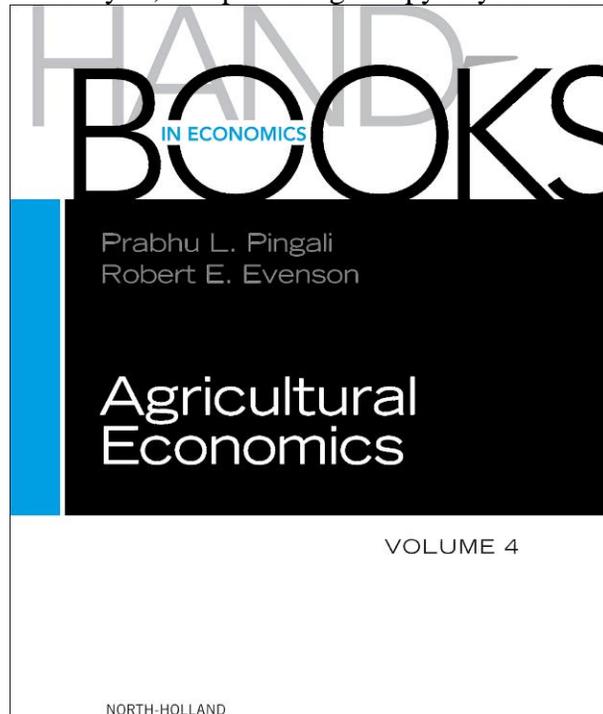


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Total Factor Productivity Growth in Agriculture: The Role of Technological Capital

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Abstract

In this chapter we compute measures of total factor productivity (TFP) growth for developing countries and then contrast TFP growth with technological capital indexes. In developing these indexes, we incorporate schooling capital to yield two new indexes: Invention-Innovation Capital and Technology Mastery. We find that TFP performance is strongly related to technological capital and that technological capital is required for TFP and cost reduction growth. Investments

in technological capital require long-term (20- to 40-year) investments, which are typically made by governments and aid agencies and are the only viable escape route from mass poverty.

JEL classifications: Q16, Q18, Q11, O13, O47

Keywords

total factor productivity

technological capital

crop production

livestock production

aggregate production

1. INTRODUCTION

This chapter has two objectives: The first is to compute measures of total factor productivity (TFP) growth for developing countries utilizing data from the Food and Agricultural Organization (FAO) of the UN. The second is to define and contrast indexes of technological capital for agriculture in developing countries and to relate these indexes to TFP growth and other indicators of economic performance in agriculture.

FAO publishes data on production of crops and livestock. FAO also publishes data on cropland, pastureland, labor used in agriculture, fertilizer, seeds, tractors and combine harvesters, and animal stocks. We utilize these data to calculate rates of change in TFP for crop production, livestock production, and aggregate agricultural production for two periods, 1961–1980 and 1981–2001.

These calculations have clear limitations, given the nature of the data on which they are based. The first limitation is that we only compute rates of change in TFP. TFP “levels” cannot be compared across countries. The second and most important limitation is that we do not make adjustments for input “quality” changes. Although in section 7 we did some adjustments for labor quality indirectly in the analysis of the determinants of TFP changes using schooling and nutrition indices applied to the labor force data (Table 10).

There is one merit, however, to these raw TFP growth calculations relative to calculations in the literature, and that is that these calculations have a “standardized” quality. A common methodology is applied in the calculation of share weights for all countries. A common time period is utilized for all countries. The fact that we have not attempted input quality adjustments also contributes to the standardized nature of the calculations.

Our second objective in this work is to develop indexes measuring technological capital. Two forms of human capital in economics have been in use for some time. We are proposing a third. The oldest form of human capital is *schooling capital*. We incorporate schooling capital in one of the technological capital indexes. In recent years, the term *social capital* has begun to be used to measure membership in social and political organization and activities associated with such memberships, including communication networks. We do not make use of this concept in this chapter.

We introduce two new indexes of technological capital. The first is Invention-Innovation Capital (II). This index is designed to measure the capacity to invent and innovate. The term *invention* includes “adaptive” inventions. The term *innovation* is used to describe activities required to “commercialize” an invention by producing products embodying the invention.

Our second technological capital index is a Technology Mastery (TM) index. This index is motivated by activities associated with technology mastery, where a producer masters techniques of production first developed by others.

Section 2 of this chapter discusses the methods used to construct estimates of TFP growth. Section 3 summarizes TFP estimates by country and region. Section 4 introduces and defines the Invention-Innovation Capital and Technology Mastery Capital Indexes. Section 5 reports an analysis of changes in technology capital. Section 6 reports relationships between technological capital and TFP growth. Section 7 reports more general “TFP decomposition” estimates. Section 8 discusses technology policy issues.

2. METHODS FOR TFP MEASUREMENT

TFP indexes can be derived in several comparable ways. The least restrictive derivation is from an accounting relationship in which the value of products is equal to the value of factors used to produce these products.

2.1 The accounting relationship derivation

Consider:

$$\sum_i P_i Q_i = \sum_j R_j I_j, PQ = RI \quad (1)$$

where P_i are product prices, Q_i product quantities, R_j input prices and I_j input quantities. P and R are price vectors, Q and I product and input vectors.

This accounting relationship simply requires that inputs, I_j , receive payments, R_j , that exhaust the total value of production ($\sum P_i Q_i$). It does not require that all producers be technically efficient in the sense that they produce on a production function. Nor does it require that producers are allocatively efficient.

When Eq. (1) is expressed in a “rate of change” form, the resultant expression is:

$$\sum_i Q_i \frac{\partial P_i}{\partial t} dt + \sum_i P_i \frac{\partial Q_i}{\partial t} dt = \sum_j I_j \frac{\partial R_j}{\partial t} dt + \sum_j R_j \frac{\partial I_j}{\partial t} dt \quad (2)$$

Now divide both sides of Eq. (2) by $\sum_i P_i Q_i$ and multiply the two right-side terms by R_j/R_j and I_j/I_j . Note that $\frac{I_j R_j}{\sum I_j R_j} = C_j$, the cost share of factor j .

The rate of change in a variable is defined as:

$$\hat{I}_j = \frac{1}{I_j} \frac{\partial I_j}{\partial t} dt$$

Thus, $\hat{P} + \hat{Q} = \sum_j C_j \hat{R}_j + \sum_j C_j \hat{I}_j = \hat{R} + \hat{I}$ when TFP is constant.

The residual TFP growth then can be measured in two equivalent ways in a closed economy in competitive equilibrium:

$$G_{TFP} = \hat{R} - \hat{P} \quad (3)$$

and

$$G_{TFP} = \hat{Q} - \hat{I} \quad (4)$$

With international trade, the price relationship will not necessarily hold, but the $\hat{Q} - \hat{I}$ relationship holds in all economies.

Note that:

$$\hat{Q} = \sum_i S_i \hat{Q}_i \quad (5)$$

where S_i is the share of product i in total output, and

$$\hat{I} = \sum_j C_j \hat{I}_j$$

where C_j is the cost share of input j in total costs.

This relationship can also be derived from a minimized cost function, and as a result, G_{TFP} is also a measure of cost reduction at constant factor prices.

2.2 Production growth rates

For calculations from FAO data, we make an approximation for estimating \hat{Q} . FAO publishes “indexes” of crop (I_C), livestock (I_L), and aggregate (I_A) production for each country for the 1961–2001 period. Because production is affected by weather, we first form three-year moving averages of each index and then estimate the following for two periods, 1961–1980 and 1980–2001:

$$\begin{aligned} \ln(I_C) &= a + b_C \text{Year} \\ \ln(I_L) &= a + b_L \text{Year} \\ \ln(I_A) &= a + b_A \text{Year} \end{aligned} \quad (6)$$

The coefficients b_C , b_L , and b_A are geometric rates of change in the indexes. Note, however, that the indexes are actually Laspyres indexes using FAO dollar prices. Given the complexities of the number of commodities and the year-to-year variability, we argue that this approximation is not a serious departure from the accounting framework. Output growth rates for 20 Latin American, 21 Asian, and 37 African countries are reported in [Appendix 1](#).

2.3 Input growth rates

For inputs, the same procedure was used to estimate growth rates for the two periods. The inputs for crop and livestock production were:

Crops: Cropland, labor, fertilizer, animal power, machine services (tractors plus harvesters)

Livestock: Pastureland, labor, fertilizer, animal capital, feed

FAO reports data series for cropland, pastureland, labor, and fertilizer. For animal power, the total of horses and mules was the series used. For machine services, tractors plus combine harvesters formed the series. Animal capital was based on cattle numbers.

Feed estimates are from [Nin, Arndt, Hertel, and Preckel \(2003\)](#). These authors transformed the total of feed consumed by animals (for all products) from the FAO database in terms of Mcal of metabolizable energy for ruminants per kg of feed (not on a dry-matter basis) based on the *United States-Canadian Tables of Feed Composition: Nutritional Data for United States and Canadian Feeds* (1982). In a second step, they transformed the total feed for each country in tons of corn equivalent, dividing the total of energy by the content of energy in a kilogram of corn. In our study we used this total of feed to estimate the annual growth rate for feed in each of the 78 developing countries and for each of the two periods of analysis.

Input growth rates are reported in [Appendix 2](#).

2.4 Input cost shares

The starting point for establishing input cost shares was that studies for Brazil ([Avila and Evenson, 1995](#)) and India ([Evenson and Kislev, 1975](#)) reported carefully measured share calculations. For India, share calculations for crop production are available for 1970 and 1985. For Brazil, share calculations are available for both crop and livestock production for 1970 and 1990 based on Agricultural Census data.

For crop production shares, “adjusted” India shares were applied to Asian and African countries. Adjusted Brazil shares were applied to Latin American countries. The adjustment process requires computing quantity cropland ratios for fertilizer quantities, seed quantities, number of work animals, and number of tractors and harvesters. These quantity/cropland ratios were then expressed relative to Brazil or India ratios. Cost shares to Brazil were as measured in Brazil studies. For other Latin American countries, the cost shares for fertilizer, seed, work animals, and machine services were scaled using the country/Brazil comparisons. The shares of cropland and labor were adjusted proportionately so that the sum of shares equaled 1.

The same procedure was applied to obtain African and Asian shares, using Indian shares as the comparison.

For livestock shares, only Brazilian shares were carefully measured. The adjustment process called for creating quantity/value ratios in real U.S. dollars for fertilizer, animal capital, and feed. The shares for fertilizer, animal capital, and feed were adjusted by comparing these quantity/value ratios to Brazil shares. The pastureland and labor shares were adjusted proportionately so as to sum to 1.

For inputs with exceptionally high growth rates (see [Appendix 2](#)) a further adjustment was required to reflect the fact that over a 20-year period the midpoint share overstates the average geometric shares. Input growth rates were compared to production growth shares for this adjustment.¹

All input shares are reported in [Appendix 3](#).

For aggregate TFP growth, livestock and crop shares in aggregate value were used to weight crop and livestock TFP growth (Prasad Rao and T. Coelli, 2003).

3. TFP ESTIMATES BY REGION AND COUNTRY

3.1 Latin America and the Caribbean

[Table 1](#) reports TFP growth estimates for Latin American and the Caribbean countries for crop, livestock, and aggregate TFP growth. The average TFP growth for both periods is also reported. Regional TFP growth rates are weighted by cropped area.

For the 1961–2001 period, only three Latin American countries—Uruguay, Guatemala, and Panama—experienced TFP growth rates below 1%. (This is roughly the rate of decline in the real prices of farm commodities; see [Figure 1](#).)

Table 1 TFP Index growth rates for Latin America and Caribbean Countries, 1961–1980 and 1981–2001

Region/Country	Agricultural TFP Growth Rates (%)						
	Crops		Livestock		Aggregate		Average
	1961–1980	1981–2001	1961–1980	1981–2001	1961–1980	1981–2001	
Southern Cone	1.49	3.14	0.72	2.51	1.02	2.81	1.92
Argentina	3.08	3.93	0.90	0.43	1.83	2.35	2.09
Brazil	0.38	3.00	0.71	3.61	0.49	3.22	1.86
Chile	1.08	2.22	0.24	1.87	0.69	2.05	1.37
Paraguay	3.97	–1.01	–0.36	1.29	2.63	–0.30	1.17
Uruguay	1.29	2.02	–0.32	0.53	0.01	0.87	0.44

Continued

Table 1 TFP Index growth rates for Latin America and Caribbean Countries, 1961–1980 and 1981–2001—Cont'd

Region/Country	Agricultural TFP Growth Rates (%)						
	Crops		Livestock		Aggregate		Average
	1961–1980	1981–2001	1961–1980	1981–2001	1961–1980	1981–2001	
Andean	1.11	1.71	1.73	1.92	1.41	1.81	1.61
Bolivia	1.73	3.14	2.81	1.39	2.30	2.33	2.31
Colombia	2.01	1.27	0.49	2.24	1.37	1.73	1.55
Ecuador	−0.74	2.24	0.98	2.51	−0.16	2.34	1.09
Peru	−0.83	1.86	1.86	2.14	0.36	1.98	1.17
Venezuela	2.42	0.87	3.41	1.07	3.03	0.99	2.01
Central America	1.65	1.05	2.77	1.53	2.17	1.32	1.74
Costa Rica	2.86	2.09	1.10	0.75	1.74	1.19	1.47
El Salvador	1.22	−0.87	1.99	1.00	1.77	0.32	1.05
Guatemala	3.31	0.53	0.90	−0.28	1.38	−0.08	0.65
Honduras	1.54	−0.39	2.07	1.91	1.91	1.25	1.58
Mexico	1.53	1.43	3.02	1.63	2.26	1.51	1.89
Nicaragua	1.33	−0.70	2.94	1.92	2.25	0.99	1.62
Panama	2.29	−1.33	1.61	1.49	1.93	0.02	0.97
Caribbean	0.66	−0.89	2.60	2.06	2.07	0.87	1.47
Dominican Rep.	0.99	−1.15	1.88	2.60	1.62	0.89	1.25
Haiti	0.60	−1.04	3.44	1.80	2.73	1	1.87
Jamaica	−0.65	1.32	3.28	−0.35	2.07	0.29	1.18
Average rate	1.46	2.40	1.42	2.21	1.39	2.31	1.85

The Southern Cone countries had the best TFP performance; the Caribbean countries had the worst (largely because of poor crop productivity performance in the 1981–2001 period). Aggregate TFP performance as well as crop and livestock TFP performance was better in the 1981–2001 period for countries in the Southern Cone and Andean regions. For Central America and the Caribbean, the 1981–2001 period showed slower TFP rates than the 1961–1980 period.

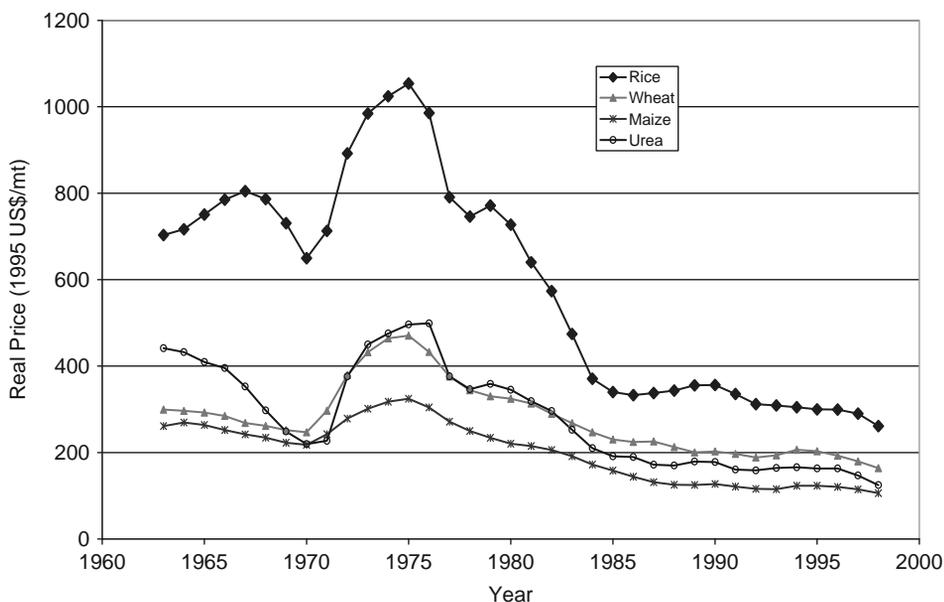


Figure 1 Real-world prices of rice, wheat, maize, and urea (five-year moving average), 1961–2000. Source: IFPRI.

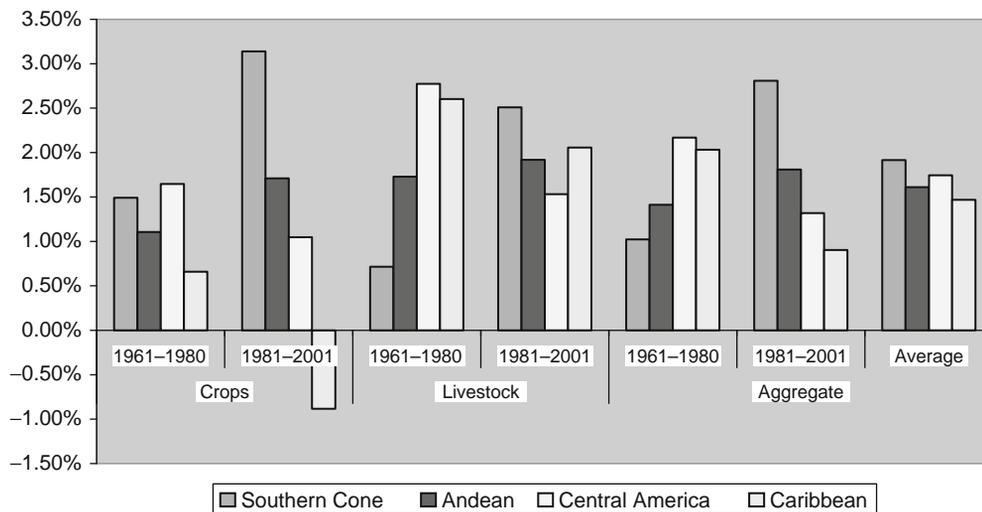


Figure 2 Agricultural TFP growth rates for LAC region, 1961–1980 and 1981–2001.

These results, in general, are very similar to those obtained by other authors for Latin American countries, e.g., [Avila and Evenson \(1995\)](#) and [Gasquez and Conceição \(2001\)](#) for Brazil, [Lema and Parrellada \(2000\)](#) for Argentina, and [Romano \(1993\)](#) for Colombia.

TFP growth rates for LAC subregions are also shown graphically in [Figure 2](#).

3.2 Asia

Table 2 shows the TFP growth rates for the Asian countries calculated for the two periods of analysis, 1961–1980 and 1981–2001, and for crops, livestock, and the aggregate.

The TFP results are also similar to those calculated for Asian countries such as India (Evenson, Pray, and Rosegrant, 1999), Thailand (Krasachat, 2002), Malaysia (Shamsudin, Rhadam, and Abdlatif, 1999), and Vietnam (Ngoc Qu and Goletti, 2001).

Table 2 TFP Index growth rates for Asia, 1962–1981 and 1981–2001

Region/ Country	Agricultural TFP Growth Rates (%)						
	Crops		Livestock		Aggregate		Average
	1961– 1980	1981– 2001	1961– 1980	1981– 2001	1961– 1980	1981– 2001	
Middle East	2.68	0.79	1.76	1.23	2.39	0.98	1.68
Afghanistan	0.63	−0.94	0.94	2.54	0.71	−0.05	0.33
Iran	3.32	2.32	2.37	5.00	2.71	3.17	2.94
Iraq	2.53	−0.06	1.25	−5.81	2.00	−1.24	0.38
Saudi Arabia	4.54	1.22	5.05	3.41	3.58	2.16	2.87
Syria	0.55	2.45	2.62	0.67	1.10	1.94	1.52
Turkey	3.40	0.12	1.43	−0.07	3.06	0.08	1.57
Yemen	1.07	2.50	0.53	2.21	0.93	2.43	1.68
South Asia	1.42	2.14	2.34	2.76	1.71	2.34	2.03
Bangladesh	−0.23	1.06	0.75	2.65	−0.01	1.30	0.65
India	1.54	2.33	2.63	2.66	1.92	2.41	2.16
Nepal	0.20	2.42	1.36	1.11	0.50	2.10	1.30
Pakistan	1.48	1.32	1.17	3.98	1.18	2.54	1.86
Sri Lanka	−0.39	−1.21	−2.19	1.30	−0.93	−0.92	−0.93
South East Asia	2.16	0.34	1.61	2.13	2.37	0.61	1.49
Cambodia	−6.14	2.27	−0.66	0.54	−5.75	1.96	−1.89
Indonesia	3.95	−0.78	3.08	2.41	4.43	−0.39	2.02

Continued

Table 2 TFP Index growth rates for Asia, 1962–1981 and 1981–2001—Cont'd

Region/ Country	Agricultural TFP Growth Rates (%)						
	Crops		Livestock		Aggregate		Average
	1961– 1980	1981– 2001	1961– 1980	1981– 2001	1961– 1980	1981– 2001	
Laos	1.74	1.95	–0.01	3.43	1.20	2.52	1.86
Malaysia	2.95	0.67	3.80	3.70	3.62	1.39	2.51
Philippines	1.62	–1.13	1.87	3.29	1.89	–0.30	0.79
Thailand	1.61	1.04	–0.76	1.26	1.18	1.08	1.13
Vietnam	–0.52	3.94	0.22	0.76	–0.37	3.26	1.45
East Asia	1.39	3.49	2.56	6.52	1.75	4.70	3.22
China	1.39	3.63	2.58	6.59	1.76	4.76	3.26
Mongolia	0.37	–9.48	1.09	–0.02	0.31	–0.54	–0.12
Average rate	1.71	2.02	2.20	3.45	1.92	2.50	2.21

TFP rates for Asian economies over the 1961–2001 period are higher than those observed in Latin America. This is primarily because of the excellent TFP performance of China. The South Asia economies had TFP performance similar to that of the Southern Cone countries in Latin America.

TFP performance varied by period. The Middle East had an excellent performance in the 1961–1980 period but a poor performance in the 1981–2001 period. The same was true for Southeast Asian countries.

Seven countries (Afghanistan, Iraq, Bangladesh, Sri Lanka, Cambodia, the Philippines, and Mongolia) had TFP growth rates below 1%. All were subject to civil strife.

[Figure 3](#) depicts subregional TFP growth rates for Asia.

3.3 Africa

The agricultural TFP growth rates for five African subregions are presented in [Table 3](#).

For Africa as a region, crop and livestock TFP rates were similar. TFP performance was better in the 1981–2001 period, particularly in North Africa and West Africa.

Sixteen of the 37 countries in Africa had TFP growth rates for the 1961–2001 period that were below 1%. Seven had negative growth rates. Both East and Central Africa had regional growth rates below 1%. The results are consistent with those obtained in other studies dealing with Africa such as: Wiebe, Soule & Schimmelpfennig (2002) and Piese, Lusigi, Suhariyanto & Thirtle (2001).

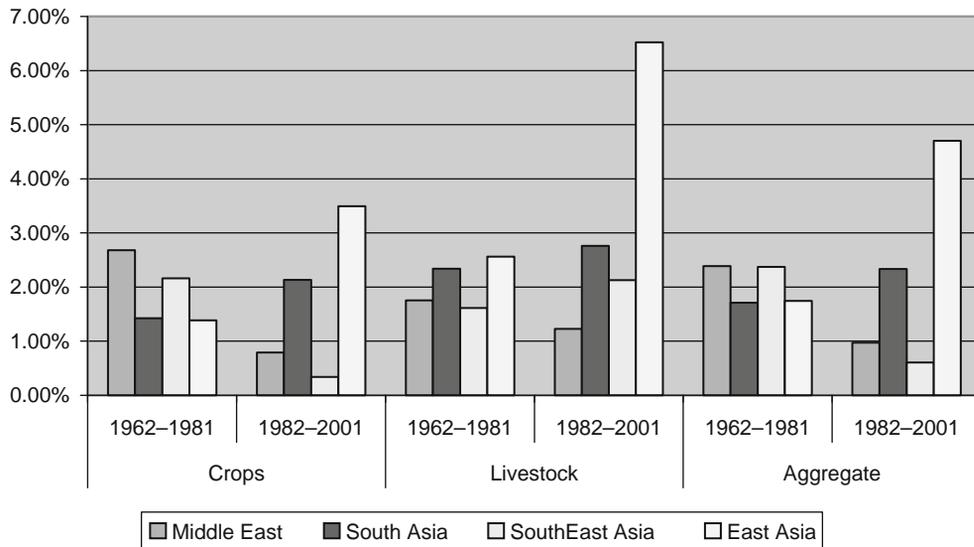


Figure 3 Agricultural TFP growth rates for Asia, 1961-1980 and 1981-2001.

Figure 4 shows African TFP growth by region.

The average TFP index growth for all three world regions for agriculture, livestock, and the aggregate are presented in Figure 5.

A synthesis of the results obtained for all the regions is presented in Table 4, classified by range.

Table 4 shows the poor performance of the African countries; more than 20% of the countries had negative growth in TFP and another 20% had TFP growth rates below 1%. The countries in Asia demonstrated the best performance (30% of the countries had TFP of more than 2%). In the aggregate, Latin American and Caribbean countries also had a good performance, with no negative TFP rates and more than 85% of the countries with TFP growth rates above 1%.

4. DEFINING TECHNOLOGICAL CAPITAL

At least three distinctive types of human resource capital have been used in the context of understanding agricultural TFP performance in developing countries:

- *Human capital* is a term that has been in use for many years. It is generally measured in years of schooling attained by workers in the labor force.
- *Social capital* is a term introduced more recently to capture social relationships in communities and countries. The measurement of social capital is not standardized but must be done in terms of organization, membership, and participation.
- *Technological capital* is a term in limited use to describe the capacity of a region or country to invent new technology and to innovate or commercialize that technology (we call this Invention-Innovation Capital, or II). It is also used to describe the

Table 3 TFP Index growth rates for Africa, 1961–1980 and 1981–2001

Region/ Country	Agricultural TFP Growth Rates (%)						
	Crops		Livestock		Aggregate		Average
	1961– 1980	1981– 2001	1961– 1980	1981– 2001	1961– 1980	1981– 2001	
North	0.78	1.88	2.20	2.12	1.29	1.98	1.63
Algeria	–1.76	2.86	4.08	2.49	0.27	2.69	1.48
Egypt	1.26	3.07	1.54	2.89	1.33	3.03	2.18
Libya	5.86	1.31	3.15	–0.38	5.13	0.76	2.95
Morocco	0.64	0.83	0.36	1.56	0.56	1.10	0.83
Tunisia	2.40	1.84	2.29	3.21	2.37	2.40	2.39
East	0.35	0.62	0.75	0.97	0.68	0.95	0.82
Ethiopia	0.14	1.95	–0.37	0.74	–0.06	1.52	0.73
Sudan	1.47	0.75	1.31	1.24	1.38	1.07	1.22
Uganda	–0.09	0.53	1.76	1.43	0.26	0.67	0.46
Kenya	1.96	–0.16	1.64	1.09	1.80	0.50	1.15
Madagascar	0.29	–0.92	0.62	0.59	0.41	–0.37	0.02
Central	0.97	0.54	1.18	1.32	1.09	0.68	0.89
Cameron	2.09	1.74	2.50	1.80	2.17	1.75	1.96
Chad	–1.41	3.85	0.84	2.48	–0.26	3.39	1.56
Dem. Rep. Congo	0.85	–1.41	–0.56	0.32	0.52	–1.00	–0.24
Rep. Congo	–0.87	–0.41	1.83	1.12	–0.24	–0.05	–0.14
Rep. Central Africa	1.42	0.76	2.98	2.36	1.78	1.14	1.46
Rwanda	1.54	–3.57	3.90	–0.14	1.76	–3.18	–0.71
Western	0.99	3.22	1.73	1.13	1.19	2.93	2.06
Benin	0.51	5.25	3.50	1.99	1.25	4.68	2.96

Continued

Table 3 TFP Index growth rates for Africa, 1961–1980 and 1981–2001—Cont'd

Region/ Country	Agricultural TFP Growth Rates (%)						
	Crops		Livestock		Aggregate		Average
	1961– 1980	1981– 2001	1961– 1980	1981– 2001	1961– 1980	1981– 2001	
Guinea	0.51	2.56	1.05	2.63	0.63	2.58	1.60
Ghana	–1.34	4.32	2.31	–0.14	–0.84	3.93	1.54
Togo	–0.15	2.82	1.09	2.14	0.16	2.70	1.43
Mauritania	–0.56	5.67	0.69	1.33	–0.25	4.90	2.32
Niger	–2.27	1.13	0.73	1.62	–1.13	1.30	0.09
Burkina Faso	0.35	2.42	–0.89	3.49	–0.02	2.73	1.35
Ivory Coast	1.85	0.62	2.81	0.82	1.91	0.63	1.27
Mali	1.47	–2.99	3.14	0.35	2.45	–1.45	0.50
Nigeria	1.83	4.31	1.58	0.94	1.76	3.75	2.75
Senegal	–1.52	4.98	3.98	0.65	0.19	3.46	1.83
Sierra Leone	–1.71	0.34	1.37	3.58	–0.95	0.91	–0.02
Southern	2.06	1.12	1.60	0.26	1.80	0.79	1.30
Angola	1.03	0.82	–0.05	–1.08	0.66	0.23	0.44
Botswana	–3.90	2.13	0.78	0.65	–2.25	1.58	–0.34
Malawi	0.64	–1.21	–0.29	–1.50	0.54	–1.24	–0.35
Mozambique	1.56	1.07	4.07	0.87	1.92	1.04	1.48
Zimbabwe	–1.75	–0.06	0.40	–1.19	–1.16	–0.40	–0.78
South Africa	4.11	2.74	3.05	1.91	3.61	2.32	2.96
Zambia	1.95	–0.28	–0.42	–1.41	1.12	–0.70	0.21
Namibia	2.00	0.56	3.81	2.21	2.64	1.18	1.91
Tanzania	–0.59	–0.40	–0.55	–1.23	–0.58	–0.63	–0.61
Average rate	1.03	1.74	1.49	1.09	1.20	1.68	1.44

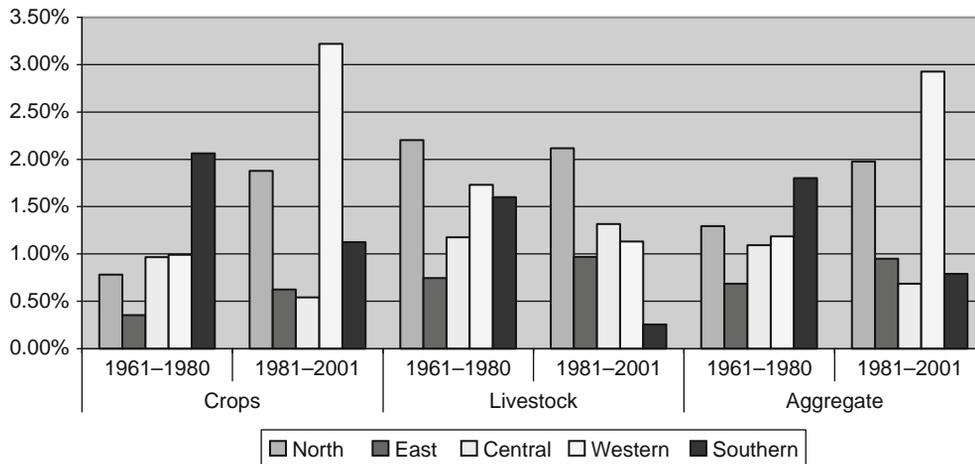


Figure 4 African TFP growth by region, 1961-1980 and 1981-2001.

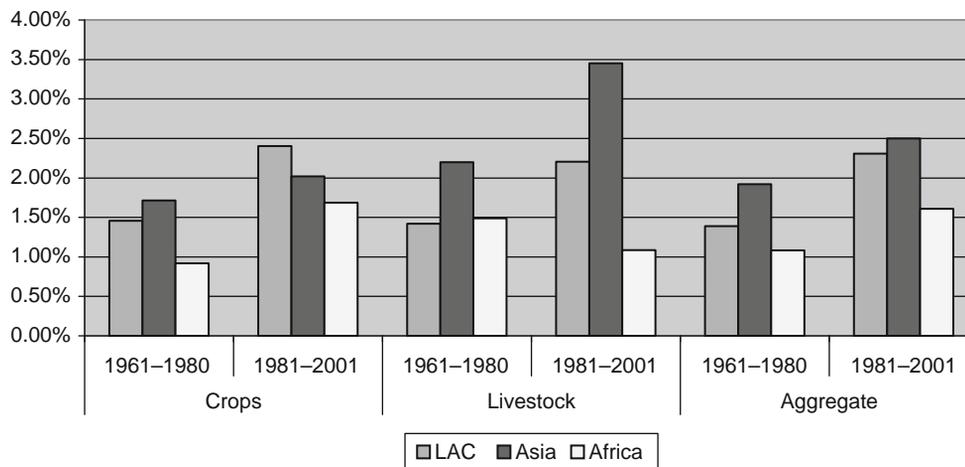


Figure 5 World TFP growth rates, 1961-1980 and 1981-2001.

Table 4 Regional aggregate TFP calculations classified by region

Region	0% > TFP	0% < TFP < 1%	1% < TFP < 2%	TFP + 2%	Total
LAC	—	3	14	3	20
Asia	3	4	8	6	21
Africa	8	8	14	7	37
Total	11	15	36	16	78

capacity to “master” technology produced outside the region or country (we call this capacity Technology Mastery Capital, or TM).

For the agricultural sector, it is well known that crop varieties developed by international Agricultural Research Centers (IARCs) and National Agricultural Research System (NARS) plant-breeding programs have a high degree of location specificity. The field performance of a crop variety depends on soil, climate, and market conditions. The Green Revolution modern crop varieties (MVs), for example, showed a high degree of sensitivity to soil and climate conditions. IARC-crossed MVs were typically released in several countries served by IARC mandates. NARS-crossed MVs, on the other hand, had limited value outside the region for which they were targeted; Evenson and Gollin (2000) report that only 6% of NARS-crossed rice MVs were released in a second country. IRRI-crossed rice varieties were typically released in several Asian countries but had little adoption in Latin America and Africa.

Yet it remains the case that many development programs in agriculture are designed to achieve TFP-based cost reductions through TM. Agricultural extension programs, in particular, are not designed to produce innovations; they are designed to facilitate improved mastery of technology already available to farmers.

In considering mechanical and chemical inventions, however, economists have differing perspectives on “spill-in” potential. Some argue that little investment is required for spill-in. Others argue that a threshold level of R&D in producing firms in a country is required for the development of the capacity to absorb technology from abroad.

Most economists also consider a distinction between domestic goods and international goods. In addition, most economists note that production for the domestic market tends to precede production of international goods for international markets. Most agree that domestic market goods are sensitive to wage rates in the country. Thus, rice harvesting has been undertaken mechanically in the United States for most of the past century. Hundreds of machines have been developed and sold by a number of farm machinery manufacturers. Brazil has realized falling costs of rice harvesting for the past 60 years because of the R&D of these firms. Bangladesh has not, because wages there are low and hand harvesting is still the minimum-cost technique for rice harvesting in Bangladesh. The TM required for effective technology spill-in is almost certainly subject to a threshold investment effect.

Ninety-two developing countries are classified by our two Technological Capital Indexes (78 have TFP estimates). Twenty-five developing countries report no R&D expenditures to UNESCO. An additional 13 countries have the lowest index value, thus at least 25 developing countries, and as many as 38, are simply not investing enough to realize industrial technology spill-in.

The appendix reports all data used for classifying criteria. The classification is done for two periods, 1970 and 1990.

4.1 The Invention-Innovation (II) Capital Index

The II Index is based on two indicators: agricultural scientists per unit of cropland and R&D as a percentage of GDP. Data for the first index are from several studies conducted by the International Service for National Agricultural Research (ISNAR) on International Agricultural Research Center. The second index is reported by UNESCO. UNESCO data may include some agricultural research, but they are interpreted here as primarily related to industrial activities. Countries are given II index values of 1, 2, or 3 based on the following:

Agricultural scientists/cropland (million ha):

- Index = 1 if value is 0.02 or lower
- = 2 if value is 0.021 to 0.06
- = 3 if value is greater than 0.06

R&D/GDP

- Index = 1 if value is 0.002 or lower
- = 2 if value is between 0.002 and 0.006
- = 3 if value is greater than 0.006

The sum of the two index values for 1970 and 1990 is the II for these two periods.

4.2 The Technology Mastery (TM) Index

The TM Index is also based on two indicators. The first is the number of extensive workers per unit of cropland. The second is the schooling levels of males over age 25. Agricultural extension programs have been widely utilized to provide advice on technological practices to farmers. Schooling is also a factor in technology mastery.

Countries are given TM index values of 1, 2, or 3 based on the following:

Extension workers/cropland (million ha):

- Index = 1 if value is 0.2 or lower
- = 2 if value is 0.2 to 0.6
- = 3 if value is greater than 0.6

Average schooling of males over 25:

- Index = 1 if value is less than 4 years
- = 2 if value is between 4 and 6 years
- = 3 if value is greater than 6 years

The appendix table provides data on these indexes. The TM Index is the sum of the values for 1970 and 1990.

4.3 Country classification

Figure 6 reports the classification of countries for two periods, 1970 and 1990. The index values are organized by II index values. Thus, II 22 means that the countries

II Classes 2 and 3 in 1970						
22	23	24	32	33	34	35
Afghanistan (22)	Benin (34)	Dominican Republic (24)	Guinea Bissau (22)	Chad (22)	Algeria (34)	Guatemala (33)
Angola (22)	Burkina Faso (43)	Ecuador (23)	Sudan (22)	Gabon (32)	Cameroon (34)	Kenya (45)
Cambodia (22)	Burundi (22)	Guinea (33)		Haiti (33)	Guyana (44)	Malawi (44)
Congo (Zaire) (23)	Central African Republic (33)	Mali (34)	Honduras (34)	Laos (33)	Indonesia (25)	Panama (56)
Ethiopia (23)	Morocco (44)	Nicaragua (34)		Madagascar (22)	Iran (23)	Peru (45)
Mongolia (44)	Rwanda (44)	Togo (23)		Mauritania (33)	Lybia (33)	Venezuela (33)
Mozambique (22)	Somalia (22)	Tunisia (24)		Morocco (33)	Nepal (34)	
Namibia (22)				Myanmar (33)	Nigeria (34)	
Niger (22)				Paraguay (24)	Senegal (33)	
				Zambia (34)	Syria (35)	
					Tanzania (34)	
					Uganda (34)	
					Uruguay (34)	
					Vietnam (33)	
					Yemen (23)	

Figure 6 Country classifications, 1970 (II Classes in Headings, TM Classes in Parentheses)

II Classes 4 and 5 in 1970					
43	44	45	46	55	56
Saudi Arabia (23)	Bangladesh (33)	Argentina (44)	Turkey (25)	Cuba (44)	Brazil (46)
Zimbabwe (45)	Bolivia (33)	Botswana (45)	India (24)	Costa Rica (44)	Chile (35)
	Colombia (44)	Egypt (35)		Philippines (46)	China (56)
	Côte d'Ivoire (23)	Iraq (22)		South Africa (46)	El Salvador (25)
	Gambia (22)	Malaysia (35)			Pakistan (24)
	Ghana (34)	Mauritius (56)			
	Honduras (24)	Mexico (35)			
	Jamaica (45)	Sri Lanka (56)			
	Jordan (45)	Thailand (45)			
	North Korea (22)				
	Sierra Leone (44)				
	Surinam (22)				
	Trinidad-Tobago (45)				

Figure 6, Cont'd

were II Class 2 in both 1970 and 1990. II 23 means that the country moved to Innovation Class 3 in 1990.

TM Class values for all countries are reported in parentheses. An asterisk means that the R&D/GDP component of the Innovation Index was actually reported to be zero.

Consider the countries that started in II Class 2. Nine countries were in Class 2 in both periods, six moved to Class 3 in 1990, and seven moved to Class 4 in 1990. Seven of the nine 22 countries also had TM 22 indexes, as did two of the six 23 countries. Only two of the 22 countries had R&D/GDP indexes of 2. Fourteen of the 22 countries reported R&D ratios of zero. Two countries, Guinea Bissau and Sudan, actually lost II ranking, reverting to level 2 status in 1990. Of the 24 countries either starting in II Class 2 or ending in that class, none would be considered to be host to competitive industries producing international goods. None are ranked as industrially competitive by UNIDO. Most are in sub-Saharan Africa, where the end of the colonial period dates from 1960. These countries inherited virtually nothing from their colonial masters (not all were in colonial relationships, however).

Next, consider the 33 countries starting in II Class 3. Two reverted to Class 2. Ten remained in II Class 3 in both periods. Sixteen improved to Class 4 and five improved to Class 5. Of the 10 countries remaining in Class 3, only 2 were in Class 3 because of industrial R&D. Six of these countries reported zero R&D. Eight of these countries were in Class 3 because of public sector investment in agricultural research. Of the 16 countries moving to Class 4, nine moved on the strength of R&D/GDP ratios. Seven countries moved to Class 4 on the strength of public sector investment in agricultural research. Of the five countries moving to Class 5, all had agricultural research investment indexes of 3 and all invested in industrial R&D.

Twenty-six countries had II index scores of 4 in 1970. Two, Saudi Arabia and Zimbabwe, reverted to Class 3 in 1990. Thirteen remained in Class 4. Nine moved to Class 5, and two moved to Class 6. Of the 13 countries remaining in Class 4, eight had agricultural research indicators of 3. Four reported zero R&D levels to UNESCO. All the countries improving to II Classes 5 and 6, of course, have significant R&D capacity.

Nine countries began in II Class 5. Five of these moved to II Class 6.

But it is clear that the 30 countries in II Class 5 or 6 in 1990 have good to excellent economic performance. Conversely, the 27 countries in II Classes 2 or 3 in 1990 have poor economic performance. All are countries in "mass poverty." The 29 countries in II Class 4 in 1990 have had mixed economic success. In general, the countries in Class 4 in 1990 with R&D capacity have tended to do a little better than the countries without such capacities.

5. CHANGES IN TECHNOLOGICAL CAPITAL

Was improvement in II Class closely related to improvements in TM Class? Was improvement related to the first-period II Class levels?

In addition to the II and TM Classes, there are two other indicator variables available for two periods. One of these is the index of industrial competitiveness constructed by the United Nations Industrial Development Office (UNIDO). The second is a ranking of an important institutional index, the Patent Effectiveness indicator of Park and Ginnarte.

Table 5 reports Tobit estimates of changes in each of the four indexes as they relate to Period 1 levels of the four indexes. These estimates indicate the following:

- Improvements in all indexes, except patent rights, are subject to diminishing returns. High Period 1 values are associated with lower improvement values.
- TM Class improvements are associated with high II Classes but not to high levels of industrial competitiveness or patent rights.
- II Class improvements are not closely related to levels of other indexes.
- Industrial competitiveness improvements and patent rights are related to TM Class levels. This appears to be primarily a schooling effect.

6. TFP GROWTH AND OTHER ECONOMIC INDICATORS AND TECHNOLOGICAL CAPITAL

Table 6 provides cross-tabulations (weighted by the value of agricultural production) of TFP growth for II Class and TM Class. These tabulations are for each period and suggest that TM class improvement does not add to II Class.

To test for this further, Table 7 reports two regressions (weighted by value of production). The first is based on II Class dummy variables plus a variable measuring the difference between TM class and II class. The second is based on TM Class dummy variables plus the II-TM Class difference.

Table 8 shows the relationship between II Class and four agricultural indicators. Countries in II Classes 22 and 23 have very low levels of Green Revolution varietal adoption and very low cereal yields. They use very little fertilizer. The 15 countries in these two classes remain in traditional agriculture. Farmers in these countries have little access to “modern” crop varieties. The Green Revolution has not reached most farmers. They also have very poor import markets.

Table 9 shows that they have low per capita incomes and that incomes have not grown significantly since 1962. All these countries are in mass poverty.

Table 5 Tobit estimates: Technology capital improvements from Period 1 to Period 2

	TM Class		II Class		Industrial Competitiveness	Patent Rights
Period 1	(1)	(2)	(1)	(2)	(2)	(2)
TM Class	-.862 (4.17)	-.871 (2.71)	-.153 (1.56)	-.116 (.81)	.04 (4.23)	.204 (2.54)
Period 2 Class	.688 (4.47)	.631 (2.43)	-.154 (2.03)	-.217 (1.87)	-.002 (.26)	-.063 (.96)
Industrial Competitiveness		-.336 (.07)		-.338 (.15)	-.047 (.29)	8.091 (5.73)
Patent rights Index		-.329 (1.26)		-.069 (.43)	-.006 (.60)	-.380 (4.22)
Constant	1.309 (2.22)	2.506 (1.98)	1.835 (5.46)	2.319 (3.31)	-.094 (2.03)	.201 (.51)
#obs	77	47	77	47	47	47
Prob> <i>Chi</i> ²	.0000	.0003	.004	.1192	.0016	.0000
Pseudo- <i>R</i> ²	.1090	.1464	.0605	.0514	-.1818	.3438

Table 6 TFP Growth: II Class vs. TM Class

II Class	TM Class			
	2	3	4	5, 6
2	0.775	0.394	1.172	
3	2.466	1.459	0.131	0.955
4	2.310	1.270	1.665	-0.187
5, 6	0.758	0.687	2.582	3.216

Table 7 Agricultural indicators by innovation class

II Class	Growth in TFP	Adoption of Green Revolution Varieties (%)	Cereal Yields (kg)	Fertilizer per Hectare (kg)
22	0.55	14	960	6
23	1.84	21	928	9
24	1.26	45	1733	48
33	0.78	44	1393	16
34	1.33	62	2368	81
45	1.83	79	2922	91
56	3.86	81	3760	210

Table 8 Agricultural indicators by II Class

II Class	Growth in TFP	Adoption of Green Revolution Varieties (%)	Cereal Yields (kg)	Fertilizer per Hectare (kg)
22	0.55	14	960	6
23	1.84	21	928	9
24	1.26	45	1733	48
33	0.78	44	1393	15
34	1.33	62	2368	81
45	1.83	79	2922	91
56	3.86	81	3760	210

Table 9 Economic growth by II Class

II Class	GDP Per Capita PPP\$ (1998)	Growth in GDP Per Capita PPP\$ (1962–1992)
22	1160	−1.08
23	930	1.04
24	3203	2.14
33	2291	0.60
34	2881	2.49
45	8430	3.49
56	4156	3.67

7. DETERMINANTS OF TFP GROWTH: A STATISTICAL DECOMPOSITION

The previous section of this paper showed that TFP growth was associated with technological capital. In this section, we refine this analysis further in a TFP decomposition framework. We consider two “adjustments” for labor quality in this section. We also consider proxy variables for general technological progress.

Consider the following TFP derivation from a production function.

$$Y = A_{(t)}(LQ_L)^\alpha H^\beta K^{1-\alpha-\beta} \tag{7}$$

where:

- Y is aggregate production
- $A_{(t)}$ is a shifter of the production function
- L is unadjusted labor
- Q_L is a labor quality index
- H is land
- K is machine and animal capital

When transformed to TFP form, this production function yields:

$$G_{TFP} = G_Y - C_L(G_L + G_{QL}) - C_H G_H - S_K G_K - G_A \tag{8}$$

where G represents growth rates in variables.

The actual “unadjusted” TFP calculations reported in [Tables 1, 2, and 3](#) are based on:

$$G_{TFP}^* = G_Y - C_L G_L - C_H G_H - C_K G_K \tag{9}$$

The difference is:

$$G_{TFP} - G_{TFP}^* = C_L G_{QL} + G_A \quad (10)$$

This suggests that variables measuring labor quality and the shift in A could be used to “explain” TFP growth.

We have two measures of labor quality. The first is associated with increased schooling of the workforce. The second is associated with increased nutrition of the workforce.

The first is the average schooling of adult males in the workforce. This variable (from the Barro–Lee database of the World Bank) is not specific to agricultural workers. It is probably the case that the average schooling of agricultural workers is lower than the average schooling for all workers. But for our purposes, it is the growth rate in schooling that is important.

The second index is the Dietary Energy Sufficiency (DES) index published by the FAO. This index is based on consumption data and effectively is an average calorie per capita measure. Both measures are reported by developing country region to show the diversity in changes in these indexes.

The measure of G_A that we use is the adoption of Green Revolution modern crop varieties in the country for the 1961–1980 and 1980–2000 periods. This is weighted by the crop shown in total agricultural production. Two of the three variables are treated as endogenous in the TFP model. The method used to deal with this is instrumental variables.

The instruments for S_C GRMVA and DES X SHL include the exogenous variables in the $G_{TFP}(A)$ equation, Reg1, Reg2 and GSCH X SHL, plus the Innovation Class variables.

Table 10 reports the estimates for both the first stage instrumented variables, S_C GRMVA and DES X SHL, and the second-stage $G_{TFP}(A)$ equations. In the TFP decomposition estimates, we find that the adoption of Green Revolution modern varieties, the growth in schooling, and improved nutrition all contribute significantly to TFP growth.

Table 10 reports a “growth accounting” exercise attributing growth to Green Revolution MVs, increases in schooling, and increases in nutrition.

8. POLICY IMPLICATIONS

In this chapter, we develop estimates of growth in TFP for two periods and for crop, livestock, and aggregate production. These growth rates bear the interpretation of rates of cost reduction at constant factor prices.

Although these growth rates are subject to errors of measurement, they are broadly consistent with our understanding of productivity growth. Highest TFP growth rates

Table 10 Determinants of TFP (Aggregate) growth: Instrumental variables

	Share Labor × Growth in Calories (Per Capita)	Share Crops × MV Adoption	TFP Growth (Aggregate)	
Constant	−10.55 (0.9)	6.73 (1.2)		−1.31 (1.5)
Din 3	27.4 (2.2)	11.2 (2.0)	Share labor × Growth in Calories	0.061 (4.0)
Din 4	31.5 (2.7)	25.6 (4.6)	Share labor × Growth schooling	
Din 5	33.9 (2.9)	30.5 (5.5)		1.5
Din 6	43.5 (3.6)	40.8 (7.2)	Share crops × MV adoption	0.029 (2.2)
OBS	15.6	15.6		15.6
R ²	0.17	0.59		—

were achieved in East Asia, followed by South Asia and the Southern Cone countries in Latin America. Lowest TFP growth rates were in East and Central Africa.

International prices for agricultural commodities have been declining in real terms over most of the second half of the 20th century (see [Figure 1](#)). All OECD countries have realized more rapid TFP gains for the agricultural production sector than for the rest of the economy. These differences average about 1% per year. Developing countries have realized Green Revolution gains at different rates. Many developing countries with slow TFP growth have realized few Green Revolution gains. Others have realized high Green Revolution gains.

Countries with low TFP gains in agriculture have fared poorly in a world where they are delivered falling real prices in an increasingly globalized economy.

Two Technological Capital Indicators were developed. The Imitation indicator was based on extension programs and on schooling levels. The Innovation indicator was based on investments in agricultural research, largely in the public sector, and industrial R&D, largely in the private sector.

Perhaps the dominant message of this chapter is that TFP performance is strongly related to technological capital. These relationships ([Table 6](#)) show that countries with minimal II or TM capital ([Figure 5](#)) are “trapped” in a price/cost squeeze. Real prices are falling more rapidly than costs are falling.

Table 11 Growth accounting, 1960–2000

Region	Actual TFP Growth	Proportion Due to:		
		Increased Schooling	Increased Nutrition	Green Revolution MVs
Latin America				
Southern Cone	2.24	0.19	0.24	0.57
Andean	1.63	0.30	0.22	0.48
Central America	1.72	0.35	0.19	0.46
Caribbean	1.58	0.39	0.26	0.35
Middle East-North Africa				
Middle East	1.63	0.19	0.23	0.58
North Africa	2.29	0.28	0.20	0.52
Asia				
South Asia	1.96	0.22	0.14	0.64
Southeast Asia	1.05	0.17	0.21	0.62
East Asia	3.24	0.13	0.33	0.54
Sub-Saharan Africa				
East Africa	0.78	0.51	0.02	0.47
Central Africa	0.87	0.62	0.00	0.38
West Africa	2.05	0.29	0.35	0.36
Southern Africa	1.29	0.39	0.03	0.58

Countries with minimal technological capital have cereal yields that are only one fourth the yields of countries with technological capital. They use only 5% as much fertilizer per hectare. They have low levels of adoption of Green Revolution modern varieties. Value added per agricultural worker is one quarter that of countries with technological capital. Growth rates in GDP per capita, though positive, are only one third those of countries with technological capital.

An effort to distinguish between the importance of innovation and imitation capital was made. It is difficult to establish this difference because the two indexes are highly correlated. It does appear that higher innovation capital, given imitation capital, contributes more to TFP growth than higher imitation capital, given innovation capital.

This chapter also reports a TFP decomposition exercise. This exercise identified the adoption of Green Revolution modern varieties, increases in schooling of the labor force, and increases in dietary energy as sources of TFP growth.

As noted, however, the major conclusion of this chapter is that technological capital is required for TFP and cost reduction growth, and this means investment in

agricultural research systems. It also means investment in industrial R&D as well as in private and public extension systems and in the schooling of farmers.

Investments in technological capital require long-term commitments to investments by national governments and by aid agencies. These investments are typically not made by NGOs. Many aid agencies have backed away from long-term (20- to 30- or 40-year) technological capital development programs. Tragically, many countries in Africa today are not receiving national government support to build the technological capital that is their only escape route from mass poverty.

End Note

1. For input/output growth differences, the adjustment was:

2% 0.91

3% 0.83

4% 0.75

5% 0.68

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APPENDIX 1

OUTPUT GROWTH RATES

Table A.1a Latin America and Caribbean: Growth Rates on Agricultural Production, 1962–1981 and 1981–2001

Region/Country	Agricultural Output Growth Rates (%)					
	Crops		Livestock		Aggregate	
	1961– 1980	1981– 2001	1961– 1980	1981– 2001	1961– 1980	1981– 2001
Southern Cone	2.79	2.98	1.74	2.95	2.16	2.80
Argentina	2.86	4.43	1.24	0.92	1.86	2.18
Brazil	3.20	3.60	4.28	4.58	3.72	3.41
Chile	1.40	2.99	1.92	3.92	1.53	3.67
Paraguay	5.35	1.31	1.26	4.17	3.53	3.27
Uruguay	1.16	2.58	0.00	1.16	0.18	1.48
Andean	2.43	2.65	3.95	2.92	3.00	3.09
Bolivia	4.01	4.36	4.72	2.77	4.45	3.83
Colombia	3.77	1.19	2.81	3.02	3.22	2.18
Ecuador	0.67	3.65	3.81	4.18	1.72	4.05
Peru	0.87	3.18	2.79	3.38	1.49	3.53
Venezuela	2.83	0.87	5.61	1.26	4.10	1.86
Central America	3.60	1.32	4.35	2.84	3.87	1.89
Costa Rica	4.76	4.26	5.74	3.14	5.15	3.77
El Salvador	2.95	−0.17	3.64	2.48	3.04	0.69
Guatemala	4.85	2.51	3.17	2.92	4.36	2.63
Honduras	3.26	1.32	3.73	4.14	3.40	2.28
Mexico	3.10	1.71	4.76	2.35	3.53	1.96
Nicaragua	2.92	0.30	5.39	2.13	3.95	1.09
Panama	3.39	−0.71	3.98	2.73	3.64	0.80
Caribbean	1.20	−0.71	2.78	0.77	1.48	−0.28

Continued

Table A.1a Latin America and Caribbean: Growth Rates on Agricultural Production, 1962–1981 and 1981–2001—Cont'd

Region/Country	Agricultural Output Growth Rates (%)					
	Crops		Livestock		Aggregate	
	1961–1980	1981–2001	1961–1980	1981–2001	1961–1980	1981–2001
Cuba	2.51	–3.11	2.25	–3.00	2.09	–3.09
Dominican Republic	2.32	–0.97	4.44	3.59	2.79	0.55
Haiti	1.68	–1.34	2.75	1.60	2.05	–0.67
Jamaica	–0.51	1.84	4.45	1.68	0.48	1.80
Trinidad and Tobago	–1.33	0.82	5.46	–0.70	0.06	0.26
Average growth rate	2.55	1.57	3.56	2.38	2.74	1.89

Table A.1b Asia: Growth rates on agricultural production, 1962–1981 and 1981–2001

Region/Country	Agricultural Output Growth Rates (%)					
	Crops		Livestock		Aggregate	
	1961–1980	1981–2001	1961–1980	1981–2001	1961–1980	1981–2001
Middle East	2.56	2.38	3.04	2.82	2.42	2.71
Afghanistan	1.64	0.01	1.92	3.82	1.81	2.15
Iran	4.74	4.16	3.26	4.30	4.06	4.15
Iraq	2.93	0.07	1.79	–3.42	2.18	–0.66
Jordan	–3.67	3.61	3.09	5.81	–2.17	3.88
Saudi Arabia	4.62	3.20	6.76	5.09	4.17	4.46
Syria	4.25	2.72	3.92	2.52	4.08	2.66
Turkey	3.41	2.01	2.19	1.03	3.09	1.81

Continued

Table A.1b Asia: Growth rates on agricultural production, 1962–1981 and 1981–2001—Cont'd

Region/ Country	Agricultural Output Growth Rates (%)					
	Crops		Livestock		Aggregate	
	1961– 1980	1981– 2001	1961– 1980	1981– 2001	1961– 1980	1981– 2001
Yemen	2.54	3.24	1.39	3.44	2.13	3.27
South Asia	2.18	2.46	2.29	3.68	2.21	2.80
Bangladesh	1.52	2.15	1.75	3.69	1.56	2.37
India	2.26	2.72	2.84	3.84	2.44	3.00
Nepal	1.51	3.66	2.65	2.29	1.85	3.26
Pakistan	3.63	3.13	2.75	6.00	3.29	4.47
Sri Lanka	2.01	0.62	1.45	2.58	1.91	0.89
South East Asia	2.28	3.00	2.41	5.32	2.27	3.47
Cambodia	–4.73	4.12	–1.96	6.20	–4.31	4.56
Indonesia	3.31	2.78	3.81	3.98	3.36	2.92
Laos DPR	2.37	3.65	0.68	5.74	2.12	4.03
Malaysia	4.68	2.15	6.23	7.00	4.84	3.44
Philippines	3.88	1.62	3.84	4.97	3.80	2.30
Thailand	4.34	1.91	3.32	4.09	4.15	2.20
Vietnam	2.14	4.80	0.96	5.27	1.90	4.84
East Asia	2.85	–1.52	4.08	1.88	2.92	1.61
China	3.14	3.74	5.31	8.28	3.25	5.20
Mongolia	1.80	–8.10	1.70	0.24	1.63	–0.13
North Korea	3.60	–0.20	5.25	–2.87	3.88	–0.23
Average growth rate	2.38	2.15	2.96	3.55	2.40	2.80

Table A.1c Africa: Growth rates on agricultural production, 1962–1981 and 1981–2001

Region/Country	Agricultural Output Growth Rates (%)					
	Crops		Livestock		Aggregate	
	1961– 1980	1981– 2001	1961– 1980	1981– 2001	1961– 1980	1981– 2001
East Africa	2.48	1.47	2.36	2.03	2.42	1.99
Ethiopia	1.69	3.50	0.32	1.43	1.11	2.67
Somalia	2.11	–2.32	2.58	0.43	2.52	0.06
Sudan	2.80	2.08	3.68	3.60	3.23	2.94
Uganda	2.29	2.90	3.20	2.86	2.29	2.96
Kenya	3.84	1.72	3.02	2.47	3.45	2.10
Madagascar	2.16	0.95	1.39	1.36	1.90	1.20
Central Africa	2.25	1.74	2.74	2.31	2.29	1.80
Cameroon	2.73	2.38	3.84	3.14	2.99	2.54
Chad	–0.38	4.88	0.67	2.31	0.09	3.86
Dem. Rep. Congo	2.31	0.05	0.50	1.38	2.08	0.21
Republic of Congo	1.10	1.56	2.88	2.17	1.39	1.68
Rep. Central African	2.40	1.74	5.00	4.38	2.94	2.71
Gabon	3.24	2.31	1.22	1.77	2.12	2.12
Rwanda	4.37	–0.74	5.05	1.02	4.44	–0.52
Western Africa	1.15	3.38	2.55	2.22	1.45	2.93
Benin	2.25	6.99	4.14	2.63	2.61	6.23
Gambia	–0.94	0.07	2.34	0.71	–0.46	0.20
Guinea	1.45	3.50	1.47	3.04	1.45	3.43
Ghana	0.24	5.90	3.76	1.31	0.63	5.33
Togo	1.09	4.06	2.01	3.05	1.20	3.82

Continued

Table A.1c Africa: Growth rates on agricultural production, 1962–1981 and 1981–2001—Cont'd

Region/Country	Agricultural Output Growth Rates (%)					
	Crops		Livestock		Aggregate	
	1961– 1980	1981– 2001	1961– 1980	1981– 2001	1961– 1980	1981– 2001
Mauritania	–1.76	4.48	0.43	1.08	0.23	1.51
Niger	0.52	3.92	1.00	1.89	0.71	3.15
Burkina Faso	2.14	4.21	0.02	4.40	1.41	4.26
Ivory Coast	4.63	3.40	4.57	2.59	4.63	3.36
Liberia	3.27	–1.19	3.80	1.01	3.32	–1.06
Mali	2.31	4.79	2.16	1.52	2.25	3.21
Nigeria	–0.09	6.42	5.11	1.79	0.70	5.60
Senegal	–0.61	1.44	2.20	4.41	–0.07	2.34
Sierra Leone	1.57	–0.65	2.63	1.71	1.69	–0.28
Southern Africa	2.00	1.79	2.43	1.41	1.90	1.52
Angola	–2.52	3.51	2.54	2.42	–1.01	3.00
Botswana	2.82	0.98	1.34	0.13	1.51	0.24
Malawi	3.58	3.09	5.28	2.07	3.74	2.91
Mozambique	0.68	2.37	2.32	0.73	0.91	1.92
Zimbabwe	3.51	2.14	3.48	2.34	3.45	1.85
South Africa	3.80	1.57	1.55	0.56	2.50	1.14
Zambia	3.17	1.72	3.94	2.34	3.50	2.00
Namibia	1.72	1.92	1.45	0.77	1.48	0.95
Tanzania	3.22	0.61	2.44	2.69	2.97	1.23
Average growth rate	1.76	2.24	2.51	1.95	1.86	2.11

APPENDIX 2

INPUT GROWTH RATES

Table A.2a Latin America and Caribbean growth rates of selected agricultural inputs, 1960–1981 and 1981–2000

Region/ Country	Agricultural Input Growth Rates (%)															
	Cropland		Labor(*)		Fertilizer + Pest. (**)		Seeds		Mechanization***		Permanent Pastures		Feed****		Animal Power*****	
	1961– 1980	1981– 2000	1961– 1980	1981– 2000	1961– 1980	1981– 2000	1961– 1980	1981– 2000	1961– 1980	1981– 2000	1961– 1980	1981– 2000	1961– 1980	1981– 2000	1961– 1980	1981– 2000
Southern Cone	1.79	−0.14	0.05	0.25	8.38	8.28	1.66	0.48	2.51	2.02	0.81	0.39	3.42	3.60	−0.53	0.93
Argentina	1.70	0.00	−0.93	0.22	9.29	12.36	−0.60	1.02	1.53	1.39	−0.14	−0.04	3.57	1.35	−1.69	0.91
Brazil	2.83	1.65	1.13	−1.54	16.98	4.63	3.82	−1.59	7.06	2.01	1.78	0.37	3.41	3.35	0.54	−0.01
Chile	0.60	−3.38	0.16	0.97	3.73	7.43	−1.10	−1.69	0.77	1.49	1.72	0.06	4.02	5.89	−0.88	1.63
Paraguay	3.57	1.24	0.64	1.68	6.35	11.62	7.46	3.41	2.80	3.68	0.75	1.57	5.09	3.82	−0.84	1.55
Uruguay	0.24	−0.23	−0.75	−0.06	5.58	5.36	−1.28	1.24	0.40	1.52	−0.07	−0.01	1.00	3.60	0.23	0.58
Andean	1.04	−0.06	1.04	0.85	8.20	2.76	0.74	1.62	5.79	0.29	0.92	0.30	4.93	2.73	1.92	1.04
Bolivia	2.04	−0.31	1.87	1.79	8.02	1.03	1.03	2.62	6.55	1.04	0.61	0.33	3.92	2.63	3.47	0.21
Colombia	0.23	−1.32	1.51	−0.14	6.40	3.41	0.82	−0.20	3.13	−0.43	0.66	0.13	7.00	4.38	3.35	1.73
Ecuador	0.01	0.93	0.64	1.06	10.00	4.98	−3.33	4.68	7.87	1.46	3.00	0.85	−0.30	3.97	1.52	2.88
Peru	2.69	0.88	1.38	1.39	2.51	4.30	0.67	1.93	2.81	−1.22	−0.19	−0.01	3.92	3.50	0.79	0.32
Venezuela	0.25	−0.47	−0.21	0.16	14.05	0.10	4.53	−0.94	8.58	0.59	0.50	0.18	10.09	−0.83	0.50	0.07
Central America	0.47	0.90	1.35	0.78	8.58	2.86	0.08	−0.71	8.90	0.85	1.08	0.95	6.92	3.83	0.11	0.68
Costa Rica	0.22	−0.13	1.68	0.87	6.89	5.18	0.78	−1.98	2.79	0.96	4.31	0.44	9.04	7.70	−0.04	1.89
El Salvador	0.96	0.66	1.61	0.73	6.63	0.72	2.31	0.52	4.24	0.94	0.04	1.71	8.54	2.76	0.57	0.40
Guatemala	0.72	0.49	1.70	2.07	10.82	5.67	−0.42	−1.01	6.25	0.64	0.83	3.41	8.53	3.69	−2.91	0.84

Honduras	0.97	0.10	1.74	0.55	7.66	10.31	1.70	1.16	15.03	2.25	0.00	0.08	6.16	4.85	-1.27	0.31
Mexico	0.18	0.63	1.44	0.36	9.91	-0.02	0.40	-7.46	4.29	1.57	0.00	0.47	8.54	2.18	3.06	0.18
Nicaragua	0.38	3.68	1.14	-0.06	10.18	-3.23	1.06	-0.11	15.02	0.98	1.14	0.00	4.85	0.20	2.59	-0.41
Panama	-0.14	0.83	0.14	0.94	7.96	1.38	-5.31	3.94	14.66	-1.40	1.23	0.55	2.79	5.41	-1.20	1.53
Caribbean	0.55	0.42	0.32	-0.43	6.32	2.63	0.06	0.32	1.27	-0.56	-0.02	-0.47	6.55	0.79	0.33	0.25
Dominican Rep.	1.92	0.58	0.53	-0.72	12.25	3.76	2.68	0.44	1.02	-0.83	0.00	0.00	15.64	5.88	0.96	0.27
Haiti	1.53	0.08	0.53	-0.72	19.22	6.94	0.10	-0.19	4.05	-2.30	-0.90	-0.21	-2.72	0.07	2.21	0.87
Jamaica	-0.69	1.42	0.53	-0.72	0.13	2.46	-2.49	1.38	1.29	0.34	0.01	-0.85	13.25	1.40	-1.54	0.09
Average rate	1.01	0.37	0.82	0.44	8.73	4.42	0.64	0.36	5.51	0.73	0.76	0.45	5.82	3.29	0.47	0.79

*Population economically active in agriculture.

**Fertilizers + Pesticides = growth rates of fertilizers.

***Growth rate of tractors + harv. mach.

****Total consumption of feed (energy) in tons of corn equivalent.

*****Animal power - stock of mules, horses and camels.

Table A.2b Asia: Growth rates of selected agricultural inputs, 1960–1981 and 1981–2000

Region/ Country	Agricultural Input Growth Rates (%)															
	Cropland		Labor*		Fert. +Pest.**		Seeds		Mechanization***		Perm. Pastures		Feed****		Anim. Power*****	
	1961– 1980	1981– 2000	1961– 1980	1981– 2000	1961– 1980	1981– 2000	1961– 1980	1981– 2001	1961– 1980	1981– 2000	1961– 1980	1981– 2000	1961– 1980	1981– 2000	1961– 1980	1981– 2000
Middle East	0.60	0.78	0.37	0.78	20.20	1.03	−0.28	0.32	8.44	3.12	−0.07	0.72	7.48	3.41	−1.16	−1.99
Afghanistan	0.21	0.00	1.50	2.26	24.72	−16.74	−0.56	0.60	8.85	0.35	0.00	0.00	4.68	2.13	1.21	−4.09
Iran	0.05	1.25	0.56	1.44	19.68	2.16	1.86	−0.64	9.14	4.32	0.00	0.00	6.29	4.02	−2.45	−1.44
Iraq	0.75	0.07	−0.94	−2.30	21.47	8.40	−1.77	−0.06	8.71	2.62	−0.09	0.00	5.03	−4.97	−6.01	−5.68
Jordan	0.72	0.77	−1.11	3.35	8.07	3.27	−3.82	1.18	4.44	1.02	0.00	0.00	3.38	8.94	−2.45	−1.44
Saudi Arabia	2.85	3.37	2.09	−4.25	8.70	4.51	0.70	−2.24	11.44	8.92	0.00	4.55	4.68	2.13	7.92	1.20
Syria	−0.89	−0.28	0.43	2.03	12.87	4.55	2.25	4.40	6.15	5.13	0.27	−0.02	5.79	2.12	−7.89	−3.27
Turkey	0.63	−0.01	0.19	1.16	16.82	1.99	0.69	0.40	9.21	1.55	−0.73	1.25	2.88	0.55	2.42	−2.72
Yemen	0.49	1.06	0.22	2.56	49.26	0.08	−1.57	−1.09	9.59	1.06	0.00	0.00	4.68	2.13	−1.98	1.55
South Asia	0.70	0.30	1.61	1.45	14.12	5.00	2.09	1.12	10.99	2.70	0.83	−0.25	2.57	4.15	−0.02	−1.22
Bangladesh	0.16	−0.74	1.20	1.23	14.22	5.97	1.05	0.39	10.09	0.95	0.00	0.00	2.02	2.59	−0.65	−0.09
India	0.26	0.03	1.63	1.21	13.88	5.30	3.07	1.87	8.28	5.03	−1.00	−0.62	1.56	3.50	−0.65	−0.09
Nepal	1.71	1.66	1.40	1.98	23.30	6.81	2.32	1.46	15.18	3.62	0.57	−0.64	2.57	4.15	1.62	−2.31
Pakistan	0.74	0.44	2.10	1.29	17.26	4.94	3.15	2.20	16.64	6.03	0.00	0.00	4.47	5.28	1.10	0.41
Sri Lanka	0.63	0.08	1.75	1.52	1.96	1.97	0.88	−0.30	4.74	−2.10	4.59	0.02	2.23	5.25	−1.55	−4.04
South East Asia	0.59	1.26	1.41	1.36	6.91	8.45	0.74	2.03	8.21	7.46	0.87	1.71	3.55	5.80	2.24	−0.59
Cambodia	−3.06	3.65	0.65	2.72	−4.86	9.49	−5.88	4.74	8.18	0.65	0.00	5.51	−4.55	5.54	5.43	5.65

Indonesia	0.00	1.15	1.14	1.68	12.45	2.72	1.96	1.03	4.34	15.44	-0.27	-0.43	4.60	5.20	-0.56	-1.65
Laos	1.37	0.86	1.72	2.20	0.42	15.06	2.08	3.00	16.18	2.65	-0.39	0.30	3.55	5.80	3.00	-2.19
Malaysia	1.04	2.51	0.93	-1.12	10.00	6.29	1.22	0.31	8.56	10.28	0.84	0.60	8.67	5.42	0.67	-0.91
Philippines	1.65	0.20	2.00	1.26	8.25	5.12	1.65	0.39	6.78	1.99	1.13	0.94	5.75	4.03	9.45	-0.16
Thailand	2.62	-0.22	2.08	0.90	14.69	9.26	2.65	0.12	4.33	10.33	4.64	0.93	4.37	7.33	-2.77	-4.89
Vietnam	0.51	0.68	1.36	1.90	7.41	11.19	1.52	4.63	9.10	10.91	0.12	4.16	2.45	7.30	0.44	0.00
East Asia	0.89	0.45	0.85	0.24	15.16	-5.86	1.62	-2.09	7.40	0.65	0.38	0.22	4.85	5.19	0.83	0.79
China	-0.29	1.26	1.90	1.06	13.72	4.82	0.53	0.00	10.83	4.70	1.80	0.76	7.45	3.97	4.10	-0.80
Mongolia	2.32	-0.13	0.51	0.10	21.73	-13.05	3.02	-6.61	4.13	-4.12	-0.68	-0.11	3.55	5.80	-0.80	1.59
North Korea	0.62	0.22	0.13	-0.43	10.03	-9.36	1.31	0.33	7.23	1.38	0.00	0.00	3.55	5.80	-0.80	1.59
Average rate	0.66	0.78	1.02	1.03	14.18	3.25	0.80	0.70	8.79	4.03	0.47	0.75	3.90	4.09	0.38	-1.03

Table A.2c Africa: Growth rates of selected agricultural inputs, 1960–1981 and 1981–2000

Region/ Country	Agricultural Input Growth Rates (%)															
	Cropland		Labor*		Fert. + Pest.**		Seeds		Mechanization***		Permanent Pastures		Feed****		Animal Power*****	
	1961– 1980	1981– 2000	1961– 1980	1981– 2000	1961– 1980	1981– 2000	1961– 1980	1981– 2000	1961– 1980	1981– 2000	1961– 1980	1981– 2000	1962– 1981	1982– 2001	1961– 1980	1981– 2000
North Africa	0.55	0.83	0.16	−0.30	9.46	−0.51	1.39	0.24	4.53	1.88	0.57	0.67	14.09	4.58	−2.49	−0.88
Algeria	0.65	0.61	−1.34	1.99	9.11	−5.73	1.22	−0.13	2.25	3.30	−0.25	−0.03	22.62	4.88	0.82	−2.51
Egypt	0.02	1.96	1.38	−0.03	5.08	2.04	1.80	0.85	3.87	2.62	0.02	1.96	3.74	4.51	−5.16	0.17
Libya	0.28	0.34	−0.56	−4.41	15.89	−1.57	2.80	0.33	9.82	1.43	1.81	0.03	20.19	1.79	−7.27	−3.25
Morocco	0.78	1.14	1.21	0.39	10.23	1.61	0.51	0.74	3.67	0.77	1.14	0.03	1.67	5.92	−0.71	−0.01
Tunisia	1.03	0.10	0.10	0.56	7.01	1.12	0.61	−0.60	3.03	1.31	0.15	1.36	22.24	5.81	−0.14	1.19
East Africa	0.96	0.35	1.79	1.89	5.33	5.86	1.15	−1.07	6.37	1.03	−0.11	−11.23	2.84	3.00	0.75	−0.63
Ethiopia	0.91	−1.38	1.89	1.90	21.17	9.61	−2.12	2.10	16.57	−2.45	−0.11	−5.89	2.92	4.51	0.15	−3.63
Sudan	0.78	1.86	1.57	1.69	4.10	−1.38	7.06	5.33	12.17	−0.40	−0.11	1.09	5.70	3.98	1.54	0.66
Uganda	1.57	0.69	2.39	2.43	−7.55	13.11	−1.65	−0.02	6.89	2.29	−0.11	−5.89	5.04	6.89	2.92	0.88
Kenya	0.58	0.28	2.73	3.13	7.57	2.76	1.98	−0.57	−2.65	5.41	−0.11	−5.89	3.57	1.29	2.92	0.88
Madagascar	1.91	0.64	2.17	2.19	6.68	11.07	1.63	−13.24	5.24	1.35	−0.11	−5.89	−0.21	1.31	−3.03	−2.57
Central Africa	0.99	0.30	1.27	1.24	7.31	−0.97	1.74	5.66	8.10	0.70	−2.70	−0.28	3.42	2.94	0.03	0.39
Cameroon	1.18	0.08	0.76	1.52	10.35	−0.78	1.75	0.52	16.77	−1.39	−0.45	−0.05	1.19	4.26	−7.47	−1.23
Chad	0.47	0.77	1.25	1.86	22.22	5.99	−1.59	5.49	12.34	−0.12	−0.45	−0.05	2.90	8.58	1.54	2.18
Dem. Rep. Congo	0.51	0.14	1.88	2.22	15.38	−7.92	2.87	2.62	6.25	3.15	−0.45	−0.05	4.47	2.30	1.54	−1.59

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Rep. Congo	1.23	1.18	1.48	1.04	-8.35	6.65	3.40	1.23	6.79	0.22	-0.45	-0.05	7.82	-2.57	1.54	-1.59
Rep. Cent. African	0.59	0.17	0.86	1.04	5.09	-4.89	2.36	0.74	7.22	2.58	-0.45	-0.05	2.09	4.69	1.54	2.18
Rwanda	2.95	-0.23	2.67	0.99	6.49	-5.85	3.38	29.01	7.33	0.45	-0.45	-0.05	5.51	3.36	1.54	2.76
Western Africa	0.73	1.61	1.26	1.48	14.20	3.52	0.51	1.87	7.80	2.98	-0.48	10.19	2.82	2.02	0.85	0.99
Benin	2.62	1.54	0.23	1.62	5.37	13.80	-0.21	3.12	2.69	2.77	-0.48	1.86	1.55	4.79	4.03	-12.48
Guinea	0.37	1.67	1.48	2.31	-6.22	12.46	2.49	1.34	7.93	7.09	-0.48	1.86	0.68	0.72	-0.52	5.73
Ghana	0.44	2.18	2.07	2.65	18.75	-1.41	4.52	-3.03	11.25	-7.15	-0.48	-0.03	3.02	4.74	1.41	-0.17
Togo	0.30	1.36	1.76	2.02	26.58	8.93	-1.71	13.24	5.04	-0.61	-0.48	1.86	3.43	6.30	2.39	4.04
Mauritania	-2.18	4.16	0.50	0.91	23.97	20.24	-5.32	23.22	10.58	6.06	-0.48	1.86	1.82	3.21	1.27	2.87
Niger	2.11	1.48	2.39	2.89	19.94	-0.47	2.57	-9.03	16.81	0.16	-0.48	1.86	12.65	4.77	0.98	-0.73
Burkina Faso	1.45	1.50	1.56	1.98	28.97	7.46	0.09	2.03	7.50	19.11	-0.48	1.86	9.48	-7.72	-0.41	1.45
Ivory Coast	2.31	2.95	2.34	1.65	11.34	5.25	3.39	0.98	14.45	2.04	-0.48	1.86	3.98	2.63	1.41	-0.17
Mali	1.24	5.34	1.71	1.79	24.50	-11.95	0.35	-0.04	11.00	6.07	-0.48	1.86	-0.12	5.14	0.80	3.88
Nigeria	0.28	0.10	0.78	0.27	24.34	-1.67	-3.80	-0.20	17.44	5.27	-0.48	1.86	-2.06	6.94	-1.55	-0.48
Senegal	0.00	-0.06	2.31	2.03	8.16	2.41	2.68	-4.96	4.92	1.17	-0.48	1.86	2.57	-0.06	2.60	4.21
Sierra Leone	1.21	0.30	0.55	0.58	13.04	-5.77	2.08	-0.49	-0.35	-0.23	-0.48	1.86	2.43	-3.22	-0.52	5.73
Southern Africa	0.62	0.70	1.18	1.55	8.47	-3.39	1.81	0.81	5.70	0.07	-0.41	0.86	3.03	2.92	3.34	0.59
Angola	0.35	0.10	1.15	2.32	13.56	-7.64	0.25	1.24	11.21	0.03	-0.41	0.21	2.45	2.95	0.47	0.42
Botswana	0.04	-0.92	0.63	1.03	1.32	7.93	4.25	2.90	8.42	3.41	-0.41	0.21	-0.91	7.62	4.97	1.74
Malawi	1.34	1.25	2.10	2.49	11.91	0.49	1.26	5.54	10.04	0.68	-0.41	0.21	2.69	2.96	3.52	-4.69

Continued

Table A.2c Africa: Growth rates of selected agricultural inputs, 1960–1981 and 1981–2000—Cont'd

Region/ Country	Agricultural Input Growth Rates (%)															
	Cropland		Labor*		Fert. + Pest.**		Seeds		Mechanization***		Permanent Pastures		Feed****		Animal Power*****	
	1961– 1980	1981– 2000	1961– 1980	1981– 2000	1961– 1980	1981– 2000	1961– 1980	1981– 2000	1961– 1980	1981– 2000	1961– 1980	1981– 2000	1962– 1981	1982– 2001	1961– 1980	1981– 2000
Mozambique	1.05	1.52	1.82	1.79	9.03	–25.08	1.74	–6.24	5.70	0.00	–0.41	0.21	1.16	5.66	5.85	1.48
Zimbabwe	1.43	1.35	2.25	1.99	6.18	0.48	2.38	–4.82	4.54	1.24	–0.41	0.04	4.51	–0.13	5.85	1.48
South Africa	0.19	1.25	–1.34	–0.50	7.63	–1.65	0.90	–13.99	3.34	–5.71	–0.41	0.21	3.94	1.88	–4.29	0.82
Zambia	0.30	0.15	2.27	2.22	12.79	–4.14	–1.97	4.91	8.23	0.88	–0.41	0.21	4.83	–1.33	5.85	1.48
Namibia	0.12	1.46	0.54	1.27	7.70	–3.08	3.53	15.58	2.41	1.05	–0.41	0.21	2.53	5.36	4.97	1.74
Tanzania	1.34	0.87	2.34	2.85	14.54	–1.24	3.96	2.13	–2.62	–0.97	–0.41	0.21	6.05	1.33	2.92	0.88
Average rate	0.86	1.02	1.35	1.48	11.19	1.11	1.34	1.83	7.52	1.70	–0.26	0.07	4.81	3.14	0.93	0.37

APPENDIX 3

INPUT COST SHARES

Table A.3a Latin America and Caribbean: Crop input cost shares, 1960–1981 and 1981–2000

Region/ Country	Crop Input Cost Shares (%)											
	Cropland		Labor*		Fert. + Chemicals*		Seeds		Mechanization*		Animal Power	
	1961– 1980	1981– 2001	1961– 1980	1981– 2001	1961– 1980	1981– 2001	1961– 1980	1981– 2001	1961– 1980	1981– 2001	1961– 1880	1981– 2001
Southern Cone	22.61	23.60	60.92	47.28	1.87	6.14	2.01	4.37	10.65	18.69	6.86	3.28
Argentina	26.59	30.45	66.65	55.98	0.15	1.34	1.62	4.67	4.71	9.36	7.50	3.84
Brazil	30.22	17.26	62.22	43.78	2.78	12.33	1.89	3.21	9.49	23.41	7.01	3.21
Chile	18.53	20.24	58.79	41.08	3.07	10.02	2.65	3.87	11.57	22.69	6.61	2.81
Paraguay	18.32	29.49	63.38	47.66	0.50	2.23	1.69	6.05	8.17	17.34	7.13	3.27
Uruguay	19.35	20.57	53.55	47.88	2.85	4.76	2.17	4.07	19.34	20.66	6.02	3.28
Andean	23.20	21.98	62.81	52.84	2.98	7.46	1.45	4.59	5.10	9.10	7.07	3.62
Bolivia	24.09	26.72	66.65	57.93	0.23	0.35	2.07	7.16	3.83	6.37	7.50	3.97
Colombia	19.37	22.82	61.45	53.11	5.37	8.06	1.78	6.37	6.20	7.09	6.91	3.64
Ecuador	24.36	17.98	56.92	45.62	3.15	5.61	0.74	1.25	8.32	22.34	6.40	3.13
Peru	18.26	22.17	63.14	56.23	4.35	7.02	1.64	4.64	5.51	4.57	7.10	3.85
Venezuela	29.92	20.23	65.90	51.33	1.82	16.29	1.03	3.50	1.61	5.13	7.41	3.52
Central America	23.29	23.59	63.62	48.30	3.91	12.55	0.92	3.19	4.04	10.23	7.16	3.31
Costa Rica	17.84	12.32	56.60	31.25	9.00	34.04	0.75	1.66	10.02	15.42	6.37	2.14
El Salvador	22.01	21.94	65.05	55.65	4.51	10.30	0.54	1.95	2.84	6.34	7.32	3.81

Continued

Table A.3a Latin America and Caribbean: Crop input cost shares, 1960–1981 and 1981–2000—Cont'd

Region/ Country	Crop Input Cost Shares (%)											
	Cropland		Labor*		Fert. + Chemicals*		Seeds		Mechanization*		Animal Power	
	1961– 1980	1981– 2001	1961– 1980	1981– 2001	1961– 1980	1981– 2001	1961– 1980	1981– 2001	1961– 1980	1981– 2001	1961– 1880	1981– 2001
Guatemala	25.15	26.71	65.90	51.33	2.88	13.52	1.03	3.50	2.37	5.13	7.41	3.52
Honduras	23.79	21.86	65.81	44.36	1.83	11.31	0.96	2.85	1.87	10.51	7.40	3.04
Mexico	26.12	29.97	65.46	55.10	1.87	6.28	1.31	3.57	3.93	9.55	7.36	3.78
Nicaragua	25.66	30.79	64.31	56.59	3.27	4.47	1.12	5.51	1.49	6.32	7.23	3.88
Panama	22.49	21.57	62.22	43.78	4.05	7.95	0.70	3.31	5.72	18.34	7.00	3.00
Caribbean	15.65	15.77	38.56	31.53	2.54	6.53	0.92	3.16	1.70	3.17	4.34	2.16
Dominican Rep.	27.24	25.74	63.65	52.24	2.78	11.12	1.29	4.18	3.04	4.58	7.16	3.58
Haiti	33.79	35.63	69.56	61.08	0.11	1.50	1.89	7.23	0.26	0.54	7.83	4.19
Jamaica	17.23	17.47	59.59	44.33	9.84	20.04	1.41	4.39	5.22	10.73	6.70	3.04

*Input costs ratio adjusted for geometric as explained in [Section 2.3](#).

Table A.3b Latin America and Caribbean: Livestock input cost shares, 1960–1981 and 1981–2000

Region/ Country	Livestock Input Cost Shares (%)											
	Permanent Pastures		Labor*		Fert. + Chem. + Medic.		Feed		Mechanization		Animal Stock	
	1961–1980	1981–2001	1961–1980	1981–2001	1961–1980	1981–2001	1961–1980	1981–2001	1961–1980	1981–2001	1961–1980	1981–2001
Southern Cone	59.95	40.47	22.72	28.76	1.74	4.42	11.21	13.91	4.38	12.44	13.42	10.78
Argentina	62.34	44.76	23.62	31.82	0.15	1.17	11.66	15.39	2.24	6.87	9.97	9.25
Brazil	58.32	38.55	22.10	27.40	3.62	6.63	10.91	13.25	5.05	14.17	19.40	15.36
Chile	59.19	37.85	22.43	26.90	2.18	8.32	11.07	13.01	5.13	13.91	6.29	3.74
Paraguay	60.86	41.11	23.06	29.22	0.31	3.02	11.39	14.13	4.38	12.51	17.39	15.87
Uruguay	59.04	40.07	22.37	28.48	2.43	2.96	11.04	13.77	5.11	14.73	14.06	9.71
Andean	60.42	43.50	22.89	30.92	2.61	4.50	11.30	14.95	2.78	6.12	13.42	10.78
Bolivia	62.46	46.29	23.67	32.90	0.18	0.23	11.68	15.91	2.01	4.67	9.97	9.25
Colombia	59.56	44.08	22.57	31.33	3.67	4.97	11.14	15.15	3.05	4.48	19.40	15.36
Ecuador	58.11	39.48	22.02	28.06	3.97	4.37	10.87	13.57	5.03	14.51	6.29	3.74
Peru	60.44	45.02	22.90	32.00	2.68	3.80	11.31	15.47	2.68	3.71	17.39	15.87
Venezuela	61.52	42.64	23.31	30.31	2.54	9.15	11.51	14.66	1.12	3.24	14.06	9.71

Continued

Table A.3b Latin America and Caribbean: Livestock input cost shares, 1960–1981 and 1981–2000—Cont'd

Region/ Country	Livestock Input Cost Shares (%)											
	Permanent Pastures		Labor*		Fert. + Chem. + Medic.		Feed		Mechanization		Animal Stock	
	1961– 1980	1981– 2001	1961– 1980	1981– 2001	1961– 1980	1981– 2001	1961– 1980	1981– 2001	1961– 1980	1981– 2001	1961– 1980	1981– 2001
Central America	60.10	40.98	22.78	29.12	3.13	8.94	11.24	14.08	2.75	6.87	7.30	5.72
Costa Rica	56.66	31.66	21.47	22.50	6.37	23.31	10.60	10.88	4.91	11.64	8.28	3.40
El Salvador	60.91	44.12	23.08	31.36	3.27	5.52	11.39	15.17	1.35	3.83	3.72	3.99
Guatemala	61.52	42.64	23.31	30.31	2.54	9.15	11.51	14.66	1.12	3.24	3.92	3.95
Honduras	61.60	38.97	23.34	27.70	1.47	12.91	11.52	13.39	2.07	7.02	6.59	5.93
Mexico	61.50	44.18	23.30	31.40	1.82	3.41	11.50	15.19	1.88	5.83	6.84	6.37
Nicaragua	60.75	45.38	23.02	32.25	3.20	2.92	11.36	15.60	1.66	3.86	13.46	12.98
Panama	57.79	39.87	21.90	28.34	3.22	5.38	10.81	13.70	6.27	12.71	8.28	3.40
Caribbean	32.60	19.47	12.35	13.84	7.96	18.90	6.10	6.69	0.99	1.11		
Dominican Rep.	60.40	43.23	22.89	30.73	3.94	8.29	11.30	14.86	1.47	2.89	4.42	5.47
Haiti	63.65	47.77	24.12	33.96	0.20	1.53	11.91	16.42	0.13	0.32	3.14	4.89
Jamaica	38.93	6.33	14.75	4.50	35.66	84.66	7.28	2.18	3.37	2.33	3.14	4.89
LAC Average rate	59.28	40.20	22.46	28.57	4.17	10.08	11.09	13.82	3.00	7.32	9.80	8.16

Table A.3c Asia: Crop input cost shares, 1960–1981 and 1981–2000

Region/ Country	Crop Input Cost Shares (%)											
	Cropland (*)		Labor		Fert. + Pest.*		Seeds		Mechanization*		Animal Power	
	1961– 1980	1981– 2001	1961– 1980	1981– 2001	1961– 1980	1981– 2001	1961– 1980	1981– 2001	1961– 1980	1981– 2001	1961– 1980	1981– 2001
Middle East	58.29	38.71	41.02	38.75	1.23	6.19	2.64	4.05	6.96	13.01	6.53	3.60
Afghanistan	71.51	69.74	46.82	49.58	0.23	0.04	2.00	3.77	0.28	0.40	7.45	4.61
Iran	54.63	34.26	38.27	37.55	1.02	4.45	2.76	2.65	11.78	19.51	6.09	3.49
Iraq	61.73	39.56	40.42	31.93	0.70	7.05	3.71	7.42	7.14	15.82	6.43	2.97
Jordan	54.85	25.63	38.43	30.62	2.58	16.94	4.53	7.28	5.19	15.17	6.11	2.85
Saudi Arabia	45.78	35.51	40.29	42.41	2.89	11.05	1.72	1.14	6.88	4.04	6.41	3.95
Syria	55.16	30.76	41.00	36.75	1.01	4.43	2.61	4.63	10.65	18.21	6.52	3.42
Turkey	57.93	31.20	40.59	37.27	1.18	4.14	2.77	3.64	7.17	20.29	6.46	3.47
Yemen	64.73	43.01	42.38	43.91	0.23	1.41	1.00	1.83	6.59	10.67	6.74	4.08
South Asia	59.30	41.70	43.82	45.64	1.13	4.03	1.33	1.87	4.04	5.29	6.97	4.25
Bangladesh	67.36	48.79	47.19	49.81	0.45	2.20	0.90	0.97	0.23	0.23	7.51	4.63
India	62.18	39.24	43.56	43.00	0.85	4.55	1.98	3.00	3.68	8.19	6.93	4.00
Nepal	71.74	48.94	46.97	49.96	0.10	0.88	1.07	1.45	0.63	1.06	7.47	4.65
Pakistan	58.58	33.38	41.04	39.87	1.21	6.22	1.51	2.22	4.64	13.28	6.53	3.71

Continued

Table A.3c Asia: Crop input cost shares, 1960–1981 and 1981–2000—Cont'd

Region/ Country	Crop Input Cost Shares (%)											
	Cropland (*)		Labor		Fert. + Pest.*		Seeds		Mechanization*		Animal Power	
	1961– 1980	1981– 2001	1961– 1980	1981– 2001	1961– 1980	1981– 2001	1961– 1980	1981– 2001	1961– 1980	1981– 2001	1961– 1980	1981– 2001
Sri Lanka	36.64	38.15	40.31	45.57	3.06	6.28	1.20	1.70	10.99	3.69	6.41	4.24
South East Asia	52.58	48.14	45.32	44.90	1.40	4.73	1.06	1.78	2.37	2.95	7.21	4.18
Cambodia	42.10	48.08	46.31	49.09	0.10	0.10	2.06	4.43	0.89	0.56	7.37	4.57
Indonesia	63.36	64.17	47.09	48.82	0.81	3.35	0.38	0.58	0.67	0.79	7.49	4.54
Laos	42.69	41.56	46.96	49.64	0.08	0.12	1.74	3.16	0.46	0.76	7.47	4.62
Malaysia	46.40	35.36	38.67	28.54	6.60	21.80	0.28	0.31	8.34	8.08	6.15	2.65
Philippines	52.20	40.91	45.93	48.87	1.23	2.75	1.02	1.25	2.13	1.11	7.31	4.55
Thailand	66.48	54.31	46.58	43.83	0.33	2.36	1.03	1.19	1.87	5.41	7.41	4.08
Vietnam	54.82	52.61	45.68	45.54	0.66	2.62	0.92	1.55	2.25	3.92	7.27	4.24
East Asia	58.18	35.48	41.44	40.30	1.71	3.16	2.42	3.77	7.13	13.34	6.59	3.75
China	62.90	38.80	44.07	46.35	1.02	6.22	1.24	1.48	3.24	2.83	7.01	4.31
Mongolia	61.40	35.98	40.20	36.73	0.35	0.99	5.34	7.78	9.50	16.60	6.40	3.42
North Korea	50.25	31.66	40.06	37.81	3.75	2.28	0.69	2.04	8.64	20.59	6.37	3.52
Average rate	56.76	41.81	42.99	42.32	1.32	4.88	1.85	2.85	4.95	8.31	6.84	3.94

*Input costs ratio adjusted for geometric as explained in [Section 2.3](#).

Table A.3d Asia: Livestock input cost shares, 1960–1981 and 1981–2000

Region/ Country	Livestock Input Cost Shares (%)											
	Permanent Pastures		Labor		Fert. + Ch. + Med.		Feed		Mechanization		Animal Stock	
	1961–1980	1981–2001	1961–1980	1981–2001	1961–1980	1981–2001	1961–1980	1981–2001	1961–1980	1981–2001	1961–1980	1981–2001
Middle East	53.69	36.40	20.35	25.87	1.10	4.11	3.84	13.27	2.32	8.61	4.91	3.00
Afghanistan	63.57	48.51	24.09	34.48	0.38	0.10	11.89	16.67	0.06	0.25	6.90	3.72
Iran	61.33	40.17	23.24	28.55	1.52	4.35	11.47	13.81	2.44	13.12	5.07	4.24
Iraq	59.72	36.44	22.63	25.90	1.30	11.75	11.17	12.52	5.17	13.39	6.88	6.77
Saudi Arabia	61.31	42.73	23.23	30.37	2.36	8.45	11.47	14.69	1.63	3.76	3.92	0.77
Syria	61.45	39.04	23.28	27.75	1.17	3.57	11.49	13.42	2.60	16.23	2.34	1.59
Turkey	59.53	39.90	22.56	28.36	1.62	3.36	11.14	13.71	5.15	14.67	10.24	6.15
Yemen	62.62	44.41	23.73	31.57	0.42	1.30	11.71	15.26	1.52	7.46	3.92	0.77
South Asia	62.57	45.28	23.71	32.18	1.13	3.25	1.80	4.94	0.89	3.73	17.63	11.49
Bangladesh	63.46	47.67	24.05	33.88	0.56	1.93	11.87	16.38	0.06	0.14	27.36	17.70
India	62.60	43.97	23.72	31.25	1.14	3.88	11.71	15.11	0.83	5.79	15.02	8.73
Nepal	63.62	47.99	24.11	34.11	0.17	0.77	11.90	16.49	0.19	0.64	21.65	14.68
Pakistan	61.77	41.61	23.41	29.58	1.70	4.93	11.55	14.30	1.57	9.58	6.90	3.72

Continued

Table A.3d Asia: Livestock input cost shares, 1960–1981 and 1981–2000—Cont'd

Region/ Country	Livestock Input Cost Shares (%)											
	Permanent Pastures		Labor		Fert. + Ch. + Med.		Feed		Mechanization		Animal Stock	
	1961– 1980	1981– 2001	1961– 1980	1981– 2001	1961– 1980	1981– 2001	1961– 1980	1981– 2001	1961– 1980	1981– 2001	1961– 1980	1981– 2001
Sri Lanka	61.41	45.14	23.27	32.09	2.06	4.72	11.49	15.52	1.78	2.53	17.20	12.64
South East Asia		44.45	23.80	31.59	1.25	5.03	1.35	4.39	0.38	3.64	7.52	6.65
Cambodia	63.64	48.42	24.12	34.41	0.06	0.11	11.91	16.64	0.27	0.42	23.65	21.76
Indonesia	63.27	46.94	23.97	33.37	0.84	2.44	11.84	16.13	0.09	1.11	8.81	5.93
Laos DPR	63.74	48.35	24.15	34.37	0.04	0.20	11.92	16.62	0.14	0.47	6.29	8.02
Malaysia	59.31	31.02	22.47	22.04	5.98	23.97	11.09	10.66	1.15	12.31	2.36	0.90
Philippines	63.08	47.16	23.90	33.52	0.91	2.43	11.80	16.21	0.31	0.67	2.53	1.53
Thailand	63.43	44.06	24.04	31.32	0.42	2.90	11.87	15.14	0.25	6.57	5.72	5.52
Vietnam	63.20	45.20	23.95	32.13	0.54	3.19	11.82	15.54	0.49	3.94	3.27	2.87
East Asia	40.88	28.80	15.49	20.47	0.67	1.92	3.48	11.59	1.97	5.59	3.82	3.82
China	62.53	45.56	23.70	32.38	1.36	4.64	11.70	15.66	0.72	1.75	4.35	2.11
Mongolia	60.12	40.83	22.78	29.02	0.65	1.11	11.25	14.03	5.21	15.01	7.12	9.36
Average rate	62.13	43.58	23.54	30.97	1.20	4.29	11.62	14.98	1.51	6.18	9.12	6.64

Table A.3e Africa crop input cost shares, 1960–1981 and 1981–2000

Region/ Country	Cropland		Labor		Fert. + Pest.		Seeds		Mechanization		Animal Power	
	1961– 1980	1981– 2001										
North Africa	49.48	31.65	39.75	37.80	2.64	4.14	3.04	4.99	9.74	15.51	6.32	3.52
Algeria	56.10	30.89	39.30	36.90	2.04	1.51	3.76	5.78	8.47	20.09	6.25	3.43
Egypt	44.46	38.20	41.80	45.63	3.10	4.51	1.12	0.89	8.69	6.53	6.65	4.24
Libya	49.73	25.83	36.96	30.86	4.76	7.67	4.80	8.89	8.74	16.80	5.88	2.87
Morocco	53.85	32.44	40.03	38.74	1.21	2.88	2.65	5.63	12.24	14.04	6.37	3.60
Tunisia	43.24	30.87	40.66	36.87	2.07	4.12	2.86	3.79	10.56	20.07	6.47	3.43
East Africa	38.33	31.79	31.63	33.24	0.28	1.03	0.84	0.90	0.04	0.16	5.03	3.09
Ethiopia	72.34	53.03	47.36	47.98	0.10	3.33	1.68	1.26	0.01	0.51	7.54	4.46
Sudan	42.96	46.14	47.26	50.57	0.73	0.40	1.37	1.77	0.09	0.13	7.52	4.70
Uganda	64.51	42.85	47.95	51.19	0.05	0.01	0.64	1.09	0.08	0.09	7.63	4.76
Kenya	50.19	48.71	47.19	49.73	0.78	2.47	1.35	1.28	0.07	0.21	7.51	4.63
Madagascar	53.64	42.81	47.20	51.13	0.14	0.37	2.13	0.38	0.05	0.07	7.51	4.76
Central Africa	57.62	45.66	38.65	35.95	0.34	2.04	5.06	13.54	0.20	0.36	7.17	3.90
Cameroon	57.92	48.97	46.17	50.00	1.06	1.40	2.79	1.80	0.01	0.02	7.34	4.65
Chad	72.32	52.53	47.35	50.19	0.07	0.75	1.84	2.36	0.01	0.01	7.53	4.67

Continued

Table A.3e Africa crop input cost shares, 1960–1981 and 1981–2000—Cont'd

Region/ Country	Cropland		Labor		Fert. + Pest.		Seeds		Mechanization		Animal Power	
	1961– 1980	1981– 2001										
Dem. Rep. Congo	66.39	57.77	46.52	50.00	0.19	0.03	3.26	3.36	0.08	0.06	7.40	4.65
Rep. Congo	44.29	27.81	36.91	25.17	0.25	9.91	21.59	34.80	1.08	2.04	5.87	2.34
Rep. Central African	57.44	58.20	45.78	50.37	0.45	0.11	4.81	2.58	0.01	0.01	7.28	4.69
Rwanda	47.36	28.68	47.80	25.95	0.04	0.03	1.09	49.86	0.01	0.01	7.60	2.41
Western Africa	56.82	47.51	40.01	42.27	0.30	0.56	2.21	3.26	0.04	0.03	6.37	3.93
Benin	50.50	57.72	47.48	49.96	0.14	1.41	1.63	1.28	0.01	0.01	7.55	4.65
Guinea	59.15	62.84	47.14	50.71	0.05	0.08	2.40	1.92	0.01	0.02	7.50	4.72
Ghana	70.55	59.01	46.20	51.08	0.36	0.26	3.09	0.89	0.10	0.05	7.35	4.75
Togo	72.32	50.21	47.35	47.98	0.13	0.91	1.67	6.17	0.01	0.00	7.53	4.46
Mauritania	69.93	55.92	45.79	39.76	0.62	0.74	3.07	20.86	0.24	0.09	7.28	3.70
Niger	72.42	53.92	47.42	51.52	0.02	0.04	1.87	0.49	0.00	0.00	7.54	4.79
Burkina Faso	72.44	49.71	47.43	50.75	0.09	0.70	1.61	1.15	0.00	0.02	7.55	4.72
Ivory Coast	56.78	41.39	45.26	49.44	1.52	1.91	3.78	2.57	0.08	0.09	7.20	4.60

Mali	71.68	67.11	46.93	51.06	0.18	0.01	2.33	1.37	0.02	0.03	7.47	4.75
Nigeria	72.43	59.23	47.43	51.27	0.26	0.26	1.05	0.56	0.02	0.07	7.54	4.77
Senegal	60.65	51.99	45.08	49.68	0.82	1.46	5.18	2.13	0.02	0.02	7.17	4.62
Sierra Leone	66.64	56.09	46.69	48.55	0.06	0.02	3.28	6.25	0.01	0.01	7.43	4.52
Southern Africa	56.89	49.23	45.18	46.66	1.75	2.14	3.17	5.74	0.53	1.53	7.19	4.34
Angola	65.60	62.07	45.96	50.09	0.82	0.13	1.97	2.16	0.56	0.91	7.31	4.66
Botswana	40.57	31.63	38.15	30.22	1.69	5.65	16.33	24.05	1.18	10.08	6.07	2.81
Malawi	63.49	41.99	47.19	50.15	0.49	1.03	1.43	2.14	0.02	0.03	7.51	4.67
Mozambique	55.44	72.37	46.20	51.46	1.13	0.00	2.40	0.49	0.36	0.15	7.35	4.79
Zimbabwe	55.23	41.09	46.02	49.08	2.16	4.07	1.24	0.65	0.33	0.55	7.32	4.57
South Africa	52.26	48.82	45.99	49.84	2.66	2.76	0.73	0.13	0.62	0.21	7.32	4.64
Zambia	62.79	54.73	46.67	49.52	1.30	1.17	0.80	2.37	0.14	0.31	7.42	4.61
Namibia	48.90	40.44	43.03	38.64	5.30	4.19	2.47	18.38	1.48	1.44	6.85	3.59
Tanzania	67.74	49.90	47.46	50.94	0.21	0.25	1.18	1.27	0.12	0.09	7.55	4.74
Average rate	59.03	47.94	45.22	46.03	1.00	1.80	3.17	6.02	1.50	2.56	7.19	4.28

*Input costs ratio were adjusted for geometric as explained in [Section 2.3](#).

Table A.3f Africa livestock input cost shares, 1961–1980 and 1981–2001

Region/ Country	Permanent Pastures		Labor		Fert. + Chem. + Medic.		Feed		Mechanization		Animal Stock	
	1961– 1980	1981– 2001	1961– 1980	1981– 2001	1961– 1980	1981– 2001	1961– 1980	1981– 2001	1961– 1980	1981– 2001	1961– 1980	1981– 1901
North Africa	49.58	33.09	18.79	23.52	1.99	4.15	9.27	11.37	3.71	11.19	4.32	2.20
Algeria	58.79	40.30	22.28	28.64	2.85	2.40	11.00	13.85	5.09	14.81	5.41	2.36
Egypt	60.22	40.91	22.82	29.08	0.48	0.91	11.27	14.06	5.21	15.04	2.57	2.34
Libya	57.07	35.91	21.63	25.52	5.68	13.02	10.68	12.34	4.94	13.20	3.93	2.22
Morocco	61.77	41.82	23.41	29.73	1.45	4.54	11.55	14.38	1.83	9.53	10.04	4.04
Tunisia	59.62	39.62	22.59	28.16	1.47	4.05	11.15	13.62	5.16	14.56	3.93	2.22
East Africa	42.12	29.97	15.96	21.30	0.23	1.44	7.88	10.30	0.49	3.65	12.69	12.38
Ethiopia	63.57	39.87	24.09	28.34	0.21	5.38	11.89	13.70	0.24	12.71	23.71	23.42
Sudan	62.82	47.11	23.81	33.49	0.48	0.54	11.75	16.19	1.14	2.67	19.20	24.36
Uganda	63.37	47.79	24.01	33.97	0.06	0.02	11.85	16.43	0.70	1.80	16.09	13.01
Kenya	62.94	45.06	23.85	32.03	0.61	2.70	11.77	15.49	0.83	4.72	17.13	13.49
Madagascar	63.53	47.57	24.07	33.81	0.13	0.96	11.88	16.35	0.39	1.31	18.19	15.71
Central Africa	53.94	38.95	20.44	27.68	0.33	3.65	10.70	250.99	1.06	2.39	22.33	18.97
Cameroon	63.02	47.56	23.88	33.80	1.14	1.93	11.79	16.35	0.17	0.36	22.76	16.52

Chad	63.72	48.18	24.14	34.25	0.14	0.87	11.92	16.56	0.08	0.15	24.81	31.73
Dem. Rep. Congo	63.24	47.95	23.96	34.08	0.29	0.05	11.83	16.48	0.68	1.44	25.78	21.79
Rep. Congo	60.28	32.05	22.84	22.78	0.38	22.38	11.28	11.02	5.22	11.78	22.76	16.52
Rep. Central African	63.57	48.49	24.09	34.46	0.33	0.21	11.89	16.67	0.12	0.18	22.76	16.52
Rwanda	63.78	48.42	24.17	34.42	0.03	0.09	11.93	16.64	0.10	0.43	15.13	10.74
Western Africa	54.17	40.86	20.53	29.04	0.46	0.99	2.41	13.69	0.43	0.77	13.37	12.53
Benin	63.73	47.32	24.15	33.63	0.11	2.60	11.92	16.26	0.08	0.19	12.88	11.73
Guinea	63.78	48.33	24.17	34.35	0.06	0.19	11.93	16.61	0.07	0.53	21.35	28.69
Ghana	62.31	47.47	23.61	33.74	0.74	0.47	11.66	16.32	1.69	2.00	7.94	9.38
Togo	63.64	47.91	24.11	34.05	0.26	1.47	11.90	16.47	0.09	0.11	12.88	11.73
Mauritania	61.77	46.10	23.41	32.77	1.28	3.23	11.55	15.84	1.99	2.06	10.04	10.04
Niger	63.82	48.62	24.18	34.56	0.04	0.07	11.94	16.71	0.02	0.05	19.04	11.07
Burkina Faso	63.71	47.83	24.14	34.00	0.19	0.96	11.92	16.44	0.03	0.76	23.70	18.64
Ivory Coast	62.12	46.74	23.54	33.22	1.65	2.17	11.62	16.07	1.07	1.80	8.75	10.61
Mali	63.46	48.18	24.05	34.24	0.37	0.03	11.87	16.56	0.25	0.99	15.37	12.41
Nigeria	63.27	47.80	23.97	33.97	0.53	0.47	11.84	16.43	0.40	1.33	12.88	11.73
Senegal	63.06	47.28	23.90	33.60	1.07	2.24	11.80	16.25	0.18	0.63	21.05	10.67
Sierra Leone	63.73	48.52	24.15	34.49	0.10	0.04	11.92	16.68	0.10	0.28	21.35	28.69

Continued

Table A.3f Africa livestock input cost shares, 1961–1980 and 1981–2001—Cont'd

Region/ Country	Permanent Pastures		Labor		Fert. + Chem. + Medic.		Feed		Mechanization		Animal Stock	
	1961– 1980	1981– 2001	1961– 1980	1981– 2001	1961– 1980	1981– 2001	1961– 1980	1981– 2001	1961– 1980	1981– 2001	1961– 1980	1981– 1991
Southern Africa	60.69	43.31	23.00	30.78	1.70	3.24	3.26	22.49	3.26	7.79	20.29	15.91
Angola	58.61	41.10	22.21	29.21	1.19	0.24	10.96	14.13	7.04	15.31	25.78	21.79
Botswana	59.57	36.73	22.57	26.11	1.55	11.04	11.14	12.62	5.16	13.50	22.15	16.55
Malawi	63.30	47.81	23.99	33.99	0.62	1.19	11.84	16.43	0.26	0.58	18.88	13.75
Mozambique	61.46	47.05	23.29	33.44	1.08	0.01	11.50	16.17	2.68	3.32	17.41	13.42
Zimbabwe	60.82	41.96	23.05	29.83	2.05	4.19	11.38	14.42	2.70	9.59	22.15	16.55
South Africa	59.76	43.99	22.64	31.26	2.25	3.54	11.18	15.12	4.17	6.09	8.05	7.40
Zambia	62.02	44.98	23.50	31.97	1.63	1.89	11.60	15.46	1.24	5.70	25.78	21.79
Namibia	57.71	38.51	21.87	27.37	4.63	6.72	10.80	13.24	5.00	14.16	22.15	16.55
Tanzania	62.94	47.63	23.85	33.85	0.32	0.34	11.77	16.37	1.12	1.81	20.25	15.36
Average rate	62.05	44.88	23.51	31.90	1.01	2.79	11.61	15.42	1.82	5.01	16.87	14.47