USUFRUCT RIGHTS IN LAND IN GRAIN SUPPLY RESPONSE ANALYSIS: THE CASE OF ETHIOPIA

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ABSTRACT

Change in the production of a crop at household levels has to date been directly associated with increase in the size of cultivated land. Given that land size can not be augmented by way of land transfer because of the existing land policy and also given that there is low level of technological application, efforts targeting increase in the production of a crop require land transfer from other crops, making aggregate changes in crop production both at the household and at the national level following incentive changes to be small.

A vector autoregression model was fitted, using macro data, to investigate interrelationships between producer prices and size of cultivated land under grains. The findings from the impulse response functions suggested that perturbations in cultivated land do cause chain reactions in producer prices but the reverse was found to be true only for area under cereals. Variance decomposition also attributed higher percentage of variation in areas to come as a result of own innovations. But sizable proportion of variations in producer prices will partly be explained by variations in areas and the remaining higher proportion by their own past. Forecast values were also computed for areas and producer prices. The results showed that both continue to decline in the same direction in the years to come as they have already attained their turning points in the year 1995/96.

INTRODUCTION

Agriculture is the mainstay of the Ethiopian Economy. It accounts for not less than 50 percent of national output, provides raw materials and labor to the industrial sector and makes substantial contribution to foreign exchange earnings.

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economic planning. For example, the shift away from "industry-first argument" towards agricultural development, in the late 1960s, was caused by food shortages. Later the "Ten-year perspective Plan" following the drought of 1984, the "Mixed economic policy" in 1990, and the "Adjustment program" in 1992 planned increase in food production.

The economic policies introduced since 1990 have created favorable environment for an increase in grain production. For example, the 1990 policy reform abolished the privileges that were given to state and cooperative farms. It lifted quota delivery systems and restrictions on inter-regional grain flows and allowed trading of farm produce at free market prices. This was further strengthened by the 1992 political and economic reform with additional policy instruments targeting, among other things, the reduction of macro economic distortions and lowering of real effective exchange rate. These policy changes targeted directly or indirectly the setting of prices right.

Different studies have, however, discovered insignificant price elasticities of supply for food crops and ascribed this to non-price factor such as the non-existence of conducive land policy. Currently farmers have only a right of use but not to sell land. This is a remnant from the previous socialist regime.

Usufruct rights in land constrain farmers' response to market based incentive changes because the level of grain production has to date been affected more by size of cultivated land. For example, during the study period two distinct policy measures having opposite repercussions on farmers' response were witnessed. The time before 1990 was characterized by unfavorable policy environment. For example, fixed pricing and fixed quota delivery systems were introduced and in some areas farmers who were unable to comply to grain quota used to be compelled to fulfill the shortfall by purchasing from open markets. This was said to have forced many farmers to change their production mix of cropping pattern to evade grain quota (Alemayehu, 1990).

Between 1987 and 1990 prices of all crops under review were increased as a result of pressure from the International Monetary Fund, the World Bank, and the African Development Bank, because officially established prices were found to be unrmunerative. As evidenced by Table 1, following adjustment of floor prices, increases in production, area, and yield (production per hectare) were registered for cereals. The response was strengthened in the subsequent years except that there was a decline in yields i.e. price changes increased grain production and increase in grain production was in turn caused by increase in cultivated land but not yield. This is because as could be seen from Table 1, the figure for yield declined during the third period. This could be ascribed to many factors of which mentionable is the 140 percent devaluation of the domestic currency in October 1992, which increased domestic price of fertilizer, and to the gradual lifting of subsidy on fertilizer.

This can further be supported by analyzing changes in total grain production in the major cropping season of the past three consecutive years (1994/95 - 1996/97). In

1995/96 a 31.77% increase in total crop production was registered. But in the following year it rose only by 1.77%. This fluctuation in the percentage increase of production was the result of notable change in area than yield. This is because, in 1995/96, increase in cultivated land was registered to be 988.35 thousands hectares but increase in area fell to 123.83 thousand hectares in 1996/97. But increases in yield were 1.55 quintal per hectare in 1995/96 and 0.28 quintal per hectare in 1996/97.

Table 1: Response of Food Production to Area (Prices are at 1994\95 base year)

	Cereals				Pulses			
Year	AVG Price Index	AVG Prod. '000 Quintals	AVG Area '000 Hectares	AVG Yield	AVG Price Index	AVG Prod. '000 Quintals	AVG Area '000 Hectares	AVG Yield
1981/82-87/88	44.84	54959.76	4860.29	11.31	39.55	6435.41	716.24	8.98
1988/89-89/90	48.66	59423.43	4928.06	12.06	51.55	5683	572.5	9.93
Since 1990/91	91.70	63238.11	5490.14	11.52	80.41	7375.63	928.63	7.94

AVG stands for Average.
Source of Original Data: Central Statistical Authority, National Bank of Ethiopia and author's computation.

The reasons for low yield could be the fact that chemical fertilizer is used by less than 14% of farmers (Dejene, 1994). Improved seeds are available for only 2 percent of peasants and 15-20 percent of crop loss occurs due to very limited use of pesticides (Ramanujam). Only 0.3 percent of agricultural lands are irrigated (WB, 1993) and agricultural research activities have brought little progress in agriculture as it has not for long been target oriented (Goshu, 1994).

Therefore, given that

1. Farmers are too poor to afford application of high input package
2. Extensive farming is not possible by way of reclamation of uncultivated land, as production has long encroached upon marginal lands in some areas because of human and livestock population,
3. Little fallow land is at farmers' disposal, and that
4. Change in area under crops is primary source of production change

It is hypothesized in this paper that increase in the production of a crop following incentive changes is possible by decreasing land allocated to other crops, making over all changes in grain production following incentive changes to be small.

Therefore, this study takes as its major objective the establishment of interrelationships between area under grains and their respective producer prices. To achieve this, vector autoregression model is fitted. The contribution of this paper may also be seen as methodological as most studies on supply response use Nerlovian Partial or Adaptive Expectation models which Nerlove himself was no longer so sure in their power as a tool for understanding the dynamics of agricultural supply in developing countries (Ramanujam). In addition, the model provides information regarding for how long, say, a change in land policy (or a change in producer prices) will continue affecting producer prices (or grain supply). It also serves as a measure of the nature of linkages between producer prices and grain supply.

The paper is organized into four sections. In section one, an attempt to highlight the current land tenure conditions in Ethiopia and their possible impact on grain production, in particular, and overall agricultural growth in general is made. Sources of data and measurement of variables are discussed in section two. In section three, discussion is made as to how investigation could proceed regarding interrelationships between size of cultivated land and price changes using a Vector Autoregression system. Finally, results are discussed and conclusions are given.

1. LAND POLICIES IN ETHIOPIA: *EFFECTS ON AGRICULTURE, AN OVERVIEW*

Different kinds of land tenure conditions were practiced prior to the 1974 political and economic reform. For example, Rist[2] system in the northern highlands, Gebbar[3] land in parts of Wollo and Northern Shoa, Schama[4] village tenure in parts of Eriteria and Tigray, Church land and State tenure both in the northern and southern parts, and Gult[5] system in the remaining parts of Ethiopian highlands (Sutcliffe, 1995; Desalegn, 1984). Following political and economic reform, which occurred in 1974, however, land fell into state hands with individual farmers possessing mere rights of use and occupancy; and sharecropping institutions were outlawed. The reason for not allowing marketing transactions on land currently is fear on the part of the government that it would intensify rural urban migration.

There are different views regarding the adverse impacts of state ownership on growth of agriculture. To mention a few, its effect on investment in land conservation, on the expansion of rural credit markets, and social tension between the "haves" and the "have nots". With regards to the latter, the tension, according to Aklilu and Tadesse (1994), created both inter-generational conflict (i.e. between fathers and sons) and intra-generational competition (between youngsters who compete for megazo[6] lands). Though implicit, conflicts are also apparent between the landless who favor another round of land redistribution and those who in one way or another obtained more than the average land size and feel that land redistribution makes them end up with little plots (Teferi, 1995).

Land distribution, which was conducted following the 1975 reform based on family size, could not satisfy new claims for land by newly formed households. Peasant associations across the country had, therefore, to deal with this by redistributing land until government in 1989 officially banned it. Land redistribution has, however, continued even after 1989 within households in the form of *miraazaa baass or gulema* lands[7]. This contributed to an increase in land diminution, dislocations, and tenure insecurity. As a result farmers whose holding is below 0.25 hectare are currently excluded from the use of the high input package, extended by the Ministry of Agriculture and Sasakawa Global 2000, since the conditions attached to the use do not permit them (ICRA, 1997). Currently a household is assumed to hold on average less than one hectare making adoption of modern yield increasing technology difficult. High intensity of crop production in most parts of the country has become a strategy to cope with the small farm sizes i.e. double cropping of small cereals is a common practice.

Tenure insecurity, which occurs owing to uncertainty regarding continuous use of a plot, is assumed, in economic literature, to cause reduction in farmers' incentives in investing in soil conservation and soil management measures. Too small land size to use legume-based crop rotation and fallowing is one reason why farmers fail to counter declining soil fertility and cultivation of high valued but less nitrogen-fixing crops in order to avoid the risk of losing plots in redistribution before earning the maximum possible was another (Teferi, 1995). Thirdly, government support in the supply of high input package is biased towards land requiring relatively less investment in land conservation i.e. majority of farmers in the hills whose lands are greater than 5% slope are not eligible to benefit from government package.

The paucity of credit channeled to small farmers by formal lending institutions, which is ascribed among other things to the sanctioning of farmers to use land as collateral, is another factor cited as responsible for impeding farmers' access to technology. For example, of the total credit disbursed by the Development Bank of Ethiopia and the Commercial Bank of Ethiopia between 1983\84 to 1992\93, only 22.2% and 2.4%, respectively, went to peasant agriculture (NBE, 1996).

The introduction of an "Adjustment Program" in 1992 provided management autonomy to credit institutions and allowed free entry of private banks into credit markets. Because of this a further decline in credit to farmers is anticipated owing to the fact that the majority of Ethiopian farmers are too poor to supply collateral required by formal credit sources. Land becomes attractive collateral provided that the owner or borrower can guarantee to the lender that his land can be transferred. As a result farmers' sole source of fund has remained to be informal. For example, an estimate by the National Bank of Ethiopia in 1996 indicated that in 1995, credit from informal sources to small enterprises, farmers included, amounted to 10% of Gross Domestic Product.

2. DATA AND MEASUREMENT OF VARIABLES

The study covers only cereals and pulses. This is because, in terms of area coverage more than 95% of the total cultivable land is on average used for cultivation of these crops. As shown in Table 2, a larger percentage of land under crops goes to cereals and pulses. Cereals include teff, barley, wheat, maize, sorghum, millet, and oats, while pulses include horse beans, field peas, haricotbeans, chickpeas, lentils, and vetch.

Table 2: Area Under Grain

Year	Cereals		Pulses	
	Million Hectare	%	Million Hectare	%
1994\1995	6.45	83	0.92	12
1995\1996	7.67	85	1.01	11
1996\1997*	6.67	83	0.91	11

Sources: Central Statistical Authority, National Bank of Ethiopia and author's own computation.
* Data is available only for main cropping season.

Because area is used in place of production as a proxy for supply, weather is excluded from the model. The use of area in place of production in supply response analysis is suggested as production figures are more susceptible to weather fluctuations. In addition, a proxy for technology in not included in the model. Small land size, at farm household level, has caused full utilization of land resource leaving almost no fallow land at farmers' disposal. Therefore, availability of technology is assumed to bring no change in land size under a crop. This is because with land falling in state hands and with a peasant having little access to additional land purchase, he or she is assumed to be dictated more by price to expand area under a crop since such a decision requires a farm household to reduce area devoted to other crops.

The time series data on output, area, and prices for the period 1981/82-1996/97 were collected from various periodic reports published by the Ethiopian Central Statistical Authority and National Bank of Ethiopia. Price indices for cereals and pulses are not readily available in Ethiopia. With this fact in mind, rural consumer price indices indexed at 1995/96 prices were used and deflated by similarly indexed price of competitive crops (price index of pulses were used to deflate price of cereals and price index of cereals were used to deflate price of pulses). Price indices were available for 1981/82 to 1995/96 at 1981/82 base year price and since 1995/96 at 1995/96 prices. The index for earlier years was converted to index with 1995/96 as the base year.

3. THE MODEL

Vector Autoregression (VAR) is used in this study to analyze the interrelationships between producer prices "P_t" and Area "A_t". It is a multiple time-series generalization of the Autoregressive model.

$$A_t = \beta_{11}A_{t-1}+\beta_{12} P_{t-1}+\varepsilon_{11} \quad \text{[1]}$$

$$P_t = \beta_{21}A_{t-1} + \beta_{22}P_{t-1}+\varepsilon_{21} \quad \text{[2]}$$

Where, A_{t-1} and P_{t-1} are area and producer prices at time t-1, and ε_{1t} and ε_{2t} are error terms.

τ The system in terms of the lag operator L is

$$\begin{bmatrix} A_t \\ P_t \end{bmatrix} = \begin{bmatrix} 1-\beta_1 L & -\beta_{12} L \\ -\beta_{21} L & -\beta_{22} L \end{bmatrix}^{-1} \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix}$$

$$= 1/\tau \begin{bmatrix} 1-\beta_{22} L & \beta_{12} L \\ \beta_{21} L & 1-\beta_{11} L \end{bmatrix} \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix} \quad [3]$$

Where

$$\tau = (1-\beta_{11}L)(1-\beta_{22})-(\beta_{21}L)(\beta_{12}L)$$

$$= 1-(\beta_{11}+\beta_{22})L + (\beta_{11}\beta_{22}-\beta_{12}\beta_{21})L^2$$

$$= (1-\lambda_1 L)(1-\lambda_2 L) \quad \text{say)}$$

where λ_1 andλ_2 are eigenvalues of the equation

$$\lambda^2 - (\beta_{11} + \beta_{22})\lambda + (\beta_{11}\beta_{22}-\beta_{12}\beta_{21}) \quad [4]$$

For the satisfaction of stationarity condition, absolute values of?eigenvalues should be less than????? otherwise there is little point in studying impulse response functions for nonstationary systems. As the condition for stationarity is satisfied for grains under study, it is found unnecessary to estimate cointegrating equations since linear combination of the variables is stationary.

4. RESULTS AND DISCUSSION

All data are transformed to logarithms. The data were examined by visual inspection of the correlograms and by Augmented Dickey-Fuller tests to determine whether they are stationary in levels or possess a stochastic trend. As shown in Appendix 1, autocorrelations die out as the lag becomes large for all the variables. But according to tests done for unit root using (summarized in Table 3 below) Augmented Dickey-Fuller, the null hypothesis for the presence of unit root was rejected only for price variables. Since linear combinations of these I(0) and I(1) variables in the VAR give a stationary series, it was concluded that the variables should appear in levels. Stationarity of these linear combinations of the variables was later proved by the eigenvalues, the absolute values of which turned out to be less than one.

Table 3: Unit Root Test

Variables	Cereals				Pulses			
	ΔA		ΔP		ΔA		ΔP	
	Coefficient	T-ratio	Coefficient	T-ratio	Coefficient	T-ratio	Coefficient	T-ratio
Constant	0.9483	1.1222	2.1628	2.0398	0.9208	1.1553	2.0854	2.1515
Trend	0.0090	1.0868	0.6483E-3	0.0811	0.0122	1.6053	0.7698E-3	0.0960
X(-1)	-0.2418	-1.1657	-0.4646	-2.1002	-0.2381	-1.2599	-0.4582	-2.0828

X(-1) stands for one-year lag of the dependent variable
Δ stands for first difference of the dependent variable
Source: Author's calculations

Lag lengths were determined by estimating the models with one and two lags and employing a likelihood ratio test. Based on the result of these tests the order of the VARs was determined to be one. Regression results of the equations with two lag orders, before a step by step deletion of non-significant variables was applied, and variance covariance matrix of their respective residuals are given in Appendix 2.

Tests for structural stability was conducted on selected models using CUSUM and CUSUM-SQUARES. The CUSUM test is used to detect systematic changes in regression coefficients, while the CUSUM-SQUARES test is used in situations where the departure from consistency of the coefficients is arbitrary and hidden. According to these tests the hypothesis for the absence of systematic and sudden or haphazard changes could not be rejected. The parameters according to these tests are constant and no departure from consistency of parameters in a sudden way exists. This means that there are no changes in the trend because of a major structural break witnessed in 1990/91. As a result data before 1990 is included to increase sample size.

4.1. Impulse Response Functions

After deleting insignificant constant terms from the model for pulses, considering the 1993/94 observation for area of pulses as an outlier based on analysis of residuals, correcting first order serial correlation using cochrane-orcutt from the equation for area of cereals, and finally making sure that the absolute values of eigenvalues computed from the two VARs are less than one; impulse response functions were computed as summarized in Table 4 (see Appendix 2 for original regression results and diagnostic tests). Impulse response functions calculate chain reactions overtime in all variables as a result of perturbation in an innovation.

Table 4 above shows a one standard deviation perturbations in the first and second orthogonalized innovations in cereals and pulses. It takes less period for reactions in producer price to die out as compared to cultivated land. One standard deviation perturbation in the first orthogonalized innovations does cause chain reactions in producer prices implying that changes in cultivated land triggered by changes in policies affecting use of land cause change in producer prices. But perturbation in the second orthogonalized innovations (producer prices) causes chain reactions only in cereals. This may be due to the supplimentariness of pulses to cereals in the dietary makeup of Ethiopian dish. This is because as evidenced by Table 2 and Table 5 greater proportion of the available arable land goes to the production of cereals despite the relatively higher price fetched by pulses.

Table 4: Impulse Response Functions

Cereals						Pulses					
$U_1 = [1\ 0]'$			$U_1 = [0\ 1]'$			$U_1 = [1\ 0]'$			$U_1 = [0\ 1]'$		
Period	Area	Price	Period	Area	Price	Period	Area	Price	Period	Area	Price
1	0.11	-0.04	1	0	0.01	1	0.12	-0.01	1	0	0.11
2	0.05	-0.05	2	0.03	0.04	2	0.11	0.02	2	0	0.08
3	0.01	-0.04	3	0.03	0.01	3	0.10	0.04	3	0	0.06
4	-0.01	-0.02	4	0.02	0	4	0.09	0.05	4	0	0.05

Source: Author's calculation

Table 5. Per kilogram Retail Prices of Cereals and Pulses in Rural Areas in Randomly Selected Years

	Cereals				Pulses			
Year	Teff mixed	Wheat mixed	maize	Sorghum mixed	Horse beans	Haricot beans	Chick peas	Lentils
1981/82	0.61	0.62	0.52	0.70	0.43	0.72	0.52	0.58
1984/85	1.18	1.08	0.85	1.02	1.05	0.96	1.37	1.53
1988/89	0.78	0.71	0.54	0.61	0.91	1.94	0.98	1.39
1992/93	1.53	1.39	0.97	1.13	1.35	2.29	1.73	2.18

Source: Central Statistical Authority, Rural National Consumer' Price index

Therefore, one may conclude from Table 4 that perturbations in producer prices do cause little impact on cultivated land and thereby grain supply. This may partly be attributable to the prevailing land holding system, as it has restricted land acquisition of any form and made capable farmers operate on *fixed plots with almost no fallow land at their disposal.* And partly to the risk averse and subsistence natures of agricultural production, which allow little room for specialization in the production of specific crops.

4.2. Variance Decomposition

Evidence on the nature of the linkages between producer prices and area is provided by the variance decomposition, which measure the proportion of forecast error variance in one variable explained by innovations in itself and the other variable. As reported in table 6 below, a larger proportion of variations in area is explained by its own past, accounting between 62%-100% for cereals and 100% for pulses. The same is true for variations in producer prices accounting for between 90%-99% for pulses and between 71%-96% for cereals.

Table 6. Variance Decomposition of Area and Producer Price

	Cereals				Pulses			
	Var. decomposition of Area		Var. Decomposition of Price		Var. Decomposition of Area		Var. Decomposition of Price	
	Area	Price	Area	Price	Area	Price	Area	Price
1st	100	0	16.7	83.30	100	0	1	99.00
2nd	97.5	2.50	29	71.00	100	0	5	95.00
3rd	62	38	4	96.00	100	0	9.7	90.30

Source: Author's calculations

*Confidence intervals are not included because of the difficulties inherent in computing standard errors for structural VARs.

Variations in producer prices are to a certain degree explained by variations in area accounting for between 4%-29% to cereals and between 1%-10% to pulses. This means that variations in supply (measured in terms of area) do affect producer prices but little will be the impact of producer price variation on supply. This may imply the continuation of the impact of the aforementioned constrains in shaping future relations between the variables given that the current policy environment continue to influence production in the future.

4.3. Forecasting

To see weather the trends in areas and producer prices experienced since 1992/93 will continue beyond the sample period, forecasting was made.

Sample period prediction performance of the VARs was measured using mean squared error (MSE), mean of forecast errors (μ_ε), standard deviation of forecast errors (σ_ε),and correlation between prediction errors and prediction values (γ) in order to check the power of the VARs in making forecasts within the sample period.

As shown in Table 7 below, the statistics obtained are small, except for area under pulses[8], suggesting that the prediction bias may be characterized as being minor and the usefulness of the model in making forecasts for future values of area and price with little prediction bias. Forecast values within and beyond the sample periods for each variable are summarized in Figure 1.

Table 7. Summary Statistics for Sample Period Prediction Errors

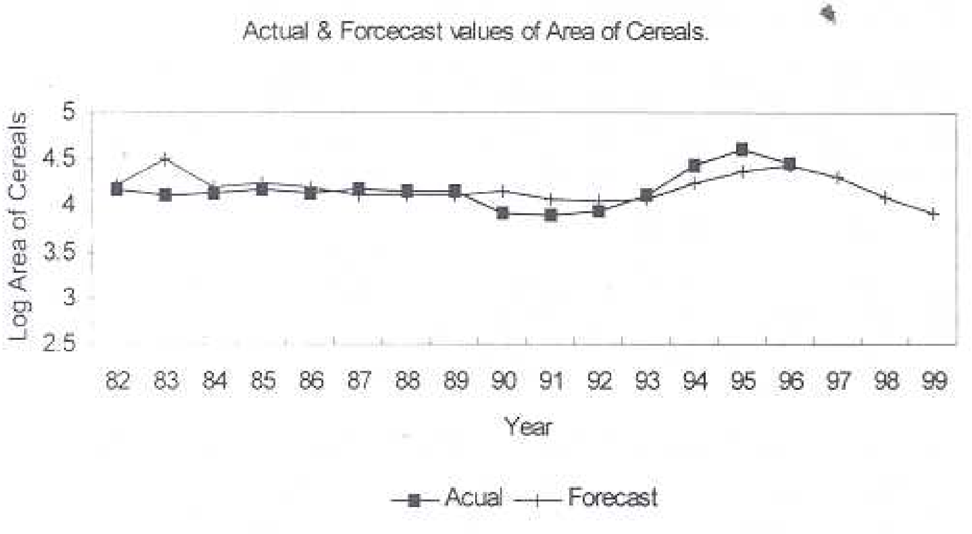
	Cereals				Pulses			
Variables	MSE	μ_ε	σ_ε	γ	MSE	μ_ε	σ_ε	γ
Area	0.14	-0.01	0.12	0.44	0.11	0.31	0.11	-0.16
Price	0.03	0	0.10	0	0.02	0	0.10	-0.20

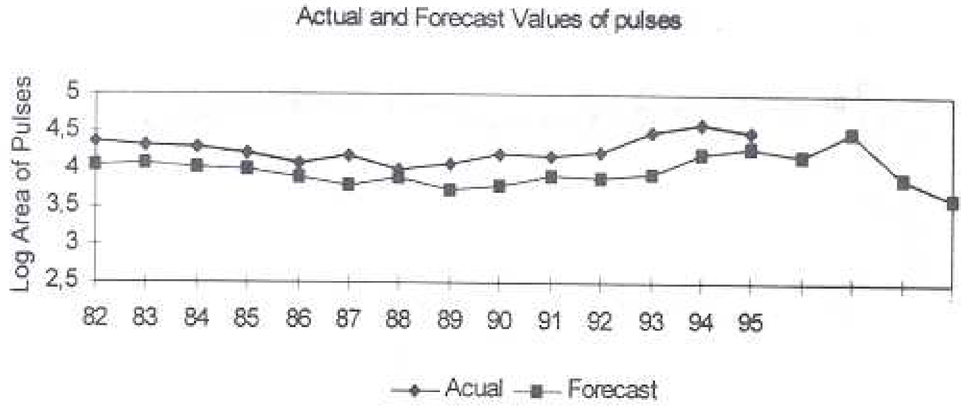
Source: Author's calculations

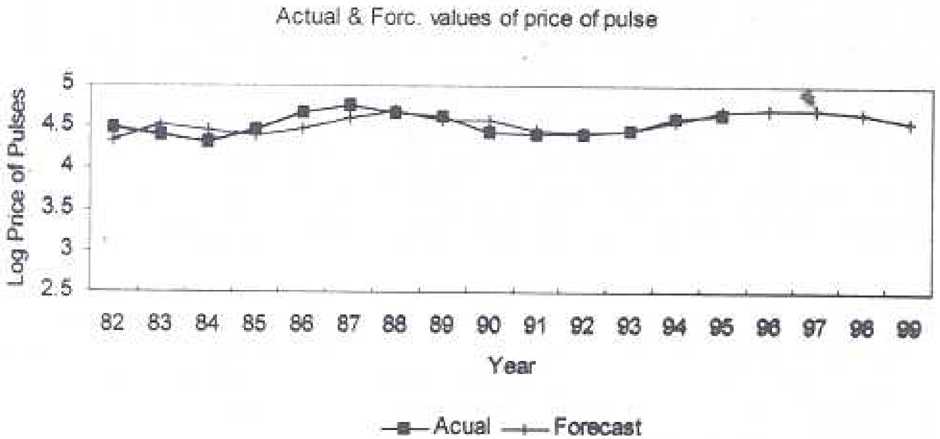
Increase in actual values occurred for the variables (Figure 1) between the years 1991 and 1994/95. This as explained earlier resulted from deregulation of marketing constraints, which were experienced prior to 1990. Since 1994/95, however, actual values have declined. One possible reason for this could be that the IMF-World Bank orchestrated restructuring, initiated in 1991/92 and being strengthened by a series of accompanying policies to date, began to achieve its target of shifting resources from the non tradable to the tradable sectors of the economy.

According to the forecasts made for values of the variables beyond the sample period (see values after 1996/97) decline continues to occur in the years to come. This decline in areas may be attributed, as explained earlier, to the increasing competition for scarce arable land coming in recent years from cash crops. This may be because of the fact that production of cash crops is becoming rewarding due to continuous adjustment of the exchange rate, which in turn is causing a rise in domestic price of these crops. It is however the author's belief that further investigation should be made to identify factors responsible for this phenomenon. These declines in areas under grain are accompanied by similar reaction in producer prices. This is in line with a priory expectation regarding direction of movements of area and producer prices.

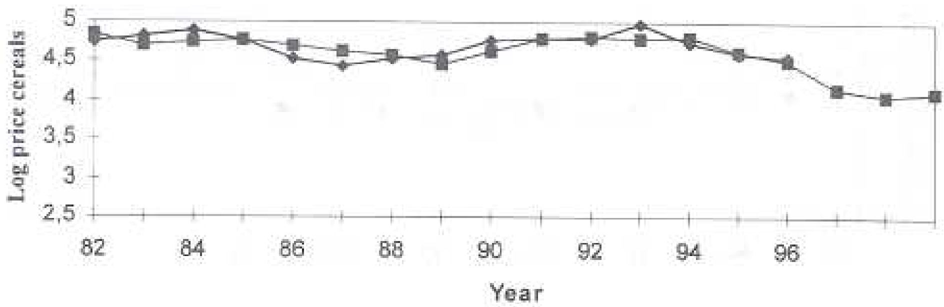
Figure 1: Actual and Forecast Values of Areas and Producer Prices for Pulses and Cereals




Actual and Forecast Values of pulses
Log Area of Pulses
5
4,5
4
3,5
3
2,5
82 83 84 85 86 87 88 89 90 91 92 93 94 95
Acual
Forecast


Actual & Forc. values of price of pulse
Log Price of Pulses
5
4.5
4
3.5
3
2.5
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99
Year
Acual
Forecast

Actual and Forecast Values of price of Cereals



SUMMARY AND CONCLUSION

Increase in production of individual food crops is directly associated with an increase in cultivated land. This is because the majority of Ethiopian farmers can not afford to apply high-powered inputs. Increase in cultivated land by way of reclamation of uncultivated land has become difficult as cultivation has long encroached upon marginal lands in most areas. Increase in the cultivated land by way of consolidation is also constrained by the current system of land holding which does not allow selling and lease of land. The system has reduced average holding to less than one hectare due to continuous redistribution and increase in human and livestock population. These have made possible only intra crop and/or inter crop transfer of cultivated land and made changes in over all grain production following incentive changes to be small.

Tenure insecurity as a cause for the reduction in the long term investment in soil conservation, the inability of farmers to use land as collateral as a cause for reduction in the use of agricultural inputs, and possible conflicts between those having land and those without are also among the consequences of state ownership of land, calling for a change in the existing rural land policy.

A system of vector autoregression was fitted to investigate interrelationships between producer prices and cultivated land. Findings from impulse response functions suggest that perturbations in cultivated land do cause chain reaction in producer prices. But perturbations in producer price cause chain reactions only in cereals. Attempts to decompose variations in the variables under consideration suggest that greater proportions of variations in cultivated land be explained by their own past. But variations in producer prices will be attributable partly to cultivated land, and partly to their own innovations. Forecast for future values of areas and producer prices were also made to see weather the trend experienced in recent years in cultivated land and producer prices will continue to occur in the future. Results indicate that they will have decreasing values as they have already attained their turning points in the year 1995/96.

The findings are in line with a priori expectation i.e. in situations where farmers operate under fixed plots and where there exist little fallow lands, both resulting from the granting of user rights on land, little change in grain production occurs following incentive changes. This could also be justifiable by risk averse behavior of farmers, subsistent production, and little market orientation.

Therefore, if an increase in grain production is to be achieved, in addition to the incentives provided, two alternatives may be considered. First, devising farmers' access to additional land by allowing land transferability. Second, reducing farmers' dependence on land size as primary means for increasing production.

VII. NOTES

[2] Rist is hereditary use rights, both matrilineal and patrilinieal. Allocation and reallocation of plots could and often did occur as new claims were made.

[3] Tenants on Gebbar land had little or no security of tenure with tenancies usually renewed annually. Tenants were unable to claim compensation for any improvements made to the land.

[4] Periodic redistribution of plots to accommodate changing population pressures.

[5] Tribute was collected by Gult holders (nobility, the clergy, and military) or by the landowner in the form of rents.

[6] Megazo lands are share cropped lands. Although share cropping is not allowed it is still being practiced between kins in some parts of the country.

[7] Except for the wording both are to mean arrangements between sons and parents when sons marry or start to plough independently. The name Gulema is used by farmers in the central highlands while miraazaa baass is used among Oromo inhabitants in eastern highlands.

[8] This could be attributed to factors not explainable by the model.

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IX. APPENDIX

Appendix 1

Autocorrelation Coefficients

	Area Under Crops		Price Deflated by Price of Competitive Crop	
Order	Cereals	Pulses	Cereals	Pulses
1	0.67496	0.43706	0.48740	0.48740
2	0.13994	0.34449	0.89527	0.89527
3	-0.30246	0.18315	-0.16827	-0.16827
4	-0.43658	-0.16411	-0.39085	-0.39085

Appendix 2
VAR Results of First and Second Orders

2.1. First Order

2.1.1. Cereals

Numbers in brackets are standard errors.

$$A_t = 0.6212A_{t-1} + 0.34084P_{t-1} + \varepsilon_{1t}$$
$$(0.26492) \quad (0.24073)$$

$$P_t = 4.1257 - 0.3378A_{t-1} + 0.4183P_{t-1} + \varepsilon_{2t}$$
$$(1.4050) \; (0.18510) \quad (0.20340)$$

First line of the equation initially showed serial correlation problem of order one. This problem was corrected using Cochrane-Orcutt. Other tests for Heteroscedasticity, Functional form, and Normality were also conducted for the two equations using microfit program. Results showed that OLS assumptions are satisfied.

2.1.2. Pulses

$$A_t = 0.93196A_{t-1} + 0.0666\,P_{t-1} + \varepsilon_{1t}$$

$$P_t = 0.25831A_{t-1} + 0.76213\,P_{t-1} + \varepsilon_{2t}$$

** All coefficients in the above two equations are significant at 5% significance level except the coefficient for P_{t-1} on line one. Diagnostic tests for serial correlation, Hetroscedasticity, Functional form, Normality were done and no problem was detected. These results were obtained after an outlier in observation 1993\94 was excluded based on analysis of residuals.

2.2. Second Order

Below are shown coefficients obtained before a step by step deletion of insignificant variables was made. Numbers in brackets are standard errors. No specification problem except that the null hypothesis for joint explanation of variations in area are rejected at 13% and 14% significance levels for cereals and pulses, respectively.

2.2.1. Cereals

$$A_t = 0.78675 + 1.352\, A_{t-1} - 0.81466\, A_{t-2} + 0.36258\, P_{t-1} - 0.12247\, P_{t-2} + \varepsilon_{1t}$$

(2.0135) (0.29178) (0.39937) (0.28811) (0.27577)

$$P_t = 3.8046 - 0.26235\, A_{t-1} - 0.045904\, A_{t-2} + 0.58160\, P_{t-1} - 0.11952\, P_{t-2} + \varepsilon_{2t}$$

(2.3754) (0.34423) (0.47117) (0.3399) (0.32534)

2.2.2. Pulses

$$A_t = 3.0183 + 0.95217\, A_{t-1} - 0.39959\, A_{t-2} - 0.12273\, P_{t-1} - 0.12439\, P_{t-2} + \varepsilon_{1t}$$
(2.9488) (0.34161) (0.47084) (0.37683) (0.39981)

$$P_t = 1.3396 - 0.026855\, A_{t-1} + 0.11616\, A_{t-2} + 0.90982\, P_{t-1} - 0.28859\, P_{t-2} + \varepsilon_{2t}$$
(2.4542) (0.28431) (0.39187) (0.31363) (0.33276)

2. 3. Variance Covariance Matrices of Residuals

Stepwise elimination of insignificant variables from the VARs was done and the following variance covariance matrices of residuals were computed for cereals with one and two lag orders. Variance covariance matrices of residuals for pulses are not presented here. This is because elimination of insignificant variables from the models resulted in equivalent models.

$$\Omega_1 = \begin{bmatrix} 0.015 & -0.003 \\ -0.003 & 0.012 \end{bmatrix}$$

$$\Omega_2 = \begin{bmatrix} 0.865 & -0.003 \\ -0.003 & 0.012 \end{bmatrix}$$

Ω_1 is variance covariance matrix of errors from the VAR with one lag order and Ω_2 is variance covariance matrix of residuals from the VAR with two orders. Testing the hypothesis that the order is $p_0 < p_1$ made selection for the order of the VAR. The null hypothesis is nested within the alternative hypothesis and it was tested by a likelihood ratio test statistic given by:

$LR = n [\ln \Omega_1 - \ln \Omega_2] \sim$ Chi square with q degree for freedom

Where q is given by $q = k^2 (p_1 - p_0)$

Appendix 3

Production, Area, and Rural Consumer Price Index for Cereals and Pulses

	Cereals			Pulses		
Year	Production	Area	Rural CPI	Production	Area	Rural CPI
1981/82	53935.04	4629.43	34.8	8203.3	793.7	23.6
1982/83	67182.83	5029.23	35	9654.6	798.8	30.5
1983/84	55268.17	4715.59	35.6	7117	761.2	29.1
1984/85	42398.47	4814.68	67.8	5017	739	51.2
1985/86	48199.87	4991.63	57.4	4673	670	49.4
1986/87	56364.29	4786.31	42.23	5316	590	45
1987/88	61369.68	5055.19	41.3	5067	661	48.2
1988/89	57335.73	4890.79	48.8	5245	557	52.8
1989/90	61511.13	4965.32	48.8	6121	588	50.5
1990/91	53201.71	3898.63	66.3	9587	678	56
1991/92	45671.3	3835.16	81	6241	664	67
1992/93	51550	3974.43	92.1	5778.5	706	76.8
1993/94	4740.1	4714.24	97.5	5091.3	1610	67.42
1994/95	65890	6450.0	106	7922.17	918.3	91.8
1995/96	92660	7670.0	100	8662.1	1008.8	100
1996/97	86293.32	6688.55	99.01	8347.33	914.39	103.8

Sources of Original data: Central Statistical Authority, and National Bank of Ethiopia