.

Handbook of Development Economics, Volume I, Edited by H. Chenery and T.N. Srinivasan
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1. Introduction

The agricultural transformation has been a remarkably uniform process when viewed from outside the agricultural sector itself. As documented by Clark (1940), Kuznets (1966), Chenery and Syrquin (1975), and the patterns reported in the introductory chapter to Part II of the Handbook, the share of agriculture in a country's labor force and total output declines in both cross-section and time-series samples as incomes per capita increase. The declining importance of agriculture is uniform and pervasive, a tendency obviously driven by powerful forces inherent in the development process, whether in socialist or capitalist countries, Asian, Latin American, or African, currently developed or still poor.

It is at least slightly puzzling, then, that a second uniform and pervasive aspect of the development process also involves agriculture – the apparent requirement that rapid agricultural growth accompany or precede general economic growth. The logic of the classical model of economic growth requires it:

> Now if the capitalist sector produces no food, its expansion increases the demand for food, raises the price of food in terms of capitalist products, and so reduces profits. This is one of the senses in which industrialization is dependent upon agricultural improvement; it is not profitable to produce a growing volume of manufactures unless agricultural production is growing simultaneously. This is also why industrial and agrarian revolutions *always* go together, and why economies in which agriculture is stagnant do not show industrial development [Lewis (1954, p. 433, emphasis added)].

The historical record to which Lewis alludes supports the strong link between agricultural and industrial growth, at least in market-oriented economies. The English model is often held up as the case in point:

> Consider what happened in the original home of industrial development, in England in the eighteenth century. Everyone knows that the spectacular industrial revolution would not have been possible without the agricultural revolution that preceded it. And what was this agricultural revolution? It was based on the introduction of the turnip. The lowly turnip made possible a change in crop rotation which did not require much capital, but which brought about a tremendous rise in agricultural productivity. As a result, more food could be grown with much less manpower. Manpower was released for capital construction. The growth of industry would not have been possible without the turnip and other improvements in agriculture [Nurkse (1953, pp. 52–53)].

Despite a significantly different view in the current literature about the impact of the English agricultural revolution on labor productivity, the key importance of the increase in agricultural output has not been challenged [Timmer (1969), Hayami and Ruttan (1985)]. Nor is this importance restricted to the lessons from the currently developed countries. In surveying the statistical link between agricultural and overall economic growth in currently less-developed countries, the World Bank reached the following conclusions:

> The continuing importance of agriculture in the economies of the developing countries is reflected in the association between the growth of agriculture and of the economy as a whole. Among countries where the agricultural share of GDP was greater than 20 percent in 1970, agricultural growth in the 1970s exceeded 3 percent a year in 17 of the 23 countries whose GDP growth was above 5 percent a year [see Table 8.1]. During the same period, 11 of the 17 countries with GDP growth below 3 percent a year managed agricultural growth of only 1 percent or less. Agricultural and GDP growth differed by less than two percentage points in 11 of 15 countries experiencing moderate growth. There have been exceptions, of course, but they prove the rule: fast GDP growth and sluggish agriculture was a feature of some of the oil- or mineral-based economies such as Algeria, Ecuador, Morocco, and Nigeria.
>
> The parallels between agricultural and GDP growth suggest that the factors which affect agricultural performance may be linked to economy-wide social and economic policies.... Expanding agricultural production through technological change and trade creates important demands for the outputs of other sectors, notably fertilizer, transportation, commercial services, and construction. At the same time, agricultural households are often the basic market for a wide range of consumer goods that loom large in the early stages of industrial development – textiles and clothing, processed foods, kerosene and vegetable oils, aluminum holloware, radios, bicycles, and construction materials for home improvements [World Bank (1982, pp. 44–45)].

The need for rapid agricultural growth and for the decline in the agricultural sector's share of output and the labor force are not contradictory, of course, but the apparent paradox gave rise to a widespread misperception that agriculture is unimportant – that it does not require resources or a favorable policy environment – *because* its relative share of the economy declines.

So long as market forces provide the primary direction to the sectoral allocation of resources, how academics perceive this process is irrelevant to the process itself. When government planners intercede, however, they do so within a framework of objectives and constraints, and this framework is ultimately conditioned by the prevailing academic understanding of how economic growth proceeds. The mainstream paradigm of the 1950s suggested that agriculture could and should be squeezed on behalf of the more dynamic sectors of the economy. This strategy could be successful if agriculture was already growing rapidly (as in

Table 8.1
Growth of agriculture and GDP in the 1970s

Agricultural growth	GDP growth			
	Above 5 percent		3–5 percent	Below 3 percent
Above 3 percent	Cameroon	Malawi[a]	Bolivia	Liberia
	China[a]	Malaysia	Burma[a]	Nicaragua
	Colombia	Paraguay	Mali[a]	Senegal
	Dominican Rep.	Philippines	Somalia[a]	
	Guatemala	Thailand	Tanzania[a]	
	Indonesia	Tunisia		
	Ivory Coast	Turkey		
	Kenya	Yemen Arab Rep.		
	Korea, Rep. of			
1–3 percent	Costa Rica		Bangladesh[a]	Burundi[a]
	Ecuador		Central African Rep.[a]	Sierra Leone[a]
	Egypt		El Salvador	Zaire[a]
	Lesotho		Haiti[a]	
			Honduras	
			India[a]	
			Pakistan[a]	
			Sri Lanka[a]	
			Sudan[a]	
			Upper Volta[a]	
Below 1 percent	Morocco		Togo[a]	Angola[a]
	Nigeria			Chad[a]
				Congo. Rep.
				Ethiopia[a]
				Ghana
				Madagascar[a]
				Mauritania[a]
				Mozambique[a]
				Nepal[a]
				Niger[a]
				Uganda[a]

[a]Low-income countries.
Source: World Bank (1982, p. 45).

Western Europe and Japan) or if it started with a large surplus relative to the subsistence needs of the rural population (as in the USSR). But if the agricultural sector started with traditional technology and yields and living standards near subsistence, the "squeeze agriculture" paradigm created economic stagnation, not growth. In those cases, major attention was needed to induce an agricultural transformation if the industrial revolution was to have any real hope of success.

Upon closer examination, it is not paradoxical that agricultural growth leads to agricultural decline. At least two mechanisms, now relatively well understood and documented, account for this process of structural transformation.[1] Engel's Law alone, in a closed economy with constant prices, explains a declining share for agriculture (and low farm incomes unless some farmers leave agriculture) no matter how fast the sector grows. Because growth is led by demand patterns in market economies, a less-than-unitary income elasticity for the products of the agricultural sector guarantees that gross value of sales by farmers will grow less rapidly than gross domestic product. As Lewis implies in the previous quotation, if agricultural output fails to grow rapidly enough, rising prices might actually garner farmers a higher share of consumers' expenditures. But this reflects *lower* real incomes, not the result of economic growth.

If the terms of trade are not to rise in favor of agriculture, farm productivity must rise – an agricultural revolution is needed. The second factor that explains the joint agricultural growth and relative decline is seen in the rapid growth in agricultural productivity, measured by output per laborer or output per hectare, in all the successfully developed countries. Technical change in agriculture in all of the OECD countries proceeded at such a pace that the long-run terms of trade declined for farm products. Lower prices thus exacerbated the sluggish demand growth due to low income elasticities; the combination put pressure on agricultural resources to move out of farming and into the more rapidly growing sectors of the economy. Such intersectoral movements of resources have been painful in all societies that have undergone successful structural transformation, and all societies have found mechanisms to cushion the adjustment process.

The paradox over the agricultural transformation occurs at this point. Just as countries learn how to institutionalize the process of rapid technical change in agriculture, its product no longer has high social value. The resulting low incomes for farmers create powerful political pressures to slow the process of structural change, and the seemingly inevitable result is massive distortion of the price structure [Johnson (1973), Anderson and Hayami (1986), World Bank (1986)]. Nearly all rich countries protect their agricultural sectors from international competition, and countries no farther along in the development process than Malaysia, Indonesia, Zimbabwe, and Mexico protect key food-producing sectors during periods of depressed world prices.

2. The process of agricultural transformation

From both historical and contemporary cross-section perspectives, the agricultural transformation seems to evolve through at least four phases that are roughly

[1] For a very useful summary of the literature that documents the agricultural transformation process itself and also attempts to explain it in terms of the prevailing models of economic development, see Johnston (1970).

definable. The process starts when agricultural productivity per worker rises. This increased productivity creates a surplus, which in the second phase can be tapped directly, through taxation and factor flows, or indirectly, through government intervention into the rural–urban terms of trade. This surplus can be utilized to develop the nonagricultural sector, and this phase has been the focus of most dual economy models of development. For resources to flow out of agriculture, rural factor and product markets must become better integrated with those in the rest of the economy. The progressive integration of the agricultural sector into the macro economy, via improved infrastructure and market-equilibrium linkages, represents a third phase in agricultural development. When this phase is successful, the fourth phase is barely noticeable; the role of agriculture in industrialized economies is little different from the role of the steel, housing, or insurance sectors. But when the integration is not successfully accomplished – and most countries have found it extremely difficult for political reasons – governments encounter serious problems of resource allocation and even problems beyond their borders because of pervasive attempts by high-income countries to protect their farmers from foreign competition. Managing agricultural protection and its impact on world commodity markets thus provides a continuing focus for agricultural policy makers even when the agricultural transformation is "complete".

2.1. Evolving stages

The four phases in the agricultural transformation call for different policy approaches. In the earliest stage of development the concern must be for "getting agriculture moving", to use Arthur Mosher's vivid phrase [Mosher (1966)]. A significant share of a country's investable resources may well be extracted from agriculture at this stage, but this is because the rest of the economy is so small. Direct or indirect taxation of agriculture is the only significant source of government revenue.

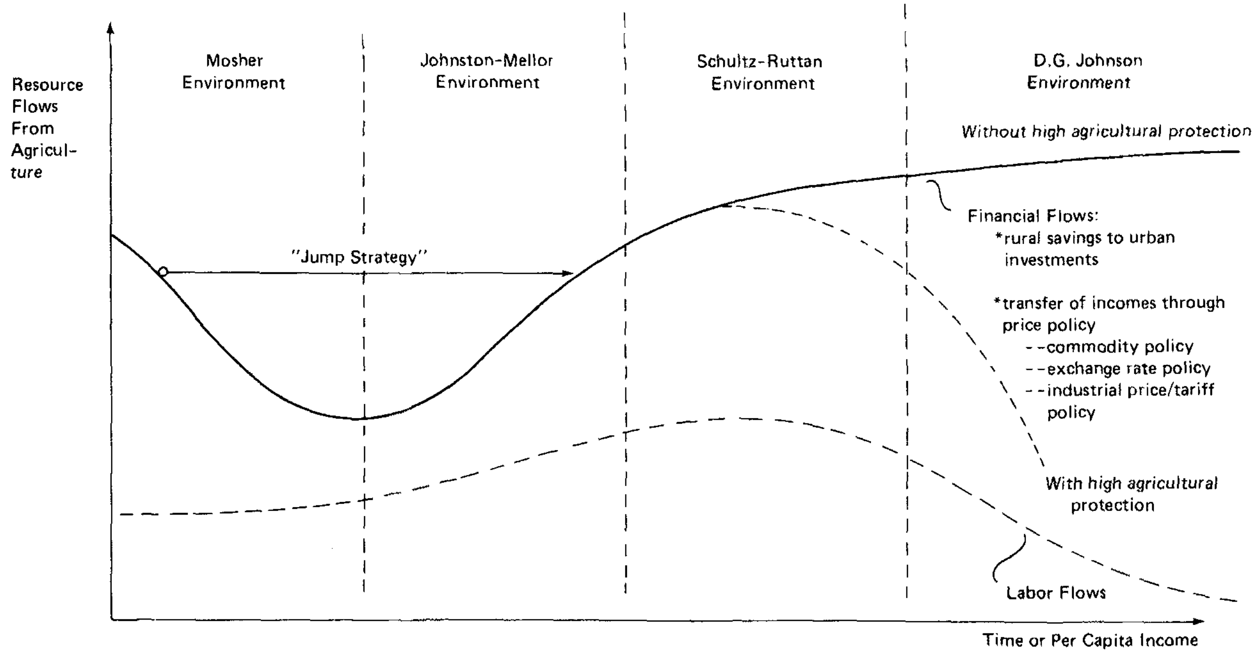
Building a dynamic agriculture requires that some of these resources be devoted to the agricultural sector itself. As the section on agricultural development policy at the end of this chapter explains, these resources need to be allocated to public investment in research and infrastructure as well as to favorable price incentives to farmers to adopt new technology as it becomes available. As these investments *in* agriculture begin to pay off, the second phase emerges in which the agricultural sector becomes a key contributor to the overall growth process through a combination of factors outlined by Johnston and Mellor (1961).

As the empirical literature on structural patterns of growth emphasizes, there is a substantial disequilibrium between agriculture and industry at this early stage of the development process [Kuznets (1966), Chenery and Taylor (1968), Chenery and Syrquin (1975)]. Indeed, differences in labor productivity and measured income (as opposed to psychic income) between the rural and urban sectors persist to the present in rich countries, although the gap is narrowing and now depends on agricultural prices for any given year.[2]

The process of narrowing the gap gives rise to the third environment for agriculture, in which it is integrated into the rest of the economy through the development of more efficient labor and credit markets that link the urban and rural economies. This integration is a component of the contribution process; the improved functioning of factor markets merely speeds the process of extracting labor and capital from those uses in agriculture with low returns for those in industry or services with higher productivity. The improved markets have welfare consequences as well, because they lessen the burden on individuals trapped in low-income occupations. The gain has costs, however. As agriculture is integrated into the macro economy, it becomes much more vulnerable to fluctuations in macro prices and level of aggregate activity and trade [Schuh (1976)] and much less susceptible to management by traditional instruments for the agricultural sector, such as extension activities and specific programs for commodity development and marketing.

This vulnerability and complexity create the fourth phase in the agricultural transformation, the treatment of agriculture in industrialized economies. As the share of the labor force in agriculture falls below about 20 percent and the share of food expenditures in urban household budgets drops to about 30 percent, low-cost food is not as important to the overall economy nor is it as expensive in relative terms to increase in price [Anderson (1983)]. A host of political problems arise if low farm incomes, induced by rapid technical change and low farm-gate prices, are allowed to push resources out of agriculture. Farmers do not want to leave, especially if they must sell their farms under duress at low prices; and urban-based unions do not want to see them coming to the cities in search of industrial jobs. A nostalgic memory of farming as a "way of life" leads many second- and third-generation farm migrants living in cities to lend political support to higher incomes for agriculture, even at the expense of higher grocery bills (which may be barely noticeable). By this stage of the process, the share of the farm-gate price of the commodity in the consumer's market basket is small because of processing and marketing costs. Commodity price supports become

[2] The structural rigidities in the economy that give rise to this substantial disequilibrium obviously mean that neoclassical models based solely on perfect markets and rational actors will fail to predict accurately the impact of government interventions. However, purely structural models that assume an absence of market response might be equally far from the mark. A messy amalgam of structural rigidities, imperfect markets, and decision-makers interested in their own, but vaguely defined, welfare seems to characterize the actual starting point from which government interventions must be evaluated.



Policy Settings:

"Getting Agriculture Moving"—institutional change; new technology; structure of markets and incentives; significant investments in rural infrastructure

"Agriculture as a Contributor to Growth"—establish market links with industry; technology and incentives to create a healthy agricultural sector; improve factor markets to *mobilize rural* resources

"Integrating Agriculture into the Macro Economy"—declining *share of food in urban* budgets; push to make agriculture efficient; shift resources out, but substantial *income distribution problems* from lagging rural labor productivity

"Agriculture in Industrial Economies"—small share of food commodities in consumer budgets; income distribution a political issue; *unemployment in industrial* sector creates pressures to keep labor in agriculture; environmental concerns and "way of life" issues

Figure 8.1. Changing environments for agriculture's contribution to economic growth.

the primary vehicle for supporting farm incomes, and the subsidies have devastating effects on resource allocation. Farmers invest heavily in land and machinery when farm prices are high, only to produce surpluses that are impossible to sell profitably [Johnson (1985), Cochrane (1979)]. Eventually, the budgetary and distortionary costs of this approach become so high that even the European Community, Japan, or the United States must face choices over how to rationalize agricultural returns with their social profitability.

The economic environments for agriculture created by these four phases are shown schematically in Figure 8.1. The financial and labor resource flows out of agriculture over time (or as incomes increase in a cross-section sample) are impressionistic. Whether the trough between the "Mosher environment" and the "Johnston–Mellor environment" in Figure 8.1 drops into negative ground or always remains positive presumably depends on alternative sources of financial resources at this stage in development. Urban or overseas remittances, petroleum revenues, or foreign assistance might temporarily fill the gap left by a declining relative contribution from agriculture.[3] But as agricultural productivity begins to rise, labor and financial flows to the rest of. the economy increase. The "Schultz–Ruttan environment" begins as the absolute population in agriculture starts to decline, and the "D.G. Johnson environment" begins as the agricultural labor force drops to a fairly small proportion of the overall labor force. Whether financial resources continue to flow out of agriculture at this stage in the process depends almost entirely on government price policy and its resulting impact on farm investment. Policies to cushion the impact on farmers of successful structural change need not inevitably rely on price interventions that impede the adjustment process, but price supports have been the most popular in the United States, Western Europe, and Japan for plausible political reasons [Anderson and Hayami (1986)].

2.2. *Agriculture and economic development*

This overview of the agricultural transformation raises two basic issues to be discussed in this chapter: the contribution or role of agriculture in economic development, and the conditions or factors that lead to the modernization of the agricultural sector itself. Obviously, many other important topics are not treated here. One is the changing control over resources in the rural sector, which determines who gains and loses during the agricultural transformation. Only the

[3] It is also important to distinguish subsectors within agriculture. An export crop subsector producing rubber or coffee might continue to provide financial resources to the rest of the economy, some of which could be returned to the foodcrop subsector in order to foster its development. Much of the discussion in this chapter is concerned with modernizing the foodcrop subsector while recognizing the important role played by the other agricultural subsectors.

structuralist and radical political economy literature deals directly with the distribution of income and power in rural areas as an integral component of agricultural development. A major theme of "neo-neoclassical analysis" since the mid-1970s, however, has been the incorporation of such issues into rational actor models of rural household decision-making [see Bardhan, Chapter 3 in this Handbook]. While much of the dynamic and macroeconomic perspective of the radical models is lost in the household models, much is gained in the form of testable hypotheses about the impact of new technology or pricing policies on the structure of rural markets and distribution of output in the short run.[4]

The historical record after the Second World War suggests that many countries saw an opportunity to pursue a "jump strategy" and move directly from the early stages of the Mosher environment in Figure 8.1 to the later stages of the Johnston–Mellor environment, thus bypassing the necessity to invest in agricultural development.

> ...the most significant comparison... is that between the levels of productivity in the under-developed countries and the western countries at the period when the latter began to industrialize.... [T]he present average level of agricultural productivity in African and Asian countries (between them representing four-fifths of the Third World population) is 45 percent below that reached by the developed countries at the start of the industrial revolution. In fact it is at the same level as that of the European countries before their agricultural revolution.
>
> Now, most under-developed countries wish, consciously or unconsciously, to by-pass this stage just when other structural conditions of development are making a "take off" more difficult than it was when most European countries and the United States were imitating England's example. What makes the failure to admit or even to recognize this problem all the more serious is that the problem itself is intractable. Leaving aside mental attitudes, landownership and political considerations, it cannot be stressed too forcibly that an increase in the area cultivated per agricultural worker is one of the essential conditions of an increase in productivity. But in view of the population explosion it is impossible to assume, even on most hopeful assumption, that the reduction in cultivated area per worker will be anything but slight [Bairoch (1975, p. 42)].

A jump strategy sees the extraction of resources from agriculture for economic development as being in conflict with the investment of public and private resources in its modernization. This has been especially true in countries with systems of planned resource allocations designed to force the pace of economic development. As more and more countries adopted the paradigm of central

[4]See Hart (forthcoming) for an eloquent complaint that such micro models effectively "gut" the Marxian analysis of its vision of class interactions providing the driving force to rural dynamics.

planning to direct these resource allocations, the separate issues of contribution and modernization became key analytical issues as well. Unfortunately, the economics profession was ill-equipped to address them because all previous examples of agricultural modernization had taken place within more or less market-oriented settings (except in the Soviet Union, where agricultural modernization remains quite incomplete). The behavior of backward agricultural systems under the new planning context became a topic of much theorizing and debate, but only in the 1960s and 1970s did the empirical record become both long and varied enough to draw reasonably firm conclusions.

It is worth summarizing briefly what the empirical record showed by 1960 when the results of Kuznets' decade-long study of the quantitative aspects of modern economic growth started to be widely available. The historical record began as early as the late eighteenth century in the United Kingdom and 1839 in the United States and as late as 1880 in Japan and 1925 in the USSR. For all countries for all time periods observed, the share of agriculture in the total labor force declined, sometimes sharply, as in Sweden, the United States, and Japan, and sometimes more gradually, as in the United Kingdom, Belgium, Italy, and Australia. The share of agriculture in national output showed slightly more mixed patterns than those of the labor force. The share was nearly stable or even rose slightly over some periods in the United Kingdom, France, the United States, and Australia. The more general tendency of the share in output to decline is clear, but the share of the labor force always declined more rapidly. The obvious result was that labor productivity in agriculture rose more rapidly than in the economy as a whole when measured over the long periods of time required for sustained economic growth to cause substantial changes in the structure of an economy. Although agricultural productivity per worker was nearly always less than the level of national productivity, its faster rise meant that the gap tended to narrow.

Three clear exceptions to this trend in Kuznets' data are Italy, Japan, and the USSR, all of which are latecomers to the process of sustained growth and are countries in which state intervention into the industrialization process was much more active than in the early developers. The failure of agricultural productivity per worker to rise as fast as national productivity in these three countries might thus be seen as an early signal that the patterns in the less-developed countries seeking to start down the path of modern economic growth might be significantly different from the historical path followed by the Western countries and documented by Kuznets. Table 8.2, drawn from a paper by Hayami (1986), shows that the recent productivity record for the rapidly growing East Asian economies confirms a strongly different pattern from that in North America and Western Europe. Even the more slowly growing developing countries (Philippines and India) have a mild reversal of the "traditional" pattern in which growth in labor productivity in agriculture exceeds that of labor productivity in manufacturing.

Table 8.2
International comparison in the growth rates of labor productivity in agriculture and manufacturing, 1960 (1958–62 averages) to 1980 (1978–82 averages)

	Labor productivity growth rate (%/year)[a]		
	Agriculture	Manufacturing	(1)–(2)
	(1)	(2)	= (3)
Developed countries:			
United States	6.3	3.2	3.1
United Kingdom	5.5	2.6	2.9
France	6.4	4.2	2.2
Germany (F.R.)	7.7	4.1	3.6
Japan	5.3	6.7	−1.4
Developing countries:			
Korea	4.0	7.5	−3.5
Philippines	3.2	3.5[b]	−0.3
India	1.3	2.1	−0.9

[a]Calculated from the ratios of the real output index to the employment index.
[b]Growth rate from 1960 to 1975.
Sources: FAO, *Production Yearbook*; UN, Yearbook of *Industrial Statistics*; ILO, Yearbook of *Labor Statistics*; OECD, *Labor Force Statistics*. Hayami (1986, p. 10).

This "premature" growth in manufacturing productivity (or, alternatively, the neglect of efforts needed to raise agricultural productivity) is especially troubling in historical perspective, as the quote from Bairoch previously indicated. Table 8.3 reproduces Bairoch's historical comparisons of "net agricultural production by male labor employed in agriculture expressed in 'direct' calories". Only Italy in 1840 had a lower productivity level than that of Africa and Asia in modern times. The gap in agricultural productivity on average between European countries beginning their industrial revolutions and Africa and Asia is, as Bairoch already noted, about 45 percent. "A gap of about 45 percent is sufficiently wide for us to be able to assert that agricultural conditions in the currently developed countries before the beginning of the industrial revolution must have been very different from those of the under-developed countries of Asia and Africa today" [Bairoch (1975, pp. 40–41)].

Based on data only up to the early 1970s, Bairoch's pessimism reflects the widespread neglect of agriculture in many development efforts in the 1950s and 1960s, as well as the shortfalls in food production that triggered the world food crisis in 1973–1974. A similar pessimism based on a quite different reading of the historical record is provided by scholars working in the Marxian tradition and following the insights of Lenin on the changing class structure of agriculture as it becomes more capitalistic under the pressures of modernization [Baran (1952),

Table 8.3
Comparisons between levels of agricultural productivity

Country and "stage" of development	Period	Index number of agricultural productivity
Developed countries:		
Recent position		
France	1968/72	100.0
United States	1968/72	330.0
Position before or during "take-off"		
France	1810	7.0
Great Britain	1810	14.0
Sweden	1810	6.5
Belgium	1840	10.0
Germany	1840	7.5
Italy	1840	4.0
Russia	1840	7.0
Switzerland	1840	8.0
United States	1840	21.5
Spain	1860	11.0
Less-developed countries:		
Recent position		
Africa	1960/64–1968/72	4.7
Latin America[a]	1960/64–1968/72	9.8
Asia	1960/64–1968/72	4.8
Middle East	1960/64–1968/72	8.6
Total for all less-developed countries:	1960/64–1968/72	5.5

[a]Excluding Argentina.
Source: Bairoch (1975, p. 40).

de Janvry (1981), Griffin (1979), Lenin (1899)]. The failure of the Marxist–Leninist prediction that peasant (family) agriculture disappears under the competitive pressures of modern corporate agriculture has led to a rethinking of the inevitability of all countries following a path through capitalism to socialism and eventually to communism. To explain the failure, the dependency school emphasizes relationships between the metropolitan (developed) center and the periphery (underdeveloped) countries in the third world. A single process of global economic growth occurs in a zero-sum context, in which the growth of the center is at the direct expense of the periphery. Class relationships in the urban-based governments of the periphery explain the perpetuation of economic policies that favor only a small urban elite (and possibly landlords). In Latin America, de Janvry (1981) and colleagues have extended the analysis to explain agricultural policy and performance on the basis of a process of marginalization. Their model argues that agricultural laborers and independent peasants gradually lose control of the resources needed to raise their living standards as large landowners invest in capital-intensive farming techniques and displace peasants from the market. The rural masses are too dispersed to mobilize effectively, and they suffer a process of gradual immiseration.

Hayami and Ruttan provide a useful summary of three theories of development and their implications for agriculture:

> The implications of dependency theory for agricultural development stand in sharp contrast to the growth-stage and dual-economy theories. The growth-stage theories attempt to explain the process of transformation from a primarily agrarian to an industrial economy. In the dynamic dual-economy models incorporation of peasants into the market results in the disappearance of dualism. The dependency perspective attempts to explain why the periphery remains trapped in a backward agrarian state. In the dependency view incorporation of rural areas into the market is the source of marginalization – it perpetuates rather than erodes dualism [Hayami and Ruttan (1985, p. 37)].

Although Hayami and Ruttan do not find the dependency theory very useful for designing policies that *foster* the process of agricultural development, one of the main questions asked by scholars of the dependency school remains unanswered: why has agricultural development played a strongly positive role in the overall development process in so few countries? Why have so many opportunities identified by agricultural scientists and economic planners been missed? Most neoclassical scholars will agree that they do not have answers to these questions.

2.3. *The role of the agricultural sector*

The debate over the role of agriculture in the process of economic development extends at least as far back as the Physiocrats in the eighteenth century. The biblical advice to store during seven good years to be ready for seven lean years certainly reflects a concern for agricultural planning. Clark (1940) and Kuznets (1966) provided the general facts about the role of agriculture during the growth process available to economists and planners at the beginning of the drive for economic growth in the less-developed countries. These facts formed the basis for the prevailing neoclassical view that agriculture was a declining sector, a "black box" in Little's phrase (1982), which contributed labor, food, and perhaps capital to the essential modernization efforts in industry. No policy efforts on behalf of agriculture's own modernization were needed because the sector declined naturally. Most interpretations of the Lewis model (1954), especially the Fei–Ranis versions (1964), which became the main teaching paradigms, ignored the factors needed to modernize traditional agricultural sectors so that they could play positive contributory roles in the development of the rest of the economy. The structuralist views of Prebisch (1950) about declining terms of trade for traditional products and the importance Hirschman (1958) attached to linkages to "modern" economic activities further diminished any apparent rationale for actively investing in the modernization of agriculture itself. As Hirschman wrote in 1958, "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" [Hirschman (1958, pp. 109–110)].

A final reason for the neglect of agriculture has recently been clarified by Sah and Stiglitz (1984). The Soviet debate in the early 1920s over industrialization policy revolved around whether turning the terms of trade against agriculture (the "price scissors") would speed the rate of accumulation for investment by the state. Preobrazhensky (1965) argued successfully that it could. Sah and Stiglitz show the precise conditions under which he was right and the welfare consequences that flowed from implementing such a policy. Although the conditions that must hold for their analysis to be valid are very stringent, a robust result is that the agricultural terms of trade should be lowered only if the state has a low rate of time discount, that is, it favors investment over current consumption. Forced-pace industrialization campaigns in such circumstances then rely on the state's capacity to extract surpluses from agriculture even in the face of stagnant or falling agricultural production.

It is easy to see why agriculture was neglected as a source of growth in early strategies of economic development. The historical record shows that it always declines in relative importance in growing economies. It is the home of traditional people, ways, and living standards – the antithesis of what nation builders in developing countries envisioned for their societies. Moreover, agriculture was thought to provide the only source of productivity that could be tapped to fuel the drive for modernization. Surplus labor, surplus savings, and surplus expenditures to buy the products of urban industry, and even surplus foreign exchange to buy the machines to make them, could be had from an uncomplaining agricultural sector. Nothing more was needed to generate these resources than the promise of jobs in the cities and a shared nationalistic pride in the growing power of the state. Despite how simplistic these promises sound in the mid-1980s, the success of the Soviet approach caused them to be very appealing when first uttered by such charismatic leaders of the developing world as Sukarno, Nkrumah, Nasser, and Nehru. The unique features of agriculture as a sector were simply not widely understood in the 1950s. Nor was it accepted that the development of a modern agriculture was necessary as a concomitant to development of the rest of the economy.

Some of these factors began to be recognized by the 1960s, and a more positive emphasis was placed on "role" rather than the more forced concept of "contribution" of agriculture. The classic article by Johnston and Mellor (1961) listed five roles for agriculture in economic development:

(1) increase the supply of food for domestic consumption;
(2) release labor for industrial employment;
(3) enlarge the size of the market for industrial output;
(4) increase the supply of domestic savings; and
(5) earn foreign exchange.

Although the second, fourth, and fifth roles are certainly consistent with the earlier "extractive" views of agriculture, Johnston and Mellor insisted that all five roles are equally important. Agriculture in the process of development is to provide increased food supplies and higher rural incomes to enlarge markets for urban output, as well as to provide resources to expand that urban output.

> It is our contention that "balanced growth" is needed in the sense of simultaneous efforts to promote agricultural and industrial development. We recognize that there are severe limitations on the capacity of an underdeveloped country to do everything at once. But it is precisely this consideration which underscores the importance of developing agriculture in such a way as to both minimize its demand on resources most needed for industrial development and maximize its net contribution required for general growth [Johnston and Mellor (1961, pp. 590–591)].

Others, especially Nichols (1963), Schultz (1953), and Jorgenson (1961), also emphasized this interdependence between a country's agriculture and its industry. Myint (1975) stressed a curious inconsistency between the "closed economy" model implicit in this domestic interdependence and the fifth role, earning foreign exchange, which obviously implies the country is open to international trade. This trade perspective returns in the 1970s and 1980s to dominate thinking about appropriate development strategies, but it was largely ignored in the 1960s, perhaps because of the dominance of the "Indian model" in development thinking, in which sheer size keeps the importance of foreign trade quite small, even apart from the "inward looking" strategy being pursued.

Despite the early insistence by agricultural economists that the agricultural sector must be viewed as part of the overall economy and that the emphasis be placed on the sector's interdependence with the industrial and service sectors rather than on its forced contributions to them, the notion of agriculture as a resource reservoir has persisted in general development models. Reynolds emphasized an important but usually overlooked distinction between static and dynamic views of the resource transfers:

> In most development models, modern industry is the cutting edge of economic growth, while agriculture plays the role of a resource reservoir which can be drawn on for supplies of food, labor, and finance to fuel the growth of urban

activities. It is argued that this is both a logical necessity and a matter of historical experience, illustrated by the case of Japan.

In commenting on this view, I must emphasize a distinction that is often not clearly drawn: (1) It is one thing to assert that, in an economy where agricultural output is not rising, the agricultural sector contains potential surpluses of labor time, food output, and saving capacity requiring only appropriate public policies for their release. This we may term the static view of resource transfer. (2) It is quite a different thing to assert that, in an economy where agricultural output is being raised by a combination of investment and technical progress, part of the increment in farm output and income is available for transfer to non-agriculture. This we may term the dynamic view of resource transfer. The model-building implications of this approach are different, and its policy implications are decidedly different [Reynolds (1975, pp. 14–15)].

The welfare consequences of the two views are also sharply different. Forced extraction of resources from a stagnant agricultural sector almost always creates widespread rural poverty, sometimes famine. Market linkages that connect a dynamic agricultural sector to rapidly growing industrial and service sectors offer an opportunity for rural inhabitants to choose in which sector they wish to participate. There are certainly losers in this process: high-cost producers in unfavorable ecological settings who cannot compete with low-cost producers in favored locales who have access to new technology; or newly landless laborers who have lost their tenancy access to land when commercial relationships replace patron–client relationships. But new technology and market linkages create more opportunities than they destroy if both the agricultural and nonagricultural sectors are growing together. An emphasis on finding the policy environment that creates such mutual growth is needed. For agriculture, that environment must call forth rapid technical change. Experience since the mid-1960s has demonstrated how to do that, but the key has been to understand why the agricultural sector is different from the industrial and service sectors [Hayami and Ruttan (1985), Timmer et al. (1983)].

3. Why agriculture is different

The early purposeful neglect of agriculture can be partly attributed to development economists who were remote from any real understanding of what makes the agricultural sector quite different from either manufacturing or services [Little (1982)]. In developing countries, the agricultural sector is different from other productive sectors of an economy, particularly in its large contribution to national income and the large numbers of participants in the sector. Both the agricultural transformation itself and the contribution of agriculture to the rest of the economy depend on three important features discussed here: the peculiarities of the agricultural production function, the importance of home consumption of output for the sector, and the role of the agricultural sector as a resource reservoir. These features are more evident in traditional societies, and their distinctiveness erodes during the process of economic modernization. The design of agricultural policy, in both poor and rich countries, is complicated by these features, but a recognition of them is essential to a full understanding of the contribution agriculture might realistically be asked to make to a country's development effort.[5]

3.1. Decision-making in agriculture

The sheer size of agriculture in most poor countries' economies, with over 50 percent of national output and up to 80 percent of the labor force in agricultural activities, distinguishes the sector from all others in the early stages of development. When directly related input and output industries and marketing activities are included, "agribusiness" seldom declines to less than 20 percent of any country's economy. Hence the sector remains the largest single "industry" in absolute size even in rich countries.

In most countries, if the available arable land were divided equally among the farm population, the resulting average farm size would be "small" by comparison with United States or European standards. Farms of less than a hectare characterize China, Bangladesh, and Java; even in Japan average farm size is still only slightly greater than one hectare. The average in India is only about 1 to 2 hectares, and in Africa and Latin America farms tend to be less than 10 to 20 hectares in size. Average farm size in the United States is well over 100 hectares and over 50 hectares in the United Kingdom.

The available farmland, of course, is usually not equally divided among all the potential farmers. The conditions of land tenure and the size distribution of farms are important characteristics of a country's agricultural decision-making environment. A country with a unimodal distribution of farm sizes – a large number of small, family-operated farms capable of supporting the family members above a subsistence level, with only a fringe of smaller and larger farms around this modal norm – has the potential to use agricultural development strategy as a means of reducing rural poverty at the same time that it increases agricultural production. Countries with bimodal distributions of farm sizes – many

[5]An effort to formalize the impact of agriculture's distinct features, especially the behavioral and material determinants of production relations, is in Binswanger and Rosenzweig (1986).

very small farms on a minority of the land with a few very large, estate-like farms that occupy most of the arable land and produce most of the food surplus available for urban markets – face much more difficult dilemmas over how to reduce the impact of rural poverty while using traditional output-increasing strategies of agricultural development [Johnston and Kilby (1975)].

In both private and collective agricultures, decision-making is conditioned primarily by the nature of incentives to work rather than by the pace and design of the work itself, and these incentives are difficult to structure in an efficient manner unless the cultivator owns the land. In situations where ownership and operation are separate, a host of complicated contractual arrangements that strive for second-best efficiency outcomes have evolved in different settings [Bardhan, Chapter 3 in this Handbook, Binswanger and Rosenzweig (1981, 1986), Stiglitz, Chapter 5 in this Handbook].

Farming is an undertaking that involves many decisions. What crops to plant, what inputs to use, when to plow, to seed, to cultivate, to irrigate, to harvest, how much to keep for home consumption, how much to sell and how much to store for later sale are the farming decisions that occupy the daily routine of most agricultural producers. What is unique about agriculture is that literally millions of individuals and households are making these decisions themselves. Changing agricultural production decisions to increase food output is an entirely different process from changing decisions about how much steel or cement to produce. In most countries a dozen or so individuals could take direct action which would lead to a 10 percent increase in steel output in a year or so, and their decisions would be decisive.

Nowhere, not even in socialist countries, can a similar small group of individuals decide to raise food production by 10 percent. A small group of planners, or the president and the cabinet, can decide they *want* food production to rise by 10 percent. They can tell the food logistics agency, the ministry of agriculture, the newspapers, and agriculture extension agents that they want food production to rise by 10 percent. But they cannot increase food production 10 percent by themselves. They must also convince the millions of farmers in their country to want to increase food production by 10 percent and make it in their self-interest to do so.

The vast number of agricultural decision-makers implies that there are simply too many to reach directly with either pleas for cooperation or police power. Farmers must see the benefits of higher output for themselves because there are too many opportunities to let high yields slip beneath the hoe or in a late fertilizer application, even under the watchful eyes of a guardian. Farming is a subtle combination of skilled craft and brute force. The brute force alone will not achieve high yields.

In traditional agriculture with static technology, farmers learn these skills by repeated trial and error. The lessons of parents and grandparents remain relevant. But when new technology becomes available, farmers do not automatically acquire the requisite skills to deal with disequilibrium [Schultz (1964, 1975)]. Government interventions can have a high payoff, particularly investment in extension services, general education (especially rural primary education that includes instruction in farming skills), and rural infrastructure to lower the costs of exchanging inputs and outputs, which become essential ingredients in speeding the adoption of new agricultural technology.

The scope for effective government intervention is conditioned by the efficiency with which farms allocate the resources at their disposal to produce crops, relative to alternative uses of these resources, the technical ability of farmers to achieve the maximum output from a given set of inputs, and the impact of alternative forms of land tenure on both allocative and technical performance of farmers. Given the large number of farmers within a typical developing country, government extension agents cannot teach each individual farmer new agricultural techniques. Price policy for farm crops and agricultural inputs, on the other hand, is an intervention that reaches most farmers quite directly while being amenable to effective government control. Consequently, knowing the role of relative prices in influencing the behavior of farmers is extremely important. The effectiveness of prices in changing producer decisions also depends on farmers' allocative and technical efficiency and on the form of tenure contract for the land they farm [Streeten (1986), Krishna (1984)]. It is a mistake to think that farmer responsiveness to price is somehow immutable and is given exogenously to the agricultural sector. Even if all farmers were narrow-minded profit-maximizers of their available production functions, there would be substantial scope for altering both the production function and the economic environment in which the maximization takes place. In a world in which risk management involves the establishment of patron–client relations, in which substantial bargaining may go on within the farm household over task assignments, the division of income, and gender-specific access to nutrients, and in which the access of farm members to labor and credit markets may change radically over time even within fairly stable agricultural technology and prices, the decision-making process itself must also be treated as a variable.

3.2. Characteristics of agricultural production functions

One unusual feature of the agricultural production function is the efficiency cost of separating labor and management. Knowing what the right inputs are, how to combine them, and how to tend the process is the major function of management. In owner-operated farming, this management skill is combined with the farm household's own labor power, which is also an important ingredient in growing crops. Several unique features of agricultural production functions contribute to the decision-intensity of farming, to the productivity of the family farm, and to the search for reasonably efficient substitutes for direct land-ownership where the family farm is not prevalent. Seasonality, geographical dispersion, and the role of risk and uncertainty are the most important.

3.2.1. Seasonality

No agricultural region of the world has an absolutely constant year-round climate. Winter and summer create distinct growing seasons in the temperate zones. Wet and dry seasons, or the monsoon season, create conditions when planting is appropriate, when harvesting would be difficult, or simply when some crops will not thrive. Climatic variations cause agricultural production to follow distinct seasonal patterns even in most tropical areas, but seasonality is not a fixed and rigid constraint. Rice will grow in the dry season if irrigation water is provided, and tomatoes will grow in Siberia in January under artificial lights in a warm greenhouse. Seasonality is important to farmers because it is generally cheaper to let nature provide many of the essential inputs for agricultural production – solar energy, water, carbon dioxide, temperature control, and essential nutrients from natural soils. But it is not always economical to let nature dictate the agronomic environment. One of the major tasks of government policy is to invest in socially-profitable interventions, such as irrigation and drainage, that increase farmers' control over the crops that can be grown in particular regions and time periods.

Seasonality also tends to create high premiums to timely performance of such critical agricultural tasks as plowing, planting, cultivating, and harvesting. Even though the available labor pool might be more than adequate to provide the required number of workers per hectare over an entire year for all the crops being grown, if certain tasks must be performed very quickly at specific times to ensure maximum yields, important labor bottlenecks might occur in the midst of an average surplus labor pool. Such bottlenecks can meet with two responses. One is to work out long-term contracts with laborers that gives them preferential access to farm employment in the off-season (or access to land to operate as a tenant farmer, or to credit, etc.) in return for working on the landowner's farm during the peak seasons [Bardhan (1984)]. Alternatively, because such arrangements tend to impose high supervisory requirements on the owner's time, they frequently induce individual farmers to mechanize specific tasks – plowing or harvesting – even when much rural unemployment exists over the course of the year. In such circumstances, a tractor that pays for itself in both private and social terms by timely plowing also has a very low marginal cost of operation for other tasks as well, and labor displacement can be much more widespread than would be indicated by the removal of the plowing bottleneck alone.

Two features of seasonality are important in designing agricultural policy. First, seasonal aspects of agricultural production frequently constrain yields because of input bottlenecks. Labor (and its supervision) is most often the constraining factor, but fertilizer, seeds, credit, or irrigation water supplies must also be available in highly-specific time periods. When fertilizer reaches the village godown a month after the proper application time, it might as well not have arrived at all. Government authorities responsible for the management of agricultural input supply distribution are frequently unaware of or insensitive to the extreme importance of timely input availability. Suppliers whose incomes depend on providing inputs to farmers when and where needed are much more responsive to shifts in weather, cropping patterns, and new technologies than are agencies trying to allocate inputs within the guidelines of five-year plans and supplies available from a planned industrial sector. Modern agriculture that uses industrial inputs as the basis for high yields is a dynamic enterprise quite unlike factories. Input and output markets must function efficiently, reacting to weather changes, alterations in cropping patterns, and technical change if production is to grow rapidly. Centrally planned allocations of industrial products to the agricultural sector are almost never in the right place at the right time, or even the right product.

Second, there are often very high private economic returns to eliminating seasonal bottlenecks in production. When these private returns are at least partly generated by higher and more stable yields of agricultural products, society is also likely to gain. But if the private gains come from displacing hired labor that has few alternative production opportunities, the social gains might be small or even negative. The seasonal dimensions to agricultural production complicate the planning process considerably. Most agricultural data are published on an annual basis, and there is an inevitable tendency to think about the sector in terms of the same annual growth performance criteria that are used to evaluate the steel or cotton textile industries. Such an annual approach hides two important roles for government analysis and intervention: in the appropriate provision of inputs when and where they are needed, and in the full analysis of the social impact on agricultural production of private investments to reduce seasonal bottlenecks.

3.2.2. Geographical dispersion

Agriculture is the only major sector that uses the land surface as an essential input into its production function. Like seasonality, this widespread use of land is due to the largesse of nature. It is almost always cheaper to let farms capture the free solar energy and rain than it is to stack a hundred stories of hydroponic "fields" on top of each other and provide the light, nutrients, and water from industrial sources. This wide geographical dispersion of agricultural production has an important economic consequence. Transportation becomes essential if any output is going to leave the farm for consumption by others or if inputs, such as modern seeds, fertilizer, pesticides, or machinery, are to be used on the farm to raise output.

In combination, seasonality and geographical dispersion create the need for a marketing system that can store the product from a short harvest period to the much longer period of desired consumption and can move the commodity from the farm where it was grown to the many households where it will be consumed. Both of these functions require that the commodity change hands and that exchange of ownership take place. This transaction can happen only when both parties agree on the terms of the exchange or the price for the commodity at the point of sale. In socialist economies the terms of exchange are often set by the state. But all other marketing services must still be provided if the food grown by farmers is to be eaten by consumers.

The necessary growth of marketing services is an often overlooked component of the agricultural transformation. As Kuznets (1966) pointed out, farmers are caught in a double squeeze by Engel's Law. The income elasticity for overall food expenditures is less than one, implying a declining share of national income for agriculture if commodity prices are stable. But a rising share of the consumers' food expenditure is devoted to marketing costs, and so farmers receive a declining share of food expenditures, thus compounding the decline in their share of national income. As discussed below, technical change has proceeded so rapidly in agriculture in the past century that farm commodity prices have tended to fall relative to prices for other goods and services produced by growing economies. Technical change is also a major factor explaining the rapidly falling share of national income captured by agriculture directly.

3.2.3. Risk and uncertainty

Farmers the world over talk primarily about two topics: the weather and prices. On these two variables ride the rewards for the whole year's effort in farming. A failed monsoon, a flood, or a hailstorm can wipe out the crop. A bumper harvest can cause large losses if the price falls too low. No other industry, even construction or tourism, is so dependent on the whims of nature and volatile markets to bring in a profit on the investment of time and money that goes into farming. Farmers who repeatedly make good decisions in the context of rapid changes in their economic environment tend to survive and thrive. Those who do not frequently fail; they move to urban areas in search of jobs or become impoverished landless laborers dependent on the rural economy for their incomes and access to food. Socialist-managed agricultures can cushion much of the welfare shock to individuals by sharing risks, but the importance of rapid and effective decision-making remains as the key to dynamic efficiency in agricultural systems.

The fact that weather is uncertain causes farmers to behave differently than they would if weather were always known. This general uncertainty usually leads farmers to choose crops that will resist weather extremes, particular varieties of crops that are more tolerant of weather variations, and lower levels of inputs than would be optimal in a certain world due to the risk of losing the investment altogether. Equally important, farmers' reactions to weather variations as they actually occur also have aggregate consequences [Roumasset, Boussard and Singh (1979)]. A late monsoon might cause millet instead of wheat to be planted, good rains might permit a second or third rice crop, and high temperatures and humidity can lead to serious pest and disease problems that force farmers to change crop rotations. Each adjustment by farmers can spill over into rural labor markets, causing serious shortages if planting must be done suddenly when the weather breaks or the harvest brought in before a flood. A particularly "dry" dry season might mean the second crop is not planted or harvested, and an important, perhaps critical, source of wage income is eliminated for many rural workers. The reduced crop output might not be the most important consequence of such a crop failure. A famine could result because of the failed income opportunities [Sen (1981)].

Fluctuations in aggregate production are magnified at the level of marketings available for consumption by nonfarm households because farm-household consumption tends to vary somewhat less than production. In years of poor weather, net marketings decline proportionately more than production. Similarly, in good years the percentage increase in marketings is usually substantially larger than the production increases. These wide fluctuations simply add to the difficulty of stabilizing domestic food prices and provisioning urban areas.

Price uncertainty also adds to the farmer's difficulty in deciding what crops to grow and how many inputs to use in growing them. Unlike the handful of manufacturers in large-scale industries, farmers are unable to set their output prices and later adjust production and inventory levels to meet the price targets. Unlike consumers, who know with near certainty the price they must pay for a given quantity and quality of a commodity at the time they buy it, farmers must make major decisions about purchases of inputs well in advance of knowing what prices their resulting output will bring. At the time many key farming decisions are made – the allocation of land to various crops, fertilizer applications, hiring labor for weeding – the farmer can only guess at the prices for the output.

Reducing weather and price uncertainties is an important role for government interventions. Dams and drainage ditches can reduce the impact of rainfall variations, disaster insurance can provide a new start even if heavy investments are wiped out, and research on more adaptable but still high-yielding plant varieties can reduce the risks of new technology. Similarly, reducing price uncertainty is a major government role, which can be accomplished with better price forecasting information, the use of import and export policy to provide a band of prices within which domestic price formation can take place, or a more aggressive floor and ceiling price policy implemented with a government-operated buffer stock program. Of course, not all stabilizing efforts are worth their costs, and some fluctuations are necessary if changes in output are to be accommodated by changes in demand, even allowing for changes in stock levels. The relative costs and benefits of commodity price stabilization have been the subject of extensive theoretical analysis. Price stabilization schemes for *world* markets perform poorly in both theory and practice [see, especially, Newbery and Stiglitz (1981)], but the merits of domestic price stabilization programs that use trade as well as buffer stocks to achieve their goals depend very much on the local circumstances of dynamics of supply and demand [Streeten (1986), Timmer (1986)].

3.3. The farm household as both producer and consumer

Truly subsistence households produce to meet their own consumption needs and do not need the market for either buying or selling. To such households price signals are not only irrelevant, they are unseen. Few such households remain in today's world, not because farm families no longer consume produce from their own fields, but because most farm families now buy and sell inputs and output in rural markets. They are aware of and react to market prices in making a wide variety of household decisions. Most farm households still retain some or most of their farm production for home consumption, and this role of home consumption is a further distinguishing feature of the agricultural sector. Few steelworkers or even textile workers take their products home for household use.

Only under highly restrictive and unrealistic assumptions about the completeness of markets and access of all farm households to them can production and consumption decisions be analyzed separately [Singh, Squire and Strauss (1985)]. In rural areas of developing countries, the need to make connected production and consumption decisions within a single household obviously complicates life for the farm household; the value of additional time spent in food preparation or tending the children must be balanced against the productivity of an additional hour weeding the rice, driving the ducks, or tending the home garden. Where it exists, the opportunity to spend some of that time working for cash on a neighbor's farm or in a rural wage-labor market places a lower bound on the value of household-farm time, and the value of leisure ultimately places a limit on the willingness to work, especially at low-productivity tasks. For households with inadequate land to grow surplus crops for sale and with limited outside employment opportunities, however, the marginal value of leisure time might be low indeed, possibly near zero. Even tiny increments to output can be valuable for very poor households.

The importance of joint household-farm decision-making also raises complex questions for analysts in search of ways to organize data and research issues into manageable and comprehensible frameworks for analysis. These complex questions have recently become the focus of a revived interest in models of household economies. The "new household economics" provides a powerful perspective on joint decision-making about food production, food consumption, investment in human capital, and even fertility and other demographic decisions. By showing how all these decisions are related to each other because of the time constraint, and hence to the economic environment surrounding the household, the household economics models provide analysts with a conceptual understanding of the complicated lives that rural people live [see Schultz, Chapter 13, in this Handbook, Evenson (1981), Rosenzweig, Chapter 15 in this Handbook]. At the same time, most such models grossly simplify the actual complexity of rural household decision making. The key issue is nearly always the functioning of rural labor markets because it determines the *perception* of the opportunity cost of labor in each household. In a survey of the theoretical and empirical literature on the functioning of rural labor markets, Binswanger and Rosenzweig offer the following conclusions:

> Progress toward a richer, integrated theoretical framework that can deal with the complexities associated with market failures as well as the determination of wages and other contractual terms has been hampered by the evolution of theory along two, mutually inconsistent paths. The rural wage determination models developed so far assume the complete absence of a land rental or sales market; that is, they take land distribution as exogenously given. The contractual choice models, on the other hand, treat the wage rate as exogenously given, while concentrating on land and credit market transactions; thus they have little to say about the determination of earnings or employment. The strength of contractual choice models lies in their clarification of the efficiency and equity implications of contracts and in their identification of the underlying causes of the market imperfections that lead to the contracts. These models also suggest the difficulties associated with policy intervention in single-tenancy or credit markets that is aimed at curing symptoms or apparent deficiencies in such arrangements. Without this integration of all the major interrelated markets – land, labor, credit – into a single, coherent rural model, however, we will be severely handicapped in attempting to predict the consequences of economic development in the rural sector [Binswanger and Rosenzweig (1981, pp. 54–55)].

3.4. What difference does the difference make?

Two important implications flow from the distinctive characteristics of agriculture relative to industry, and both are treated extensively in sections that follow. First, if agricultural decision-making is in fact based on rational assessments of highly heterogeneous environments, substantial knowledge of micro environments is necessary to understand the impact of policy interventions or technical change on the agricultural sector. Designing new technology and fostering its widespread adoption is primarily a public sector activity because of the relatively small scale of individual farmers, but the success of any given technical innovation depends on the private decisions of those same multitudinous farmers. Understanding the source, dynamics, and impact of technical change in agriculture is thus a major part of understanding the agricultural transformation, a process vastly complicated by the smallness of scale, geographic dispersion, and heterogeneity of the environment, both economic and ecological, that is characteristic of agriculture in developing countries.

The second important implication of agriculture's distinctiveness is how it conditions the role of public policy, particularly that other than the design and implementation of research leading to technical change. The vision dies hard of agriculture as a resource reservoir to be tapped indiscriminately, without reinvestment or adverse consequences for growth, on behalf of the urban economy. Although a few countries have a record of sustained progress in agriculture and concomitant overall economic growth, the list is short. Only eight countries listed in the *World Development Report, 1986* have growth rates for agricultural GDP of 3 percent per year or greater for both the 1965–73 and 1973–84 periods, along with growth rates for total GDP of 4 percent per year or greater for the same two periods: Kenya, Pakistan, Indonesia, Ivory Coast, Philippines, Thailand, Brazil, and Mexico. Sri Lanka and Turkey came close; Malaysia would probably have been included had data been available for the earlier period. Because population growth in several of these countries is near or more than 3 percent per year, even these excellent aggregate performances leave the rate of growth per capita at levels that permit a doubling of incomes in a quarter of a century at best.

It has obviously been difficult to find the right mix of policies to sustain agricultural growth. Much of the reason traces to a failure of policy-makers to understand the characteristics of agriculture that make policy design so complicated. They face yet another paradox: the essentially private-sector nature of agricultural decision-making at the same time that the environment for that decision-making is heavily dependent on sound government interventions into agricultural research, rural infrastructure, and market relationships. The distinctive characteristics of agriculture argue that governments intervene into agricultural decision-making at great risk, for they can easily cause farmers to withdraw from making investments and producing for the market, which are essential to mobilizing resources for overall economic growth. And yet, intervene they must. The environment for transforming agriculture is a public good created by wise but active public intervention.

It is easy to get the mix wrong, even to have the elements backward. Some governments have tried to dictate farm-level decisions on inputs and outputs while totally ignoring both the investments in research and infrastructure needed to create a healthy agriculture and the pricing environment that will mobilize peasants on behalf of higher productivity. But enough success stories have been accumulated for some general lessons to be propounded. The dimensions of successful technical change are discussed next, followed by a review of overall policies for agricultural development.

4. Transforming agriculture

Agricultural output can increase along a given supply curve or with a shift in the supply curve to the right. The scope for increasing output along a fixed supply curve by continuing to raise prices is extremely limited even in fully commercial and technically advanced farming systems; nearly all long-term growth in crop and livestock production comes from investment that expands capacity and from technical change that increases output–input ratios. The importance of prices for transforming agriculture is not in triggering the short-run response of farmers, although this is sometimes quite dramatic in situations where severe distortions are eliminated, but in conditioning the investment climate and expectations of all decision-makers in the rural economy about the future profitability of activities in the sector. Positive expectations lead to rapid investment in technical change when it is available.

4.1. The sources and dynamics of technical change

Technical change is the source of most growth in productivity in the long run, since continued investment in capital that embodies traditional technology very quickly faces low marginal returns [Schultz (1964), Hayami and Ruttan (1985)]. As late as the 1920s, most of the agricultural innovations in Europe and the United States arose on the farm and were gradually diffused by word of mouth and by agricultural colleges. Such on-farm innovation continues, but the scientific revolution in agriculture has made the discovery of technical innovations much more dependent on knowledge and capital investment. Very few farmers even in the United States have the resources to carry out significant agricultural research programs, and most such research is conducted by publicly-funded centers for agricultural research and by a handful of large agribusiness concerns, which are involved primarily in developing hybrid seed technology, chemical technology (herbicides and insecticides), and agricultural machinery.[6] The small scale of operations and limited financial resources of most farms mean that little important agricultural research is conducted by farmers.

[6] The revolution in biotechnology might change the concentration of agricultural research in the near future. Numerous small companies, many associated with faculty members of universities, are engaged in genetic manipulation of important agricultural crops and animals, although the impact on farm productivity has not yet been significant.

Diffusion of new technology is also a matter of policy concern, especially because not all farm households have equal access either to the knowledge to use new technology or to the agricultural and financial resources needed to make it productive on their own farms. Some inputs are lumpy and cannot be used efficiently on farms of even average size in many parts of the world. Large-scale tube-wells and tractors might contribute significantly to higher productivity even on small farms if institutional arrangements could be found to separate the service flows that such inputs can provide from the ownership of the assets themselves.

The evidence suggests that truly profitable innovations spread quickly no matter what the government does. Wherever the entrepreneurship exists and the economic environment permits, rental arrangements and tractor-hire services frequently emerge spontaneously [Goldman and Squire (1982)]. However, the location-specific nature of much new agricultural technology, especially seed technology, means that large areas of a country might be bypassed by the diffusion process unless government research and extension workers are actively engaged in the on-farm testing and evaluation of new technology. Adapting a general agricultural technology to a specific seed strain or technique that fits individual farming environments is a major responsibility of local research and extension stations.

An important concern of government policy is the impact of technical change on agricultural employment and rural income distribution. Historical evidence shows enormous variation in both the short-run and long-run impacts of innovations. The issues cannot be addressed satisfactorily by looking only at an individual farm or even at the agricultural sector [Scobie and Posada (1978), Hart (forthcoming), Hayami (1984)]. The primary effect of higher-yielding varieties of wheat and rice, for example, has probably been on food intake of nonagricultural workers. In addition, agricultural innovations tend to be embodied in inputs that must be provided through markets. An increased role for market relationships might threaten the risk management aspects of established patron–client relationships and thus have complicated effects on the entire rural economy and eventually on the urban economy as well.

Most technical change in agriculture involves improvements in the biological processes by which plants and animals grow and yield output useful to society or in the mechanical functions that are necessary for the biological processes to carry on more efficiently than in a natural setting. Primitive agriculture uses natural biological materials and processes in combination with human labor and management to bring in a crop or livestock product. Modern agriculture uses scientific knowledge to reshape the biological materials so that each plant and animal is more productive, and it increasingly substitutes machines for human labor.

Biological–chemical innovations, such as hybrid seeds, fertilizers, and pesticides, all tend to be yield-increasing and thus save on land. Mechanical technology can also have a yield effect when it permits more timely cultivation and an extension of multiple cropping, cultivation of heavy soils, or the use of water pumps on dry lands, but most mechanical technology is designed to make agricultural work less physically burdensome and to save on the amount of labor needed to produce a unit of output.

4.1.1. A simple model of changing agricultural productivity

Productivity in agriculture traditionally is measured in one of two ways: in output per hectare, or output per agricultural worker. Despite the focus by agricultural scientists on the former measure, from a welfare perspective the latter measure is clearly the relevant one. Output per hectare is important only as a vehicle for raising output per worker. In land-scarce environments facing rapid population growth and limited absorption of labor by industry, of course, raising output per hectare might be the *only* way to raise labor productivity. Most analyses treat both measures, and the model here, derived from Hayami and Ruttan (1985), does as well.

Figure 8.2 plots agricultural output per unit of land area in logarithmic units on the vertical axis. Hayami and Ruttan convert agricultural output into wheat units, Bairoch (1975) uses "direct" calories, and the World Bank reports agricultural value-added and contribution to GDP in its annual *World Development Report*. For the purposes of this discussion, the vertical axis is simply crop yields per hectare.

The horizontal axis measures agricultural output per worker on a logarithmic scale. Most econometric analyses of changes in agricultural productivity use output per worker as the dependent variable, and the workforce is traditionally defined as male workers in agriculture for the reason, indeed a rather lame one, that women play very different roles in agricultural production in different parts of the world and national statistical offices are not very consistent in how they treat the matter. For the purposes here, the workforce is measured as the entire economically active agricultural population. Because both axes are measured in logarithms, 45° lines trace out constant ratios of land per worker. Productivity changes over time can be traced out by connecting the coordinates at the beginning and the end. Figure 8.2 illustrates a variety of possibilities.

From the point of view of improving the welfare of rural workers, only movements to the right – toward higher output per worker – can help. Even then, the distribution of output among workers, landowners, and owners of other factors of production will determine whether or not the higher productivity has widespread welfare effects. Straight movements to the right are likely to be relatively rare. As Figure 8.2 notes, such movements imply a declining agricultural workforce and no changes in yields, normally in conjunction with new

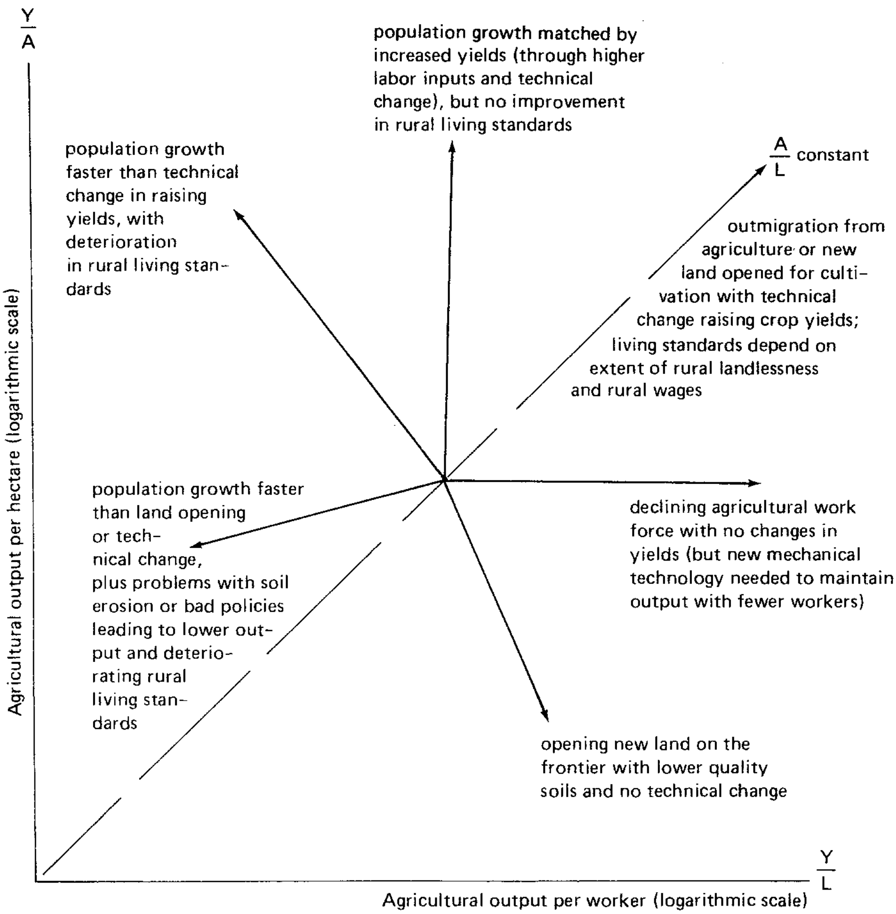


Figure 8.2. Various possibilities for changing land and labor productivities in agriculture.

mechanical technology to maintain levels of output with fewer workers per hectare.

What might have been a typical path while new continents were being colonized in the seventeenth and eighteenth centuries, but which is virtually unseen now, is rising labor productivity with falling land productivity. Lower-quality soils, distance from input and output markets, and low demand for technical innovations do not prevent extensification of agriculture at the frontier from raising living standards – and hence inducing migration – even while yields are falling.

The far more common pattern is a movement upward to the right, as the productivity of both land and labor increases. If the movement is exactly in a 45°

direction, agricultural land per worker remains constant, and yields must rise if labor productivity is to rise. A striking difference between currently developed countries and poor countries is their paths relative to this 45° line. As Bairoch (1975) noted, and evidence from Hayami and Ruttan (1985) to be presented shortly indicates, most developed countries increased land per worker even in the early stages of their development, whereas only a few less-developed countries are able to do so. The reasons are obvious. Either new lands must be opened faster than population growth, or out-migration from agriculture must proceed fast enough to cause an absolute reduction in the agricultural work force. Only a handful of countries can meet either of these conditions.

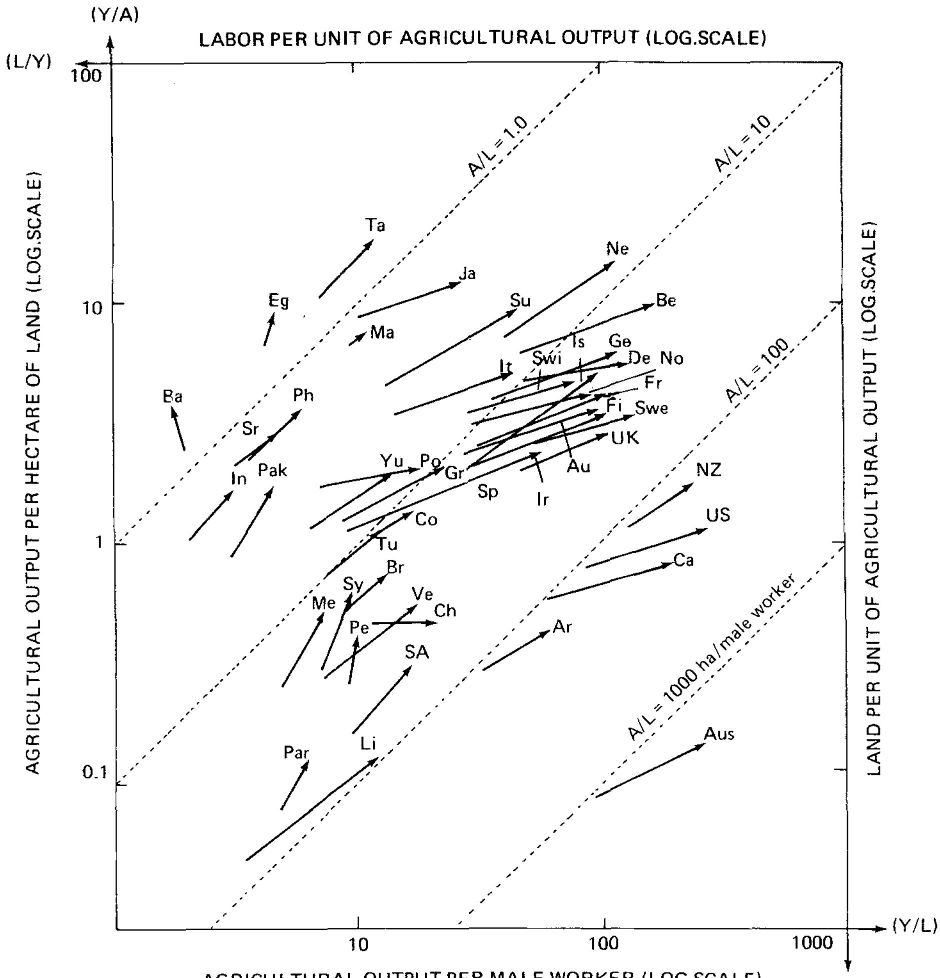
In countries with very limited agricultural land resources and rapid rates of growth in population, often the best that could be done since the early 1960s was to maintain constant labor productivity by increasing crop yields at the same pace as expansion of the rural workforce. This combination generates a vertical growth path, which might alternatively be described as running fast technologically to stand still economically. But some countries have not even done this well. Their populations have grown faster than the pace of technical change on farms, and their productivity path is an arrow up and to the left, reflecting lower standards of living in rural areas.

The most dismal situation, however, is movement downward to the left, reflecting deterioration in *both* measures of agricultural productivity. Output per hectare and output per worker fall in such circumstances. The reasons might be extremely rapid growth in population with expansion into ecologically unstable agricultural areas, or such bad policies that farmers retreat from even the technology that they used previously. None of the countries in Hayami and Ruttan's analysis fits this last pattern, but no countries from sub-Saharan tropical Africa were in their sample.

4.1.2. The historical record

Hayami and Ruttan (1985) assembled evidence for changes in productivity of agricultural labor between 1960 and 1980 (see Figure 8.3). Three patterns are obvious. Nearly all countries in their sample showed improvement in *both* dimensions of productivity – only Bangladesh had a decline in labor productivity, and only Chile had a decline in land productivity. Most developed countries had faster increases in labor productivity than in land productivity, thus presenting patterns of change "flatter" than the 45° lines of constant area per worker – hence farm sizes had increased. Most developing countries had patterns of productivity change steeper than the 45° lines, implying decreased area per worker and smaller farm size.

Hayami and Ruttan see three basic patterns of agricultural development in this historical record (see Figure 8.4). The Asian path requires strongly rising land



Key:

Argentina	Ar	Finland	Fi	Mexico	Me	Sri Lanka	Sr
Australia	Aus	France	Fr	Netherlands	Ne	Surinam	Su
Austria	Au	Germany, F.R.	Ge	New Zealand	NZ	Sweden	Swe
Bangladesh	Ba	Greece	Gr	Norway	No	Switzerland	Swi
Belgium	Be	India	In	Pakistan	Pak	Syria	Sy
(& Luxembourg)		Ireland	Ir	Paraguay	Par	Taiwan	Ta
Brazil	Br	Israel	Is	Peru	Pe	Turkey	Tu
Canada	Ca	Italy	It	Philippines	Ph	United Kingdom	UK
Chile	Ch	Japan	Ja	Portugal	Po	United States	USA
Colombia	Co	Libya	Li	South Africa	SA	Venezuela	Ve
Denmark	De	Mauritius	Ma	Spain	Sp	Yugoslavia	Yu
Egypt	Eg						

Figure 8.3. International comparison of labor and land productivities in agriculture, the 1960 data points connected to the 1980 points by arrows. *Source:* Hayami and Ruttan (1985, p. 121).

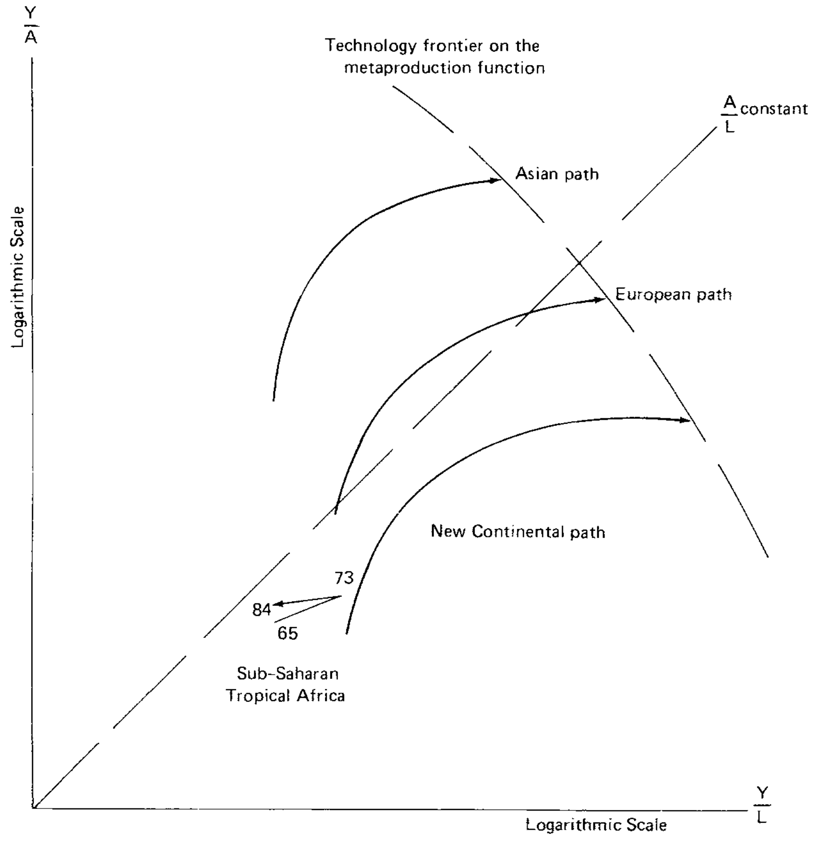


Figure 8.4. Patterns of change in agricultural productivity.

productivity in early stages to cope with small farm size and rapid growth in population, but eventually labor productivity grows rapidly as the rest of the economy absorbs rural workers and raises wages. This is the "Korea–Taiwan–Japan" model, but Pakistan, Philippines, Indonesia, Sri Lanka, and even Egypt might also have access to this path.

At the other extreme, the path of productivity change in the newly opened continents with surplus land is almost uniformly in the direction of higher labor productivity, and this has been true in the United States, Canada, and Australia since the mid-nineteenth century. It was only after the higher commodity prices caused by the world food crisis in 1973–74 that land productivity rose faster than labor productivity in the newly settled continental areas.

The European path falls nicely between the land-scarce and the land-surplus paths. In Figure 8.3, many countries are clustered here, and Hayami and Ruttan note that the paths for Denmark and the United Kingdom create an envelope that contains the entire European experience:

> Denmark, which has remained relatively specialized in agricultural production among European countries, has attained a high labor productivity in agriculture by increasing output per unit of land. In contrast, the United Kingdom, which initiated the Industrial Revolution, has attained a relatively high level of agricultural efficiency mainly by enlarging agricultural land area per worker in response to the absorption of labor in nonagricultural occupations. France, which traditionally followed an agrarian policy designed to protect the peasant family farm (*la petite exploitation familiale*) from external competition and internal social change, achieved higher output per hectare than the United Kingdom but slower growth in output per worker than either the United Kingdom or Denmark until the formation of the European Economic Community (EEC). Since 1960, stimulated by increased demand for the protected EEC market, output and productivity of French agriculture have expanded at a very rapid rate [Hayami and Ruttan (1985, p. 130)].

Connecting the most advanced countries along each productivity path reveals the technology frontier (see Figure 8.4). Hayami and Ruttan describe this frontier as a metaproduction function, arguing that the underlying technologies that describe it are potentially available to all countries at a point in time. The technology actually developed and disseminated depends on relative factor scarcities. "Induced innovation" leads scientists to develop mechanical technologies to raise labor productivity in labor-scarce societies (for example, the new continents), whereas scientists in land-scarce societies, such as those in Asia, develop biological–chemical technologies to raise output per hectare. The potential of induced innovation to solve the agricultural problems of the currently developing countries will be discussed below. First, some special problems of the African experience must be placed in the context of productivity.

In addition to the three stylized productivity paths generated by the sample of countries in the analysis by Hayami and Ruttan, Figure 8.4 shows the growth path in agricultural productivity for Africa from 1965 to 1984, calculated from recent World Bank data. The definitions used are not identical to those used by Hayami and Ruttan, but the pattern shown is robust and perplexing. Between 1965 and 1973, Africa's productivity performance was very much like that of new continental areas: slow growth in land productivity and more rapid growth in labor productivity. Because of rapid growth in population, this increase in labor productivity reflected significant progress in increasing overall agricultural output.

Something quite unique in historical experience occurred in Africa between 1973 and 1984. For the entire continent between the Sahara and South Africa, the productivity of *both* land and labor declined. In Hayami and Ruttan's sample, only *one* country experienced a decline in each measure separately, and none declined in both. In Africa, an entire continent made up of more than thirty countries suffered a decline in both (although a few individual countries saw growth in both measures). The reasons for this startlingly poor performance are only beginning to be analyzed and understood, but it is virtually certain that a complex combination of bad weather, inadequate and inappropriate agricultural technology, and poor economic policies are to blame. The interplay between technology and agricultural development policy is the key issue here. Some analysts (but not Hayami and Ruttan) have seen induced innovation as an automatic market solution to a country's development problems. The African experience shows clearly that such is not the case.

4.1.3. Sources of productivity differences

Differences in agricultural productivity can stem from a variety of factors: different endowment of internal resources, such as land and livestock; different use of technical inputs, such as fertilizer and mechanical power; different investment in human capital through general and technical education; and different size of farms, which might generate economies or diseconomies of scale. Table 8.4 shows examples from the effort by Hayami and Ruttan (1985) to explain differences in productivity of agricultural labor according to differences in these factors' contributions to output. The contribution of each factor to productivity is based on econometric analysis of the same data set that generated Figure 8.3. Hayami and Ruttan estimated a production function by pooling their cross-section data for 44 countries for three time periods (1960, 1970, and 1980) and used the Cobb–Douglas output elasticities to account for differences in labor productivity. The results contradict Bairoch's pessimism about the potential of developing countries to raise their labor productivity in agriculture in the context of diminishing land per worker. In the three low-income countries in Table 8.4 – India, Philippines, and Peru – roughly half the difference in labor productivity relative to that of the United States was due to differential use of technical inputs and investment in human capital (general and technical education). Even the internal resource constraints are not completely binding because investment in livestock has an elasticity of output about double that of land. Scale economies are significant in Europe and newly opened continents but not on the small-scale farms characteristic of Asia and Africa.

Hayami and Ruttan conclude this part of their analysis on a positive note:

> The perspective implied by the results of this analysis for agricultural development in the less developed countries is essentially encouraging. It is clear that

Table 8.4
Accounting for differences in labor productivity in agriculture of selected countries from the United States as percent of U.S. labor productivity

Country (per capita GNP in U.S. $ in 1980)	Year	Output per worker (WU)	Difference in output per worker from U.S. as percent of U.S.		Percentage of difference explained by: Internal resources		Technical inputs		Human capital		Scale economies		Residual	
Low-income countries:														
India (240)	1960	2.2	97.7	(100)[a]	28.0	(29)	25.0	(25)	29.0	(30)	26.4	(27)	−10.8	(−11)
	1980	3.1	98.9	(100)	29.2	(30)	24.9	(25)	24.7	(25)	27.3	(28)	−7.2	(−7)
Philippines (690)	1960	3.3	96.5	(100)	28.8	(30)	24.9	(26)	20.4	(21)	24.8	(26)	−2.4	(−3)
	1980	5.9	97.9	(100)	29.5	(30)	24.9	(25)	16.4	(17)	25.2	(26)	1.9	(2)
Peru (930)	1960	9.6	89.8	(100)	20.7	(23)	24.2	(27)	23.7	(26)	22.6	(25)	−1.5	(−2)
	1980	10.1	96.5	(100)	27.1	(28)	24.8	(26)	18.1	(19)	25.0	(26)	1.5	(2)
Middle-income countries:														
Argentina (2390)	1960	34.9	62.8	(100)	−3.1	(−5)	24.3	(39)	19.0	(30)	2.4	(4)	20.2	(32)
	1980	63.8	77.6	(100)	11.3	(15)	24.4	(31)	16.8	(22)	3.1	(4)	22.0	(28)
Greece (4380)	1960	9.1	90.3	(100)	27.2	(30)	23.9	(26)	20.3	(23)	23.4	(26)	−4.5	(−5)
	1980	25.8	91.0	(100)	28.4	(31)	23.6	(26)	16.5	(18)	23.5	(26)	−1.0	(−1)
Israel (4500)	1960	25.9	72.4	(100)	26.5	(37)	21.5	(30)	14.3	(20)	18.7	(26)	−8.6	(−12)
	1980	101.8	64.3	(100)	26.1	(41)	22.0	(34)	13.8	(21)	14.9	(23)	−12.5	(−19)
High-income countries:														
Japan (9890)	1960	10.3	89.0	(100)	29.2	(33)	22.4	(25)	8.3	(9)	25.8	(29)	3.3	(4)
	1980	27.8	90.2	(100)	28.9	(32)	22.6	(25)	9.8	(11)	26.2	(29)	2.7	(3)
France (11730)	1960	32.4	65.5	(100)	23.0	(35)	16.9	(26)	17.3	(26)	11.7	(18)	−3.4	(−5)
	1980	101.8	64.3	(100)	23.2	(36)	15.5	(24)	15.7	(25)	11.1	(17)	−1.2	(−2)
Denmark (12950)	1960	46.4	50.6	(100)	17.7	(35)	12.8	(25)	13.9	(28)	3.0	(6)	3.2	(6)
	1980	131.3	54.0	(100)	18.4	(34)	12.7	(24)	14.5	(27)	6.8	(12)	1.6	(3)

[a] Inside of parentheses are percentages with output per worker set equal to 100.

Note: Per capita GNP in 1980 and agricultural outputs per worker in 1960 and 1980 in the United States are $11 360 and 93.8 and 285.1 WU, respectively.

Source: Hayami and Ruttan (1985, p. 154).

agricultural output per worker in the LDCs, especially the poorest ones, can be increased by several multiples by adequate investments in education, research, and the supply of modern technical inputs, even if land area per worker continues to decline because of growing population pressure in the rural sector... It is especially encouraging to find that the agricultural production function of the LDCs is neutral with respect to scale. This implies that the low-income LDCs will not be too severely handicapped by the declines in the land-man ratio and farm size, relative to the older developed countries, at least over the next decade or two [Hayami and Ruttan (1985, p. 157)].

4.1.4. Problems with technical change

Biological–chemical innovations were discovered and introduced in land-scarce, labor-abundant societies, such as Japan and Western Europe, whereas mechanical innovations were developed and used in land-rich, labor-scarce societies, such as the United States, Canada, and Australia. Such induced innovation suggests that each society develops an agricultural technology appropriate to its resource endowments and agricultural needs. This process might not continue to yield appropriate results, however, in the context of a much more interdependent international agricultural system. Perhaps more troublesome, the examples Hayami and Ruttan used to illustrate the relevance of their induced innovation hypothesis are all large countries, which are easily able to justify the overhead expenses of a modern agricultural research and extension system. The means to develop appropriate technology for small poor countries, such as Chad, Haiti, or even Laos, remains to be seen.

Because most new agricultural technology is embodied in a physical input – a bag of fertilizer, a new seed, a tractor, or an irrigation pump – it can be effective in a farmer's field only if a purchase (or rental arrangement) is made. Several consequences flow from this simple fact. For small farmers to participate in the benefits of technical change, not only must it be workable on their small farms (combines, for instance, usually are not), but they must also be able to purchase the input that carries the new technology. If a new seed-fertilizer package has a 200 percent rate of return, even borrowing from a village moneylender at 10 percent per month might be profitable. But for the full benefits of modern technology to reach small farmers, it might be essential that formal rural credit systems be accessible to the farm household with only half a hectare or less.[7]

Equally important, if new technology is embodied in inputs, a marketing and distribution system is necessary for farmers actually to be able to purchase the inputs. Many traditional agricultural societies have a long history of small-scale

[7]The dangers of subsidizing this credit are now well recognized. See Adams and Graham (1981) and Gonzalez-Vega (1977).

marketing of surplus output to urban regions in exchange for consumer items, such as cloth, kerosene, or pots and pans, needed by farm households. There is no similar experience with large-scale movements of inputs, such as fertilizer or modern seeds, to those same dispersed farm households. The embodied nature of agricultural technology means that farmers cannot just be told about it. The marketing system must also deliver the inputs when needed.

A further characteristic of embodied agricultural technology is that complementary fixed capital investments are often required to achieve the maximum benefits from the innovation. Usually this investment takes the form of better water control, land-leveling, and drainage. Sometimes much better control of seed bed preparation or more sensitive and faster harvesting techniques to avoid shattering and other harvesting losses is also needed; these might require tractors with modern implements or, for harvesting, combines or threshers. Shorter-maturity cereal varieties often are ready to harvest while the rainy season is still under way and solar drying is difficult or impossible. In such cases mechanical dryers and added storage capacity are essential.

4.2. Unresolved issues

Many questions are unresolved or still contentious in the agricultural development profession. Most involve the relationship between technical change and the policy environment needed to make it effective. The problem in defining the relationship is partly due to the lack of understanding of household decision-making, especially in environments where linked contracts among labor, land, and credit complicate analytical models. Moreover, economists have had a difficult time modeling the interface between micro decisions and macro outcomes because neither micro competitive models nor macro policy models provide an adequate basis for analysis of decision-making in this grey area. Serious disputes over the long-run sustainability of modern, input-intensive agriculture are unresolved. The following discussion does not answer these questions but does frame them in the context of the previous discussion of technical change and the discussion yet to come of agricultural development strategies.

4.2.1. Evolution in thought

Research in the 1970s into the links between technical change and the decision-making environment at the farm level led to three quite significant changes in thinking about agriculture and development. First, and no doubt the most important for the long run, agricultural decision-makers – farmers and traders – began to be thought of as an integral part of the rest of the economy, connected to it by rational decision-making in the face of new technologies or income and price changes. Acceptance of this principle by economic modelers and policy-makers led to a fundamental shift in attitudes about how agriculture should be treated in the development process – not as an isolated appendage but as a key component essential to the health of the overall organism.

Second, new importance was given to developing and choosing appropriate technologies, whether in agriculture directly, in processing, or in the industrial sector. If millions of farmers, or thousands of traders and small industrialists, were making rational decisions about investment, the nature of the technology set facing them would be at least as critical as the set of prices in determining the consequences of economic growth for employment and income distribution. In addition, farm-level decision-making was obviously conditioned by farm-level constraints and opportunity costs for household resources, especially unskilled labor. Technical packages that were inappropriate in the face of those constraints – especially packages imported largely intact from Western agricultural systems – were not adopted, and agricultural development failed to take place. Sparked by the world food crisis in 1973–74, but guided by this earlier understanding of the importance of fitting technology to field-level conditions, nearly all the international centers for agricultural research devoted a significant share of their budgets to discovering the nature of farm-level constraints on the adoption of new technology and to developing specific crops as well as entire farming systems that dealt more effectively with these constraints [see IRRI (1978), CIMMYT (1984)].

The third major change in thinking in the 1970s also was sparked by the world food crisis, but it similarly had its roots in the new understanding of micro decision-making and the key role of technical change in agriculture. Early agricultural development strategies were aimed at providing resources for urban industry by helping "early adopters" of new farm technology. The consequences of this strategy for income distribution and rural welfare prompted the development of the "basic needs" movement and efforts to promote "growth with equity" [Chenery et al. (1974)]. In some sense this concern for equity was an almost inevitable consequence of renewed emphasis on improved technology, which better-off farmers tended to adopt earlier, and on better price incentives for higher output, which clearly benefited larger farmers with a higher proportion of marketed output. Indeed, the focus on price incentives to achieve production results often overlooked the potentially serious consequences for poor consumers who were net purchasers of food, many of whom were very small farmers or landless laborers in the countryside [Timmer (1979)]. Out of the concern for promoting equity and meeting basic needs came a major revival in interest in demand analysis. Although Indian planners had used income elasticities for staple foods disaggregated by income class in the earliest five-year plans, no one had attempted the empirical disaggregation of price elasticities by income class until after the world food crisis in the mid-1970s. Because food prices can change from year to year by much larger relative amounts than incomes per capita, knowing such disaggregated price elasticities became critical to judging the welfare impact of the wide price fluctuations characteristic of the 1970s.[8] As Eicher and Staatz (1984) summarized it, the 1970s were primarily a period when agricultural economists renewed their microeconomic roots, and the decade brought forth a rich, and often confusing, harvest of new empirical evidence. It remains for this evidence to be synthesized in the 1980s to provide better understanding of the development process and agriculture's role in it.

4.2.2. *Farm decision-making*

One of the difficulties in understanding decision-making in agriculture is that farmers face remarkably diverse ecological and economic settings. Corporate businessmen in California or Sao Paolo make their living from agriculture, but so too do near-subsistence peasants in India or Guatemala. Despite differences in scale of operation and location, however, private agriculture is a markedly homogeneous industry in the kinds of decisions that must be made day in and day out and in the uncertainties that surround those decisions. The corporate soybean farm in Sao Paolo or the rice farm in California has more in common with the wheat-growing peasant operation in the Punjab than with U.S. Steel or Volkswagen of Brazil. Much of the daily work done on these farms is at the initiative of the individual workers, and the incentives they face to perform this work in a timely and careful fashion strongly influence the quality and quantity of agricultural output.

Modeling farm decision-making is relatively simple under two extreme sets of assumptions: if the household is entirely self-sufficient and faces no markets, and if the household faces a complete set of perfect markets. Even these simple settings can be complicated by risk and uncertainty, by bargaining among members of the household over access to resources and output, and by non-pecuniary externalities in the welfare function as reflected by investment in the maintenance of a "moral economy" [Hart (forthcoming), Jones (1986), Scott (1976)]. As emphasized previously by Binswanger and Rosenzweig, however, it is the reality of interlocking land, labor, and credit markets and the explicitly limited access of some households to some markets that challenge model-builders who hope to capture the complexity of rural life and thereby be able to predict the outcome of changes in policy and technology or the commercialization of rural transactions. At a conference organized by Binswanger and Rosenzweig

[8] An attempt to generalize from early empirical results about the relationship between income level and the magnitude of the pure substitution term in the Slutsky matrix is in Timmer (1981); a review of the literature on disaggregated demand parameters is in Waterfield (1985) and Alderman (1986).

(1981) to examine the empirical record on these issues, what was striking was the sheer diversity of arrangements at the micro level. While this is not cause to reject model-building as an approach to understanding decision-making of rural households, it does caution against making general predictions without specific empirical foundation to the model. Building such empirical foundations to household decision-making models has occupied a substantial part of the agricultural economics profession since the early 1970s [Singh, Squire and Strauss (1985)]. The results show clearly the merits of treating the household as a combined producing and consuming unit, but, as Binswanger and Rosenzweig note, the dynamic aspects of the household's interactions with its environment are only beginning to be revealed:

> Explanations of the long-term changes associated with development must be found, ultimately, in models that explicitly treat the reproductive and technological behavior that leads to the long-term evolution of supply and demand. Attention has recently turned to the study of decisions that have long-term consequences – decisions about human capital investment, fertility, health, technical change, and agricultural intensification. Such decisions, however, are themselves conditioned by the outcomes and institutional arrangements in rural factor markets. The integration of market and household behavioral models within an explicit dynamic framework enveloping all sectors of an economy has yet to come [Binswanger and Rosenzweig (1981, pp. 55–56)].[9]

4.2.3. *Micro–macro links and structural change*

Trying to explain the declining share of agriculture during the process of structural transformation by analyzing the decision-making of farm households is a bit like trying to explain evolution by studying the molecular biology of plants and animals. The explanation for evolution, of course, must ultimately have its basis in molecular biology, and, likewise, structural transformation must be based on micro decision-makers. But our capacity to move from one level to the other is very limited. Aggregation of micro outcomes does not trace out macro growth paths very well, primarily because of the difficulty in specifying investment functions and the introduction of technical change. Even the reverse causation, where macro settings influence micro decision-makers, has only recently been incorporated into models of agricultural sector performance [Chilchilnisky and Taylor (1980), Schuh (1976), Taylor (1980), and Timmer, Falcon and Pearson (1983)].

[9]Such an integration obviously takes us outside the realm of this chapter into the other topics treated in this Handbook. In particular, see the chapters by Bardhan (Chapter 3), Behrman and Deolalikar (Chapter 14), Bell (Chapter 16), Birdsall (Chapter 12), Rosenzweig (Chapter 15), T. Paul Schultz (Chapter 13), Sen (Chapter 1), Stiglitz (Chapter 5), and Williamson (Chapter 11).

One specific attempt to measure the impact of macro prices on structural change in agriculture was reported in Timmer (1984). The share of agriculture in GDP was the dependent variable in the model, which used the same variables for income and population size as those used by Chenery and Syrquin (1975). However, the rural–urban terms of trade were also added as an explanatory variable. The terms of trade as well as the per capita income variable were explained by a simple four-equation, recursive structural model, with income per capita depending on lagged income per capita, lagged "real" foreign exchange rate, lagged investment, and the share of oil imports in GDP. The real exchange rate (in purchasing power parity) was then explained by lagged income per capita, the current account balance, real cereal prices in world markets, and the oil import share. In the next step, investment as a share of GDP was explained by current income per capita, the foreign exchange rate, the current account balance, and the oil import share. Finally, the rural–urban terms of trade were determined by the foreign exchange rate, real prices for noncereal agricultural products in world markets, real cereal prices in world markets, and the oil import share. It was then possible to estimate a Chenery–Syrquin equation with agricultural share of GDP as the dependent variable and predicted values of each of these dependent variables in the structural model as independent variables in the model of structural change.

The model was estimated for seven countries in the Asia–Pacific region for the years 1960 to 1980.[10] All variables in all equations were significant and of the right sign, confirming the logic of the structural model. More interesting was the separate importance of the foreign exchange rate and the oil import share in determining the rural–urban terms of trade in these countries, especially because the oil import share was also a highly important variable in explaining the foreign exchange rate itself. The two oil price shocks in the 1970s thus opened a window of opportunity to trace the effects of a major macro perturbation as it rippled through the economy, including the agricultural economy. The results of estimating the model and simulating changes in the oil price (holding import or export volumes constant in the short run) confirmed the notion that the agricultural sector is strongly influenced by variations in macro prices. The positive effect of currency devaluations on the rural–urban terms of trade was confirmation that rural goods and services tend to be more "tradable" than urban goods and services. No logic requires this result, of course, and many economists would tend to think the opposite – bulky, low-value agricultural commodities are naturally protected by high marketing costs and should therefore be less tradable than urban industrial goods. This view fails to reflect two considerations. First, strong

[10] The countries were Indonesia, South Korea, Malaysia, Mexico, Philippines, Sri Lanka, and Thailand. They were chosen to have a balance among oil importers, oil exporters, and a country approximately self-sufficient. An oil exporter naturally has a negative oil import share in the model.

substitutions are possible among agricultural commodities in both production and consumption. Sweet potatoes might not be tradable directly, but if they compete for resources and customers with rice that is tradable, the sweet potato economy will behave as if they were a tradable commodity. Second, extensive protection is provided to the urban industrial sector in most developing countries, protection that has the effect of converting the sector from tradable to nontradable. Consequently, these empirical results showed that the strong tendency of developing countries to maintain overvalued exchange rates (even for their existing degree of industrial protection) not only impedes efficient resource allocation and rapid growth (because of the importance of the foreign exchange rate in the per capita income equation), but also significantly biases income distribution against the rural sector.

Oil imports force countries to remove some of that bias. As pressures build to create incentives to export in order to pay for the oil imports, the rural sector receives improved terms of trade since it produces many of those exportable goods. The effect is symmetrical for oil exporters. As oil prices rise for exporting countries, the terms of trade deteriorate for their agricultural sectors. Since the oil share is also a significant factor in exchange rate determination, the ultimate impact of oil prices is even larger. Consequently, "Dutch Disease" – the decline in employment and output in labor-intensive export sectors in countries experiencing a boom in resource prices – is at least as much a rural problem as an urban industrial one. The agricultural difficulties of Nigeria, Venezuela, Mexico, and Indonesia (until 1978, when macroeconomic management changed in order to cope with the problems created by high oil prices) can be seen to have common macroeconomic roots. Likewise, the increased supplies of agricultural commodities in world markets and the reduced demand for them in the early 1980s must also have at least part of their explanation in sectoral responses to the oil price changes of the 1970s. As oil prices fall in the 1980s, some of the pressure to export agricultural commodities should be reduced (although servicing the debt incurred while oil prices were high attenuates this effect to some extent). As a consequence, agricultural commodity prices in world markets should recover somewhat relative to oil prices.

This type of analysis – conducted within a general-equilibrium perspective even if not within a formal, computable general-equilibrium model – reinforces the early and partial results obtained in the 1970s from analysis of choice of technique in production in developing countries: macroeconomic policies, especially with respect to macro prices – wage rates, interest rates, and foreign exchange rates – significantly influence these choices and consequent employment and output levels, as well as income distribution. The link from macro policy to agriculture is quite strong. In the other direction, the general-equilibrium consequences of agricultural adjustments to shifts in these policies seem to be quite significant, but these are not yet understood in other than the roughest theoretical and empirical way.

4.2.4. Resources for growth and sustainability

Parallel to the incorporation of agriculture into macroeconomic and general-equilibrium analysis has been the growing acceptance of what was a highly controversial and widely denied argument in the 1970s: that rapid economic growth with broad participation of the entire population for sustained periods of time was necessary for a country to deal successfully with widespread poverty and hunger. The desirability of such growth was seldom questioned; the controversy was over the adequacy of the world's resource base to sustain such rapid growth for more than a handful of special cases (the "Gang of Four": Singapore, Taiwan, South Korea, and Hong Kong). The more radical segment of the basic needs movement adopted a *small is beautiful* philosophy that called for substantial changes in the lifestyles of the rich in order that the poor could share more equitably in a limited standard of living for the entire world [Schumacher (1975), Lappe (1971)].

Although this perspective has certainly not disappeared, a decade-long decline since the mid-1970s in basic food prices on world markets, to historic lows in real terms, and the monthly efforts by OPEC in the mid-1980s to prop up oil prices against a seemingly inexorable market determined to lower them, have changed the nature of the debate. The issue is not whether the global resources are available for economic growth, but whether they can be managed appropriately to generate and sustain that growth. The record after the world food crisis in 1973–74 reveals that farmers and societies respond vigorously to apparent food shortages, whether in response to prices in world markets or to a perceived vulnerability to uncertain external market supplies. Technical change in agriculture, at least in the United States and Western Europe, has accelerated in the 1980s after stagnating in the 1970s, and it is difficult not to see this as a form of induced innovation in the Hayami–Ruttan sense.

The sustainability of this technical change has been repeatedly challenged, especially after the first oil shock in the early 1970s. Lester Brown has been one of the most articulate and influential of these challengers, and his *State of the World, 1984* contains a succinct statement of the concern:

> Although the economic crisis of the eighties is exacerbated by economic mismanagement, its roots lie in the depletion of resources, both nonrenewable and renewable. During the fifties and sixties the world economy steadily boosted its use of oil, a finite resource, putting it on a path that by definition was not sustainable over the long run. The depletion of oil reserves, and its effect on world oil prices, is the most immediate threat to world economic

> stability, but the depletion of soil resources by erosion might be the most serious long-term threat. The unprecedented doubling of world food supplies over the last generation was achieved in part by adopting agricultural practices that led to excessive soil erosion, erosion that is draining the land of its productivity. After a point agriculture can no longer be sustained and the land is abandoned.
>
> Sustainability is an ecological concept with economic implications. It recognizes that economic growth and human well-being depend on the natural resource base that supports all living systems. Technology has greatly expanded the earth's human carrying capacity, most obviously with advances in agriculture. But while the human ingenuity embodied in advancing technology can raise the natural limits on human activity, it cannot entirely remove them. A sustainable society is one that shapes its economic and social systems so that natural resources and life-support systems are maintained. Today, we study the archaeological sites of earlier civilizations that failed to do so, depleting their soils, mismanaging their irrigation systems, or otherwise embarking on an unsustainable development path [Brown (1984, pp. 1–2)].

Of course, none of these civilizations possessed the scientific capacity of modern societies to create new technologies specifically designed for the resource shortages that emerge over time. Unless this capacity suddenly erodes dramatically, it seems likely to provide solutions to future shortages of resources in similar fashion to those of the past.

4.2.5. Role of government

At the same time that planners have learned that resource management rather than resource constraints per se is the primary bottleneck to economic growth, they came to view prices generated in international markets as important signals about relative scarcity of various resources and to regard trade as the most efficient vehicle to alleviate significant imbalances of resources in a given country. The importance of market signals and trade has led to a growing consensus around a market orientation and the use of private incentives as the most effective way to achieve economic growth, at least in agriculture. Millions of decision-makers have turned out to be too many to reach from central planning offices, because agricultural diversity is too great for information to reach those offices effectively. Agriculture is itself changing too rapidly for planners to keep up. This rapid change is reflected primarily in international markets, and agricultural economies that are cut off from those markets miss key signals about the efficiency of domestic resource allocation.

An emphasis on the role of international markets and trade is easily caricatured into an argument for free trade and "getting prices right" by setting them at whatever the border price happens to be [Volrath (1985), for example]. The extent to which a country's internal decision-makers face international market signals is one of the key policy instruments available to a government to influence income distribution as well as efficiency of resource allocation. Because dynamic efficiency is more important for economic growth than static optimization, a concern for the long-run impact of prices on expectations, investment, and technical change is entirely legitimate. Free trade provides no guarantee that dynamic efficiency will be achieved, and the record of East Asia cannot be offered as evidence that free trade leads to rapid growth. That same record does suggest, however, the importance of an export orientation for industry in combination with growing incomes in the rural sector. For an agricultural development strategy to be relevant for the 1990s, it must incorporate the factors responsible for that record.

5. Agricultural development strategy

Several lessons have been learned since the mid-1960s about the functioning of the agricultural sector and its potential role in the development process. The agricultural sector has been seen in a general-equilibrium perspective, and the importance of macroeconomic policy for agricultural performance has been recognized. Rapid economic growth has been considered necessary to deal with the human welfare concerns that stem from poverty and hunger, and such growth is feasible because of the potential for technical change. Market-oriented systems with private incentives have shown superior performance in achieving this growth. Policy analysis has tended to concentrate on one of three dimensions of government intervention into the agricultural growth process: stimulating traditional agriculture into growth; maintaining agricultural growth to generate resources for the rest of the economy; and protecting the welfare of farmers from their own high productivity during the final and painful stages of structural change in industrialized societies.

5.1. Policies for "getting agriculture moving"

It has become increasingly recognized that in order for agriculture to play a multiplicity of positive roles, it needs resources and favorable development policies, not heavy taxation and neglect. By the 1970s, agreement was being reached on the nature of resources needed to develop agriculture, and some progress was being made in identifying the policies needed to make those resources effective. Heavily influenced by Schultz's book, *Transforming Traditional Agriculture*, and the increasingly widespread evidence that farmers responded rationally to economic incentives, strategists in the late 1960s and early 1970s focused on two complementary agendas: understanding the microeconomic setting of farm-level decision-makers in order to create incentives for investments in higher output, and generating the stream of technical innovations that would be profitable for individual farmers to adopt in order to produce that output.

With high food prices in world markets in the mid-1970s, providing better incentives to rural producers was a "simple" matter of liberalizing trade policy and permitting international price signals to be more freely transmitted to the domestic economy. Because rural economies had been discriminated against for so long by the industrialization strategies, rural incomes were very low relative to urban incomes. Goals in terms of both equity and efficiency were furthered by raising agricultural prices to their world levels, a point stressed by Schultz and his colleagues (1978) and now pursued by Western aid agencies.

The emphasis in the late 1970s and early 1980s on market liberalization as a means of providing adequate price incentives to agricultural producers has run into serious problems in the mid-1980s. Allowing domestic food and agricultural prices to be determined by world prices creates serious difficulties for both producers and consumers because commodity prices in world markets are much more variable than prices for industrial products. Since the mid-1970s when this strategy was articulated, many prices, especially for grains, have collapsed to historic lows, and there is relatively little prospect of recovery in the foreseeable future or at least within the vision of planning agencies and policy-makers. Once the painful decision is made to raise price incentives to farmers, it is not easily reversed, especially because the medium-term consequences for income distribution would be sharply negative.[11] To provide farmers with positive price incentives then requires agricultural price protection, which might possibly lead to the same type of high-cost, inefficient agricultural sector that presently exists for industrial sectors in these developing countries.

The appropriateness of an incentive-led strategy for agricultural development, as opposed to a market-liberalization strategy, depends on whether the argument for protection has any merit: that providing adequate price incentives to farmers through protection from international competition will encourage an infant industry to grow up and produce at low cost.[12] In the 1950s and 1960s, import substitution for industrial products was used to justify the use of price protection for domestic (infant) industry, through tariffs, quotas, or bans on cheaper foreign goods. As industries matured, their goods would be able to compete with foreign

[11] The very short-run consequences for poor consumers would be positive, just as they were negative when price incentives were adopted in the first place [Timmer (1979)].

[12] Protection has also been justified on the basis of price stabilization, i.e. that "low" prices in world markets would rise to "normal" or "trend" levels before long. But an analysis of alternative trends to be used to defend this proposition shows that the current price is a better predictor of future prices, for at least five years into the future, than estimated trends [see Schwartz (1987)].

goods in local markets and be exported, and trade barriers could come down. But for various reasons that had to do with "X-efficiency" and political economy, only a few countries were able to make this transition [see Pack, Chapter 9, and Westphal, Chapter 20, in this Handbook]. The industrial sectors in most developing countries are high cost and inefficient, and they remain heavily protected. The agricultural sectors in these countries have borne much of the burden imposed by the industrial and trade policies, in the form of high-cost inputs and overvalued exchange rates that (implicitly) subsidize imported foodstuffs and tax rural exports [see S. Lewis, Chapter 30 in this Handbook].

Protection for the rural sector carries clear benefits but equally clear costs and risks. Protection would maintain the momentum in agricultural production achieved through higher price incentives, and it would also support income levels in rural areas. But if the lessons from industrial protection in the 1960s are applicable to agriculture in the 1980s, planners should be cautious. If the agricultural sector is fundamentally different in its response to protection from that of the industrial sector, or if world markets for its output are sufficiently different because of price instability, then short-run protection might be appropriate. The answer is complicated by the realization that the economies most successful in translating import substitution into export-led growth – Japan, South Korea, and Taiwan – also have adopted the highest rates of agricultural protection [Anderson and Hayami (1986)].

5.2. Alternative strategies for maintaining the transformation process

The lessons from the Asian success stories do not define a single strategic approach to agricultural development. The agricultural sector is a means to an end – not an end in itself. Three sharply different paths for appropriate policies toward agriculture are open if the goal is to speed the overall process of development. The first path has parallels to the philosophy of the 1950s, in which benign neglect of agricultural policy was thought to be sufficient for stimulating the process of economic growth. This perspective grows out of the recognition of the role of well-functioning markets and decision-makers operating in a world of "rational expectations". In this view, most policy is irrelevant to farmers in more than a very transitory sense, and this is especially true of price policy:

> One lesson that we should be able to learn from observation of the world is that the absolute incomes earned by farm families in various countries have no relationship to farm prices. Even stronger, the relative incomes of farm families have no relationship to farm prices, except as benefits of higher prices have been capitalized into the value of land and land has been acquired by gift or inheritance [Johnson (1985, p. 43)].

In this world, agricultural incomes are determined by employment opportunities outside agriculture, the agricultural sector *must* decline in proportional output terms and absolutely in the labor force, and the long-run decline in basic agricultural commodity prices due to technical change simply emphasizes that society is best served by getting resources out of agriculture as rapidly as possible. Although the clearest case for this view of the world is in the OECD countries, a host of middle-income countries, and even some quite poor countries, are also facing the problem of declining real incomes in the agricultural sector under the impact of rapid technical change domestically and lower world prices for the resulting output. This perspective is obviously consistent with the view that open economies will show better performance than those with substantial trade barriers.

A sharply different path has been sketched by Mellor and Johnston (1984). Building on their earlier stress on balanced growth (1961), Mellor and Johnston call for an "interrelated rural development strategy" that improves nutrition in one dimension while it fosters the broader growth process in the other. The approach calls for a major role of government in strategic design and program implementation, a role that is in marked contrast with the free-market approach sketched out previously:

> We have, therefore, emphasized that improvements in nutrition [one of Mellor and Johnston's key objectives for agricultural development] require a *set of interacting forces*: accelerated growth in agriculture; wage goods production; a strategy of development that structures demand towards high employment content goods and services; increased employment; and increased effective demand for food on the part of the poor. Agricultural growth not only satisfies the need for food to meet nutritional requirements (which is the other side of the wage-goods coin), but fosters a favorable employment-oriented demand structure as well. Agriculture's role in generating a structure of demand, favorable to rapid growth in employment, is central [Mellor and Johnston (1984, pp. 567–568, emphasis added)].

Mellor and Johnston go on to summarize their earlier argument that agriculture can play this multiplicity of roles only if a unimodal development strategy is followed, that is, one in which a broad base of smallholders are the central focus of agricultural research and extension services and the recipient of the bulk of receipts from agricultural sales. The authors see the dualism inherent in bimodal strategies – those placing modernization efforts primarily on large, "progressive" farms while neglecting the "backward" smallholders – as the major obstacle to putting their set of interacting forces in motion:

> The most common barrier to the interrelated strategy indicated is pronounced dualism in capital allocations – too much to industry and the unproductive

> elements of the private sector rather than to agriculture, and to capital-intensive elements within those, as well as to large-scale and therefore capital-intensive allocations within agriculture. The outcome of the strategy will depend upon national-level decisions about macroeconomic policies, exchange rates, interest rates, and investment allocations among sectors and regions, not just within agriculture itself. Indeed, the whole strategy fails if it is viewed simply as the responsibility of agriculture ministries [Mellor and Johnston (1984, p. 568)].

This interrelated strategy must be directed by government planners; there is relatively little concern or role for the private sector, other than small farmers. The analysis leading to the strategy remains heavily influenced by closed economy considerations, and little attention is given to either domestic marketing activities or their relationship to international markets. Three key elements are suggested as essential to meeting all objectives of agricultural development – massive investment in human capital through nutrition, health, and family planning services in the countryside, creation of the complex, rural organizational structures seen in Japan and Taiwan that provide services to small farmers while also serving as a voice for their interests, and investment in rapid technical change appropriate to these small farmers in order to raise agricultural output and rural incomes simultaneously.

Notably missing in this list of key elements is significant concern for the structure of incentives for agriculture relative to industry's or for the country's tradables relative to those of foreign competitors. Although it is realized that the macroeconomic setting is no doubt important to agriculture, it remains outside the scope of appropriate strategy for agricultural development. Not surprisingly, given the argument in Johnston and Clark (1982), the intellectual foundation for this strategy lies in rural development, not in a vision of agriculture linked to the macro economy and world markets by powerful market mechanisms. It is this latter vision which provides the third potential path for agricultural development strategy for the rest of the 1980s and into the 1990s.

The third approach contrasts with both the "free market" and "interrelated rural development strategy" approaches. It calls for government policy interventions into outcomes in domestic markets but uses markets and the private marketing sector as the vehicle for those policy interventions. This "price and marketing policy" approach recognizes widespread *market failures* in agriculture as well as extensive *government failures* in implementation of direct economic functions.[13] The strategic dilemma is how to cope with segmented rural capital and labor markets, poorly functioning land markets, the welfare consequences of sharp instability of prices in commodity markets, the pervasive lack of informa-

[13] This is a theme of both the Bardhan (Chapter 3) and Stiglitz (Chapter 5) in this Handbook.

tion about current and future events in most rural economies, and the sheer absence of many important markets, especially for future contingencies involving yield or price risks. One powerful lesson emerged from the postwar development record: direct government interventions through state-owned enterprises to correct market failures frequently make matters worse by inhibiting whatever market responses were possible in the initial circumstances, without providing greater output or more efficient utilization of resources. The agricultural sector in particular is vulnerable to well-intended but poorly conceived and managed parastatal organizations that attempt a wide array of direct economic activities, including monopoly control of input supplies, capital-intensive state farms, and mandated control over crop marketing and processing. As Bates (1981) has demonstrated, these direct controls and agencies have a strong political economy rationale for a government that tries to reward its supporters and centralize power and resources in the hands of the state [see also Lipton (1977)].

The answer to the dilemma over making matters worse, in the "price and market policy" approach, is to gain a much clearer understanding of the necessary interaction between the public and private sectors. Government intervention into agriculture for political reasons has an ancient history. One major claim of monarchs to the throne was their capacity to keep food prices cheap and stable, as Kaplan (1984) made clear and as several modern governments have discovered to their demise. Political objectives for the performance of agriculture – its capacity to feed the population regularly and cheaply, or its ability to provide fair incomes to farmers caught in the painful pressures of successful structural transformation – are inevitable and, in some long-run sense, highly desirable.

The "price and marketing policy" path argues that these objectives are best served by making carefully designed interventions into the prices determined in markets, not by leaving markets alone or by striving to reach the objectives through direct activities by the government [Timmer (1986)]. If the "free market" approach incurs heavy political costs as markets relentlessly redistribute incomes to the winners in the course of economic development, and the "interrelated rural development strategy" incurs heavy managerial and administrative costs as the government plays an active and direct economic role, the "price and marketing policy" approach incurs heavy analytical costs.

These analytical costs come from the need to understand each country's path of structural change, the workings of factor and commodity markets, and the potential impact of macro and commodity price interventions on these markets and ultimately on the structural path itself. It requires that government intervention be based on an empirical understanding of economic responses to a change in policy and the political repercussions from them. There is an important role for models in illuminating where to look for these responses, but the models themselves cannot provide the answers. This is especially true as attempts are made to build into the models the response of policy itself to changes in the economic environment [see Roe, Shane and Vo (1986)]. Such endogenous policy models might reveal some of the historical factors that accounted for policy shifts, but they seldom provide a sense of when the degrees of freedom for policy initiative are about to expand. Frequently, this is in times of crisis. Policy-makers often embark on bold experiments in such times, and the payoff would be very high if sufficient analytical understanding already existed in order for them to anticipate the response to a policy change.

All three strategic approaches recognize the importance of government investments in agricultural research and rural infrastructure. Even here, however, there are likely to be significant differences in emphasis. The free-market approach is likely to put a relatively greater share into research, the rural development strategy into human capital investments, and the price and marketing approach into rural infrastructure that lowers marketing costs. Investments in all three areas are obviously desirable. The issue is at the margin: where are scarce resources to be invested? In addition, different countries have different starting points and different needs, so no single strategic approach makes sense for all countries. But it is difficult to see how countries can develop their rural sectors without relatively efficient marketing systems and adequate financial incentives for their farmers. Accordingly, significant elements of the price and marketing approach seem destined to be incorporated into all successful agricultural development strategies, even if they emphasize the free market or rural development approaches in other dimensions.

5.3. Agricultural policy and structural change

Hayami and Ruttan have asked why agricultural growth has not been faster and more evenly spread around the world:

> We indicated that the basic factor underlying poor performance was neither the meager endowment of natural resources nor the lack of technological potential to increase output from the available resources at a sufficiently rapid pace to meet the growth of demand. The major constraint limiting agricultural development was identified as the policies that impeded rather than induced appropriate technical and institutional innovations. As a result, the gap widened between the potential and the actual productive capacities of LDC agriculture [Hayami and Ruttan (1985, p. 416)].

This emphasis on the relationship between policy and agriculture's role in structural change has provided the organizing theme for this chapter. A progression of topics has followed from understanding why the agricultural sector is different from the industrial and service sectors and how the differences condition the nature of effective policy interventions. The factors needed for inducing the agricultural transformation, to "get agriculture moving", involve a complex mix of appropriate new technology, flexible rural institutions, and a market orientation that offers farmers material rewards for the physical effort they expend in their fields and households and for the risks they face from both nature and markets.

The role of the government has been analyzed throughout this chapter, first, as it fosters the transformation process through its investments – in both budgetary and policy terms – in agricultural development, and, second, as it tries to cope with the problems of success. A recurrent theme of this chapter has been that a successful structural transformation is painful for the agricultural sector in all societies; nearly all rich countries protect their farmers at the expense of domestic consumers and taxpayers and of foreign producers. The rapidly growing economies of East and Southeast Asia are facing this issue in an acute fashion, well before their overall economies can bear the fiscal burden of heavy agricultural subsidies [Anderson and Hayami (1986)]. The experiences of the currently developed countries with respect to the social, political, and economic stresses caused by a declining role for agriculture have important lessons for latecomers about to encounter these same stresses [Reich, Endo and Timmer (1986)]. There is a world of difference, however, between those countries growing rapidly enough to be feeling the consequences for income distribution of the relative decline of the agricultural sector and those countries in which the agricultural transformation itself has yet to begin in a significant way. The contrast between Asia and Africa in this regard is striking. Many development specialists feel that reversing Africa's declining food production per capita and declining real incomes per capita is the most important challenge for the rest of the century. For the agricultural development profession, the difficult question is whether the lessons from Asia in stimulating the process of agricultural transformation can be transferred to the vastly different African setting. Many policy experiments are now under way; analysis of the record generated in the 1980s by these experiments will provide new insights in the 1990s into determining which models of development can best stimulate and explain the process of structural transformation.

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