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Effects of Crop Commercial Orientation on Productivity of Smallholder Farmers in Drought-prone Areas of the Central Rift Valley of Ethiopia

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Abstract

This paper examines the tradeoff between commercial orientation and crop productivity among smallholder farm households living in drought risk-prone areas of the central rift valley of Ethiopia. The study was built on the hypothesis that there is a one-way causation between commercial orientation and productivity. The relationship between commercial orientation and crop productivity is assessed in a censored simultaneous equation model framework. Results indicate that there is a unidirectional relationship with total factor productivity being influenced by the endogenous commercial orientation factor. The influence of commercial orientation is expounded with the addition of farm and non-farm characteristics. Thus, in priority order, number of non-oxen livestock, commercial orientation, agricultural credit and sex have been important factors positively influencing productivity whereas labor availability for farming, distance and off-farm wage labor employment have been working against increased productivity of the smallholder farm households. However, it was observed that with a shift from commercial orientation criteria to unrestricted level of market participation in crop sales, the type, magnitude and direction of determinant factors have increased emphasizing the seriousness of performance influencing factors along with market participation to the majority of the smallholder farmers. The findings suggest that programs targeted at improving market access have the potential to increase agricultural productivity.

Introduction

Market participation and agricultural production are inseparable when improvement in living standards of smallholder farmers is considered (Timmer 1997). However, it is generally recognized that various rural population groups adapt differently to the process of commercialization where depending on resources, social and economic conditions and government policies available to them, a certain group of households benefits in the form of higher incomes and the rest suffers a decline in income (Bouis and Haddad, 1990). Considering the positive view, one could expect that commercialization of agriculture benefits the poor by offering direct income benefits. The direct income effects are further complemented by indirect income effects through forward and backward linkages that are generated by the increased demand for inputs for commercialized agriculture and use of some of the farmers' increased income for creating other income generating activities and to buy consumer goods locally. When there is an enhanced output growth commercialization enables the generation of sustained and added income. Increased sale of produce, purchase of inputs and off-farm employment and increased sharing of gains altogether contribute to food security by means of increased household farm output and income. Therefore, productivity is an important aspect of commercialization.

Agricultural productivity leads to access to crops that are high in nutrients and empowers particularly poor farmers by increasing their access to decision-making processes, increasing their capacity for collective action, and reducing their vulnerability to shocks, through asset accumulation (Hazell and Haddad, 2001). Agricultural productivity has the key role of assisting farmers to link themselves to the global trading system. Productivity increases can be gained via intensified use of inputs such as fertilizer, pesticides and seeds or by efficient reallocation of resources. The gain in productivity causes an increase in income which is important both to get out of subsistence and to continue and advance business. The interaction of productivity growth and farm incomes leads to pro-poor outcomes (Lipton, 2004). Thus, growth results from a combination of increased productivity and increased cash sales.

Various empirical studies pointed out that, in Ethiopia, smallholder farmers face problems of low agricultural productivity and low market participation (Daniel, *et. al.*, 1995, Workneh and Michael, 2002, MoFED, 2002, FAO, 2004). In fighting against subsistence production and poverty and addressing the national demand, the Ethiopian government has laid out support policies and strategies in order to promote agricultural productivity and market orientation (Daniel, *et. al.*, 1995; MoFED, 2002). It is imperative that farmers' living condition should be improved by improving either of the two since market participation acts as a stimulant for increased productivity and higher productivity is essential for surplus production for the market. However, to the best of the authors' knowledge, in spite of studies made elsewhere (such as von Braun, 1994, Barrett, 2007, de Janvry and Sadoulet, 2002 for one-way causation; and, Key, *et. al.*, 2000, Bellemare and Barrett, 2006 for two-way causation) in country research on the direction of causality and trade-off between market participation and productivity is non-existent. This phenomenon is more demanding around farmers living in relatively risk prone areas as their livelihood is much more threatened by additional forces of drought-risk than economic reasons only. The working hypothesis of this study is that there is a unidirectional relationship between commercial orientation and productivity. Thus, this study tries to define market participation and productivity in terms of commercial orientation and factor productivity and establish the relationship that may exist between commercial orientation and productivity among smallholder farm households in drought-prone areas of the central rift valley of Ethiopia. The study area is located within 7^0 - 9^0 latitude and 38^0 - 40^0 longitudes (Zonal Atlas 1999). The study area suffers from serious moisture stress and the fact that moisture stress areas make more than 60 per cent of the land mass of the country gives strong basis for the importance of the particular study. The surface area covers an estimated 7840.5 km^2 of land. The total population is estimated at 1.2 million persons with density range of 68.2 to 372.6 persons per km^2. Recent data shows that household size ranges between 4 and 9 members (CSA, 2006). The area is characterized by mixed farming where crop production is dominant. Farmers grow different types of crops where *tef (Eragrostis tef)*, haricot beans and maize are dominant in terms of the level of production.

Materials and Methods

The Data and sampling frame

This study assesses the influence of commercial orientation on productivity using a random sample of 314 smallholder farm households living in drought risk-prone areas of the central rift valley of Ethiopia. Farm households are represented by household heads considering the unitary decision-making framework dominantly existing in the study area. Sample farmers were identified through stratified multistage random sampling procedure. Strata were formed based on differences in farming systems and proneness to drought. Cross-section data on household and non-household characteristics that are pertinent to describe the level of crop production and market participation of smallholders was obtained through surveys conducted in Zway-Dugda, Boset and Siraro-shalla ditricts of Oromyia Regional State during March to July 2007. The explanatory variables defined for this study are given in Table 1.

Table 1. Distribution of farm households by total factor productivity and commercial orientation indices

Total factor productivity		Commercial orientation	
Index range	% households	Index range	% households
0.03-0.09	6.1	0	8.9
0.10-0.45	73.9	0.01-0.24	24.8
0.46-0.95	17.2	0.25-0.49	41.7
0.96-0.25	2.9	0.5-0.74	20.1
-	-	0.75-1.0	4.5

Sample size=314
Source: Field survey data

Method of analysis

Analysis of the relationship between commercial orientation and productivity was done in three steps. The first step involved determining the measure of productivity; the second step dealt with determining the measure of commercial orientation and the third step was aimed at establishing the mathematical relationship in the appropriate form of the model for estimation. In this analysis aggregates of the different variables were used for the benefit of assessing the overall performance of farmers in the study area. The major procedures applied are given as follows

Determining a measure of productivity in crop production

As a measure of productivity, index of total factor productivity (TFP) involving elements of outputs and inputs was defined over gross value of crop output, labor and traction power (human and animal), rental value of cultivated land and value of purchased inputs (fertilizer, chemicals and seeds). A one year (i.e. the study period), district level monthly average market prices of crops and inputs were used in the analyses. The total factor productivity elements were then estimated with total factor productivity index program (TFPIP) version 1.0 software that was developed by Coelli and Battese to produce a widely used Tornqvist TFP index (Coelli and Battese, 1998). Total factor productivity index was preferred to partial measures of productivity to avoid a misleading picture of performance that may be obtained from the partial productivity measures and hence to accommodate the relationship of total output to total inputs.

The general form of Tornqvist TFP index defined in its logarithmic form is:

$$\ln \text{TFP} = \ln \frac{O}{I} = \ln O - \ln I \ldots\ldots (1)$$

Where, TFP=total factor productivity, O= output index, I= input index

Thus, TFP was determined following Coelli and Battese's (1998) Tornqvist index formula that was adapted and applied to this study as:

$$ln\text{TFP}_{i0} = \underbrace{[\frac{1}{2}\sum_{i=1}^{6}(\omega_i + \omega_{i0})(ln\, y_{i0} - ln\, y_i)]}_{\text{Output side}} \quad \underbrace{- [\frac{1}{2}\textstyle\sum_{j=1}^{6}(v_j + v_{j0})(ln\, x_{j0} - ln\, x_j)}_{\text{Input side}} \qquad (2)$$

Where ω = value share of outputs; $\boldsymbol{v}$ = value share of input; $\boldsymbol{y}$ = output (s) in physical quantities; x = input (s) in physical quantities; i = i^{th} output (maize, *tef*, haricot beans, wheat, barley, sorghum and millets); j = j^{th} input (human labor, animal traction, land, seed, fertilizer, chemicals); o = observations (sample farm households).

Determining a measure of commercial orientation

Commercial orientation of smallholder farmers is defined in terms of a scale neutral measure adapted from von Braun *et. al.* (1994) and Strasberg *et. al.* (1999). Accordingly, farm households involved in greater sales of crop output with an index value of 0.5 and above are regarded as commercial oriented and those in lesser or no sales are subsistence oriented. Therefore, sales indices of those households who participated in crop sales beneath 50 percent of what they have produced during the crop year are treated as censored, lower limits in the Tobit model. The general formula used to derive the index is given as follows.

$$Index_{Hi} = \frac{\sum Sales_{ij}}{\sum Production_{ik}} = \begin{cases} < 0.5, subsistence\ oriented \\ \geq 0.5, commercial\ oriented \end{cases} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3)$$

Where, $Index_{Hi}$= crop commercial orientation index of a household, $\sum Sales_{ij}$ = the summation of gross monetary value of crop *j*, (*j*=1,2,..,*j*) sold out by a household *i*, (*i*=1,2,…,*i*) and $\sum Production_{ik}$= the summation of gross monetary value of total crop *k*, (*k*=1,2,..,*k*), production both valued at monthly average market prices for the year under study. *k*≥*j*; *k*=*j* if the type of crop sold out and those produced are the same.

In this study, *tef*, maize, haricot beans, barley, wheat, sorghum and millets crops are considered for analyses since these are the most important cereal crops grown by the farmers.

Analysis of the relationship between commercial orientation and productivity

To guide the empirical approach a conceptual framework adapted from Michael, *et. al.* (2001) was used.

Therefore, assuming that individuals are price takers, the commercial orientation (C) and total factor productivity (Y) can be defined by the following relationships.

$$C = C(p, X_C, \alpha_C)\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(4)$$
$$Y = Y(p, X_Y, \alpha_Y)\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(5)$$

where p is a set of all prices, X_C and X_Y are sets of all observable determinant factors of C and Y (provided in Annex Table 1), α_C and α_Y are sets of unobservable characteristics that are related to C and Y.

The reduced form of the above two equations can then be specified as:

$$C = C(Y, X, \alpha)\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(6)$$
$$Y = Y(C, X, \alpha)\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(7)$$

where X includes all variables in X_C and X_Y, α includes all factors in α_C and α_Y.

The effect of commercial orientation on total factor productivity (*d*Y/*d*C), which this paper tries to address, can be written as

$$dY/dC = Y_C + Y_\alpha d\alpha/dY\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots5$$

Estimation of the reduced form by standard techniques would result in a biased result due to the endogeneity factor leading to correlation of the dependent variables with the error (unobserved) terms. Moreover, the fact that commercial orientation involves censored data would make results of a given model as inconsistent inputs to another model if used without making adjustments. Therefore, a model accommodating endogeneity and censorship is required and the empirical approach is outlined as follows.

Considering the above argument a simultaneous model with censored endogenous variable adapted from Vella (1993) was employed to determine the relationship between the fully observed output and censored commercial orientation indices. The approach was preferred in order to wisely treat the inconvenience caused by censored endogenous variables in a simultaneous framework of Tobit and ordinary least squares (OLS) which requires adjustment of outputs from the Tobit model as an input for the OLS model to generate consistent estimates (Angrist and Krueger, 2001). Vella's procedure was designed to adjust the inconsistency particularly due to endogeneity of censored regressors by generating generalized residuals estimated from the reduced form and including them in the structural form for finalized estimation of the tradeoff.

Vella's approach considered the interplay of structural and reduced forms and was adapted for this study as follows.

The structural form of the model is given as;

$$y = \beta_0 + \beta_1 C + \beta_2 X + v \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(9)$$

Where, y is a measure of crop production (total factor productivity); β, coefficients to be estimated; C is the observed index of commercial orientation; X is a set of exogenous determinant variables listed in Annex Table 1; v is error term, $v \sim$ N $(0, \sigma^2)$

The reduced form of the endogenous dependent variable is given by:

$$\hat{C} = \pi Z + u \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(10)$$

Where, $\pi Z = \alpha_0 + \alpha_1 X$

$$C = \hat{C} \text{ if } \hat{C} > 0, \text{ otherwise } 0$$

Where, $\hat{C}$ is the latent index of commercial orientation, π and α are coefficients to be estimated, u is the error term, $u \sim$ N $(0, \sigma^2)$

In estimating the tradeoff, two major steps were followed. In a simultaneous regression framework the two stages method is the widely used and easiest way to correct for endogeneity.

The first step includes estimation of the censored commercial orientation index on all of the exogenous variables in the system by Tobit (Tobin, 1958) to obtain generalized residuals that are needed for transformation of the observed commercial orientation index with errors that are independent of the regressors. Thus, the generalized residuals are needed to obtain consistent estimates of the coefficients of the variables.

Subsequently, estimates of the generalized residuals were obtained using the following relationship (Vella, 1993).

$$\tilde{v}_i = -\tilde{\sigma}_v(1 - I_i)\tilde{\phi}_i(1 - \tilde{\Phi}i)^{-1} + I_i\tilde{u}_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (11)$$

Where, $\tilde{v}_i$ is the generalized residual for each observation or the expected value of residual derived by estimating the above equation conditional on C_i; $\tilde{u}_i = C_i - \tilde{\Omega} Z_i$; $\tilde{\Omega}$ and $\tilde{\sigma}$ are Tobit maximum likelihood regression estimates of Ω and σ_v; $\tilde{\phi}$ *and* $\tilde{\Phi}$ are probability and cumulative distribution functions; Z_i is a vector of exogenous variables. I takes the value one if C_i is uncensored and zero otherwise.

The second step involved estimation of equation 9 by OLS after including generalized residuals. A series of regressions consisting of estimating the reduced form (equation 10) and estimating and re-estimating the structural for (equation 10) by OLS by including generalized residuals defined by equation 11 and the expected value of the commercial orientation index defined by equation 12 as additional regressors were undertaken. The expected value is needed to investigate the influence of the observed values of commercial orientation on total factor productivity.

The latent variable for the expected value of commercial orientation was obtained by the following relationships (Vella, 1993).

$$E(C_i^*|C_i) = I_i\tilde{\Omega} Z_i + (1 - I_i)\lfloor \tilde{\Omega} Z_i - \tilde{\sigma}_v \tilde{\phi}_i(1 - \tilde{\Phi}i)^{-1} \rfloor, \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (12)$$

$i = 1, \ldots, 314$ observations

Where, $E(C_i^*|C_i)$=the expected latent variable conditional on the censored one; Z_i = variables influencing C_i; $\tilde{\Omega}$ and $\tilde{\sigma}$ are Tobit maximum likelihood regression estimates of Ω and σ_v; $\tilde{\phi}$ *and* $\tilde{\Phi}$ are probability and cumulative distribution functions. l takes the value one if C_i is uncensored and zero otherwise.

Results and Discussion

Descriptive statistics on factors considered in the econometric analysis shows that few farmers have indices of TFP and commercial orientation well above 0.5 and all except those variables expressed with dummy values record much lower values than the maximum. The fact that 95% of the cases are very far from their respective maximum value implies that the performance of smallholder farm households is at subsistence level. This is further verified by their achievement of TFP and commercial orientation index (Table 1) where over 70 percent of farm households registered an index of below 0.5 in both cases. Mean values also show low performance. Total factor productivity index stretches from less than 0.1 to 2.5 and over 65 percent of the total farm households in the sample registered below the average index of 0.32 indicating a poor performance in productivity of households. Similarly, the average performance of the farm households (i.e., average index value of 0.16) is much lower than the cutoff value of the commercial orientation index. Further exposition of the socioeconomic characteristics of sample farmers is given in Annex 2.

Table 2. Farmers' assessment of the trend of own farm productivity over the past 15 year (1983-2007)

District	Counts of sample farmers						
	Non-response	Significantly reduced	Decreased	No change	Improved or increased	Significantly improved or increased	Total
Siraro_ Shalla	4 (1.3)	1 (0.03)	44 (14.0)	5 (1.6)	27 (8.6)	0	81 (25.8)
Zway_ Dugda	0	1 (0.03)	69 (22.0)	28 (8.9)	19 (6.0)	2 (0.06)	119 (37.9)
Boset	0	1 (0.30)	60 (19.1)	16 (5.1)	36 (11.5)	1 (0.03)	114 (36.3)
Total	4 (1.3)	3 (1.0)	173 (55.1)	49 (15.6)	82 (26.1)	3 (1.0)	314

Figures in parentheses are percent of farmers from the total (N=314)
Source: Field survey data

Further assessment of the decline in productivity as pointed out by the sample farmers is summarized in Annex 2. Farmers' reaction to the trend and status of crop productivity was reflected by comparing the situations during the survey period and those over fifteen years period prior to the study. Responses were consistent across the study districts and the statistical test was significant (χ^2=30.9, at <1 % level). Only 17 percent of the sample farmers responded that their agricultural productivity has improved over the fifteen years period prior to the study. Despite some perceiving no change, the remaining proportion of farmers replied that output, land and labor productivity had declined along with their financial position.

In estimating the regression function, various tests were tested. Twenty six influential outliers with large residuals whose absolute values were in excess of 2.5 were excluded from analysis. Results of regression analyses were obtained following a two-step process. The reduced form of the commercial orientation index involving all exogenous variables obtained from the primary equation was first estimated (Table 3, column 2) to obtain estimates of coefficients (β and σ) to compute the generalized residuals and expectation of commercial orientation using equation 10. The generalized residuals and expectation of commercial orientation were estimated by establishing the mathematical relationships using the different computational facilities provided by STATA version 10 software package. The generalized residuals acting as inverse Mill's ratio or as conditional expectation of the error term with zero mean error provides for improved agreement with OLS variables and the error terms in the system.

Subsequently, results of OLS regression were obtained by introducing the generalized residuals and expectation of commercial orientation index in the primary equation (Table 3, columns 4 and 5). With the introduction of the generalized residuals the coefficient on commercial orientation continues to be significant and positive with improved magnitude which is an indication of the importance of the variable. The generalized residual was statistically significant when the observed response variable was used to estimate the tradeoff that is expected to exist between productivity and commercial orientation parameters verifying the endogeneity of the commercial orientation index in a non-recursive relationship and hence a problem of getting consistent estimates if direct estimation of the original model using OLS is to be made. Furthermore, the negative sign on the generalized residuals underscores unobserved factors that tend to reduce the contribution of commercial orientation to higher productivity. On the other hand, absence of change in the original sign of the observed variable when generalized residual is introduced in the model indicates absence of serious multi-collinearity. It is also noticeable that increased statistical significance is achieved on the response factor after accounting for endogeneity. The evidence about the endogeneity of the commercial orientation index and lack of statistical significance of the generalized residuals in the expected response model (Table 3, column 5) clearly suggest the use of the expected response instead of the observed one to estimate the role of commercial orientation on productivity along with a predetermined set of explanatory variables. This may credit the value of the generalized residuals for adjusting the inconsistency caused by the endogeneity (Vella, 1993) and in a study of the non-recursive relationship between the censored commercial orientation index and the continuous index of TFP. The final model for the tradeoff between productivity and commercial orientation (Table 3, last column) was statistically significant ($p<0.01$, $R^2=0.51$) showing an evidence on the relevance of the model.

Table 3. Results of simultaneous equation for censored endogenous explanatory variable (N=288)

Factors influencing productivity	Reduced form (Tobit model)	Structural form (OLS model)			
		Observed response		Expected response	
		Without generalized residuals	With generalized residuals	With generalized residuals	Without generalized residuals
indxallcropsf	-	0.16 (0.097)*	1.07 (0.477)**	1.83 (0.907)**	0.56 (0.304)*
gen_resid	-	-	-1.28(0.66)**	-0.59 (0.401)	-
sex	0.05 (0.079)	0.2 (0.108)*	0.19 (0.108)*	0.12 (0.115)	0.18 (0.109)*
lnfarexp	-0.08 (0.035)*	-0.02 (0.056)	0.015 (0.058)	0.12 (0.093)	0.02(0.062)
educated	0.03 (0.036)	0.06 (0.054)	0.052 (0.054)	0.01 (0.061)	0.05 (0.054)
depratio	-0.1 (0.087)	-0.1 (0.134)	-0.04 (0.135)	0.08 (0.161)	-0.04 (0.137)
activetoland	-0.02 (0.013)	-0.01 (0.019)	-0.01 (0.019)	0.01 (0.024)	-0.006 (.020)
landculha	-0.04 (0.033)	-0.02 (0.051)	0.02 (0.052)	0.07 (0.066)	0.02 (0.054)
cultparcel	-0.02 (0.015)	0.02 (0.022)	0.03 (0.022)	0.05 (0.027)*	0.03 (0.023)
fertuser	0.08 (0.040)**	0.08 (0.063)	0.06 (0.064)	-0.05 (0.095)	0.04 (0.068)
lnlaborMD	0.006 (0.047)	-0.55 (0.07)***	-0.55(0.07)***	-0.56 (0.07)***	-0.56 (.07)***
lnoxenhrs	0.03 (0.053)	0.04 (0.079)	0.14 (0.082)*	-0.02 (0.084)	0.02 (0.079)
NoOxenTLU	0.01 (0.004)**	0.03(0.006)***	0.02(0.006)***	0.01 (0.010)	0.02 (.007)***
offincome	-0.093 (.035)***	-0.21 (0.05)***	-0.18 (0.05)***	-0.04 (0.1)	-0.16 (.06)***
aidrecipient	0.05 (0.057)	0.06 (0.09)	0.05 (0.09)	-0.024 (0.1)	0.03 (0.09)
aid_received	-0.0002 (0.0002)	-0.0004 (0.0002)*	-0.0004 (0.0002)*	-0.0001 (0.000)	-0.0003 (.000)
creditrecipient	-0.006 (0.050)	0.14 (0.083)*	0.03 (0.078)	0.14(0.082)*	0.14 (0.082)*
creditBIRR	0.00002(0.0000)	0.0001(0.0001)	-0.0001(0.00)	-0.0001(0.00)	-0.000(0.000)
ExtVisits07	0.01 (0.033)	0.04 (0.052)	0.03 (0.052)	0.02 (0.053)	0.03 (0.052)
Siraro-Shalla	0.05 (0.068)	-0.18 (0.104)*	-0.22(0.106)**	-0.28 (.117)**	-0.21 (.106)**
_cons	0.44 (0.235)*	1.53 (0.353)***	1.19(0.392)***	0.95 (0.471)**	1.39 (.365)***

*, ** and *** indicate statistical significance at 10, 5 and 1 percent level, respectively.
Values in parentheses are standard errors. Response term is total factor productivity and the endogenous censored variable is commercial orientation, both expressed by index; gen_resid=generalized residuals; ln=natural logarithm. Variable definition is given in Table 1.
Source: Field survey data

Therefore, results of regression estimates using the expected response model indicate that commercial orientation is positively and significantly influencing productivity. Numerical result shows that a one unit increase in the commercial orientation index is associated with 0.15 unit increase in mean value of the productivity index (Table 4). The result, though in a unidirectional causation, confirms the statement that productivity and commercialization of surplus output are closely related (as mentioned by Timmer, 1997). The estimated beta coefficients on statistically significant determinant factors (Table 4 last column) show that number of non-oxen livestock measured in tropical livestock unit, the index of commercial orientation, use of agricultural credit and sex of the household head have been important factors positively influencing productivity whereas increased availability of labor for farming, location dummy for Siraro-shalla (distant) district and off-farm wage labor employment have been working against increased productivity in the order of importance.

Table 4. Beta coefficients for statistically significant determinants of productivity

Factors influencing productivity	Structural form (OLS model) beta values against dependent variables		
	Observed response	Observed response with generalized residuals included	Expected response
Commercial orientation index for all crops sold out (indexallcropsf)	0.08*	0.51*	0.15*
Sex of household head (sex)	0.09*	0.08*	0.08*
Log of active labor in the household (lnlaborMD)	-0.81***	-0.81***	-0.81***
Log of oxen hours used (lnoxenhrs)	0.06	0.04*	0.03
Non-oxen tropical livestock unit (NoOxenTLU)	0.23***	0.20***	0.20***
Off-farm income (offincome)	-0.19***	-0.15***	-0.14***
Amount of aid received (aid_received)	-0.10*	-0.09*	-0.08
Credit recipient (creditrecipient)	0.12*	0.12	0.12*
Siraro-shalla district	-0.14*	-0.16**	-0.16**

*, ** and *** indicate statistical significance at 10, 5 and 1 percent level, respectively.
Response term is total factor productivity; ln=natural logarithm
Source: Field survey data

Increased level of participation of households in crop sales is likely to increase the financial capacity of farmers that allows them to overcome key agricultural production constraints such as on acquiring fertilizers (Strasberg *et. al.,* 1999). It is also reported in Workneh and Michael (2002) that commercialization of farm production is an important strategy of transforming low productivity subsistence production of small farm holders into surplus and market orientation system. Farmers' participation in increased crop sales would allow them to acquire resources for reinvestment to improve agricultural productivity and obtain income (Govereh and Jayne, 2003). Determinants on the positive side could be regarded as those more related to the incentive generated from self-esteem to commercialize, working capital and natural endowment. The psychological preparedness of farmers to engage in and accept agriculture as one of the profit making businesses creates an incentive to promote cash crop output and make better use of productivity enhancing inputs. The working capital includes livestock ownership and credit access and is the basis to raise smallholder farmers' capacity to engage in risky agriculture. The natural phenomenon includes the longstanding influence of cultural relationships between male and females in agricultural production where males have better experience of making production and marketing decisions independently. Male and female have separate spheres of decision-making with females engaged more in well-being provisioning. Smith and Chavas (1999) also reported the existence of this phenomenon among farmers in rural West Africa. We may safely conclude from this that only those male farmers who are committed to produce more and make big sales with better access to credit and livestock ownership contribute to the increase in total factor productivity.

Labor man-days available for agricultural production is negatively associated with productivity probably due to the underemployment problem caused by capacity limitation in terms of access to physical and financial capital. Households enjoying off-farm employment tend to have lower productivity perhaps due to time constraints on other farm activities as studies other parts of the world indicated (Shively and Fisher, 2004) and due to the main reason that these farmers undergo wage labor employment because of capacity limitations to undertake own farm activities. The negative determinants have to do much with the level of poverty of smallholder farmers who often lack resources to make better use of productivity enhancing agricultural inputs such as seeds and fertilizers. This argument may also be partially supported by the usual sources of inferior quality seeds, including purchase from market and own stock, that the smallholder farmers access to, the types of crops produced such as haricot beans and *tef* contributing to low inherent productivity and the very low amount of fertilizer that was used. Distance as a transaction cost was also a factor working against productivity in that those farmers that are located relatively far away from the capital city and from market centers as compared to the other locations suffer from low productivity due probably to the relative inaccessibility of input and output markets and to the lack of required capacity to make use of information about demand and supply conditions. Lack of capacity may be further defined in terms of lack of confidence on the market information, poor financial position and low output available for sale in distant markets causing high and unaffordable marketing costs.

Market participation index was also constructed to compare whether productivity is influenced by the same set of factors as commercial orientation when the level of market participation was relaxed for all farmers who sold out their produce regardless of volume limits. It must be noted that similar steps were followed for analyzing market participation.

Market participation index was found to be again endogenous with increased strength of influence. However, five additional determinants were found to influence the tradeoffs between the market participation index and productivity factor. Access to credit and sex of the household head were not statistically significant in this case (Table 5 and Table 6). In order of importance, productivity of market participants in crop sales of any volume is positively influenced by increased level of the market participation index, the size of cultivated land, herd size excluding oxen, the amount of fertilizer applied, size of active family members in relation to cultivated land and literacy of household head (Table 5). Availability of family labor in man-days, distance from market center, wage labor employment and amount of aid received were found to be negative determinants of crop productivity. It is to be noted that the matching factors for commercial orientation and market participation act in the same direction though they differ in the magnitude of their coefficients. The model results indicate that with a shift from market orientation to market participation, the number, types and magnitude of influence of determinants of TFP in crop production have increased, indicating the seriousness of performance reducing conditions among the majority of smallholder farmers.

Table 5. Results of simultaneous equation for censored endogenous explanatory variable on market participation of smallholder farmers

(N=288)

Factors influencing productivity	Reduced form (Tobit model)	Structural form (OLS model)			
		Observed response		Expected response	
		Without generalized residuals	With generalized residuals	With generalized residuals	Without generalized residuals
indxallcropsp		0.228 (0.132)*	2.139 (0.935)**	1.762 (0.55)***	1.744 (0.512)***
gen_resid			-2.018 (0.979)**	-0.012 (0.141)	
sex	0.076 (0.055)	0.158 (0.135)	-0.013 (0.146)	-0.003 (0.131)	-0.001 (0.128)
lnfarexp	0.059 (0.024)**	-0.009 (0.054)	0.104 (0.079)	0.100 (0.066)	0.098 (0.064)
educated	-0.012 (0.026)	0.109 (0.051)**	0.130 (0.053)**	0.140(0.052)***	0.140(0.051)***
depratio	-0.058 (0.064)	-0.087 (0.124)	0.027 (0.132)	0.010 (0.121)	0.009 (0.120)
activetoland	-0.026 (0.009)***	-0.001 (0.020)	0.049 (0.032)	0.048 (0.026)*	0.048 (0.025)*
landculha	-0.069 (0.025)***	0.003 (0.051)	0.139 (0.087)	0.136 (0.072)*	0.134 (0.069)*
cultparcel	-0.002 (0.010)	0.005 (0.020)	0.003 (0.020)	-0.001 (0.020)	-0.001 (0.020)
fertuse	-0.003 (0.035)	-0.073 (0.066)	-0.065 (0.066)	-0.073 (0.065)	-0.073 (0.065)
fertkg	0.001(0.0002)***	0.002(0.0003)***	0.001 (0.001)*	0.001(0.001)***	0.001 0.001)***
lnlaborMD	0.044 (0.035)	-0.595 (0.077)***	-0.663 (0.086)***	-0.661(0.08)***	-0.661 (0.075)***
lnoxenhrs	0.030 (0.037)	0.096 (0.088)	0.034 (0.092)	0.014 (0.095)	0.015 (0.094)
NoOxenTLU	0.0002 (0.003)	0.021 (0.007)***	0.021(0.007)***	0.021(0.007)***	0.021(0.007)***
offincome	-0.098(0.025)***	-0.202(0.054)***	-0.010(0.107)	-0.020(0.078)	-0.022 (0.076)
aidrecipient	0.027 (0.044)	0.086 (0.093)	0.052 (0.091)	0.032(0.091)	0.033 (0.090)
aid_received	0.0002(0.0001)**	0.0004(0.0002)*	0.00005(0.0002)	0.0000(0.000)	0.00003(0.0002)
creditrecipient	-0.001 (0.041)	0.084 (0.074)	0.066 (0.072)	0.075(0.074)	0.075 (0.073)
creditBIRR	0.0002 (0.0003)	0.00005(0.0001)	0.0001 (0.0001)	0.0001(0.000)	0.0001 (0.0001)
ExtVisits07	0.001 (0.023)	0.054 (0.050)	0.048 (0.051)	0.045 (0.050)	0.045 (0.050)
Siraro-shalla	0.067 (0.054)	-0.267 (0.116)**	-0.393 (0.128)***	-0.382(0.12)***	-0.380 (0.121)***
_constant	0.241 (0.166)	1.295 (0.342)***	0.814 (0.416)**	1.118(0.339)***	1.120(0.338)***

*, ** and *** indicate statistical significance at 10, 5 and 1 percent level, respectively.

Values in parentheses are robust standard errors. Response term is total factor productivity and the endogenous censored variable is commercial orientation, both expressed by index.

Source: Field survey data

Table 6. Beta coefficients for statistically significant variables in crop market participation of smallholder farmers

Factors influencing productivity	Structural form (OLS model) beta values against dependent variables		
	Observed response	Observed response with generalized residuals included	Expected response
Market participation index for all crops sold out (indexallcropsp)	0.085*	0.793**	0.413***
Education status (educated)	0.095**	0.113**	0.122***
Active member to land ratio (activetoland)	-0.002	0.134	0.131*
Cultivated land in hectares (landculha)	0.005	0.208	0.200*
Amount of fertilizer used in kilograms (fertkg)	0.299***	0.156*	0.181***
Log of labor used in mandays (lnlaborMD)	-0.870***	-0.968***	-0.965***
Non-oxen tropical livestock unit (NoOxenTLU)	0.187***	0.187***	0.190***
Off-farm income (offincome)	-0.176***	-0.009	-0.020
Amount of aid received (aid_received)	-0.105*	-0.013	-0.008
Siraro-shalla district	-0.199**	-0.293***	-0.283***

*, ** and *** indicate statistical significance at 10, 5 and 1 percent level, respectively.
Response term is total factor productivity; indexallcropsp=index of market participation of farmers in all crops sold out; ln=natural logarithm
Source: Field survey data

Conclusion

The study concluded in 2007 focuses on the cases of grain crops producing smallholder farmers located in the central rift valley of Ethiopia that extends from Siraro-shalla district in the west to Boset district in the east.

Analysis of the trade-off between smallholder farmers' commercial orientation index and total factor productivity index supported non-recursive relationship where the trade-off between agricultural commercial orientation and productivity of households is defined by the contribution of the former to the latter. The reverse causality of productivity on commercial orientation behavior of the sample farmers could not be verified. Therefore, despite the much lower level of productivity, commercial orientation of farmers described by their respective indices of increased volume of crop sales is a requirement for increased productivity.

On the other hand, it should be clear that the contribution of commercial orientation to productivity may not be meaningful without the complementary effect of resource endowment of farmers. In this study agricultural productivity requires the individual contribution of the other factors too in order for the commercialization process to be meaningful. The complementary determinant factors include sex, herd size, access to credit, availability of active labor, off-farm employment for wages and location. Male farmers with large herd size and those who had access to fertilizer credit were found to be more productive than their counterparts. Increases in labor availability, off-farm employment and location were found to be setbacks to total factor productivity. Generalizing from beta coefficients of statistically significant determinants, excess labor is the most important factor limiting productivity of the smallholder farmers in crop production.

The positive factors of capacity and the negative determinant factors of inefficiency are also complementary. They emphasize the general state that the sample farmers lack capacity or access to make better use of agricultural productivity enhancing inputs such as seeds and fertilizers.

Based on the findings of this study, one can safely say that strategies aimed at improving farmers' livelihood in the study area must be directed to wealth creation, as markets can only stimulate wealth creation if households are able to participate effectively. Problem and niche-specific interventions may be necessary to build up farmers' capacity through access to and provision of productivity-enhancing inputs such as credits, improved seeds and fertilizer and through remunerative income sources. Long distance from developed market places was found to be a constraint to increased productivity, adding transaction cost of obtaining the advantages thereof and implying in the need for improving access to developed markets through efficient, accessible and trustworthy input-delivery mechanisms. Excess economically active labor requires comprehensive and profound effort including creation of job opportunities through diversified and interlinked value adding activities, promoting extra capacity to produce in slack seasons and employment outside agriculture

The influence of commercial orientation on productivity remains strong under a range of additional factors. Accordingly, any policy design should consider the performance of commercialization activities in enhancing productivity within the framework of self-esteem, economic and environmental factors that are likely to shape the significance and contribution of getting involved in crop and other fields of commerce and not in isolation. Agricultural development efforts should be transformed to accommodate the realities of the majority of smallholder farmers instead of only the few 'progressive' ones.

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Annex 1. Definition and expected sign of variables used for analysis

Variable Code	Definition	Expected Sign	Measurement
Household Characteristics			
sex	Sex of household head	±	Dummy; 0 female, 1 male
educated	Education status	+	Dummy; 0 illiterate, 1 literate
lnfarexp	Log of farming experience of household head	±	Number of years
depratio	Dependency ratio	-	Proportion
Efficiency Parameters			
indxallcropsf	Commercial orientation index for all crops sold out	+	Index between 0 and 1
indexallcropsp	Market participation index for all crops sold out	+	Index between 0 and 1
activetoland	Active members to land ratio	+	Proportion
cultparcel	Number of parcels of land cultivated	-	Continuous
fertuser	Fertilizer user?	+	Dummy; 0 no, 1 yes
fertkg	Amount of fertilizer used	+	Kilogram, continuous
offincome	Income from off and non-farm activities	±	Dummy; 0 no, 1 yes
creditrecipient	Credit recipient?	+	Dummy; 0 no, 1 yes
aidrecipient	Aid recipient	±	Dummy; 0 no, 1 yes
Asset (Endowment)			
NoOxenTLU	Non-oxen tropical livestock unit	+	Continuous
landculha	Cultivated land in hectares	+	Continuous
lnlaborMD	Log of active labor in the household	+	Mandays, continuous
lnoxenhrs	Log of oxen hours used	+	Continuous
Physical and Institutional Characteristics			
creditBIRR	Amount of credit received (Ethiopian Birr)	+	Continuous
aid_received	Amount of aid-received (Birr)	±	Continuous
ExtVisits07	Visits by extension agents in 2006/7	+	Continuous
Climate/location			
Siraro-shalla	Siraro-shalla district	-	Dummy: 1 Siraro-shalla, 0 Others

Note: 1 TLU = 250 kg live weight of an animal

Annex 2. Descriptive analysis of variables used in the analysis

N=314

Variable	Mean	Std. Dev.	Min	Max
Index of total factor productivity	0.32	0.23	0.03	1.57
Index of commercial orientation for all crops sold	0.16	0.28	0.00	0.87
Index of market participation of all crops sold	0.35	0.22	0.00	0.87
Sex of household head	0.93	0.25	0.00	1.00
Level of education of household head	1.98	0.93	1.00	4.00
Farming experience	26.24	12.81	3.00	70.00
Dependency ratio	0.52	0.19	0.00	1.00
Active member to land ratio	2.78	1.62	0.52	9.33
Land cultivated (hectares)	1.97	0.86	0.38	5.00
Number of parcels of land cultivated	2.71	1.38	1.00	9.00
Fertilizer users	0.51	0.50	0.00	1.00
Active labor in man-days	588.11	514.90	39.75	3567.00
Oxen hours employed	1298.33	1181.23	48.00	9816.00
Non-oxen tropical livestock unit	4.37	5.23	0.00	39.55
Employment off-farm	0.55	0.50	0.00	1.00
Aid recipients	0.23	0.42	0.00	1.00
Amount of aid-received (Birr)	45.01	152.10	0.00	950.00
Credit recipients	0.37	0.48	0.00	1.00
Amount of credit received (Birr)	266.19	518.44	0.00	2555.00
Extension visits	0.25	0.52	0.00	2.00

Source: Survey data