ON THE TRADE-OFF BETWEEN FOOD AND NONFOOD AGRICULTURAL PRODUCTION IN THE DEVELOPING COUNTRIES AND ASPECTS OF FOOD SUFFICIENCY POLICY

Alberto D.K. Agbonyitor

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Country Analysis and Projections Division
Economic Analysis and Projections Department
The World Bank

ABSTRACT

Recent analyses of agricultural performance in the developing countries question the appropriateness of nonfood (for export) crop promotion as a development strategy by arguing that such a strategy leads to the problem of food deficiency. The evidence in this paper using cross-section data for Sub-Saharan Africa does not support this proposition. The evidence suggests a tendency for nonfood production growth to be accompanied by food output growth across country groups. Also it is found that labour force growth has the most weight on food production growth, and the coefficients of labour and capital are higher in the middle income than in the low income countries. Nonfood agricultural output expansion and improvements in food output growth are not inconsistent development objectives.

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Lack of a secure access to food is a major concern in the developing countries. This food insufficiency reflects demand side factors such as low household incomes and low per capita GDP. However, in Sub-Saharan Africa (SSA) where agriculture is the dominant economic activity, and the major source of income for the vast majority of the population, there is a close relation between income, agricultural productivity and food insufficiency.

In the view of some researchers this SSA food insufficiency is the result of development policies that emphasize nonfood (for export) crop production at the expense of local staples (Berry, 1984; Clute, 1982; Hinderink and Sterkenburg, 1983). Clute (1982) labels the problem an "export syndrome". Lofchie (1975) refers to it as "Africa's agrarian paradox" of "consistent failure in food production" with "booming success in the cultivation of export crops".

With trade, however, it is not immediately apparent why the composition rather than the per capita level of aggregate agricultural output should be crucial for enhancing access to food (Please and Amoako, 1984). Whatever the other arguments advanced in this respect, 1/ a necessary though not sufficient condition for the trade-off is that

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* This paper developed from an earlier study of import behaviour (especially the aspect concerning the effect of agricultural growth on food imports) in Africa which was conducted as part of Sub Saharan African Debt Study. The paper benefitted from discussions with E. Gerken and L. Pritchett. I also received comments from V. Thomas, C. Obidegwu, E. C. Hwa and members of the EPDCO work-in-progress seminar group. Ms. S. Fallon assisted with typing.

food and nonfood production compete for scarce resources. But various studies cast doubt on the relevance of the trade-off thesis in SSA agriculture with evidence of widespread intercropping of staples and export crops of varying production cycles (Cleave, 1974; Hill, 1963; Berry, 1984). Also Lockhead et al (1980), Antle (1983) and Nguyen (1979) have shown that education, infrastructure, and capital goods imports which are financed in most countries from nonfood agricultural export earnings have positive effects on agricultural production.

The food-nonfood trade-off thesis has implications for policy, especially given that nonfood agricultural production is mainly for exports. Kydd and Hewitt (1986), for example, question the consistency of medium term adjustment programs that combine agricultural export promotion with domestic food-sufficiency objectives. Also considering the basic nature of food for human resource development, the relation between food and nonfood output growth should be investigated before basing national food policies on the agricultural output composition argument.

This study uses cross section data to examine the relation between food and nonfood production growth in the SSA economies. Because of the quality of the data, it is prudent to consider the results tentative. However, the overall evidence does not suggest an inverse association between food and nonfood output growth. On the contrary, the tendency is for high (low) nonfood growth rate to be accompanied with high (low) food output growth across countries. In the case of input effects, the growth of the agricultural labour has the most weight on food production growth. The estimated coefficients of labour and capital are smaller in the low income countries than in the middle income countries.

Without jumping to conclusions about specific countries, this result suggests that the general inclination to attribute low food output growth to nonfood output expansion is misleading. Improvements in nonfood agricultural output growth and domestic food supply expansion are not inconsistent development objectives. Though agricultural output composition can be changed through policy, improvements in labour and capital productivities and the removal of obstacles against labour and capital flow into agriculture constitute the effective ways of promoting food and nonfood agricultural production, and reducing the dependence on food imports.

ANALYTICAL FRAMEWORK

We consider how the trade-off theses can be meaningfully formulated and tested. For an agricultural economy which produces food (F) and nonfood (X), using fixed inputs land (N) and Labour (L), the transformation curve can be stated as:

$$T\ (F,\ X,\ N,\ L) = 0 \tag{1}$$

Then if the fixed inputs are fully employed, an expansion of X would require resource transfers from F in the short run leading to output changes ΔX and ΔF:

$$\Delta X = (\Delta L \cdot MPL_x + \Delta N \cdot MPN_x) \tag{2}$$

$$\Delta F = -(\Delta L \cdot MPL_f + \Delta N \cdot MPN_f) \tag{3}$$

where MPI_j is the marginal product of I in the production of j. Equations (1) and (2) imply a negative correlation between food and nonfood output growth rates, which but for a few exceptions (e.g. intercropping practices and Myint's (1968) Vent-for-surplus theory), is a theoretical validation of the trade-off thesis. However, the food problem is not a short run issue. World Bank (1981) reports, for example, have pointed to a stagnation and, in some cases, negative growth in food production in the SSA economies between the 1960s and early 1980s. Therefore, to be meaningful, the trade-off thesis must be interpreted in the context of longer term development objectives.

Over the longer term, labour force growth, technological change, land development and imported inputs allow an outward expansion of the production possibility frontier. The interaction between food and nonfood growth is, therefore, more complex since income from nonfood output can allow the farmer to acquire additional intermediate inputs to use the existing land and capital resources even more effectively. If the trade-off thesis is valid, then using cross-section data, countries with high growth in nonfood agricultural output should have lower food output growth. It is this long run concept of the trade-off thesis that is tested in this investigation.

In absence of disaggregated input data for food and nonfood sectors, it is convenient to adopt a multi-product multi-factor production function which is consistent with the fact that multiple outputs are most often the norm in SSA agricultural production (Mittelhammer et al, 1981; Cleave, 1977; Hill, 1963; Berry, 1984):

$$Y\ (X,\ F) = Z\ (K,\ L,\ N,\ M) \qquad (4)$$

$$M_t = f\ (X_{t-1}) \qquad (5)$$

where K is capital and M is other inputs. L and N are defined as in equation 1. Equation 5 describes the resource flow back from nonfood output into agricultural production. Where nonfood agricultural output is an important source of export earnings, the flow back effects of imported goods can contribute to infrastructural development and stimulate agricultural production (Freedman, 1970; Berthelemy and Gagey, 1985).

Using a Cobb-Douglas 2/ version of (4) and (5):

$$F^{a_1} X^{a_2} = AK^{b_1} L^{b_2} N^{b_3} M^{b_4} \tag{6}$$

$$M_t = CX_{t-1}^{d} \tag{7}$$

where A is neutral technical change, C is a constant, and a_i, b_i and d are positive coefficients. If changes in technology, input use, and productivity all affect agricultural production, then using G_j for the growth of j, and the natural logarithm (ln) of (6) and (7), we obtain the food and nonfood output growth interaction relation:

$$a_1\ GF + (a_2 - b_4 d)GX = GA + GS + GR + GQ \tag{8}$$

$$GR = (b_2\ GL + b_3\ GN + b_1 GK)$$

$$GS = (\Delta b_1\ \ln K + \Delta b_2\ \ln L + \Delta b_3\ \ln N)$$

$$GQ = (\Delta b_4\ d + b_4\ \Delta d - \Delta a_2)\ \ln X - \Delta a_1\ \ln F$$

$$GX_t = GX_{t-1} \text{ is average annual growth of X}$$

In (8) output growth is accounted for by (i) neutral technical change GA, (ii) input productivity change GS, (iii) growth of factor use GR, and commodity market and output productivity effects GQ. 3/ From equation (8):

$$a_1\ GF = GA + GS + GR + GQ + (b_4\ d - a_2)\ GX \tag{9}$$

Equation (9) does not provide an a priori theoretical validation for the trade-off thesis. The overall relation between GF and GX is an empirical issue depending on the coefficient $(b_4 d - a_2)$, and the effects of technical change and input growth, all of which contribute to shifting the production possibility frontier, and thereby raising both food and nonfood production.

STATISTICAL ANALYSES

(a) Naive Correlation Test

The simple correlation test has been used often implicitly with subsets of SSA data to validate the trade-off theses (e.g. Lofchie, 1975, 1982; Clute, 1982). In this section, we apply this test to cross-section data for the whole region using for country i the linear regression form4/:

$$GF_i = \Theta_0 + \Theta_1 GX_i + e_i \tag{10}$$

$$\Theta_1 < 0$$

$$Var(e_i) = \sigma_i^2 \tag{11}$$

A refined version of (10) is obtained by allowing the correlation coefficient to vary for the various groups of countries in the region:

$$GF_i = \alpha_0 + \sum \alpha_j D_j GX_i + e_i \tag{12}$$

$$\alpha_j < 0; \; j = 1, 4$$

$$D_j = 1, D_k = 0 \text{ for } j \neq k$$

where D_j are dummy variables, and D_1 is for semi-arid low income countries; D_2 is for other low income countries; D_3 is for middle income oil importers; and D_4 is for middle income oil exporters.

According to the proponents of the trade-off thesis, equations (10) and (12) would be causal relationships with the strong interpretation that it is nonfood agricultural output expansion that is the cause of low food output growth. Even if we adopt a weaker correlation interpretation, negative values for α_j and θ_1 would be required to validate the trade-off thesis except in that case there may be other factors such as inputs, weather and policy environment influencing both food and nonfood output growth. The input effects are considered in a later section.

Data and Estimation

The countries in the sample are shown in Appendix A. The food and nonfood statistics are obtained from the World Bank (1981, p. 167). Nonfood comprise mainly sisal, cotton, timber, tobacco rubber, hides and skin, and also tea and coffee which are considered deficient in nutrients. Land, capital and labour data are obtained from FAO Country Tables, 1983. Food includes staples mainly cereals and meat. L is the agricultural labour force, and land N refers to arable land plus land under permanent crops. Number of agricultural tractors in use is a proxy for capital stock K. The data used in estimation are average annual growth rates between 1969-71 and 1977-79 for food and nonfood; 1971-80 for labour; 1970-79 for land use, and 1971-80 for agricultural tractors in use. There is no reliable survey data on livestock.

Table 1: ESTIMATED RESULTS

Equation	OLS Q_1	WLS Q_2	OLS Q_3	WLS Q_4
C	1.741 (0.195)*	1.576 (0.161)*	1.741 (0.211)*	1.560 (0.181)*
All Countries (Nonfood)	0.083 (0.031)*	0.088 (0.015)*		
Semi Arid Low Income (D_1)			-0.012 (0.083)	-0.016 (0.044)
Other Low Income (D_2)			0.077 (0.046)**	0.049 (0.023)*
Middle Income Oil Importers (D_3)			0.150 (0.080)**	0.147 (0.028)*
Middle Income Oil Exporters (D_4)			0.108 (0.065)*	0.106 (0.025)*
R^2(adjusted)	0.15	0.50	0.13	0.63

Standard errors are in parentheses.

OLS = Ordinary least squares.

WLS = Weighted least squares.

* = Statistically significant with a 2.5 % error one tailed test.

** = Statistically significant with 5% error one tailed test.

The quality of the production data is affected by (a) difficulties of obtaining accurate information on farm inventories and farm household consumption, and (b) unreported transfer of produce between neighbouring countries due to foreign exchange controls. Subject to these caveats, equations Q_1 to Q_4 are estimated using weighted and unweighted least squares, with the reciprocal of GX as the weight.

From the estimated coefficients only the semi-arid low income countries show a negative correlation which is not statistically significant. As a group, the semi-arid countries were the hardest hit by the severe droughts of the 1970s (Derrick, 1977; Wheeler, 1984). The total results, however, show a tendency of positive correlation between food and nonfood output growth for all countries grouped, for the middle income oil importers and exporters, and for the other (non-arid) low income countries. The estimated OLS and WLS coefficients are similar in magnitude, and the weighted least squares estimates have high adjusted R^2.

The Production Function

In this section, the trade-off theses is tested using a production function. The inter-country production function approach employed here presumes that all countries have access to the same technology. A country's production technique and related coefficients are, therefore, samplings from the same technological pool. The production technique and coefficients can vary for various groups of countries in the region because of differences in the input environment (Mundlak, 1963). Scandizzo (1983) used SSA output data to show 5/ that (a) the production function is stable with no statistically significant biased technical change, and (b) agricultural growth is characterized by the growth of input use. With this evidence, equation 9 can be approximated to equation 13 with the trade-off hypothesis $\beta_4 < 0$.

$$GF = \beta_0 + \beta_1 GK + \beta_2 GL + \beta_3 GN + \beta_4 GX + \varepsilon \qquad (13)$$

$\beta_0 = (GA/a_1)$, $\beta_1 = (b_1/a_1)$, $\beta_2 = (b_2/a_1)$, $\beta_3 = (b_3/a_1)$, $\beta_4 = (b_4 d - a_2)/a_1$.

The use of input growth in equation (13) corrects directly for differences in resource base which were ignored in the naive test. In addition dummy variables were used to control for differences in neutral technical change between low income and middle income countries. The resulting OLS estimates are shown in Table 2. Contrary to the trade-off hypothesis, the nonfood coefficient is positive and statistically significant. When we distinguish between low income and middle income countries, the nonfood coefficient is still positive though only the low income value remains statistically significant. For the other inputs, labour has the dominant weight on agricultural production with statistically significant coefficients which are higher in the middle income than in the low income countries. The coefficient of capital is also higher in the middle income countries and statistically significant.

Table 2: PRODUCTION FUNCTION ESTIMATE

Equation	OLS Q_5		OLS Q_6		OLS Q_7		OLS Q_8	
Constant (a)	0.218	(0.489)						
Constant (l)			0.340	(0.631)	0.487	(0.663)	0.393	(0.621)
Constant (m)			-0.471	(0.722)	-0.370	(0.760)	-0.401	(0.689)
Labour (a)	0.864	(0.292)**						
Labour (l)			0.858	(0.393)*	0.814	(0.406)*	0.846	(0.385)*
Labour (m)			1.032	(0.447)*	1.038	(0.458)*	0.968	(0.4104)*
Land (a)	0.076	(0.120)						
Land (D_1)			-0.528	(0.345)	-0.485	(0.358)	-0.499	(0.332)
Land (n)			0.006	(0.132)	0.022	(0.149)	0.021	(0.125)
Tractor (a)	0.033	(0.026)**						
Tractor (l)			0.026	(0.027)	0.024	(0.028)	0.025	(0.026)
Tractor (m)			0.212	(0.091)*	0.209	(0.094)*	0.208	(0.089)*
Nonfood (a)	0.059	(0.029)*					0.056	(0.029)**
Nonfood (l)			0.068	(0.042)**				
Nonfood (m)			0.044	(0.043)				
Nonfood (D_1)					0.028	(0.075)		
Nonfood (D_2)					0.083	(0.053)**		
Nonfood (D_3)					0.017	(0.064)		
Nonfood (D_4)					0.073	(0.070)		
R^2 (Adjusted)	0.31		0.79		0.78		0.79	

Standard errors are in parentheses.

* = statistically significant at the 2.5 percent level, one tailed test.

** = statistically significant at the 5 percent level, one tailed test.

a = all countries; l = (D_1 + D_2) low income countries; m = (D_3 + D_4) middle income countries; n = (D_2 + D_3 + D_4) non arid countries. D_1, D_2, D_3, D_4 are defined in Table 1.

Table 3: DERIVED STRUCTURAL COEFFICIENTS
(All Countries: Based on Equation Q_5)

For	a_1 = 0.560	a_1 = 0.670	a_1 = 0.784
a_2	0.440	0.330	0.216
b_1	0.018	0.022	0.026
b_2	0.484	0.579	0.677
b_3	0.043	0.051	0.060
b_4	0.455	0.348	0.237
d	1.04	1.062	1.107

Middle Income Countries (Based on Q_8)

For	a_1 = 0.560	a_1 = 0.670	a_1 = 0.784
a_2	0.440	0.330	0.216
b_1	0.117	0.139	0.163
b_2	0.542	0.649	0.759
b_3	0.012	0.014	0.017
b_4	0.329	0.198	0.061
d	1.433	1.856	4.260

Low Income Countries (exc. semiarid)
(Based on Q_8)

For	a_1 = 0.560	a_1 = 0.670	a_1 = 0.784
a_2	0.440	0.330	0.216
b_1	0.014	0.017	0.020
b_2	0.474	0.567	0.663
b_3	0.012	0.014	0.017
b_4	0.500	0.402	0.300
d	0.943	0.914	0.866

The differences in the estimated input coefficients between middle income and low income countries are statistically significant when we test with the F statistic by comparing the results of equation Q_5 to Q_6 and Q_7 in turn. For Q_5 and Q_6, the F statistic is $F(5, 27) = 15.06$, and for Q_5 and Q_7 $F(7, 25) = 10.44$. Thus the hypothesis of equality of low income and middle income coefficients for each input is rejected. The equality of the nonfood coefficient across income groups is also tested using equations Q_7 and Q_8 which give $F(3, 25) = 0.288$, indicating the hypothesis is not rejected. Since there are not adequate degrees of freedom to estimate meaningful equations for each income group, Q_8 would be the best result from the F tests.

DISCUSSION AND POLICY ISSUES

Given concerns about the quality of the data, inferences from the estimation can only be tentative. With respect to the estimation, the structural coefficients are not identified, but Table 3 illustrates some values for the structural parameters based on constant returns to scale and normalized values for a_i $(a_1 + a_2 = 1)$. The values for d are obtained from $(\beta_4\ a_1 + a_2)/b_4$, with b_4 as residual of $(b_1 + b_2 + b_3)$. Results of other studies compare favourably with the derived structural coefficients in Table 3. Scandizzo (1982), for example, estimated values for East, and West and Central (W-C) African Countries in the ranges shown in Table 4 with estimates obtained by Antle (1983) for developing - including African - countries. The conditional derived structural coefficients in Table 3 are plausible compared to the results in Table 4.

Table 4: (Other Estimates)

	Labour	Land	Capital (Tractor)
Scandizzo			
East Africa	0.546 - 0.713	0.053 - 0.246	0.107 - 0.187
W-C Africa	0.358 - 0.382	0.388 - 0.478	0.170 - 0.241
	Labour	Land	Capital(Livestock)
Antle			
N = 47	0.333 - 0.467	0.021 - 0.149	0.175 - 0.329
N = 26	0.222 - 0.414	-0.029 - 0.259	0.015 - 0.055

N = number of countries.

While the estimated results do not necessarily indicate individual country behaviour, they nevertheless reflect expected food-nonfood relations among the various country groups. The result would suggest that sub-regional differences be taken into account in analyzing food output growth scenarios, especially in the light of significantly different effects of labour and capital in low income and middle income countries. Improvements in nonfood agricultural output growth are not inconsistent with food output expansion objectives over the long term. Though agricultural output composition can be changed with policy, food output expansion does not require that nonfood output growth be reduced. With the possible exception of countries with growing rural landlessness (e.g. Kenya) labour force growth has the most weight on food production growth. The removal of policy induced obstacles against labour and other resource flow into agriculture would stimulate both nonfood and food output growth.

The effects of nonfood growth on food imports would vary across countries because of differences in the elasticity of food imports with respect to income, prices and population growth. If imported food is an inferior good (i.e. negative income elasticity), then given constant average annual growth rates for population, agricultural labour and land use, reduction of food dependence with income growth would require increased capital investment in food production. If food imports, on the other hand, have positive income elasticities, then as domestic food output grows, reduction of food dependence would depend more critically on pricing policies to shift consumption towards domestically produced food.

FOOTNOTES

1/ It is often argued that reliance on food imports exposes a country to the instability of world grain prices thereby compounding food insecurity (Vengroff, 1982; McBean, 1966; Clute, 1982). Given volatile weather conditions, however, domestic food production in SSA tends to fluctuate more than the relevant food import price index. Hence minimal food importation does not necessarily imply enhanced food security (Falcon, 1984).

2/ This function is considered inconsistent with profit maximization, though it is still useful for growth accounting. (Plaxico, 1950; Mundlak, 1963; Scandizzo, 1983).

3/ If the weights a_1 and a_2 are endogenous, then GQ would reflect the output productivity effect and the response of capital inputs to non-food output growth. Also because of the truncation, it can be shown that the estimate of Θ_1 is biased. However it is only the sign of Θ_1 that is relevant for the correlation test.

4/ Note that for variable Y and X the correlation coefficient γ and the regression coefficient b are directly related by $b = \gamma(\sum y^{1/2}/\sum x^{1/2})$ where y and x are deviations from the means and X is the explanatory variable.

5/ Scandizzo estimated the meta production function for three periods 1966-68, 1972-74 and 1978-80.

Appendix A: CLASSIFICATION OF COUNTRIES

Low Income (Semi-arid)

Chad, Mali, Niger, Somali, Burkina Faso

Low Income (Other)

Benin, Burundi, CAR, Ethiopia, Guinea, Guinea Bissau, Lesotho, Madagascar, Malawi, Mozambique, Rwanda, Sierra Leone, Sudan, Tanzania, Togo, Uganda, Zaire

Middle-Income (Oil Importers)

Botswana, Cameroon, Ghana, Ivory Coast, Kenya, Liberia, Mauritius, Senegal, Swaziland, Zambia, Zimbabwe

Middle-Income (Oil Exporters)

Angola, Congo, Gabon, Nigeria

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