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Agricultural Growth and Food Imports in Developing Countries: A Reexamination

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Introduction

The relationship between agricultural growth and food imports in developing countries has recently attracted renewed interest among agricultural and trade economists. This is largely in reaction to the strong opposition by farm lobbies in the United States to development assistance programs abroad that promote foodgrain production allegedly to the detriment of U.S. agricultural interests,[1] which in turn was stimulated by the substantial fall in U.S. farm exports since 1981.

The major food crops, including cereals, roots and tubers, pulses, groundnuts, plaintains and bananas, account for the bulk of total calorie intake in developing countries. Although they are net exporters of noncereal food staples, developing countries as a group import cereals much more heavily. For example, developing countries' exports of noncereal food crops averaged 7.8 million tons annually during the period 1979–83 which was only about

one-sixth of their net cereals imports over the same period. It seems reasonable, therefore, to use the terms "food imports" and "net cereal imports" interchangeably in this paper.

Nine years ago, Bachman and Paulino (1979) observed a strongly positive effect of agricultural growth on food imports of developing countries during the period 1961–76 and concluded that "staple food exporters have little cause to worry about the rapid growth of food production in the developing countries" (p. 35). A number of more recent studies have also documented the historical and cross-country correlations between agricultural growth and food imports through the early 1980s (Kellogg 1985; Lee and Shane 1985; Houck 1986; Timmer 1987).

The volume of food imports to developing countries actually increased in the 1980s, but other developed countries have gained larger market shares than the United States. It would seem then that the observed decline in U.S. agricultural exports in the 1980s has been caused by factors other than the growth of farm output in developing countries, involving the "international recession, currency exchange rates, bumper crops around the globe, international debt repayment problems, political maneuvering, and trade-strangling policy adjustments" (Houck 1986, p. 2).

The positive correlation between agricultural growth in developing countries and increases in their food imports is typically specified at a high level of country aggregation; as some writers have pointed out, there are some exceptions to the general rule (Paarlberg 1986). Indeed, as table 1 indicates, some developing countries show (1) a high agricultural growth rate but a low or even negative growth rate in net cereal imports (e.g., Paraguay and Pakistan), and (2) a low or even negative agricultural growth rate and a high cereal growth rate (e.g., Nigeria and Chad). It is also not necessarily the case that relationships based on past observations will continue to hold in the future.

This paper systematically examines the effect of agricultural growth on food imports of developing countries. In the next section, an analytical model is developed to provide the framework for identifying the conditions under which agricultural growth in developing countries may or may not lead to increased food imports. Cross-country data for 34 developing countries is used to estimate the model and analyze the collective experiences of these countries over each of the two observation periods 1961–84 and 1973–84. Individual Asian country relationships between agricultural and food import growth rates are then examined, and the reasons for the signs and relative magnitudes of the food import elasticity with respect to agricultural production are discussed. The paper ends with some concluding comments.

Analytical Considerations

Agricultural growth in developing countries affects food imports through the induced increase in national income, which affects food demand, and through the likely expansion in domestic food supply. The extent to which

Table 1
Average Annual Growth Rates
(percent)

Country	Agricultural value added[a]		Net cereal imports[b]	
	1961–1984	1973–1984	1961–1984	1973–1984
Chad	-0.69	-0.95	12.24	12.07
Ethiop	1.49	1.01	17.77	21.94
Mali	2.92	4.05	14.37	4.72
Tanzania	2.84	2.73	6.27	8.07
Uganda	1.33	-0.27	-1.41	8.22
Togo	1.58	1.33	9.38	24.70
Somalia	2.17	2.48	10.40	17.18
Sierra Leone	1.97	2.17	4.07	4.21
Ghana	1.19	-0.27	5.07	7.76
Sudan	3.32	3.44	4.75	12.95
Senegal	1.49	1.00	4.42	5.11
Mauritania	-0.42	1.34	7.84	5.64
Liberia	4.47	2.79	4.72	7.85
Ivory Coast	3.87	4.03	9.92	14.24
Nigeria	0.67	-1.18	15.10	14.40
Cameroon	3.05	2.13	7.35	5.82
India	2.29	2.20	-7.52	-11.64
Sri Lanka	2.73	3.56	0.37	-4.60
Pakistan	3.58	3.07	0.70	-14.75
Bolivia	3.18	2.27	3.42	4.49
Indonesia	3.79	3.72	8.24	0.67
Philippines	4.29	4.38	3.10	3.94
Morocco	2.10	0.01	9.67	8.84
Honduras	2.74	2.46	6.28	5.43
El Salvador	2.60	1.51	4.83	7.23
Egypt	2.81	2.65	8.57	10.42
Dominican Republic	3.69	3.22	9.03	4.54
Ecuador	3.03	2.27	10.14	8.93
Costa Rica	398	1.95	4.80	5.62
Paraguay	5.17	6.10	-4.02	-2.95
Tunisia	4.29	2.17	7.06	13.39
Colombia	3.87	3.87	7.41	7.11
Malaysia	4.68	4.78	3.50	6.77
Korea	3.17	2.24	11.60	8.72

NOTES:
a. Agricultural value added in constant prices.
b. Net cereal imports in metric tons.

Sources: Food and Agriculture Organization of the United Nations, Agricultural Supply Utilization Accounts Tape, 1985.
World Bank, World Bank data tape (economic data sheet I), 1985.

agricultural production can fuel overall economic growth, and hence raise national income, is determined in part by the relative size of agriculture and its growth linkages with the rest of the economy. The magnitude of the income multiplier effects arising from agricultural growth linkages, on both the demand and supply sides, are determined critically by the existing infrastructure, particularly in the rural areas (Mellor 1976). For example, despite comparably rapid agricultural growth in the Philippines and Taiwan during the 1960s, a much greater impetus to nonagricultural activities was generated in Taiwan owing to the more developed rural infrastructure and hence stronger growth linkages that were present (Ranis and Stewart 1987).

Rising national income leads to changes in both the volume and composition of food consumption according to the existing income distribution. Income elasticities are high (1) for cereals among low-income households and (2) for livestock products among the more affluent. Cereal demand for direct food consumption would then increase significantly among low-income families, while high-income households would expand their consumption of livestock products and thereby boost the derived demand for feedgrains. It is also likely that rural and urban households have different magnitudes of income elasticity of food demand. An additional determinant of food demand is the government's pricing policy as it affects food consumers. The domestic food price is a politically sensitive issue in most developing countries and can be realistically assumed as policy-determined.

Domestic food supply is also likely to increase with agricultural growth, with the magnitude of the induced expansion depending on the country's agricultural resources, pattern of public agricultural investments, and relative prices facing agricultural food producers. These factors will largely determine whether the structure of agricultural growth will favor food or nonfood production.[2] In theory, therefore, the influence of agricultural growth on food imports (the difference between food demand and domestic food supply) can be positive or negative.

The above considerations can be represented more formally as follows. The difference between a country's food demand (D_f) and its domestic food supply (S_f) is met by food imports (M_f), i.e.,

$$M_f = D_f - S_f, \tag{1}$$

which can be expressed in terms of growth rates (denoted by a dot [.] over the variable), as

$$(1 - s)\dot{M}_f = \dot{D}_f - sr\dot{X}_a, \tag{2}$$

where

s (= S_f/D_f) = good self-sufficiency ratio,

r (= $\dot{S}_f/\dot{X}_a$) = agricultural growth structure coefficient,

$\dot{X}_a$ = growth rate of agricultural output.

Next, a food demand function, with agricultural income or value added (V_a), nonagricultural income (V_n) and other variables as arguments, is specified:

$$D_f = D_f(V_a, V_n, \ldots), \tag{3}$$

which can be written as,

$$\dot{D}_f = e_a\dot{V}_a + e_n\dot{V}_n + \ldots, \tag{4}$$

where e_a and e_n are the elasticities of food demand with respect to agricultural income and nonagricultural income, respectively. Because our analytical interest here is only in the effects of agricultural growth, other factors affecting food demand that are considered exogenously determined (such as population size and the government's pricing policy) do not have to be shown explicitly in equations (3) and (4).[3] The above formulation of the food demand function allows for an income distribution effect. Anticipating problems of data availability in the subsequent estimation of the demand equation, we are unable to specify a distinction by income-size groups. However, incomes of agricultural (rural) households in developing countries are generally observed to be significantly lower on average than those of nonagricultural (urban) households. It is worthwhile, therefore, to have $\dot{V}_a = \dot{V}_n$ entered separately in equation (4) instead of combining them into an aggregate income growth variable.[4] Eliminating $\dot{D}_f$ in equation (2) by using equation (4) and setting $\dot{V}_a = \dot{X}_a$ (i.e., assuming no change in the ratio of value added to value of output),

$$(1 - s)\dot{M}_f = (e_a - sr)\dot{X}_a + e_n\dot{X}_n + \ldots \tag{5}$$

which expresses the growth rate of food imports in terms of the growth rates of agricultural and nonagricultural production.

It remains to specify that nonagricultural production is a function of agricultural production, among other possible influences, i.e.,

$$\dot{X}_n = k\dot{X}_a + \ldots, \tag{6}$$

which invokes the mechanism of agricultural growth linkages with the rest of the economy described above. The coefficient k can be referred to as the growth linkage elasticity, indicating the percentage change in nonagricultural production that results from a one percent change in agricultural production, other exogenous variables remaining the same.

Equation (6) can be used to eliminate $\dot{X}_n$ in equation (5), which yields the following expression for the elasticity of food imports with respect to agricultural production (abstracting from other exogenous influences):

$$E(= \dot{M}_f/\dot{X}_a) = (e_a + e_nk - sr) / (1 - s). \tag{7}$$

The sign and magnitude of E is therefore determined by the five parameters contained in equation (7). Since $0 < s < 1$ for net food-importing countries, $E \gtrless 0$ depending upon,

$$e_a + e_nk \gtrless sr. \tag{8}$$

It is also clear that the effect of agricultural growth on food imports will be greater: (1) the higher are the income elasticities of food demand, e_a and e_n; (2) the higher is the growth linkage elasticity, k; (3) the lower is the agricultural growth structure coefficient, r (i.e., the less rapid is the expansion of domestic food supply relative to the growth of agricultural nonfood production); and (4) the lower is the food self-sufficiency ratio, s.[5] This set of parameters (e_a, e_n, k, s, and r) provides the basis for the explanation of the relationship between food imports and agricultural growth in developing countries, in the aggregate and individually, which is addressed in the following two sections of the paper.

Cross-Country Analysis

Our interest here is in the collective experience of the developing countries in our sample. The developing countries being examined are food-deficit countries with a large agricultural share in gross domestic product (specifically, more than 20 percent in the early 1970s). It is the medium- to long-run, rather than the short-run, relationship between agricultural production and food imports that will be analyzed. For this reason, the relevant variables are expressed in average annual (compound) rates of changes (i.e., the trend values) over each of the two observation periods, 1961–84 and 1973–84.[6] Using a multicountry, long-period analysis enables us to abstract from dynamic considerations (e.g., adjustment lags) and short-term disturbances (e.g., weather); it also reduces the probability of gross error arising from sources peculiar to individual countries and specific short periods.

Based on the model developed in the preceding section, we need to derive aggregate values (i.e., values covering the entire sample of 34 countries) for the set of five parameters indicated above. First, the food self-sufficiency ratio, s, is computed from data on production and total domestic use of major food crops. For the period 1961–84 the value of s was found to be 0.915, and for the period 1973–84, it was 0.913. These are surprisingly close values. Next, based on the calculated growth rates of major food crop production and of agricultural value added using World Bank data, the aggregate agricultural growth structure coefficient, r, was computed and found to be 0.872 (= 2.38% ÷ 2.74%) for the period 1961–84 and 0.783 (= 1.80% ÷ 2.30%) for the period 1973–84 — which imply a rather significant reduction in the value of r from the earlier subperiod 1961–73. Not only has the share of food in agricultural production decreased for the 34 food-deficit developing countries as a group, but the decline was more rapid during the more recent subperiod 1973–84.

The three remaining parameters (e_a, e_n, and k) are estimated econometrically using the food demand equation (4) and the agricultural growth linkage equation (6). In view of the recursive nature of the two equations, it is appropriate to use ordinary least squares (OLS) estimation, which we

apply to the two sets of observations (expressed in trend values, as indicated above), one set each for the periods 1961–84 and 1973–84.

The empirical estimates presented in table 2 should be interpreted to reflect the quantitative influences on nonagricultural output and on food demand for the 34 developing countries as a group. The coefficient estimates, except those for $\dot{V}_n$ in the food demand equation, are statistically significant at the 5 percent level. Between 43 and 60 percent of the variance of the dependent variables is explained, which appears reasonable for a cross-section study of this type.

Complementing the role of agricultural income (V_a) as a domestic demand variable, export growth ($\dot{X}$) representing foreign demand is also shown to be a significant determinant of growth in nonagricultural production ($\dot{V}_n$).

The elasticity estimates with respect to V_a are, however, markedly higher than those with respect to X. Indeed, it is remarkable that the growth linkage elasticity is found to be greater than unity for each of the two periods (1.298

Table 2
Aggregative Regression Results

	1973–84	1961–84
Growth linkage equation:	1.410 $\dot{V}_a$	1.298 $\dot{V}_a$
	(7.37)	(8.70)
$\dot{V}_n$ as dependent variable		
	0.291 $\dot{X}$	0.253 $\dot{X}$
	(2.55)	(4.04)
	$\bar{R}^2$ = 0.488	$\bar{R}^2$ = 0.592
Food demand equation:	0.646 $\dot{V}_a$	0.706 $\dot{V}_a$
	(2.64)	(4.69)
$\dot{D}_f$ as dependent variable		
	0.105 $\dot{V}_n$	0.131 $\dot{V}_n$
	(1.02)	(1.67)
	0.714 $\dot{Pop}$	0.697 $\dot{Pop}$
	(3.16)	(2.95)
	$\bar{R}^2$ = 0.532	$\bar{R}^2$ = 0.598

NOTES:
V_a = Agricultural value added.
V_n = Nonagricultural value added.
X = Exports.
D_f = Food consumption.
Pop = Population size.
Dot (.) over a variable denotes average annual rate of change.
Numbers in parentheses are t-values.

for 1961 and 1.410 for the period 1973–84). This is broadly consistent with existing empirical evidence based on household data at the regional village level (Mellor 1976; Ranis and Stewart 1987). That the elasticity estimate is higher in the period 1973–84 presumably reflects the general improvement in rural infrastructure over time in each country which, as pointed out above, can enhance the linkage effects of agricultural growth on the rest of the economy.

In the food demand equation, population growth (Pop) is specified to be an additional explanatory variable; as shown in table 2, its coefficient estimates are statistically significant.[7] The estimated income elasticities of food demand — 0.706 for the period 1961–84 and 0.646 for the period 1973–84 for agricultural income; 0.131 for the period 1961–84 and 0.105 for the period 1973–84 for nonagricultural income — appear reasonable in both relative and absolute magnitudes. In particular, the lower food elasticity estimates for the later subperiod 1973–84 would seem attributable to the increasing average levels of agricultural and nonagricultural incomes.

Substituting these values of the five parameters in the expression for E given in equation (7),[8] the elasticity of food imports with respect to agricultural production is calculated to be 0.92 for the period 1961–84 and 0.91 for the period 1973–84. These two E-values are remarkably close and can be explained as the result of offsetting influences. First, the income elasticities of food demand, both e_a and e_n, are lower for the period 1973–84 than for the period 1961–84, which tends to lower E in the period 1973–74. However, the lower self-sufficiency ratio, s, lower agricultural growth structure coefficient, r, and higher growth linkage coefficient, k, in the period 1973–84 make for a higher E.

In an earlier study applying regression analysis on 1983 and 1984 data for 48 developing countries, Houck (1986) finds that a 10 percent rise in agricultural productivity was associated with a 9 to 10 percent increase in per capita income, and a 10 percent gain in per capita income was associated with a 10 to 11 percent rise in per capita food imports. This would imply an approximate one-to-one correspondence between proportionate changes in food imports and agricultural output, assuming that the growth rates of population and agricultural employment are about equal. It is striking that our own findings, based on a different methodology, a different (smaller) sample of developing countries, and different time periods, also show a close unitary elasticity of food imports with respect to agricultural production.

Individual Asian Country Relationships

Aggregate relationships based on cross-country data are useful in that they permit broad generalizations to be made across countries. However, they conceal differences among countries that may arise from differing values of behavioral and policy parameters. In the present context, significant differences in the quality of available data among the 34 developing countries

in our sample are also likely to exist. It is well known, for example, that published data in Asian countries are generally more reliable than those in subSaharan Africa. In the above regressions, use of average growth rates instead of levels presumably made intercountry data more comparable (among other advantages). In pursuing the empirical examination of the effect of agricultural growth on food imports, focus is given to seven Asian countries in our sample (India, Indonesia, Malaysia, Pakistan, Philippines, Korea, and Sri Lanka). Annual data for the period 1961–84 is used for each country to assign values to the five parameters identified above.

The observed values of the food self-sufficiency ratio shown in the first column of table 3 range from 53.6 percent for Malaysia to 98.0 percent for Pakistan. Another South Asian country, India, is seen to be highly self-sufficient (96.8 percent), while Sri Lanka shows a relatively low 61.7 percent. Agricultural growth during the period 1961–84 in all South Asian economies apparently favored food production, as reflected in the values of the growth structure coefficient being greater than one. Among the East Asian countries, only Indonesia shows an r-value exceeding one, while the Philippines has 0.97; the two countries with the highest per capita income in the group, Malaysia and Korea, show markedly lower values (0.506 and 0.486, respectively). Therefore, as far as these two parameters (s and r) are concerned, there are indeed significant differences in the observed values across countries for the period 1961–84.

We again make use of regression analysis to derive estimates of the remaining parameters, that is, the growth linkage elasticity, k, and the food demand elasticities with respect to agricultural and nonagricultural incomes, e_a and e_n. To get around problems relating to short-run dynamics and instability, a five-year moving average of annual growth rates is calculated as the unit of observation over the period 1961–84.

Table 3
Average Values of the Food Self-Sufficiency Ratio and Agricultural Growth Structure Coefficient, 1961–84

	Self-sufficiency ratio (s)	Growth structure coefficient (r)
India	0.968	1.306
Indonesia	0.949	1.208
Malaysia	0.536	0.566
Pakistan	0.980	1.330
Philippines	0.908	0.970
Korea	0.718	0.486
Sri Lanka	0.617	1.491

Source: Food and Agricultural Organization, Agricultural Supply Utilization Accounts Tape, 1985.

The regression results for the growth linkage and food demand equations are presented in table 4. The first column shows statistically significant estimates of the growth linkage elasticity for each of the seven Asian countries, ranging from 0.215 for Korea to 1.598 for Malaysia. The estimated elasticity for India (0.697) is relatively low but is somewhat higher than Rangarajan's (1982) estimate of 0.5, which was based on a macroeconometric analysis of the Indian economy using data for the period 1961–72. Comparing the magnitudes of the estimated coefficients of $\dot{V}_a$ and $\dot{X}$, agricultural growth consistently appears as a much more potent influence on nonagricultural production than export expansion, except in Korea where the agricultural share in GDP rapidly declined under the industrial export-led development that occurred during the period.

The estimated food demand elasticities with respect to agricultural income are remarkably high, exceeding 0.70 for all but two of the Asian countries (Korea and Sri Lanka). The positive effect of nonagricultural income is found to be statistically significant only for India and Malaysia, and the estimated elasticity e_n is expectedly lower than the corresponding e_a estimate for each

Table 4
Estimation Results for Asian Countries

	Growth linkage equation (dependent variable: $\dot{V}_2$)			Food demand equation (dependent variable: $\dot{D}_f$)			
	$\dot{V}_a$	$\dot{X}$	$\bar{R}^2$	$\dot{V}_a$	$\dot{V}_n$	$\dot{P}_f$	$\bar{R}^2$
India	0.697	.331	.688	.810	.519	-.532	.796
	(2.35)	(3.05)		(3.05)	(2.10)	(-1.22)	
Indonesia	1.347	.168	.960	.996	.165	-.243	.966
	(6.36)	(3.17)		(3.63)	(0.59)	(-2.42)	
Malaysia	1.598	.012	.922	.764	.402	—	.887
	(4.01)	(0.08)		(4.46)	(2.29)		
Pakistan	1.431	.095	.851	.947	.182	—	.930
	(6.62)	(1.20)		(4.56)	(1.08)		
Philippines	1.267	.012	.970	.715	.228	-.013	.836
	(17.26)	(0.44)		(3.07)	(1.72)	(-0.06)	
Korea	0.215	.558	.770	.651	.121	-.485	.955
	(2.05)	(4.13)		(2.47)	(1.12)	(-2.75)	
Sri Lanka	0.763	.040	.644	.544	.111	-.560	.680
	(4.61)	(0.79)		(2.33)	(1.04)	(-0.79)	

NOTE:
P_f = Consumer food price relative to the general CPI; see table 2 for definitions of other symbols.

country. Because the initial regressions for Malaysia and Pakistan yielded positive coefficients of the food price variable, this explanatory variable was subsequently dropped. Among the other countries, negative coefficient estimates were statistically significant only for Indonesia and Korea. Population growth was also initially significant but later removed due to its strong correlation with $\dot{V}_a$ or $\dot{V}_n$ in each country.

Based on the values of the five parameters (s, r, k, e_a, and e_n) derived above,[9] the elasticity of food imports with respect to agricultural production can be computed for each Asian country using the expression for E given in equation (7). The calculated E-values are as follows: India, -2.88; Indonesia, 1.42; Malaysia, 2.38; Pakistan, -3.48; Philippines, 1.34; Korea, 1.16; and Sri Lanka, -0.76. What emerges is a subregional differentiation in which the three South Asian countries show negative elasticities while the four East Asian countries have positive elasticities. The latter values are each seen to be significantly higher than the aggregative E-value of 0.92 derived earlier from cross-country data for the period 1961-84.

For India, Pakistan and Sri Lanka, the heavy food orientation of their agricultural growth and relatively slight food demand effects of income growth during the period were the major factors explaining the negative effect of agricultural production on food imports.

Among the East Asian countries, the positive E-values for Malaysia and Korea can be largely attributed to the markedly low degree of food self-sufficiency and an agricultural growth structure heavily favoring nonfood production.[10] While Indonesia and the Philippines had relatively higher s- and r-values during the period, this was dominated by the large incremental food demand out of agricultural and (less so) nonagricultural incomes, resulting also in a positive elasticity of food imports with respect to agricultural production.

Concluding Remarks

Our finding from the cross-country analysis, involving 34 developing countries with a significantly large agricultural sector as a share of GDP, of a positive aggregate elasticity of net cereal imports with respect to agricultural production indicates that the positive income-induced demand effect of agricultural growth on food imports outweighs the negative domestic food supply effect. Moreover, the estimated elasticity is found to be close to unitary, implying that the positive effect of agricultural growth on developing country's food imports is not insignificant. In general, therefore, it is to the advantage of developed country food exporters that agricultural growth in developing countries is accelerated, provided that the aggregate values of the five parameters examined above do not change substantially.[11] Also, the interests of developed country exporters is not likely to be harmed by agricultural development assistance to developing countries, which can be viewed as an effective means of expanding the world food market. Of course, this does not mean that each exporting country is assured of rising food export-

to developing countries, since there will be competition for market share among food exporting countries.

While agricultural growth is necessary to sustain overall economic growth in developing countries with a high agricultural share in GDP, it is not a sufficient condition for increased food imports. The country's resource endowments, structure of public investments, food pricing policy, and, more generally its food self-sufficiency policy, may lead to a situation where the positive income effect on food demand induced by agricultural growth is overbalanced by the incremental domestic food supply.

Would industrial growth, which does not entail a substitution of domestic food supply for imports, have a stronger influence on developing countries' cereal imports than agricultural growth? The answer is not necessarily because of the differing effects on overall economic growth and income distribution which, in turn, affect food demand. Many developing countries that promoted rapid industrialization at the expense of agriculture have shown low GDP growth rates and a demand pattern oriented toward nonfood, capital-intensive products. It is not surprising, therefore, that regression analysis, based on 1983 and 1984 data for 48 developing countries, indicates that a 10 percent rise in agricultural productivity was associated with a 9.0–10.2 percent increase in per capita GDP, whereas a 10 percent rise in manufacturing productivity was associated with only a 1.5–2.6 percent increase in per capita GDP across countries (Houck 1986). Beyond such statistical correlations, further empirical work on the relative impact of agricultural and industrial growth on developing countries' food imports is clearly warranted. This would best be carried out at the individual country level since, based on the results presented above for the eight Asian developing countries in our sample, there can be significant qualitative and quantitative differences among developing countries in the effect of agricultural growth on food imports.

ENDNOTES

1. "Responding to this pressure, the U.S. Department of Agriculture has begun to raise active objections inside the government to Treasury Department-approved World Bank farm-lending projects in such countries as Malaysia, Indonesia, Papua New Guinea, Argentina, and Brazil" (Paarlberg 1986, p. 1354). In October 1986, the U.S. Congress enacted a law, popularly known as the Bumpers Amendment, placing restrictions on the use of development assistance funds in international development activities that would cause substantial injury to U.S. exporters.
2. See Bautista (1986) for an analytical and empirical investigation of the impact of differential pricing policies concerning food and export crops on the agricultural output mix, among other effects, in the Philippines.
3. These other explanatory variables are included, however, in the statistical estimation done below.
4. In de Janvry and Sadoulet (1986), for example, the growth rate of gross domestic product is specified as a determinant of the growth rate of the consumption of agricultural product i (i = cereals, wheat, corn).

5. Since equation (7) can be written as

$$E = r + \frac{e_a + e_n k - r}{1-s},$$

the necessary and sufficient condition is that $e_a + e_n k > r$.

6. The beginning year in the period 1961–84 is not always strictly observed due to lack of data in the early years for some countries, especially concerning the World Bank time series of national accounts data. The shorter, more recent subperiod 1973–84 is worth giving separate attention owing to the presumed better data quality and for later comparison of findings with those derived from the 1961–84 data set.
7. In the absence of comparable cross-country data on domestic relative food prices, the agricultural terms of trade was initially included in the regressions as a relative price variable. But this variable did not yield satisfactory results. (Estimation was done using both ordinary least squares and two-stage least squares.) This can be interpreted to imply (1) that relative price effects are not significant in developing country food consumption, or (2) that the agricultural terms of trade is not a good proxy for the relevant food price variable.
8. Note that the inequality condition given in note 5 is satisfied.
9. Note that the parameter values for India, Pakistan, and Sri Lanka do not satisfy the inequality in note 5.
10. In Malaysia, for example, the production index for paddy, the principal food crop, rose from 47 in 1961 to 84 in 1983, while that for the two major nonfood (export) crops, rubber and palm oil, increased from 52 to 102 and from 4 to 117, respectively (Jenkins and Lai 1987, p. 251). More generally, the ratio of food to nonfood production in value terms declined sharply from 0.31 in 1963 to 0.13 in 1983.
11. To be able to say something about the likely future changes in those parameters, one will need to examine for each country the more basic mechanisms behind the aggregate relationships. In particular, instead of having a single demand function for foodgrains, it may be necessary to explicitly model the interrelated markets for cereals and livestock products, considering both the demand for cereals for direct human consumption and the foodgrain input demand for livestock production. Moreover, the mix of food products (e.g., between cereals and meat) and their demand elasticities are likely to be different at different income levels, and would also need to be taken into account (Yotopoulos 1985).

APPENDIX A
Sources of Data

Annual data on agricultural value added, nonagricultural value added, gross domestic product, exports and population for the 34 countries included in the cross-country analysis were obtained from the *1987 World Tables* published by the World Bank, while those on net imports and domestic consumption of cereals were obtained from the "FAO Supply Utilization Accounts Tape, 1985."

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