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Agricultural Growth, its Determinants, and Their Relationship to World Development: an Overview

INTRODUCTION

The pace and pattern of agricultural growth is strongly conditioned by the global environment within which it occurs and, in turn, further influences that environment. In that regard, two related factors have been particularly important to the recent development of the agricultural sectors in developing countries. The first is the growing 'surplus' agricultural capacity of the developed countries – created by a static internal demand and continually increasing supplies from the progress of modern technology and farm support policies – creating low and unstable prices in international markets. The second is the relative neglect by many developing countries of their own agricultural sectors, which is, in part, a result of world market conditions. Only recently have macroeconomic difficulties and debt problems forced some developing countries, especially in Latin America and Africa, to undertake programmes of reform, the major thrust of which has been on changing the internal terms of trade in favour of agriculture and, in particular, of export agriculture by the removal of price distortions and by reducing the role of the public sector in marketing arrangements for inputs and outputs.

In the context of the current global environment, the removal of price distortions presents both a point of controversy and a rather difficult problem in efforts to increase agricultural production. The main issue focuses on the extent to which these actions alone generate an *aggregate* supply response and the magnitude and speed of that response. In an environment of falling world prices, while an initial spurt in production can be obtained by removal of various types of prolonged distortions, sustaining that production growth requires the technological, physical, and institutional infrastructure, which many countries now lack precisely because of their neglect of the agricultural sector. These issues are illuminated by the experiences of different countries over the past few years, experiences which shed light not only on the process of agricultural development itself, but on its relationship to overall growth in the global economy.

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In the past decade, a number of countries in Latin America and Asia have used modern high-yielding technology to reduce their cost of production and, particularly in Asia, have taken advantage of 'surplus' labour to expand domestic employment in the course of expanding production. In spite of prevailing market conditions, these countries have actually increased their shares of primary agricultural exports in world markets by making major public investments to induce technological change in production. As a consequence of all these forces, demand for food generated by increased employment has generally outpaced domestic production, leading to need for food imports which have been further encouraged by declining world prices.

On the other hand, the downward pressure on commodity prices and their instability in the 1970s led many developing-country exporters of tropical commodities, especially in Africa, to shift out of tropical export crop production. They neglected opportunities for technological change, foregoing opportunities to reduce costs in export production and subsequently lost shares in world markets. Their increased demand for food imports, largely population-generated, has had to be financed from a shrinking pool of export earnings, leading to increasing reliance on food aid and other forms of foreign assistance (Lele, 1988c).

Clearly, in terms of the relationship of agricultural growth to the world economy, it is the first type of technological change-based, income-generated growth in world trade which is both sustainable and desirable. Understanding what causes technological change and how sources of growth in production change over the course of the development process from the relative dominance of traditional inputs, such as land and labour, to nontraditional, knowledge- and technology-based inputs is crucial in understanding the potential for agricultural growth to promote growth in the world economy.

In this context, it is useful to analyse the determinants of agricultural growth, along the lines developed by Minhas and Vaidyanathan (1965) and extended by Narain (1977), by decomposing agricultural growth into the contribution of changes in area, yield, and crop composition. This form of analysis indicates the importance of nonprice factors underlying the various sources of growth. For example, an expansion of area often requires substantial investments in transportation, communications and other forms of social infrastructure to open up new areas and to facilitate specialization and exchange. Yield growth is also based largely on public investment in the generation and application of technology. Changes in crop composition occur due to shifts to more productive areas and to higher value commodities. Change in crop composition is, in part, an embodiment of technological change as lower production costs cause resources to shift to commodities benefiting from the new technologies. But, it also reflects a response to changes in demand structure arising from changes in both foreign and domestic markets, which can allow greater resource productivity.

Because of their short-term nature, current adjustment programmes do not address the issues relating to the role of governments in providing basic public goods - agricultural research and extension, physical infrastructure and education - the various nonprice factors fundamental to initiating and sustaining growth in agriculture. These are areas in which macroeconomic difficulties, the related shortages of government revenues and other factors have, if anything,

reduced public investment and recurrent expenditures to a minimum. Important questions remain regarding how the level of accumulated stock of public goods and institutional capital, which vary among countries at different stages of development, influences the impact of price changes on supplies, particularly through the presence of efficient factor and product markets. Another question is what effect does getting prices right have on the process of agricultural growth in countries with very different factor endowments (those that are land-surplus as distinct from labour-surplus). And finally, whether and how price changes induce the needed public investment to overcome the public goods constraint when it exists, as some economists have argued, or whether they only generate private capital formation?

Of course, compared to an emphasis on growth of the large-scale estate sector, the resource requirements of a broad-based, smallholder approach may have short-run costs in terms of the pace of overall growth - trade-offs which are particularly apparent in circumstances of low national incomes, where trained manpower and institutional capacity needed to achieve broad-based growth are limited, but where rapid growth is desired. The extent to which these trade-offs are minimized will depend on investment in expanding the supply of human and institutional capital.

In the remainder of the paper, we turn to the debate on the relative roles of price and nonprice factors in stimulating growth in agriculture. In particular, we consider the economics of diminishing, constant, and increasing returns to scale and the nature of the relationship between capital accumulation and technical change and their effect on growth. We then provide empirical evidence on sources of growth for clues about the role of price factors and technological change in agricultural growth, followed by an examination of empirical studies of price responsiveness. That evidence indicates that, while correction of price distortions can assist in resuming growth in circumstances of prolonged taxation of the agricultural sector, increasing prices alone may not be a feasible or indeed even a desirable route to pursue, due to the adverse income effects of price changes on domestic consumers, the increased costs of production that movements on the production possibility curve may imply or due to the declining world market prices. We end by spelling out the nature of appropriate public investment to achieve sustained and widespread growth.

CAPITAL ACCUMULATION, TECHNOLOGICAL CHANGE, AND AGRICULTURAL GROWTH

Whereas the law of diminishing returns was explained in terms of agriculture in circumstances of growing population using up the fixed land frontier, the concept of constant returns to scale remained in currency for a long time because of the simplicity of the idea of capital accumulation as the primary source of growth. Harrod and Domar's growth theory was easy to model not only because of the assumed constant relationship of capital to output, but also because of the assumption of homogeneity of capital. Therefore, growth could be considered simply in terms of aggregate capital/output ratios and differences in them over time and across countries. Consistent with this idea, other notable economists,

including W. Arthur Lewis, considered increased saving and investment rates as the single most important determinant of accelerated economic growth in developing countries.

With the work of Solow, growth theory shifted its focus from the contribution of capital and other traditional forms of input to the importance of nontraditional inputs - technical change and other knowledge-based factors. That literature suggested that the contribution of these latter factors was far more significant than that of conventional forms of (physical and other) capital.[1] The agricultural counterpart of this general economic work consisted of the celebrated study of the adoption of hybrid maize in the US by Griliches. Indeed, there is now very little disagreement among economists of the fundamental importance of technical change in reversing the Malthusian effects of diminishing returns in agricultural production. The major debate that remains concerning increasing returns from technical change is about the determinants of technical change.

Mirroring the general growth literature, a substantial body of agricultural growth theory has emerged which stresses the importance of relative prices in determining the rate of aggregate agricultural production, mainly through the process of capital accumulation, assisted by favourable terms of trade in agriculture. It perceives technological and even institutional change as being essentially the embodiment of capital, induced by changes in relative prices (Hayami and Ruttan, 1985; Mundlak, 1988). On the other hand, following Marshall, T.W. Schultz considers knowledge to be the most powerful engine of production and the simplifying assumption of homogeneity of capital 'a disaster for capital theory'. He attributes the dynamics of growth largely to investment in human capital leading to technical change, division of labour and specialization (Schultz, 1988). Whereas Schultz and others have stressed high rates of return to investment in human capital and technology and the strong interaction between them, they have also decried the inadequate investment in the development of human capital and technology, recognizing by implication the failure of both the market and the public sector to induce additional investment in areas of high rates of return. Determinants of public sector investment and differences among countries in this regard thus still remain a great puzzle.

Empirical evidence on sources of agricultural growth in developing countries clearly demonstrates the growing importance of technological change at later stages of development. In the following section we review a number of studies for clues to the roles of accumulated physical and organizational capital associated with technological change.

THE ROLE OF TRADITIONAL AND NONTRADITIONAL FACTORS IN AGRICULTURAL GROWTH

A number of studies decompose agricultural growth in developing countries into its component parts, roughly along the lines of traditional and nontraditional inputs, including: (l) area effects, defined as changes in gross planted area and indicating the effect of an expansion of traditional inputs on production; (2) yield effects, reflecting the importance of nontraditional inputs in production; (3) locational effects, meaning shifts in production from high (or low) potential

regions which tend to reinforce the effects of technology and investment in physical capital; and (4) cropping pattern effects, defined as shifts into higher (or lower) value crops, representing changes in relative prices or internal demand and changes in technology.[2] However, it is important to note that most do not explicitly explore the relative roles of price and nonprice factors in inducing growth.

Regional studies for the most part show the relative contribution of yield and area effects being related to the stages of development. Thus yield effects have acquired greater importance relative to area effects over time in Latin America and Asia, in contrast to Sub-Saharan Africa where area effects still dominate.[3] Country studies similarly support a close relationship between the onset of the Green Revolution and the importance of the yield effect.

For India, Narain (1977) documents the fact that changes in cropping patterns to higher priced crops and shifts in area to more productive regions accounted for 69 per cent of total growth in India in the 1950s. In the 1960s, however, yield effects dominated, accounting for as much as 61 per cent of total growth (Table 1a). Hossain's analysis (1980) of post Green Revolution Bangladesh finds for cereals that technological factors, specifically the adoption of modern varieties, similarly contribute the major share in overall growth. In Mexico, between 1940 and 1986, area effects have also diminished in importance, providing a negative influence on growth in recent periods as land was taken out of production. The contribution of yield has dominated in latter periods, rising from 27.3 per cent in the 1940-55 period to 62.5 per cent in 1955-72, and falling slightly to 51.6 per cent as changes in crop composition became increasingly more important (Table 1b).

Technology's influence on production growth also causes shifts in location and crop composition. Ranade (1986) and Bindlish (forthcoming) find that shifts in location to more productive regions and increases in total area explain an increasing proportion of the growth in rice production in India in the post Green Revolution period, as opposed to yield effects. But these changes were largely the result of an increase in the multiple-cropped area, a direct result of technological breakthroughs in rice. Furthermore, technological change helped tap the comparative advantage of the more productive regions in India providing benefits associated with locational changes. Lele and van der Walle (1988) observe the increasing importance of cotton in Francophone Africa in the 1970s as being mainly due to the introduction of modern technologies that greatly expanded yields and returns to producers. Lele (1988b), in a study of six countries in Africa,[4] notes large shifts from (higher value) export crops to food crops in all countries analysed, except in Kenya and in Malawi's estate agriculture. As will be discussed below, differences among these countries can be attributed primarily to differences in nonprice factors such as access to technological change and other nontraditional types of capital.

MEASURING THE IMPACT OF PRICE AND NONPRICE FACTORS ON GROWTH

While there is a clear consensus in empirical studies about the strong role of relative prices in allocating resources among crops, few studies analyse the

TABLE 1A *Absolute changes in productivity per hectare, India 1954/55 to 1961/62 and 1961/62 to 1972/73 (in Rupees).*

	1954/55 to 1961/62	1961/62 to 1972/73
Cropping pattern effect		
(a) Pure	-14.4	15.6
(b) Interaction	1.0	7.8
(c) Sub-total (a + b)	–12.4	23.4
% of Total	(35.2)	(30.5)
Locational effect		
(a) Pure	–2.1	3.4
(b) Interaction	–9.7	3.0
(c) Sub-total (a + b)	–11.8	6.3
% of Total	(33.8)	(8.3)
Pure yield effect	–10.8	46.9
% of Total	(30.9)	(61.2)
Total	–35.0	76.6

Note : Sagar (1980) has criticized Narain's use of 1961/62 as the base period for decomposing growth between 1952/53 and 1961/62. According to Sagar, the change of base periods changes the estimates of the pure effects, while those of the interaction effects remain unchanged. Ranade (1986) confirms Sagar's conclusion for cropping pattern interaction, although the charges that the locational interaction effect also changes with the base period.

Source: Narain (1977).

TABLE 1B *Average annual growth in the total value of agricultural output, Mexico (per cent contribution)*

	1940-55	1955-72	1972-81	1983-86
Total agriculture	5.5	4.8	3.1	–0.9
Area contribution	3.0	2.6	0.4	–2.0
	(54.5)	(54.2)	(12.9)	(222.2)
Yield contribution	1.5	3.0	1.6	0.9
	(27.3)	(62.5)	(51.6)	(–100.0)
Composition contribution	0.9	–0.8	1.1	0.2
	(16.4)	(–16.7)	(35.5)	(–22.2)
Agricultural GDP as % of total GDP	18.6 (1955)	11.5 (1972)	8.8 (1981)	9.7 (1986)

Source: From Issa (1988).

aggregate supply response to intersectoral terms of trade. Chhibber (1988), in his recent survey, classifies existing estimates between short-run and long-run elasticities, and further into those based on: (1) cross-sectional country studies; (2) general equilibrium studies; (3) time-series studies; and (4) cross-sectional farm studies. Peterson's (1979) cross-country study shows much higher elasticities, of the order of 1.3 to 1.7, than any reported below, but his assumption of a common production function is suspect given substantial known differences among countries in techniques of production. Cavallo and Mundlak's general equilibrium model for Argentina (1982) also shows a higher elasticity – 0.9 per cent – than other estimates reported by Chhibber. The former portray technical change as embodied in capital formation which is, in turn, made possible by changes in intersectoral terms of trade.

As would be expected, Chhibber shows that time-series estimates of elasticities for developed countries are generally greater than unity, whereas for developing countries they are less than unity. Also, within developing countries, there seems to be a clear gradation in long-run supply elasticities. Argentina, for example, where land is in surplus and accumulated human and physical capital is considerable, has the highest range of measured elasticities, between 0.42 to 0.78 per cent (or 0.9 by adding to Cavallo and Mundlak's study). In India, on the other hand, where land is far more scarce and physical and institutional capital much less developed, elasticities range between 0.13 and 0.63 per cent. Aggregate production response to prices in Africa is usually quite low, because of shortages in institutional and physical capital. In Kenya – one of the more advanced African countries – and Ghana, for example, measured elasticities range from 0.16 and 0.34 per cent.

TABLE 2 *Response of output, area, and yield to changes in price of wheat, Punjab (India), 1952/53 to 1979/80*

	Elasticity with Respect to					
	Wheat	Price$_a$	Fertilizer	Price$_a$	Irrigation$_a$	
Dependent Variable	I	II	I	II	I	II
Production	0.08	0.52[b]	–	–0.29[b]	2.55[b]	1.69[b]
Area	0.03	0.02	–	–0.06	–0.10	–0.68[b]
Yield	0.05	0.50[b]	–	–0.23[b]	2.66	1.00[b]

Note: [a]I and II refer to pre and post green revolution periods, respectively.
[b]Statistically significant at 5 per cent.

Source: Ranade, Jha, and Delgado (1988).

The elasticity of production with respect to nonprice factors typically tends to be greater than for price factors. This has been shown consistently for India in the case of the roles of prices *vis-à-vis* irrigation in explaining wheat and rice production growth (Table 2). A cross-sectional study of fertilizer use across several rice-producing countries in Asia reported by Chhibber presents the same general phenomenon.

Lele and Meyers' study of Kenyan agriculture (1987) – while recognizing the strong role of price incentives – stresses the importance of public sector investments in the processing of smallholder tea and coffee and especially Kenya's 'tea roads' in the production growth of these crops since the 1960s. These factors are not easily modelled in econometric estimations of supply elasticities, a fact which tends to overstate those estimates. In the face of similar price incentives, the distribution of access to nonprice factors among smallholder and estate agriculture has produced a similarly uneven response. Despite one of the best smallholder-orientated services in the developing world in Kenya, imperfections in labour markets and inadequate access to widening capital for hiring labour inhibited Kenya's smallholder tea and coffee producers from intensifying their production. On the other hand, the estates' greater ability to mobilize capital and labour, obtain purchased inputs and gain access to knowledge led to rapidly rising estate yields which were over twice those of smallholder yields in tea production, and 80 per cent higher in coffee production (Lele and Agarwal, 1988).

Price factors do explain some of the shift from export to foodcrops in Africa, however. Prices in Tanzania, Nigeria and Cameroon were particularly biased against export crops for a prolonged period, in the former two countries due to the overvaluation of the exchange rate, despite some direct subsidization of export crops, and in the latter due to the direct taxation of agriculture. Tobacco prices in Tanzania dropped 72 per cent relative to the price of maize between 1971 and 1985. And in Nigeria, which was once a world leader in exports of cocoa and palm oil, export prices declined by as much as 50 per cent relative to rice between the mid-1970s and mid-1980s (Lele, 1988b). These changes in relative prices, combined with rapid growth in incomes and domestic demand associated with Nigeria's oil boom, made Nigeria a net importer of many crops, including palm oil, and also led to increases in internal food prices.

That technological change can overcome an adverse price environment by reducing unit costs and increasing returns is demonstrated abundantly by Nigeria's example. For example, World Bank funded cocoa projects during the height of Nigeria's oilboom exceeded all production targets, in spite of an overvalued exchange rate that implicitly taxed production costs. The use of improved planting material in those projects made possible returns to labour that were fully competitive with the rapidly rising nominal wages in the nonagricultural sector. Unfortunately, various factors, including expectations of poor cocoa market prospects and conflicts between the federal and the state government regarding the financing of cocoa, led the Bank to discontinue funding of those projects (Lele *et al.*, 1988).

In cotton development in Africa, similarly, Lele and van de Walle (1988) further document the dominance of technology relative to prices. Cotton producer prices were substantially lower in Cameroon than in Kenya, Malawi or Nigeria in both nominal and purchasing-power-parity exchange rate terms. However, Cameroonian cotton yields were over 10 times those in Nigeria and nearly 7 times greater than in Kenya. Unlike Nigeria, Cameroonian cotton production also increased despite a substantial decline in the relative prices of cotton *vis-à-vis* maize. In the 1980s, they were only one third of those in the early 1970s – a result of the 'Dutch Disease Syndrome'. The increased access of cotton

producers to technology and services provided by SODECOTON, a paternalistic public sector organization, explains why returns to labour use in cotton were higher than in the rather high wage nonagriculture sector. In contrast, both cotton and foodcrop production in Nigeria have been hamstrung by the failure of the research system to generate appropriate technology for small farmers, unintegrated food markets due to poor infrastructure and the lack of credit and information for traders (Lele *et al.*, 1988).

Nigeria's example illustrates that government and donor pessimism since the early 1970s about expected export market prospects was associated with a confusion between absolute and comparative advantage in the dispatch of policy advice by donors to African governments as well as a confusion between the individual and global interests of producers. This contributed significantly to the shift of government and donor financed investments out of export crops to food crops in Africa explaining in part the loss of export markets by Africans (Lele, 1988b).

The various examples cited above also provide some additional insights into the extent to which distortionary prices may necessarily constitute a disincentive to production. Where a strong comparative advantage in particular crops or activities exists, such as cocoa in Nigeria and cotton in Cameroon, the use of resources in such an activity may be profitable compared to the next best option in spite of rather significant price distortions, especially when modern technology is introduced and efficient services are offered to small farmers for their production. By the same token, a strong price advantage for export crops may not necessarily ensure allocation of resources by small farmers to the production of these crops, if for instance uncertain food supply in the market heightens food insecurity. In such a case, increasing the productivity of the foodcrops concerned or developing reliable food markets by investing in roads and other constraining factors may be the more realistic option to release resources for the production of export crops rather than raising export crop prices. The use of price distortions may even be necessary to improve income distribution (among regions or classes of farmers), to reduce risk in the adoption of new innovations, to mobilize government revenues, or to bridge the gap between private and social gain - as in the use of fertilizers to maintain soil fertility for future generations (Lele and Christiansen, 1988). Finally, price distortions may also be necessary to prevent production increases of certain crops in which a country is a large producer and for which world demand is inelastic.

Mellor (1978) has argued that, in the case of foodcrops, using nonprice factors to obtain aggregate supply responses may be more desirable from the view point of protecting the incomes of the poor. In India, since expenditures on food consumption constitute nearly 60 per cent of the total expenditures of the landless and marginal farmers who depend on the market for food supplies, price increases have a substantial adverse effect on their real incomes. With growing population pressure, market dependence for food by small and marginal farmers is increasing in Africa.[5] Increased food prices, in turn, increase the cost of wage labour and decrease the competitiveness of labour in the manufacturing sector, as has been the case in Nigeria.

Given the relatively greater importance of nonprice factors, even after taking into account the indirect effects of adverse macroeconomic policies on agricul-

tural prices, allocating resources to nonprice investments may also be more efficient than increasing prices. Based on a CGE model of India, de Janvry (1985) estimates that, compared to the alternative of price support (with food subsidies to maintain consumer prices) versus groundwater irrigation and high yielding varieties, the present value cost advantage of the latter over the former is 680 per cent at an interest rate of 8 per cent.

Finally, we should reiterate the difficulty of diagnosing appropriate prices to which to respond. As pointed out in the case of African countries earlier, governments do seem responsive - but often in a counterproductive manner - to price shifts that are due to relatively short-term demand shifts. For example, Levine *et al.* (1988) documents a sharp decline in irrigation investment in Southeast Asia due to the decline in projected rice prices in the 1980s, as well as the previous cyclical changes which put lagged production responses in counter-response to actual prices. Hayami (forthcoming) shows similar, counterproductive shifts in public investment in agricultural research.

THE ROLE OF PUBLIC GOODS

It is evident from the preceding discussion that the generation of modern technology and the associated use of increased inputs requires substantial investment in nontraditional types of capital, such as research and extension facilities, education and other institutions. Rural infrastructure, such as roads, irrigation, drainage systems, communications networks and delivery systems, is necessary to provide farmers with access to markets for modern inputs and for their increased output. All these forms of capital have externalities but require lumpy investments on a scale which small farmers cannot always mobilize. A great deal of such investment must inevitably be undertaken by the public sector at the early stages of development. The common feature of the success achieved in Japan and Taiwan, China is that each created such an effective set of public goods.

In Bangladesh, similarly, improved infrastructure has paved the way for major growth linkages and multipliers. Areas with good infrastructure use 92 per cent more fertilizer per hectare than areas with poor infrastructure. The linkage effects of that growth produced a level of nonagricultural employment that was 30 per cent higher than the poor infrastructure areas, and wage rates that were 12 per cent higher (Ahmed and Hossain, 1987). In much of Africa, however, the scarcity of rural roads means that marketing margins between producers and customers are as much as four times higher than in Asia, reducing returns to producers and limiting the potential for growth in their production (Ahmed and Rustagi, 1987).

Finally, the proper balance between price and nonprice factors (especially technological change and institutional development) can lead not only to rapid and equitable growth in the agricultural sector, but to sustained growth throughout the domestic economy. This is especially the case in countries where land access is relatively equitable - unlike much of Central and South America where the concentration of landholding and the consequent skewed income distribution can result in spillage of the bulk of demand into the import sector. In contrast,

in much of Asia and Africa, important *domestic* linkages and multipliers are created in the nonagricultural sector through the income growth of a large number of small producers in agriculture (Mellor, 1976; Mellor and Lele, 1973). Thus, broad-based agricultural growth results in substantial growth in employment and incomes in the rest of the economy.

Why do such linkages frequently not materialize? Whereas economies of scale do not necessarily obtain in agricultural production - and there may even be diseconomies associated with increased management requirements of large farms using improved technology (von Braun, *et al.*, forthcoming) - scale economies do hold in the provision of services, that is, in research, input supply, marketing, and other support institutions, providing an incentive for governments who are short of trained personnel and institutions to opt for large-scale agriculture. In addition, for these powerful international growth linkages to materialize requires major public investment in transportation and communications infrastructure. Bautista (1988) documents the sharp differences among countries in the extent to which potential linkages are actually realized.

To put it in a different way, the provision of public goods to make small farmers productive is much more demanding of public sector human and institutional capital than that needed to make large-scale estates productive. If countries are short of human and institutional capital, it is tempting to invest in large-scale production despite the fact that domestic resource costs of smallholder production may well be lower relative to those of large-scale estate production (Lele and Agarwal, 1988). Underinvestment in human and institutional capital relative to physical capital may result from the failure of governments and donor agencies to recognize the nonhomogeneity of different forms of capital and the importance of knowledge as the engine of growth. The resulting shortages of planning and implementing capacity may result in the continuation of premia placed by governments on large-scale production. The role of donors in perpetuating this state of affairs must not be overlooked. In Africa, between 35 and 65 per cent of government expenditures and public investments since the early 1970s in many countries have come from foreign assistance (Lele, 1988b), and both governments and donors have grossly underemphasized the importance of establishing human and institutional capital. This explains, in part, why estate agriculture has been more productive in Malawi and Kenya compared to smallholder agriculture.

CONCLUSION

As land pressure increases, the need to intensify smallholder agriculture and to increase productivity becomes urgent in many parts of Asia, Latin America, and Africa, especially as the adjustment process moves the relative terms of trade in favour of agriculture, reducing urban wages and opportunities for employment in the public sector. Adjustment places a greater burden on the agricultural sector to 'deliver' growth than ever before. For this to occur, however, governments and donors will have to place greater faith in the Marshall-Schultzian dictum of knowledge as the engine of growth and the need for public investment in different forms of human, physical, and institutional capital to achieve the unbounded

growth that increasing returns promise for the mass of small producers. While they will have to ensure that the agricultural sectors are not inordinately heavily taxed for a prolonged period, thereby discouraging growth, price incentives by themselves are unlikely to result in a strong aggregate supply response for which complex public policy is critical.

NOTES

[1]An updated discussion of this issue may be found in Fischer (1987).

[2]Use of this methodology serves mainly a descriptive purpose. Alauddin and Tisdell (1986) note a number of problems with this methodology, including its dependence on the assumption of constant returns.

[3]For developing countries as a whole, growth in yields contributed 70 per cent of the production increase in the 1960s. That share increased to 80 per cent in the 1970s. For Sub-Saharan Africa yields made no contribution to growth in the 1960s and contributed only 50 per cent in the 1970s (Paulino, 1986).

[4]The study is part of the World Bank's project on Managing Agricultural Development in Africa (MADIA), covering Kenya, Tanzania, Malawi, Nigeria, Cameroon, and Senegal .

[5]In Kenya, for instance, 50 per cent of the maize consumed by smallholder producers in the Eastern province is purchased in the market, and in Malawi, 80 per cent of the smallholder households in the crowded Southern region are dependent on the market for maize (Lele, 1988a and 1989).

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DISCUSSION OPENING–ROBERT EVENSON

Uma Lele and John Mellor address themselves to an important dimension of agricultural development, the determinants of agricultural growth. Agricultural growth has been accorded different emphases over the roughly four decades of modern emphasis on economic development. It was given low emphasis, at least by general development policy-makers, in the first decade, the late 1940s to late 1950s, when industrial policy was given emphasis. In the second decade, the late 1950s and early 1960s, it gained prominence, partly because of the recognition of the problems that emerge when food production growth is lower than population growth. Major foundations for technology-producing and extending institutions were established during this time. (This included the IARCs.) The green revolution decade, the late 1960s and early 1970s, changed the perception of the role of growth. Its importance was, in one sense, accentuated, but this was also a decade when unrealistic expectations regarding growth were formed. The Green Revolution was seen as an easy solution to many problems; these expectations were not realized.

In the most recent decade, the post green revolution decade, policy has been dominated by world market events, external debt problems, low food prices, and so on. Agricultural growth, however, has moved back to centre stage because non-growth orientated policies have performed poorly. In their paper, Lele and Mellor provide us with a general perspective on growth. They briefly review several growth-theory contributions with a view to identifying price and nonprice factors in growth.

The paper also addresses three bodies of empirical literature:

1 Yield - productivity - accounting.
2 Supply response studies.
3 Several public goods case studies.

They conclude that:

(a) The supply response literature indicates that changing prices explain relatively little agricultural growth.
(b) The yield accounting literature shows that nonprice factors, i.e. yield increase, have been important.
(c) The case studies, and related evidence generally, support a strong complementarity or interaction between the price and nonprice factors in explaining growth.

I have the following general comments on the paper.

(i) The theory literature cited does not support the notion of complementarity between price and nonprice factors.
(ii) The empirical literature reviewed have, by and large, also not addressed the interaction.
(iii) The case studies discussed do indicate some interaction but the case for the interaction remains undeveloped.

Actually the relationship between prices and growth is complex because growth affects prices. For a given set of technologies, an output price increase relative to input prices will produce a 'once-for-all' increase in production. This will change output growth in the short run but not in the long run. A long-run change would require continuously increasing prices. Agricultural prices in real terms have generally been declining, not increasing, over long periods. This is because nonprice factors – chiefly technology – have been contributing to production and supply growth. Even if supply elasticities to price were much higher than they are estimated to be, prices cannot explain very much growth because they do not rise over time.

The growth theory literature, with the exception of the induced innovation models, does not address the relationship between prices and nonprice factors. Indeed, the work of Solow and others was designed to enable a separation of growth into a price-induced inputs component and a residual which is implicitly due to nonprice factors. The yield accounting studies reviewed by Lele and Mellor do not consider inputs other than land (and irrigation) and thus are not fully consistent with this literature. (The substantial body of total factor productivity literature in agriculture was not reviewed by Lele and Mellor.)

The induced innovation literature has concentrated on the valuation of alternative packages of technology under different relative prices of inputs. It predicts that technology producers will seek to maximize the value of the technology from a given research programme by changing research direction. Thus relative factor prices will influence the direction of research but not necessarily the level of research activities. This theory thus does not effectively address the role of relative output/input prices.

Since most investments in agricultural research are in the public sector, the role of prices in guiding such investment must be explored in the context or public goods investment models. Induced innovation motives may play a minor role in such models. Actually public goods models raise the possibility that nonprice factors may be used as substitutes rather than complements to prices. (There is little empirical support for this proposition, however.)

Lele and Mellor do discuss several issues that have more to do with the *valuation* of technology than to do with *investment* in technology. Much technology may be imported from outside the economy or produced without regard to prices. Price relationships in a given economy may then affect the actual value of existing technology in a significant way. The low implicit rental price of land, for example, in some African countries, may mean that existing technology will have a lower value in these economies than in land-scarce economies.

The duality-based systems of supply equations and factor demand equations

that are now being used widely in technology studies offer an opportunity to examine some of these price-technology interactions. At present, such studies do not allow for such interactions, but the induced innovation concept can be used to develop interaction specifications.

The recently developed treatments of imperfect and interlinked markets in agriculture also suggest some price/non-price interactions although they are less clear. When transaction costs are high, economic units tend to be subsistence in character. In family farms, then, the implicit shadow price of leisure (or work) may vary greatly between farms. Thus the valuation placed on alternative technologies that may be used could also vary greatly. This, in turn, would retard adoption and experimentation with technology.

The basic thesis that unfavourable farm prices (through one or another form of taxation) lower the value of existing or potential technology and retard its adoption is used to explain poor economic growth in agriculture in low-income countries. At the same time, it is argued in other studies that economic stress introduced into advanced protected agriculture may accelerate technical change. There clearly is value for further analytic and empirical studies to clarify the role of price/non-price relationships in agricultural growth. The case studies reviewed and interpreted by Lele and Mellor offer some useful starting points for further work.