AFRICAN FARMER RESPONSE TO PRICE: A SURVEY OF EMPIRICAL EVIDENCE

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ABSTRACT

Believe it or not, there has been prolonged controversy among Anglo Saxon Economists regarding whether or not Africans are rational Economic beings. Several man years and huge sums of money have been spent on studies and several doctorates have been awarded by distinguished universities on the basis of studies designed to see whether Africans can really behave in an economic way similar to that of Anglo Saxons. On the agricultural front this debate has taken the form now popularly known as "Supply Response of African Farmers".

This paper surveys and gives outlines of some major Empirical works done in what is sometimes known as Anglophone East and West Africa. The literature is organised on the basis of three broad hypotheses:

(1) Positive response,
(2) Pervese response,
(3) No response.

The paper points out some of the general weaknesses of these studies and concludes by calling on Economists to put some aspects of this debate to eternal rest.

INTRODUCTION

Over the past decade, there has developed an awareness of the urgent need for micro-oriented studies to provide basic information to planners and policy makers. These studies do, also provide a more rational basis for research workers in determining their research priorities. Furthermore, they can give extension workers factual information on the acceptability of innovations.

One micro problem that has occupied the energies of some Western trained economists during the last decade is the question of economic rationality on the part of African farmers. Looked at objectively, this question has had two phases. Firstly, there has been a "positive" phase in which the issue has been to determine what African farmers do under different economic situations. Secondly, there has been a "hypothesis testing" phase in which the issue has been to determine why African farmers do things the way they do. Like with many other issues, "factual" findings and opinions do differ on these subjects. Therefore, this controversy now popularly known as "Supply Response of African Farmers" has sparked off a chain of empirical exercises, aimed, among other things, at resolving the disagreements.

This paper attempts to take stock of the empirical work that has been undertaken in this field in West and East Africa. Outlines of these studies will be given and general critical comments will be made regarding the extent to which they resolve or do not resolve the issues. Finally, suggestions will be made regarding the necessity to re-direct research energies.

HYPOTHESES ABOUT SUPPLY RESPONSE IN AFRICA

Hypotheses about the supply responsiveness of agriculture to prices in Africa may be divided into four major categories:

(a) that farmers respond normally and efficiently to relative price changes;

(b) that the marketed surplus is inversely related to price;

(c) that institutional constraints are so limiting that any price response is insignificant;

(d) that farmers are indifferent to relative prices and therefore changes in output level and mix are a result of non-economic factors.

Advancing hypothesis (a), T.W. Schultz (20) states that the rate at which farmers who have settled into a traditional agriculture accept a new factor of production depnds upon its profit with due allowance for risk and uncertainty. He maintains that policies based on the doctrine of farmers indifference or perverse response to prices do impair the efficiency of agriculture in the less developed countries. He, however, concedes that some institutional and cultural restraints may have adverse effects on production, but that such restraints leave considerable leeway for responses to economic variables. M.L. Dantwala and W.P. Falcon (4) subscribed to this view. J.W. Mellor (16) suggested in fact, that because of greater flexibility in production techniques, agricultural supply may be more responsive in the less developed countries than in the developed countries particularly in the short run.

The second major hypothesis (that the marketed surplus is inversely related to price) has been advocated by S.D. Neumark(18), P.N. Mathur and H. Ezekiel (15) D.R. Khatkhate (10) and Stephen Enke (6) among others. They argued that farmers may have fixed or relatively fixed monetary obligations. Therefore, the argument goes, they only sell as much as is necessary to obtain the desired money income.

The relatively fixed desire for money income may exist because of relatively fixed monetary charges for rent, debt service, and a small amount of consuption of non-agricultural goods. Any resources that don't have to be employed in production for money income would be employed in food production for on-farm consumption. Farmers therefore maximise their production (subject to the constraints which are imposed by factor availability and production functions), sell whatever is needed to obtain their monetary income and consume the rest, or (if produced commodities are not edible) refuse to harvest the rest. The marketed surplus, thus, varies inversely with the market price of the crops concerned.

The third major hypothesis (that cultural and institutional restraints make any price response of agriculture in the less developed countries insignificant), appears repeatedly in the literature related to underdeveloped countries. An extreme position is J.H. Boeke's "Social Dualism". (2) Boeke says that the social systems in the poor countries are different from the social systems of the developed countries, not in degree, but in kind. He concludes that the less developed countries, therefore, require economic theories which are different in kind from those applicable to more developed countries. As an example, he says:

> "When the price of rice or coconuts is high, the chances are that less of these commodities will be offered for sale; when wages are raised, the manager of the estate risks that less work will be done... only when rubber prices fall does the owner of a grove begin to tap more intensively, whereas high prices mean that he will leave a larger or smaller portion of his tappable trees untapped." (2, pp33-5)

Another set of institutional restraints which has received considerable emphasis includes various market imperfections. In particular, it is said that the factor market is imperfect in several important respects. Inadequate transportation and communication facilities may be limiting supplies of factors such as chemical fertilizers in rural markets. It is claimed that even within small geographic areas, factor markets are very fragmented because of traditional tenure arrangements, and the existence of barter exchange. Factor inputs are thus not easily reallocated in response to price changes.

The fourth hypothesis (that African farmers' production habits are influenced by factors other than non-economic ones), follows from the study of coffee and cotton supply in Uganda by MacBean (11) and implicitly in the more recent work by Etherington (7).

Empirical Tests of Hypotheses About African Farmer Response to Price

West Africa

Cocoa Farmers

Stern (21) discussed the determinants of cocoa supply in West Africa for the period prior to 1945, and found evidence for Nigeria that the price of cocoa influnced the planting decision. The statistical tests for Ghana indicated some evidence of the importance of prices in the harvesting decision for the pre-1938 period, but the long-run influence of prices was questionable. Statistical relationships for other West African countries, for either the pre or postwar periods, and those for Ghana and Nigeria in the post-1946 era, were not found significant. The stern model includes an equation for acreage planted in cocoa for Nigeria (1919/20-1944/45):

$$\overline{AP}_t = -5.14 + 1.11\,\overline{P}_t$$

$$R^2 = 0.86 \qquad F = 152.76$$

where

$\overline{AP}_t$ is a five-year centered average of acreage planted to cocoa, and

$\overline{P}_t$ is a five-year centered average of the real price of cocoa.

The relationship implies a price elasticity (at the mean) of 1.29 for acreage planted. It includes also an estimation of current annual cocoa production for Ghana (1923/24-1937/38).

$$Y_t = -203.16 + 1.05\ AH_t + 0.54\ P_t$$
$$(190.64)\ (0.47)\qquad (0.25)$$
$$R^2 = 0.40 \qquad F = 4.05$$
$$Y_t = 392.37 - 0.61\ AH_t + 0.32\ P_t + 6.52\ t$$
$$(271.16)\ (0.70)\qquad (0.21)\qquad (2.34)$$
$$R^2 = 0.65 \qquad F = 6.82$$

where

Y_t is the current annual cocoa production,
AH_t is the number of harvested (bearing) acres,
P_t is the current real price of cocoa, and
t is a time trend.

In 1965, Bateman (2) offered a new case study of cocoa in Ghana covering the period 1946-1962. It is based on the assumption that given the perennial nature of the crop, the objective of the cocoa producer is to maximize the net present value of his investment in cocoa. Coffee is considered the only significant alternative to cocoa production in some regions of Ghana and the expectation models used are of the Nerlovian type. The study suggests that annual changes in cocoa production (harvested) can be explained by producer prices, rainfall, and humidity. The relevant estimated relationship being in the following form:

$$\Delta Q_t = c_o + c_1\ P_{t-K} + c_2 P_{t-s} + c_3\ C_{t-K} + c_4\ C_{t-s} + c_5 \Delta R_{t-1} + c_6\ \Delta H_{t-1} + U_t$$

Where ΔQ_t is the year to year change in the amount of cocoa harvested.
P_{t-1} is the real producer price of cocoa lagged 7 years,
P_{t-s} is the real producer price of cocoa lagged 12 years,
C_{t-K} is the real producer price of coffee lagged 8 years,
C_{t-s} is the real producer price of coffee lagged 12 years,
ΔR_{t-1} is the difference in rainfall from one year to the other lagged one year,
ΔH_{t-1} is the difference in humidity from one year to the other, lagged one year, and
U_t is the error term.

According to Bateman, P_{t-K}, P_{t-s}, C_{t-K}, and C_{t-s} enter the equation because they indirectly determine planting in their respective years.

TABLE 1.

REGRESSION COEFFICIENTS FOR REGIONAL SUPPLY FUNCTIONS FOR GHANAIAN COCOA, 1946-62 (4 Regions)[1]

Region	Constant	Cocoa Price[2] P_{t-k}	P_{t-s}	Coffee Price[3] C_{t-k}	C_{t-s}	Rainfall	Humidity	R^2
Central	-10.820 (7.04)	129[d] (.060)	.151[b] (.054)	-.137[f] (.186)	-.021 (.202)	.828[b] (.305)	-.820[f] (.613)	.792
	-14.854 (3.90)	.100[b] (.037)	.151[a] (.045)			.931[a] (.290)		.740
Western	- 4.498 (2.45)	.069[a] (.020)	.058[b] (.019)	-.200[b] (.066)	.133[b] (.069)	.430[c] (.198)	-.006 (.085)	.797
	- 1.419 (1.57)	.058[a] (.019)	.069[a] (.017)	-.170[b] (.063)		.327[e] .604		.742
Volta	- 1.455 (2.27)	.093[a] (.019)	.081[a] (.017)	-.353[a] (.059)	.604[a] (.067)	.604[a] (.140)	.069[f] (.063)	.898
	1.692 (1.38)	.097[a] (.018)	.101[a] (.015)	-.377[a] (.057)		.576[a] (.125)	-.290[c] (.138)	.892
Eastern	.603 (5.97)	.022 (.057)	.237[a] (.41)	-.029 (.196)	-.485[b] (.160)	.889[c] (.359)	-.988[c] (.439)	.852
	1.522 (4.925)		.240[a] (.036)		-.501[a] (.140)	.923[a] (.254)	.990[c] (.404)	.848

For footnotes see continuation of Table 1.

TABLE 1 (Continued)

Region	Constant	Cocoa Price[2]		Coffee Price		Rainfall	Humidity	R^2
		P_{t-K}	P_{t-s}	C_{t-K}	C_{t-s}			
Old Ashanti	14.273 (14.03)	.157[f] (.111)	.392[a] (.089)	-.148 (.424)	-1.83[d] (.587)	1.967[c] (.748)	-1.989[c] (.762)	.904
	15.688 (12.895)	.124[c] (.056)	.390[a] (.084)		-1.321[d] (.410)	1.967[b] (.684)	-2.059[b] (.694)	.902
Sunyani	19.790 (20.571)	.166[c] (.071)	.178[d] (.087)	-.365[e] (.245)	-.855[e] (.605)	1.618[c] (.586)	-4.305[e] (1.749)	.783
Goaso[3]	- 2.949 (1.45)		.078[c] (.030)			.715[d] (.355)		.548

1. The figures in parentheses are the standard errors of the coefficients. Significance levels indicated by the author are as follows: a = .01; b= .02; c = .05; d = .10; e = .25; f = .50.

2. The variable P_{t-K} represents the real producer price of cocoa lagged eight years in each region; variable P_{t-K} represents P_{t-12} (i.e., the real producer price of cocoa lagged 12 years) for every region except Sunyani and Goaso, where the value of "s" is 13 and 10, respectively.

3. The lag structure for coffee prices is identical with the lag in cocoa prices. See 2.

4. For an explanation of the Goaso coefficients and the problem with this station, see Bateman's text.

TABLE 2

AGGREGATE SUPPLY FUNCTIONS FOR GHANAIAN COCOA, 1946-62, 1949-62[1,2]

Pooled Regions	Constant	Cocoa Price		Coffee Price		Rainfall	R^2
		P_{t-K}	P_{t-s}	C_{t-K}	C_{T_S}		
Volta, Central & Sunyani3, 1949-62	4.036 (7.72)	.125[d] (.068)	.120[c] (.082)			.989[e] (.719)	.18
		.121[a] (.017)	.133[a] (.021)			.793[a] (.181)	.77
Volta, Western[4] 1946-62	-.219 (1.111)	..069[a] (.013)	.081[a] (.012)	-.239[a] (.042)		.420[a] (.113)	.76
		.069[a] (.013)	.081[a] (.012)	.239[a] (.042)		.420[a] (.113)	.76

1. The figures in parentheses are the standard errors of the coefficients. Significance levels indicated by the the author are as follows: a = .01; b= .02; c = .05; d = .10, e = .25; f = .50.

2. Since not all of the regional functions contained the same variables, it was necessary to adjust the dependent variable in the regional equations which had additional parameters.

3. The dependent variable in the Volta region was adjusted for C_{t-K} and humidity so that it could be pooled with the Central region; the dependent variable in Sunyani was adjusted for both coffee prices and humidity so that it could be pooled with the Central region.

4. The dependent variable in the Volta region was not adjusted and the humidity variable was omitted for the regression. When humidity was included, homogeneity was rejected in each test at all levels.

Source: Bateman, op. cit.

The changes in K_{t-i} and H_{t-i} enter because of their direct effects on output.

Asymmetry in Price Responsiveness of Cocoa Farmers

In their empirical analysis of the nature of price response by Western Nigeria cocoa farmers, Olayemi and Oni (19) point out that in most studies on response, there is often the assumption (albeit implicit) that farmers' response to price changes are fully symmetrical and reversible (19, p. 347). They indicate that this may be an over-simplification of reality especially for tree crops and in situations of imperfect knowledge of the input, and output markets by farmers. Asymmetry in price response, they say, may take any of two forms:

(a) a response to an increase in producer price may be greater than that of a corresponding decrease in producer price, and

(b) a response in which there is a lack of response to producer price increases or the response to producer price increases which is lower than that of a corresponding decrease in such prices. This latter case, Olayemi and Oni contend may be what gave the protagonists of hypotheses b, c and d (page 2 of this paper) their wrong conclusions that farmers either don't respond at all or sometimes respond perversely to price.

The main hypothesis of this study is that "some asymmetry in acreage response to price exists among Western Nigeria cocoa farmers: They use cross-section data from three zones: Egba - Egbado-Ijebu; Ibadan-Oshun, Ife-Ilesha-Ondo-Ekiti. Those subdivisions are based on known ecological differences and age distribution of the cocoa trees in Western Nigeria. Ordinary least squares method was used to fit four different functional relationships; linear (equation1) double-log (equation 2) exponential (equation 3) and quadratic 4). The results are shown in table 3.

TABLE 3.

ACREAGE RESPONSE TO PRICE INCREASES

Equation	Dependent variable	Constant term	Regression P	Coefficient P^2	SE	R^2
(1)	Y	-3.541	3.301 (2.401)	-	16.015	0.104
(2)	Log Y*	-5.05	1.217** (4.589)	-	0.683	0.194
(3)	Log Y	0.456	0.003** (4.443	-	0.864	0.189
(4)	Y	-2.452	0.267** (6.814)	0.001 (1.615)	15.959	0.103

* = Log form of regression coefficient.
** = Statistically significant at 1% level.
Figures in ponentheses are t retios.

Y = Acreage to be established.
P = Producer price.
SE = Standard error of estimate
Source: Olayemi and Oni, *Ibid*, p. 350.

The corresponding results for a price decrease are shown in table 4.

TABLE 4

ACREAGE RESPONSE TO PRICE DECREASES

Equation	Dependent Variable	Constant Term	Regression Cofficients P.	P^2	SE	R^2
(5)	Y	-0.412	0.031**	-	4.831	0.310
			(7.591)			
(6)	LogY*	-2.223	0.643**	-	0.772	0.417
			(10.670)			
(7)	LogY	-5.924	0.007**	-	0.772	0.416
			(10.661)			
(8)	Y	0.178	0.016	0.00008	4.834	0.311
			(0.043)			

* - Log form of regression coefficient
** = Statistically significant at 1% level
figures in parentheses are t-ratios.

Source: Olayemi and Oni, Ibid p. 351.

The results in tables 3 and 4 show a positive price response and this response is greater in the form of acreage reduction than in the form of acreage expansion. The mean elasticities obtained from the various equations of the two price situations are shown in table 5.

TABLE 5.

ELASTICITIES OF RESPONSE

Function	Elasticity with respect to Price Increases	Elasticity with respect to Price Decreases
Linear	14.419	1.151
Double-log	1.217	0.643
Exponential	1.155	0.706
Quadratic	0.202	0.571

Source: Olayemi and Oni, Ibid., p. 351

As a more rigorous test of the asymmetry hypothesis Olayemi and Oni tested a single equation and obtained the following results:

$$Y = -0.382 + 0.030P + 2.234D$$
$$(4.073) \quad (2.113)$$
$$R^2 = 0.250$$

Where Y and P are as defined ealier and D is a dummy variable that takes the value 1 for price increases and 0 for price decreases. The figures in parentheses are t-ratios. They conclude that since from the t-ratios D is statistically significant at the 0.05 level, this significance constitutes a valid test of asymmetry in price response (19, p 352).

Nigerian Tobacco Farmers

In an econometric study of the supply of air cured tobacco in Western Nigeria, Adesimi (1) employed ordinary least squares multiple regression techniques to estimate seven versions of the following model:

$$A_t = f[(+) A_{t-1}, (+)P_{1t-1}, (-) P_{2t-1}, (-)P_{3t-1}, (-) P_{4t-1}, (+) T, U_t]$$

Where
A_t = Tobacco harvested acreage in period t;
A_{t-1} = Tobacco harvested acreage in period t-1;
P_{1t-1} = Price per lb of leaf tobacco in period t-1;
P_{2t-1} = Price per lb of yam in period t-1;
P_{3t-1} = Price per lb of cassava in period t-1;
P_{4t-1} = Price per lb of maize in period t-1;
T = A linear trend variable representing changes in the population of growers;
U_t = A residual error term.

The signs preceding each variable are supposed to indicate the expected signs of the coefficients. P_{2t-1}, P_{3-1}, and P_{4t-1}, are supposed to represent the opportunity cost of producing tobacco (i.e. the production alternatives of tobacco growers).

Adesimi estimated seven versions of the above model in its log specification. The results are shown in the following equations.

(1) $$A_t = 6.62 + 0.63^{**}P_{1t-1} - 0.78^{*}P_{2t-1} + 1.08^{**}T$$
$$(0.24) \quad (0.44) \quad (0.11)$$
$$R^2 = 0.95, \bar{R}^2 = 0.94 \quad 'd' = 1.0$$

(2) $A_t = 3.17 + \overset{**}{0.74}\, A_{t-2} + \overset{**}{0.83}P1t-1 - \overset{**}{1.25}P_{2t-1}$

$\qquad\qquad (0.10) \qquad\quad (0.30) \qquad\quad (0.58)$

$R^2 = 0.92,\ \bar{R} = 0.90,$ 'd' = 1.9

(3) $A_t = 6.30 + \overset{*}{0.27}A_{t-1} + \overset{**}{0.60}P_{1t-1} - \overset{**}{0.96}P_{2t-1} + \overset{**}{0.77}T$

$\qquad\qquad (0.14) \qquad\quad (0.22) \qquad (0.42) \qquad (0.19)$

$R^2 = 0.96, \bar{R}^2 = 0.95,$ 'd' = 1.6

(4) $A_t = 3.74 + \overset{**}{0.72}\, A_{t-1} + \overset{**}{0.76}P_{1t-1} - \overset{**}{0.85}P_{2t-1} - 0.40P_{3t-1}$

$\qquad\qquad (0.11) \qquad\quad (0.31) \qquad\quad (0.71) \qquad (0.41)$

$R^2 = 0.92,\ \bar{R}^2 = 0.90,$ 'd' = 1.7

(5) $A_t = 6.93 + 0.01\, A_{t-1} + \overset{**}{0.27}P_{1t-1} + \overset{**}{0.34}_{2t-1} - \overset{**}{1.11}P_{3t-1} +$

$\qquad\qquad (0.08) \qquad\quad (0.12) \qquad\quad (0.28) \qquad (0.16)$

$\qquad\qquad \overset{**}{1.09}T$

$\qquad\qquad (0.11)$

$R^2 = 0.99,\ \bar{R}^2 = 0.98,$ 'd' = 1.8

(6) $A_t = 4.40 + \overset{**}{0.70}\, A_{t-1} + \overset{**}{77}P_{1t-1} - \overset{*}{0.92}P_{2t-1} + \overset{*}{1.12}P_{3t-1} - \overset{**}{1.61}P_{4t-1}$

$\qquad\qquad (0.10) \qquad\quad (0.28) \qquad\quad (0.63) \qquad (0.78) \qquad (0.73)$

$R^2 = 0.94,\ \bar{R} = 0.92,$ 'd' = 1.8

(7) $A_t = 6.92 + 0.05A_{t-1} + \overset{**}{0.31}P_{1t-1} + 0.24P_{2t-1} - \overset{*}{0.60}P_{3t-1}$

$\qquad\qquad (0.08) \qquad\quad (0.12) \qquad\quad (0.28) \qquad (0.36)$

$\qquad - \overset{*}{0.49}P_{4t-1} + \overset{**}{1.02}T$

$\qquad\qquad (0.31) \qquad (0.11)$

$R^2 = 0.99,\ \bar{R}^2 = 0.98,$ 'd' = 1.5

** indicates that the coefficient is significant at the 5% level, while * indicates significance at the 10% level.

Noting that only equation 3 satisfies all the appropriate economic and statistical criteria in the sense that all its estimated parameters are statistically significant and carry the "right" signs, Adesimi then computes short and long-run acreage supply elasticites from this equation. The results are presented in table 6.

TABLE 5

SHORT AND LONG-RUN ELASTICITIES OF AIR CURED TOBACCO IN W. NIGERIA.

	Short-run Acreage supply Elasticites with respect to		Long-run acreage elasticities with respect to	
Adjustment Elasticity	Own Price (P_{1t-1})	Price of Yam (P_{2t-1})	Own Price (P_{1t-1})	Price of Yam (P_{2t-1})
0.73	0.60	-0.96	0.82	-1.32

He concludes from these results that the relatively high value of the adjustment coefficient suggests that:

(i) much of the acreage supply adjustment takes place in the short-run;

(ii) the magnitude of the long-run price elasticity of supply suggests tobacco supply is inelastic since "a given increase in the expected returns from tobacco would give rise to a less that proportional increase in the amount of acreage Sown to tobacco" (1, p. 320).

Nigerian Rice Farmers

Welsh (22) tested two hypotheses in connection with Abakalike Rice Farmers of Eastern Nigeria. These were:

(i) that peasants in a traditional agriculture respond to economic incentives by allocating very efficiently the factors of production at their disposal;

(ii) that their savings and investment decisions tend to maximise returns to scarce resources.

He concluded that peasants are responsive and went on to complain that too many experts in agricultural development have too eagerly adopted the idea that peasant farmers are not rational economic men, as an easier explanation to the lack of development.

East Africa

Malawian Tobacco Farmers

Dean (5) attempted to explain peasant grown tobacco production in Malawi and to make some predictions regarding various supply relationships.

In the Dean model which covers 35 years (from 1926 to 1960) all of the variables are transformed to a percentage change basis; a transformation identical to a transformation to first difference among logarithms. The basic equation in the model is as follows:

$$\Delta'S = \alpha + \beta\Delta'P_T + \gamma\Delta'W + \delta\Delta'P_I + \phi\Delta D_t$$

S is the symbol for sales of tobacco in pounds,
P_T is the money price of tobacco,
W is the wage rate obtainable abroad (South Africa and Rhodesia),
P_I is the price index,
D_t is the weather, and
Δ' expressed the percentage change in the variables between year t and year t-1. ΔD_t expressed the absolute change in weather.

Dean defined the expected price of tobacco as a weighted average of all past prices, according to Koyck:

$$P^*_t = \alpha_1 P_{t-1} + \alpha_2 P_{t-2} + --- + \alpha_n P_{t-n}$$

A weighted average wage rate was also calculated according to the equation:

$$W^*_t = 0.45\ W_t + 0.45\ W_{t-1} + 0.10\ W_{t-2}$$

The expected average wage rate W^*_t is considered to be a function of all previous average wage rates in the past years, in a manner identical to the above expected price model. Prices involved in the construction of the price index were obtained from several sources. For all commodities being imported, unit values including custom duties were used. Data were drawn from foreign trade statistics. Prices were also obtained for a few commodities produced in Malawi.

Weather was introduced in the model through a dummy variable, which was given the value +1 when the weather has improved from one year to the next, the value -1 when it has deteriorated, and the value 0 when it has been even from one year to the next.

Several alternative dependent variables were tried. These were: the percentage change in tobacco sales per capita $\Delta'(S/Pop)_t$; the percentage change in tobacco sales per grower $\Delta'(S/G)_t$; and the percentage in the number of growers relative to the whole population $\Delta'(G/Pop)_t$. The determining variables tested included:

$\Delta'(P_T/P_I)_{t-1}$, the percentage change in the deflated price of tobacco lagged one year,

$\Delta'(W/P_I)_{t-1}$, the percentage change in the deflated weighted wage index,

$\Delta'P_{Tt}$, the percentage change in the undeflated current price of tobacco,

$\Delta'P_{Tt-1}$, the percentage change in undeflated current price of tobacco lagged one year,

$\Delta'P_{Tt-2}$, the percentage change in undeflated current price of tobacco lagged two years,

$\Delta'P_{Tt-1}$, the percentage change in the price index of "cash" goods lagged one year,

$\Delta'\overline{W}_{t-1}$, the percentage change in the weighted wage index, and

D_t, the change in the weather between year t and year t-1 expressed on a first difference basis. D is a dummy variable.

Estimates of the alternative equations of the Dean model are shown in Table 7. From the results, it appears that Malawi tobacco growers would be responsive to price incentives, and that farm labor would respond to changes in wages in a manner consistent with economic theory.

Kenyan Coffee Farmers.

Joseph Maitha (13) estimated a supply function of Kenya coffee, and calculated price elasticities of supply in three sub-categories of coffee production:

(i) estate production,
(ii) smallholdings and
(iii) industry.

He fitted the following equation to the data in each sub-category:

$$\text{Log } X_t = a_o + a_1 P_{n,t-m} + a_2 \log Q_{t-1} + \log Z$$

where P = real producer price of coffee,
Q = Quantity of coffee
X = Stock of acreage under coffee
Z = A dummy variable to represent effects of the Swynnerton Plan,
n,= the number of price terms in the distributed lag expression,
m,= the order of the lag scheme,
t = a time subscript.

Maitha obtained the elasticities shown in table 8.

TABLE 7

EMPIRICAL FINDINGS OF THE DEAN TOBACCO SUPPLY FOR MALAWI (1926-1960)

Independent Variables	$\Delta'(S/Pop)_t$	$\Delta'(S/Pop)_t$	Dependent Variables[1] $\Delta'(G/Pop)_t$	$\Delta'(S/G)_t$
$\Delta'(P_T/P_I)_{t-1}$		.529(3.91)	.337(4.04)	.148(1.30)
$\Delta'(\overline{W}/P_I)_{t-1}$		-.674(-1.81)	-.533(-2.32)	-.134(-0.43)
$\Delta' P_{Tt}$	-.006(-0.04)			
$\Delta' P_{Tt-1}$	.512(3.44)			
$\Delta' P_{Tt-2}$	.082(0.56)			
$\Delta' P_{It-1}$	-.025(-0.07)			
$\Delta' W_{t-1}$	.865(-0.64)			
$\Delta' D_t$	.307(3.16)	.311(3.46)	.011(0.20)	.314(4.14)
Constent term	.089(0.96)	.082(1.56)	.019(0.59)	.061(1.39)
R	.708	.706	.625	.658
R^2	.381	.445	.326	.372
Von Neumann's ratio	2.557	2.558	2.210	2.797

1. Figures in parentheses indicate the value of corresponding t- statistic. Significance levels are not stated explicitly by the author.

R = Uncorrected multiple correlation coefficient.

R^2= Square of the multiple correlation coefficient, correeted for degrees of freedom.

Source: Dean, Ibid

TABLE 8

ESTIMATED PRICE ELASTICITES OF ACREAGE,

1946-64

Sector	Elasticity	
	Short Run	Long Run
Industry	0.152	0.379
Estates	0.159	0.397
Smallholdings	0.204	0.511

Source: Maitha, ibid., p. 70.

He then concludes that Kenya farmers are relatively responsive to price incentives. In his results, smallholders, who are mainly Africans, show a higher response to price than estate farmers, who are mainly Europeans. Furthermore, Maitha (12) estimated Kenya's coffee supply function using productivity as the dependent variable, rather than acreage. He tested the following equation:

$$\log (Q/X)_t = c_o + c_1 P_{n,\ t-m} + rT$$

where (Q/X) is a productivity index;

c_o, a constant composed of several parameters, including rainfall, and technology;

c_1, a constant;

P, rent-price ratio;

n, the number of price terms in the distributed lag expression.

m, the order of the lag scheme;

r, a constant;

T, a trend factor;

Table 9 shows the estimated price elasticities of productivity, 1946-64.

TABLE 9

ESTIMATED PRICE ELASTICITIES OF PRODUCTIVITY, 1946-1964

Sector	Elasticity	
	Short Run	Long Run
Industry	0.637	0.955
Estates	0.657	0.985
Smallholding	0.644	0.965

Source: Maitha, ibid., p.85

These results confirmed his earlier results based on acreage response.

D.J. Ford (8) contended that Maitha's derivation of the long-run elasticities was incorrect. He argued that when the acreage functions are taken together with the corresponding yield functions, the long-run elasticities must be derived in the context of a simultaneous model, or some assumption is necessary about the factors which influence P_t (price). His estimates of long-run price elasticity of acreage and yield are tabulated in Table 10 alongside Maitha's for comparison.

TABLE 10

ESTIMATED LONG-RUN PRICE ELASTICITIES OF COFFEE ACREAGE AND YIELD

Sector	Acreage Elasticity		Yield Elasticity	
	Maitha	Ford	Maitha	Ford
Industry	0.379	0.380	0.955	0.692
Estates	0.397	0.474	0.985	0.705
Smallholding	0.511	0.558	0.965	0.957

Source: Ford, ibid.

Ford observed that compared to the Maitha results, the simultaneous determination of the long-run supply elasticities for acreage changes the results very little, but very significantly for the price elasticity of yield on estates, and for the industry as a whole.

<u>Kenyan Tea, Maize, Coffee, Cotton, Pyrethrum and Dairy Farmers</u>

The most recent additon to the literature known to this researcher is the work of Etherington (7) and Wolgin (23). Etherington's exercise consisted mainly of the specification and estimation of multiperiod production functions for smallholder tea in Kenya. The basic models for the statistical estimations are reproduced below.

(i) $\frac{Q_{it}}{\sum_{k=3}^{7} X_{kit}} \; Y_{it} = \beta_{oi} + \beta'_{oot} + \sum_{k=4}^{7} \beta'_k P_{kit} + U_{it}$

(ii) $Y_{it} = \beta'_{oi} + \sum_{k=4}^{7} \beta'_{kit} + U_{it}$

(iii) $Q_{it} = \beta_{oi} (\sum_{k=3}^{7} \beta'_k X_{kit}) + \varepsilon_{it}$

Where: Q_{it} is the output of green leaf from firm i in year t;

X_{kit} is the number of stumps of age k on firm i in year t;

β_k is the yield coefficient of stumps of age k years, i.e. it gives the number of pounds of green tea obtained from a stump k years old. (k=3 to 7)

β_o is an overall intercept.

β_{oi} and β'_{oi} are the "farm effects" for their respective model (i.e. the Farm management effect coefficient)

β_{oot} and β'_{oot} are the "year effects" for their respective models (i.e. Weather Change effects)

$P_{kit} = \frac{K_{kit}}{\sum_k X_{kit}}$ is the proportion of total stumps in any group k. (k=4 to 7)

$Y_{it} = \frac{Q_{it}}{\sum_k X_{kit}}$ is the yield achieved by farm i. in year t.

β'_k is the contribution to the overall yield derived from the proportion of stumps of age k (k=4 to 7).

ε_{it} and U_{it} are the error terms for their respective models.

The most important subset of variables considered was the number of age distribution of the stock of tea bushes on a random sample of tea farms.. An important consequence of this was the derivation from the functions of tea yield coefficients for bushes of differing ages and these coefficients were then used as a basis for ex-post predictions of output for a separate sample of farms. Etherington pointed out however, that although these predictive coefficients gave fairly accurate predictions of output, they could not remain constant in the face of changing technology. He then showed how his basic equations could be modified to take account of these changes in techniques of production.

These models don't have any direct reference to producer price. It appears, therefore, that Etherington didn't on a priori grounds consider the price variable as being an important explantory variable in yield response.

In a 1973 study of farmer behaviour in Kenya, Wolgin (23) adopted a Neoclassical model of farmer behaviour under conditions of uncertainity to answer the following questions:

(i) What effect does risk have on farmer behaviour?
(ii) Are farmers efficient in their allocation of scarce resources?
(iii) What are the bottlenecks that limit agricultural production?
(iv) How responsive are farmers to changes in the price vector?

In this probability model, it is assumed that rather than maximise income, farmers seek to maximise expected utility. He shows that if the distribution of income (a random variable in this model) is normal, the behavior whereby farmers maximise expected utility is equivalent to maximising a modified utility function whose arguments are:

(i) Expected return and
(ii) The standard deviation of income.

Microlevel data obtained from the Kenya Government Small Farm Sample Cost Survey were used to estimate Cobb-Douglas production functions for eight enterprises: local maize, hybrid maize, coffee, cotton, tea, pyrethrum, improved dairy and unimproved dairy. Five categories of inputs were used in the Cobb-Douglas production functions: Land, family labor, hired labor, purchased inputs and the capital stock. Four ecological zones were identified as defining crop combination and therefore the units forming the bases of the data set. These were: Zone three (Balanced Ecological Zone); zone four (Kikuyu grass Ecological Zone); zone five (Star grass Ecological Zone); and zone six (Mixed Ecological Zone). The technique of instrumental variables (using prices and fixed inputs as the instruments) was used in the estimations.

Two hypotheses were tested: (i) A farmer will have no reason to equate the marginal value product of any input to the input's price, and consequently, will not equate the marginal value products of any input in each of two uses. Thus, using the equation of marginal value product and input price; as a criterion for economic efficiency is invalid for it is founded on the assumption that "risk", the variance of income, plays no part in the farmer's calculation. If "risk" is indeed important in the farmer's calculations, then one would expect that the marginal value products of all inputs into the high risk/high return crop would be systematically higher than the marginal value products of the low risk/low return crops (23, p. 104), (ii) the ratio of the marginal products of any two inputs in any pair of uses will, in fact, be equal to the price ratio of the inputs, and equal to each other (21, p. 105).

The measures of elasticity of output supply and input demand with respect to output prices for the total of eight enterprises in the four ecological zones are presented in tables 11 through 14.

TABLE 11

MEAN ELASTICITY OF OUTPUT WITH RESPECT TO OUTPUT PRICES

A. Balanced Ecological Zone, Zone Three

	Maize Price	Coffee Price	Pyrethrum Price	Milk Price
Inputs				
Family Labor	-0.6717	-0.0156	-0.0555	0.0230
Hired Labor	0.0914	-0.0353	0.0198	0.1446
Purchased Inputs	-0.0033	-0.0034	0.0042	0.0149
Outputs				
Local Maize	0.0381	0.0518	-0.380	-0.0764
Hybrid Maize	0.0611	0.1106	-0.0416	-0.1070
Coffee	0.0844	-0.0062	-0.0008	-0.0286
Pyrethrum	0.0039	0.0004	0.1782	-0.0001
Improved Dairy	0.1124	-0.0003	-0.0024	0.1211
Unimproved Dairy	-0.0881	-0.0065	-0.0692	0.1944

Source: Wolgin, Ibid p. 101

TABLE 12

B. Kikuyu Grass Zone, Zone Four

	Maize Price	Coffee Price	Tea Price	Milk Price
Inputs				
Family Labor	0.0035	-0.0149	0.0118	0.2234
Hired Labor	0.0051	-0.0015	0.0011	0.3112
Purchased Inputs	-0.0306	0.2303	-0.0115	-0.0814
Outputs				
Local Maize	0.0201	-0.0517	-0.0019	0.2231
Coffee	0.0300	0.1344	0.0211	-0.0199
Tea	0.0561	0.0404	0.2245	-0.0466
Improved Dairy	-0.0144	-0.0771	-0.1023	0.4432

Source: Wolgin Ibid p. 102

TABLE 13

C. Star Grass Zone, Zone Five

	Maize Price	Cotton Price	Coffee Price	Milk Price
Inputs				
Family Labor	0.0654	0.1345	0.0234	0.0055
Hired Labor	0.1432	-0.0583	0.0662	-0.0572
Purchased Inputs	0.0237	-0.0249	-0.0437	0.0002
Outputs				
Local Maize	0.4672	0.0455	0.0234	-0.0335
Hybrid Maize	0.5237	0.0722	0.0511	-0.0722
Cotton	0.0035	0.0712	0.0008	0.0000
Coffee	-0.1335	0.0004	0.0237	-0.0187
Unimproved Dairy	-0.0449	0.0000	-0.1175	0.2213

Source: Wolgin, Ibid p. 102.

TABLE 14

D. Mixed Ecological Zone, Zone Six

	Maize Price	Milk Price
Inputs		
Family Labor	0.2213	0.1448
Hired Labor	0.0788	-0.0006
Purchased Inputs	0.0922	-0.0044
Outputs		
Local Maize	0.1543	-0.0055
Unimproved Dairy	-0.0009	0.0784

Source: Wolgin, Ibid p. 103.

From these results, Wolgin then concludes that:

(i) Farmers were constrained in the total quantity of resources they were able to use by imperfections in factor markets (23, p. 105);

(ii) Farmers were efficient in their allocation of resources across crops (23 p. 105);

(iii) Farmers were risk-averse and tended to employ fewer resources in high - return/high-risk crops than would be predicted by profit maximisation theory (23, p. 105);

(iv) Short-run elasticities of output with respect to output prices were higher than expected though as he clearly points out, some turned out, to be negative (23, p. 105).

Tanzanian Sisal Growers

G.D. Gwyer (9) estimates the long-run and short-run elasticities of sisal supply in Tanzania. His basic general model is:

$$N_t = f(P^*_t, t, \text{ID } 61, (A/M)_{t-1})$$

Where N_t = annual rate of planting;

P^*_t = Nerlovian expected level of prices during the yielding lifetime of sisal;

t = a proxy for expectations of increasing costs;

ID 61 = a zero-one variable for political independence that occurred in 1961;

$(A/M)_{t-1}$ = a measure of the age composition of mature sisal.

His short-run elasticity estimations, according to various lag specifications of the model, ranged between 0.213 and 0.432. The long-run elasticity ranged between 0.419 and 0.696. His conclusion was that these estimates showed significant price response.

Tanzanian Cotton Farmers

Again in Tanzania, Kighoma Malima (14) carried out an empirical study of the determinants of cotton supply. He divided Tanzania into two regions: the lake region and the coastal region. He then used "expected" producer price (P^*), the number of cotton buying stations (B_t), labor force availability (L_t), and a trend factor (T_t) as the explantory variables in his supply function. He assumed farmers, formed their expectations about price as in the Nerlovian model, but, with only the four nearest historic periods determining P^*_t. The following equations were tested for each region:

$$\text{(i)} \quad q_t = a_o + a_1 P^*_t + a_2 b_{t-1} + a_3 T + u_t.$$

$$\text{(ii)} \quad q_t = a_o + a_1 P_t + a_2 b_{t-1} a_3 l_t + u_t.$$

Where P^*_t = log P^*_t

b_t = log B_t

l_t = log L_t.

The value of 0.1 was used for the coefficient of expectation relating expected price to historic prices. This was the coefficent, among many others greater than 0 but less than 1, that maximized the multiple coefficent of determination. His results are tabulated in Table 15.

He concludes from the tests for the lake region that all the t-statistics for total output coefficents (except for the constant terms) are significantly non-zero at the 3% level. But in the coastal areas, only the price elasticity coefficient is significantly non-zero at the .03 level. These results show that cotton farmers in both regions are significantly responsive to price.

TABLE 15

STATISTICAL ESTIMATION RESULTS

	Total Cotton Production	Lake Cotton Production	Coastal Cotton Production
Constant	-1.21	-0.54	-10.15
	-(0.37)	-(0.15)	-(1.83)
P^*_t	2.45	2.46	5.98
	(3.23)	(2.88)	(3.06)
b_{t-1}	0.91	0.74	0.49
	(3.05)	(6.39)	(1.25)
T	0.08	0.09	0.06
	(5.76)	(6.39)	(1.68)
R-Squared (R^2)	0.96	0.96	0.64
Durbin-Watson	1.22	0.99	1.26
Number of Observations	13	13	13
Constant	-85.96	-91.95	-72.11
	-(5.64)	-(6.04)	-(1.78)
P^*_t	2.44	2.45	6.02
	(3.27)	(2.89)	(3.10)
b_{t-1}	0.91	0.79	0.48
	(3.08)	(2.49)	(1.22)
1_t	5.85	6.53	4.56
	(5.84)	(6.44)	(1.72)
R^2	0.96	0.96	0.64
Durbin-Watson	1.22	0.99	1.25
Number of Observations	13	13	13

The figures in parentheses are the t-statistics for the respective coefficients.

Source: Malima, Ibid.

Ugandan Coffee and Cotton Farmers

MacBean (11) tried to test the statistical significance of producer price of coffee and cotton in determining their acreage in Uganda. He found no such relationship. In the case of coffee he concluded that because it is a perennial crop with a gestation period of about five years, the hypothesis that its supply may in the short run be responsive to price changes could be dismissed even on a priori grounds. In the case of cotton, he estimated the relationship between acreage and producer price deflated by coffee producer price: the rationale for the deflation here being that coffee is the cash cropping alternative to cotton. He again found no statistical relationship between cotton acreage and deflated cotton prices. In the MacBean models therefore, there is no perceptible African farmer response to relative commodity prices. This led him to conclude that any changes in coffee and cotton acreage and output must be considered purely random.

Concluding Remarks

All the studies reviewed in this paper in one way or another are concerned with the nature and direction (if any) of response by African farmers to different economic parameters (mainly prices). Many of these studies leave much to be desired.

One of the major weakness of these studies is a serious lack of specification. Consider, for example, Bateman's study (2). The empirical model is somewhat ambiguous. One may question first why coffee should be considered as the only significant alternative to cocoa production in a country where coffee production is very small relative to cocoa. The introduction of both P_{t-8} and P_{t-12} may also be questioned as has the assertion that the coffee price variables should have the same lagged distribution. There is probably some intercorrelation between P_{t-8} and P_{t-12}, as well as between C_{t-8} and C_{t-12}. A more complete investigation of the distributed lag pattern of the producers' price response would have been necessary for cocoa and for coffee. Furthermore, the use of a humidity variable along with the rainfall variable :as both variables are obviously intercorrelated. Some composite index might be used instead, or rainfall only if the proximity of the equator line justifies discounting temperature variations. The level of significance of the various parameter estimates and the absence of the test for serial correlation among the residuals for all equations also suggests that the conclusion drawn from the model should be interpreted with reservation.. Another case is Dean's work (5). His estimates appear somewhat ambiguous. The omission of technological change, price of alternative products and the handling of the weather through a dummy variable appear highly questionable. In addition, although Deane defines the expected price of tobacco as a weighted average of all past prices he nevertheless avoids the use of a distributed lag formulation in the equations of the model proper. Furthermore, in his definition of the weighted average wage rate, the coefficient estimates (or weights) of expected wage equation appear to be guesswork. It is not clear also how the weights were chosen for the commodities produced in Malawi whose prices were used together with imported commodities in the construction of his price index.

Some specification errors are a result of inacurate factual a priori knowledge of the countries being studied by some Western economists. Consider for example the MacBean study (11). Why would coffee be considered the only production opportunity cost to cotton farming (and vice versa) when the bulk of cotton production is geographically located in areas that do not and cannot grow cotton? couldn't a disaggregation of the model and data have revealed a more accurate picture? Sometimes, aggregated national data conceal vast regional structural differences that are so important in analysing the mode of response of farmers to economic stimuli. Rather than take total coffee and cotton acreage in Uganda, if MacBean considered them on a regional basis, he would have clearly realised that the two are competing for land inputs only in Central Uganda. Therefore, clearly not one model could have been adequate for explaining variations in the acreages of these crops in all regions of the country.

Sometimes specification problems are result of faulty theoretical exposition. Some Western economists still think that African farmers grown some crops primarily for cash and some others primarily for on farm consumption. This is the well publicized "cash crop" " "food crop" distinction. There is, of course, no analytical basis for this neat classification. Theoretically any crop can be offered for sale if the price is high enough; and this includes any food crops. Similarly, the production of any so-called cash crop will cease if the price is sufficiently low. To point at the seriousness of this error in model specification, consider again the MacBean study (11). The only reason he could have regarded coffee and cotton as the material production alternatives in Uganda is that he had in his mind the mistaken traditional classification of these crops as the cash crops of Uganda.

Another feature of the specification problems manifests itself in the form of some important omissions by some studies. This sometimes leads to very restrictive assumptions as in the case of Etherington's otherwise excellent study (7). Its main problem is the assumptions underlying his formulation. He assumes that changes in tea output on small-holder farms in Kenya can be explained primarily in terms of industry adjustment to institutional cum legal phenomena. In his words. "Thus the development of the last ten years have been symptomatic of an adjustment to a situation of disequilibrum. It is not that tea prices have suddenly become more favourable. If anything, the relative price of tea has fallen over the period in harmony with the excess supply situation that has been developing on the world tea markets (7 p. 168). Surely it is conceivable that the price effect (even in a situation of declining prices) could have affected the tendency to industry expansion. The fact that industry is expanding in the face of declining prices does not provide a <u>priori</u> evidence of the non importance of price.

Most of the studies reviewed in this paper are concerned with farmer response in terms of inter crop substitution or occupational alternatives but say nothing about the total supply of farm output or the total supply of effort by the stock of labor on the farm or in the economy.[1] If this were to be taken into account, certain hypotheses tested in these studies would have to be re-formulated, specifications would need to be revised and results re-interpreted. For example, in the Etherington study (7) the over all increase in tea production in the face of declining prices can be interpreted as an increase in the supply of effort by tea growers to counter act the downward pressure on income due to declining prices. With this type of interpretation (which is plausible), one would then have to stop looking at the supply schedule as a simple relationship between price and quantity supplied. And what could be more rational than this mode of behaviour in a situation of limited economic opportunities. Even in the U.S.A. with the current wave of inflation chopping on the real incomes of salaried personnel, people are taking on second and third jobs and part time employment to maintain a certain standard of living.

Another major source of weakness of these studies is a frequent use of data proxies. One such study particularly weakened by poor data is Wolgin's (23). As he notes himself (23, p. 107), his work would have been much more convincing if he had available, in particular, time series microlevel information which would have facilitated the study of the more interesting long run supply response.

A final point to make is that one gets very tired of reading through elaborate formulations and estimations' study after study, only to come to the same conclusions: "Therefore growers respond to price incentives." As this survey has shown, there is enough evidence to make this conclusion a truism and so let us put hypotheses b, c and d (stated earlier in this paper) to rest once and for all. Let us concentrate our energies on the more fundamental underlying allocative decisions, let us push research further into the normative phase of determining what farmers ought to do and in the policy phase of determining how changes in what the farmers do can be brought about in the light of why they are doing so and in the light of what we think they ought to do given that they respond to price incentives (at worst like Europeans and Americans).

Footnotes

1. I owe this point to Professor Ian Livingstone of the Institute for Development Studies, University of Nairobi.

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