Intensification and Crop Commercialization in Northeastern Ethiopia[1]

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Abstract

Due to low farm production and productivity the majority of subsistence farmers in Ethiopia are not self-sufficient in food, and deliver meager amounts of farm output to consumers and agro-processing industries. Agricultural growth, an important pathway to food security, is realized through increases in per capita farm endowments (physical and financial assets and resources) and adoption of appropriate and proven technology and requires a transformation out of the semi-subsistence, low-input and low-productivity agriculture into a high productivity commercial agriculture.

This article investigates farm commercialization from two perspectives - output-oriented and input-oriented farm commercialization. Logistic model was applied to examine factors of commercial participation and use of chemical fertilizer, while Cob Douglass production function was employed for the analysis of production determinants. The data used for the analysis was collected from farm households sampled from communities in Northeastern Ethiopia.

The regression analysis of commercialization asserts that lack of market access (measured by distance) and engagement in livestock and off-farm employment significantly and negatively impact food crop commercialization. Total food crop production has been found to impress a strong and significant effect on commercialization. The production analysis indicated that farm size operated and technology (chemical fertilizer) are the most important production factors under the context of the study areas. Results of estimation of fertilizer use show the important and positive role of access to oxen and credit, and size of operated farm.

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The findings of the study generally imply the need for rationalization of policies and institutions in order to create incentives and rules that promote land transaction and markets for credit, product and input.

1. Introduction

Ethiopia's economy is primarily based on agriculture, accounting for 50 % of GDP employing 85 % of its labour and 90 % of total foreign exchange earnings. According to CSA (2002) 10,738,000 small farm households cultivated 9,133,510 ha. in 1999/2000 comprised of 93 % annuals, the rest permanent crops, at average area of 0.79 ha./household. About 95 % of cultivated land is under smallholder agriculture, the rest under state and commercial farms. Ethiopia's food security and agricultural development are thus highly dependent on the performance and development of smallholder farming systems. Cereals occupy more than 70 % of cultivated land and are the main staple foods in Ethiopia.

At the level of developing countries, about 440 million farmers still practice mainly subsistence agriculture, and subsistence crops cover more than 50 percent of cultivated land in the majority of low-income countries (von Braun and Kennedy, 1994). Ethiopian small farm holders who produce more than 90 % of agricultural production of the country are by and large subsistence producers. It is estimated that only 20 % of smallholder production goes to markets, mostly by a small percentage of farmers with access and means. Smallholders in the highlands of central and northern Ethiopia in particular produce mainly food crops, and for the most part are not involved in conventional cash crops (coffee, cotton, sugar cane, groundnuts, and vegetables)[4].

Due to low farm production and productivity, majority of subsistence farmers are not even self-sufficient in food, and deliver meager amounts of farm output to consumers and agro-processing industries (markets).

Intensification, an important mechanism for transforming subsistence smallholder farms into economically viable and commercially oriented farming units (Hinderink and Sterkenburg, 1987; von Braun and Kennedy, 1994; Pender, Place and Ehui, 1999), is at low level in Ethiopia. For example, on average, cereals yield 12 qt[5]. per hectare and pulses about 9 qt per hectare, both very low by world standards[6].

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[4] Farmers in southern, western and eastern low lands and mid-altitudes of the country are engaged considerably in the production of cash crops, particularly coffee, and in livestock and livestock products.

[5] 10 qt. = one metric ton

[6] For instance, the 2000 average per hectare yields of teff (*Teff eragrostis*), sorghum, maize, wheat and barley, the five major crops in the country in terms of area allocated to their production, are 7.96 qt, 11.54 qt., 18.25 qt., 13.79 qt. and 10.82 qt., respectively (CSA, 2002). The world average per hectare yields of

The basic research question of this paper are thus what constrains small farm households from pursuing an outward-looking market orientation, producing surplus over and above their consumption requirements, or from devoting land and labor to cash crop cultivation.

This paper attempts to show: (i) determinants of food crop commercialization, and (ii) farm input intensification; and (iii) combined with the former, the contribution of resource access and technology to agricultural output, hence marketed surplus.

2. Farm Commercialization Perspectives

Food security is a key policy objective in Ethiopia's social and economic development strategy (FDRE, 2001). Agricultural growth, an important pathway to food security[7], is realized through increases in per capita farm endowments (physical and financial assets and resources) and adoption of appropriate and proven technology (Hayami, 2001) and requires a transformation out of the semi-subsistence, low-input and low-productivity agriculture into a high productivity commercial agriculture. Given population growth and limits of area expansion, yield growth and market oriented patterns of crop production (commercialization) are prerequisites to agricultural economic growth (Strasberg et. al.1999). Commercialization, along with specialization, intensification and development of markets and trade, are fundamental building blocks for achieving economic growth. (von Braun and Kennedy, 1994).

However, the sale of incidental surpluses does not transform farming units automatically into commercial farms (Hinderink and Sterkenburg, 1987). Commercial farming involves also profit and loss accounting in financial terms, and a wage earning labor system (Carpenter 1971 as cited in Hinderink and Sterkenburg, 1987). Practical achievement of marketed surplus and commercialization thus include indicators of effective market participation: gross value of sales; importance of purchased inputs; share of hired labor as a percentage of total labor; time spent on growing cash crops versus crops for self consumption; and, acreage planted with

wheat, maize, barley and sorghum in 2000 are 27.189qt, 42.880 qt., 24.419qt and 13.679qt.respectively, while the average yields of the same crops for Africa are 17.805 qt, 17.246qt., 5.096qt and 8.791qt. in that order (http://faostat.fao.org).

[7] Food importation at the national level through expanded growth in international trade, or food purchase at the household level through expanded income, are other important pathways.

crops for sale as a percentage of total cultivated area (Hinderink and Sterkenburg, 1987).
Hinderink and Sterkenburg (1987) distinguished between three perspectives of farm commercialization:

(i) Economic-technocratic perspective: emphasizes economic and technical measures of increasing productivity and production for the market, where commercialization is tightly associated with modernization, and technology and market development are key determinants of agricultural transformation. Development is seen as a uni-linear process in which agricultural development in developing countries must follow the path of developed economies. The role of green revolution technologies is emphasized and combined with integrated rural development to remove institutional and infrastructural bottlenecks for market penetration.

(ii) Psychological-cultural perspective: attitudes, motivation and other farmer behavior are emphasized. According to Rogers (1970, cited in Hinderink and Sterkenburg, 1987), subsistence farmers: are inclined toward mistrust which negatively affects cooperation and organization beyond the family circle; lack interest in innovations; are fatalistic, village centered, and not very individualistic; have low level of aspiration; limited attention for the future; and have little inclination to save and invest. Less commercialized communities are isolated vis a vis the outside world which negatively affects specialization of production, trade, technological innovation and social change. The hierarchical authority structure and the subordination of individuals to community interests prevail over personal contractual relationships and economic decisions. Social controls limit the already limited choice of subsistence farmers in land use, cropping patterns and production technology (Abercrombie 1961 cited in Hinderink and Sterkenburg, 1987).

(iii) *Political-economic perspective*: political context and the nature of power relations at various geographical scales motivates the choice of economic system and the degree of integration into the global economic system. Agricultural commercialization contributes to development, but only when accompanied or preceded by structural change at various geographical scales. The political-economic and institutional context is proposed as a major sphere explaining longitudinal and spatial differences in socioeconomic development. Spatial differentiation is related to the intensity of market integration, interpreted as a process of structural change from subsistence to market economy. Four aspects of market integration are identified: increasing importance of wage labor, growing crops for sale, markets developed for consumer

goods and production inputs, and purchase of consumer goods and services (Dietz and Van Haastrecht, 1982 in Hinderink and Sterkenburg, 1987)

Each perspective plays a partial role in explaining agricultural commercialization in Ethiopia. Agricultural commercialization cannot be understood without taking into account the socio-cultural, political-institutional and economic-technical contexts that condition the nature of capital formation, the organization of production, technological changes and crops grown. For purposes of this study, the definition of Hinderink and Sterkenburg (1987:19) is used: agricultural commercialization involves "deliberate action on the part of agricultural producers - of their own free will or by means of coercion - to use the land, labor, implements and annual inputs (owned, purchased, hired, borrowed, obtained on credit or through customary arrangements - reciprocal or not) in such a way that a greater or smaller part of crops produced and /or animals raised is for exchange or sale".

Von Braun and Kennedy (1994) argue that one of the main reasons for the choice of subsistence production over commercial production in Sub-Saharan Africa is that own-production of food is a response to high transaction costs and risks related to production, markets, and employment. Subsistence production can largely be viewed as an insurance policy of farm households in response to risky income and market environment. Because subsistence farmers devote their time and land resources largely to own farm production, mechanisms that increase farm output impact food security in two ways: (i) directly increasing food availability and (ii) promoting production for market that increases cash income to enable food purchase. This second path is made possible by enhancing cash crop production and marketable food crops and livestock products. In addition, off-farm income, if accessible, augments household income and purchasing power. The commercialization pathway is dependent off course on local comparative advantages in agricultural potential, population density (demand) and market access (Pender et al., 1999).

However poor, risk-averse farmers with little land and resources are usually reluctant to gamble on new and highly risky crops, regardless of their potential profitability, unless their food security is first assured (von Braun et. al., 1991). Holden and Hailu (2002) in their empirical study in southern Ethiopia conclude that poverty and subsistence constraints undermine the ability to intensify production through the purchase of farm inputs or the planting of perennial cash trees. Adewumi and Omereshi (2002), based on their study of 291 sample farm households in Kwara state of Nigeria, conclude that meeting food requirement is the primary objective of farming households even prior to maximizing gross margin. Farming households

there view agricultural activities as a personal non-monetary need first and an income need only second (ibid). Notwithstanding the importance of self-sufficiency in the psychic of poor farmers, Dembele et al (2003) in assessing the commercialization of cereals in Mali after the 1980 market reform observed that cereal commercialization was enhanced by use of productivity increasing inputs and technologies, and that commercialization varied by farm size, crop type and type of farming.

Recent studies (Von Braun and Kennedy, 1994; Strasberg et. al., 1999) show that the conclusion sometimes made in the literature that commercialization has a negative effect on food crop production and nutrition is flawed. Von Braun and Kennedy (1994) observe that improved technology helps subsistence farmers to commercialize in low-risk ways; commercialization of agriculture entails a substantial expansion of demand for hired labor; and, commercialization contributes to food security via increased income and food availability. Although commercialization of agriculture is generally a matter of stimulated private-sector activity, they also argue that public action in Sub-Saharan Africa is crucial to facilitate the power of its driving forces - macro economic and trade policy, market reform, rural infrastructure improvement, and the development of legal and contractual rules under which farmers, traders and processors operate.

3. Data and Empirical Model

Data for this study were collected from 420 randomly selected farm households in Bati, Jamma, Dessie-Zuria, and Legambo woredas (districts) in Ethiopia by BASIS-CRSP project in 2000 and 2001.

Regarding the analytical models, let production (Y) be determined by the relation Y = f{A, L, K, T} where A is land, L is labor, K is capital, and T is technology. Consumption (C) is determined by household size in adult-equivalent consuming units (CU) and investment (I) made on non-consumption expenditures, i.e. C= f (CU, I). Fertilizer and improved seeds, depicted by technology, T, represent an input-oriented measure of farm commercialization. Marketed surplus (MS), defined as MS = Y-C, is an output-oriented measure of farm commercialization measured in this study via two constructs: percentage of farm households who participate in food crop marketing (Commercialization Participation, CP), and the ratio of total quantity of food (cereals, pulses and oil seeds crops) sold relative to total output produced (Commercialization index, CI).

As indicated in Table 1, except for Jamma farmers whose participation in marketing declined, the participation of farmers (CP) in other *woredas* increased in 2001/02 compared to 2000/01 (36.2 % to 51.1 %), due to better rainfall distribution. The commercialization index (CI), however, remained relatively static, and is generally low for all woredas. Jamma farmers who sold the highest proportion (CI-0.13) of food produced in 2000/01 sold a lower proportion (CI=0.07) in 2001/02 due to frost in the area, while CI in Dessie-Zuria and Legambo showed a slight increase. CP however showed considerable variability across woredas, hence was chosen as the output-oriented indicator of commercialization in the multivariate analysis that follows.

Table 1: Farmer Participation in Food Grain Marketing and Commercialization Index

Year	Item	Bati	Jamma	Dessie-zuria	Legambo	All *woredas*
2000/01	Commercial Participation (CP), %	34.9	60.4	24.7	20.5	36.2
	Commercialization Index (CI)	0.06 (0.14)	0.13 (0.16)	0.07 (0.17)	0.07 (0.17)	0.08 (0.16)
	N	106	106	97	83	392
20001/02	Commercial Participation (CP), %	35.8	48.5	58.8	62.1	51.1
	Commercialization index (CI)	0.05 (0.10)	0.05 (0.10)	0.10 (0.13)	0.10 (0.13)	0.08 (0.11)
	N	106	103	97	103	409

Source: BASIS-Ethiopia survey data. N= Number of respondents. Figures in parentheses are standard deviations.

Agricultural technology (T) - chemical fertilizer and improved seeds - plays an important role in commercialization, via their purchase from markets or government sales depots. Their adoption is generally influenced by size of farm holding, credit access, educational level of household members and agro-ecology. For the multivariate analysis of participation in input-oriented commercialization and adoption of agricultural technology, a logit model was employed based on the functional form in equation (1) (Maddala, 1992):

$$\log [\, p_{i\,/(1-p)}] \approx \beta_o + \sum_{j=1}^{k} \beta_j x_{ij} \qquad (1)$$

Where, log $[p_{i/(1-P)}]$ is log of odds ratio, β_o is constant term, β_j are coefficients, and x is independent variables. The dependent variable (log-odd ratio) is the natural logarithm of the ratio of the probability that the i-th farmer participates in food crop commercialization (or adopts technology) to the probability that the i-th farmer does not (1-p).

Neo-classic economic theory informs us that land, labor and capital are the basic factors of production. Recent theory (Ray, 1998) explains that in addition to these conventional factors, technology and human capital play crucial roles in transforming agricultural production by helping to accelerate partial and total factor productivity. The relationship of these factors to determination of agricultural output in the Ethiopian highlands is examined in this analysis by employing the Cobb-Douglas function in equation (2):

$$Q = aX_1^b X_2^c X_3^d --- X_n^m \qquad (2)$$

where, Q is food production, X_n refers to n-th factor of production, and b, c, d …… m are factor elasticities associated with the possible influencing variables. See Table 2 for variable names and definitions, and Appendix 1 for descriptive statistics. A priori expectation of the influence of explanatory variables on farm output follows.

*Market distance i*s used as a proxy for market access, as remote villages are exposed to poor road and telecommunication infrastructure and high transportation costs. Farmers nearer to market towns are expected to have higher participation in food crop marketing and technology adoption because transport and information costs increase with distance.

Agro-ecology affects commercialization of food crops and input procurements through locational factors, but also indirectly affects technology choice and application (chemical fertilizer and improved seeds) through biophysical interactions. Jamma woreda is agro-ecologically suited for crop farming because it is endowed with relatively better rainfall, soil, temperature, and topography (flat) that enable superior yield responsiveness of modern inputs compared with other study sites.

Food crop production, the total production of cereals, pulses and oilseeds, is taken as a measure of aggregate food output (Q). All else constant, an increase in food crop

production either decreases the food gap between own-production and consumption within the household, or increases food grain surplus for sale to outside markets.

Table 2: Names, Definitions and Measures of Explanatory Variables

Variable name	Definition	Measure
Head's gender [SEX3]	Gender of household head	1=male, 0= female
Consuming units [AE_CU_4]	Household size in adult-equivalent consuming units	Number of consuming units
Labor units [AE_LU_4]	Household labor in adult-equivalent labor units	Number of labor units
Agro-ecology [jamadumy]	Agro-ecological zone of the village in which the household resides and farms	1=Jamma woreda, 0= other woredas
Livestock-TLU [LIV_TLU4]	Livestock size (excluding oxen)	Tropical livestock units (TLU)
Land operated [LA_OP45]	Total farm size operated during 2001/02 cropping year (*belg+meher* seasons)	Hectares
Oxen [OXENOWE3]	Number of oxen owned	Count
Head's education [EDULEVE2]	Educational status of household head	0=non-literate, 1=read and write, 2= primary school, 3=post-secondary school
Head's literacy [LITRAT2]	Literacy status of household head	1=literate 0=non-literate
Market distance [DISMARK]	Distance to main market place	Minutes to walk
Credit [CREDIT_2]	Value of credit received	Birr
Food crop output [C_OUTPU2]	Total food crop output	Kg.
Non-farm income [NFI_YR2A]	Non-farm income (business and wage employment income)	Birr
Head's age [AGE_RND3]	Age of household head	Years

Note: Numbers in variable names indicate year or survey round.

Oxen: as the major source of traction power and an important capital asset, is expected to influence farm production positively by enabling farmers to accomplish seedbed preparation and seed covering on time and thoroughly, thus facilitating the

use of other complementary technological inputs such as fertilizer and improved seeds.

Non-oxen livestock holding, measured in Tropical Livestock Units (TLU)[8] is taken to measures livestock wealth, the principal asset in the Ethiopia's highlands. Livestock activities compete with crop production for labor and other resources in ways that negatively affect food crop commercialization. Animal manure is also a substitute for fertilizer if widely and substantially applied on farmers' fields. But, income generated by livestock activities could also be used for the purchase of inputs that benefit crop-oriented and input-oriented commercialization positively.

Operated farm size[9]*:* is hypothesized to affect food production and technology adoption positively. As landholding size in the Ethiopian smallholder sector is very small, even a slight increase in farm size operated can be expected to substantially increase household food production and hence marketed surplus.

Household consumption, approximated by household family size in terms of standard adult-equivalent consuming units[10], is expected to negatively affect crop commercialization through three mechanisms: a) household labor time for crop production is decreased because of demands for household maintenance and reproduction; b) increased food demand derived from more mouths to feed; and c) decreased labor productivity in the event that low consumption for poor households erodes human nutrition.

Household labor refers to the number of adult-equivalent labor units[11] within the household. For a high land*/*labor ratio, a positive effect on total food production would be expected, but the effect would tend to converge toward a small, minimum

[8] Tropical livestock unit is calculated as 1.00 for a cow, 0.60 for heifer or young bull, 0.10 for calf, 1.43 for a camel, 0.80 for a horse, 0.70 for a mule, 0.50 for a donkey, 0.10 for a goat or sheep, and 0.01 for a chicken.

[9] Operated farm is land cultivated that includes own farmland held and land obtained in cash renting (rented-in) or in share cropping (shared-in) from other farm landholders. Leased-out farmland includes farm parcels rented-out on cash or shared-out in sharecropping arrangement to other farmers.

[10] Male (female) less than 1 year of age are assigned a weight of 0.3 (0.3), ages 1-6 a weight of 0.5 (0.5), ages 7-13 a weight of 0.7 (0.7), ages 14-19 a weight of 0.9 (0.9), ages 20—59 a weight of 1 (0.9), and ages greater than 59 a weight of 0.9 (0.7), respectively (source?)

[11] Coefficient for converting household labor into adult-equivalent standard labor units were as follows: for a male (female) less than 8 years of age 0.00 (0.00), 0.50 (0.50) for ages 8-14, 1.00 (0.70) for ages 15-65, 0.50 (0.35) for ages 66-75), and 0.00 (0.00) for ages above 75.

subsistence wage (reflecting a flattening of marginal labor productivity) as the land/labor ratio grows tight under conditions of high land use pressure.

Age of household head is used as proxy for management experience. It is expected to influence production and technology adoption positively during the most productive working years, then decline as labor productivity falls toward retirement.

Literacy of household head measured by educational level is assumed to positively influence commercialization as literate or educated farmers tend to have better access to extension service and advice of local development agents, and make better use of internalizing that information.

Chemical fertilizer, the amount of chemical fertilizer (Di-Ammonium Phosphate (DAP) plus Urea) applied by a farm household for food crops is expected to increase food production, given certain preconditions (timely application, sufficient soil moisture, favorable climate).

Off-farm income, including business and wage employment, theoretically could affect commercialization and adoption of technology either positively by easing cash liquidity constraints that impede the purchase of modern inputs, or negatively by competing with crop production for a limited supply of labor within the household.[12]

Credit. Cash credit augments the household budget constraint enabling farmers to purchase (or expand their purchase of) farm inputs, in particular fertilizer and seeds that would enhance farm productivity.

4. Regression Results

4.1 Food Crop Commercialization

The regression results in Table 3 seek to identify the main determinants of food crop-oriented commercialization. Results show that distance to main market is negatively and significantly related with participation in food crop commercialization as expected. An increase in market distance by 1 minute is predicted to decrease market participation by about 0.06 % (1- 0.994). Non-farm income is also negatively

[12] The robustness of labor rental markets in rural areas is a critical conditioning factor, as hired labor if available could help augment a binding household labor constraint.

related to food crop commercialization. As non-farm income increases by 1 Birr, odds of market participation decline by 0.001 %, as non-farm income activities compete with crop farming for labor and other resources. It is also common observation that farmers who are not well endowed with farm resources and production capacity, resort to low-paying non-farm activities, in particular petty trading and selling of firewood.

Table 3: Logit Regression Estimates for Farmers' Participation in Food Crop Marketing in South Wollo, Ethiopia, 2001/02 Cropping Year

Variable	B	S.E.	Wald	Exp(B)
Market distance	-0.006	0.002	7.966***	.994
Head's gender	0.254	0.268	0.895	1.289
Head's age	0.007	0.008	0.930	1.007
Consuming units	-0.032	0.080	0.155	.969
Non-oxen-livestock	-0.168	0.057	8.712***	.845
Non-farm income	-0.001	0.000	10.634***	.999
Food crop output	0.001	0.000	13.506***	1.001
Head's literacy	0.409	0.250	2.679*	1.505
Constant	-0.108	0.683	0.025	.897

Dependent variable: Participation in food crop marketing (commercialization), 1=participant, and 0 = non-participant

Note: Exp(B) shows the predicted change in odds for a unit increase in the predictor.

Omnibus tests of model coefficients: Chi-square= 51.083; df. = 8; sig. level = 1 %

Cox and Snell R^2 = 11.9 %; Nagelekerke R^2 = 15.9; percentage of correct prediction: 66.2 %; N included: 402 (95.7 %); *** = sig. at 1%; * = sig. at 10 %

Livestock holding (excluding oxen) is also negatively related with crop-oriented commercialization. An increase in one TLU results in a decline in the odds of market participation by 15.5 %, due to competition between livestock activities and crop farming for labor and other resources. Crop output, however has a significant and positive impact on food crop commercialization. As crop output increases by one unit, the odds of market participation increases by 100 %.

The regression analysis also shows the positive and significant (at about 10 % level) relation of literacy and participation in commercialization of food crops. Farm households with better education level seem to be keen to participate in food crop marketing. The education effect could be direct (market-orientation) or indirect via better production skill

and knowledge. Household size measured in adult-equivalent consuming units, which reflects household subsistence needs, is negatively related with participation in food crop commercialization. The negative sign suggests that households with large family size are forced to consume much or all of their production, supplying an insignificant amount or none for market, but the finding is not statistically significant. Neither gender nor age shows any significant impact on market participation.

In short, the regression analysis confirms that lack of market access (measured by distance) and engagement in livestock and off-farm employment significantly and negatively impact food crop commercialization. Literacy and total food crop production play a positive role, but only the latter has a strong significant effect. The logical question is therefore what determines food crop production in ways that stimulate marketed surplus, the focus of the next section.

4.2 Determinants Food Crop Production

Results of the Cobb-Douglass production function estimation are shown in Table 4. The empirical model (F-value=3.865, sig. level=1 %) estimated coefficients of farm size operated, household labor, age of household head (proxy for knowledge, skill and experience), oxen owned, fertilizer used, and cash credit received. Beta coefficients in the model are elasticities reflecting the percentage change in output resulting from a percentage change in input use.

As Table 4 shows, land size operated is highly significant with an elasticity of 0.518. A doubling of the present size of land operated (mean size=1.46 ha.) would result in an increase of food production by 51.8 %, other factors remaining the same. The coefficient for chemical fertilizer[13] is also significant and implies that doubling of the current level of fertilizer application would result in an increase in food production by 35.5 %. As the average amount of fertilizer used in the study areas is small (20.87 kg. per household, as shown in appendix 1), there are sizable output gains to be made from expanded fertilizer application. The result for oxen however is not statistically significant, suggesting the social capital is enabling oxen-less households to borrow or rent oxen in ways that prevent yield-deterioration.

Age of household head is negatively related to food production. This could be due to the better educational level of younger farmers; a bivariate statistical association test has shown that more of younger household heads are literate, while most of older

[13] In the production function improved seeds and fertilizer were tested and found to show a high level of co-linearity problem, and thus excluded.

farmers are non-literate. The credit coefficient in the regression is insignificant and negative, which is consistent with Damite and Negatu (2004) findings that the small cash credit obtained by farmers is used for smoothing consumption of food-short households. Household labor is negative but highly insignificant. This negative relation, though statistically insignificant, could be probably due to larger size of family labor in relation to other factors of production.

Table 4: Cobb-Douglass Estimation of Food Crop Production in South Wollo

Variable	B	Std. Error	Beta	t-value
(Constant)	8.504	1.259		6.757
log of household labor	-0.0558	0.228	-0.038	0.245
log of oxen owned	0.233	0.219	0.149	1.062
log of land operated	0.518	0.215	0.377	2.406**
log of credit received	-0.124	0.098	-0.199	1.262
log of head's age	-0.755	0.276	-0.378	2.738**
log of fertilizer (DAP+Urea)	0.355	0.148	0.387	2.391**

Dependent Variable: log of food crop production; ** = sig. at 5 % level

In sum, farm size operated and technology (chemical fertilizer) are found to be the most important factors of production under the context of the South Wollo in the 2001/02 cropping year. Policies and institutions that facilitate access to farmland (in particular via land rentals and sharecropping) require attention, particularly in situation where land underutilization is evident. Similarly, one has to focus on policy and institutions that promote technological change in smallholder agriculture. The next section deals with the adoption patterns and constraints of agricultural technology, particularly chemical fertilizer in the study area.

4.3 Farm Input Intensification

Smallholder farming households in the study *woredas* use limited chemical fertilizer, improved seeds, herbicides, insecticides, and farm implements. Chemical fertilizers are applied mainly to cereals, but its application to pulses and other crops is not common (Demeke et al., 1997). Improved seeds and chemical fertilizer are the dominant improved technologies used by farmers in the study areas (see Appendix 2 for the percentage of users of improved seeds and fertilizers). Maize and wheat are the main crops for which improved seeds are extensively promoted, the rest benefiting less from improved seed technology. Both a greater proportion of farmers and the average amount of seeds and chemical fertilizer applied in Jamma woreda

are greater than in the other study woredas in 2000/01 and 2001/02. Bati farmers use the least improved seeds and chemical fertilizer both in terms of average amount of inputs used and percentage of users. However, a higher proportion of Bati farmers apply manure, and rates of manure application are the highest in Bati, compared with other study woredas.

The results of the regression estimation of fertilizer use are shown in Table 5. Regression estimation was also carried out for Jamma, a study woreda in which the highest proportion of farmers use chemical fertilizer (Appendix Table 1), for more insights.

The regression results show that operated farm size has a positive and statistically significant impact on fertilizer use in both South Wollo and Jamma woreda. A unit change in size of farm operated entails more than two and half times and eight times higher chance to use chemical fertilizer in South Wollo and Jamma, respectively. This could be due to economies of scale, for fertilizer transaction cost per unit of operated land is lower for larger farms. Also larger farms often have greater influence (social capital) on personnel involved in fertilizer distribution.

Table 5: Logit Regression Estimation of Use of Chemical Fertilizer in South Wollo

Variable	South Wollo (All Study woreda)				Jamma woreda			
	B	S.E.	Wald	Exp(B)	B	S.E.	Wald	Exp(B)
Market distance	.007	.007	.944	1.007	-.016	.011	2.026	.985
Head's age	.003	.015	.037	1.003	-.008	.020	.149	.992
Labor units	.071	.222	.103	1.074	.124	.369	.112	1.131
Farm size operated	.974	.351	7.686***	2.648	2.147	.750	8.202***	8.557
Soil quality	.860	.502	2.934*	2.363	1.499	.746	4.033**	4.477
Oxen	1.482	.448	10.942***	4.400	1.649	.677	5.931**	5.203
Non-oxen livestock, TLU	-.344	.140	6.070**	.709	-.512	.220	5.432**	.599
Non-farm income	-.001	.001	1.333	.999	-.002	.002	.852	.998
Credit	.003	.001	9.668***	1.003	.003	.002	2.375	1.003
Head's literacy	.877	.542	2.615	2.403	1.221	.745	2.684	3.390
Jamma-dummy	5.995	.981	37.361***	401.426	-	-	-	-
Constant	-10.665	2.072	26.492	.000	-3.355	2.344	2.050	.035

Dependent variable: use of chemical fertilizer (DAP and/or urea), 1=user, 0 = non-user

Note: Exp(B) shows the predicted change in odds for a unit increase in the predictor.

Omnibus tests of model coefficients for all woreda (South Wollo): Chi-square= 229.679; df. = 11; sig. level= 1 %

Cox and Snell R^2 = 43.6 %; Nagelkerke R^2 =74.6 %; Percentage of correct prediction: 95.5 %; N included: 401 (95.5%).
Omnibus tests of model coefficients for all Jamma woreda: Chi-square= 70.465; df. = 10; sig. level= 1 %
Cox and Snell R^2 = 51.3 %; Nagelkerke R^2 =69.0 %; Percentage of correct prediction: 86.7 %; N included: 98 (94.2 %).
*** =sig. at 1 % level; ** = sig. at 5% level; * = sig. at 10 %

Fertility status of soil, traditionally measured as low fertility (*tuff*), medium fertility (*lem-tuff*) and high fertility (*lem*), also has a role in the decision of whether and how much fertilizer to use. Findings of the regression analysis show that farm households with better soil quality tend to use chemical fertilizer. Soil quality is positively induced by the application of organic manure, rotation and residual fertilizer carry-over. Landscape may also affect soil fertility via its effect on erosion. A change in soil quality towards better level in South Wollo and Jamma woreda results in the increase of odds of applying fertilizer by 2 times and four and half times respectively, other factors remaining constant. These results are consistent with the findings for agro-ecology, as proxied by the Jamma dummy variable, which also shows a positive and significant effect on fertilizer use. This could be probably better quality soils respond to chemical fertilizer better than poor quality soils, for good quality soils have better organic matter that enhances the productivity impact of chemical fertilizer.

Increasing oxen holdings by one unit increases the odds of using fertilizer in South Wollo and Jamma by more than four times and five times, respectively, other factors remaining unchanged. Oxen power is a critical production factor for small farm holders (Negatu, 2004). The relationship between livestock holding (excluding oxen) and fertilizer use is found to be negative and significant in both South Wollo and Jamma. An increase in one TLU in South Wollo and Jamma, other factors remaining constant, reduces the odds of applying chemical fertilizer by 29.1 % and 40.1 %, respectively, reflecting both competition for household labor, and substitution effects between manure and fertilizer need.

An increase in the credit received in one unit would increase the chance of applying fertilizer in South Wollo by 100 %. In Jamma, credit coefficient is positive but not significant at 10 %. The results indicate in general the importance of credit in improving farmers' access to chemical fertilizer.
The fertilizer adoption estimation results in general imply the need and importance of policies and institutions that promote farmers' access to oxen, that increase size of operated farm, and access to credit. The results imply also the need of agricultural diversification through promoting food crops production in agro-ecologically suitable

areas like Jamma and non-staple food crops and off-farm activities in agriculturally less suitable agro-ecological areas like Bati (Kola agro-ecology) and Legambo (Wurch agro-ecology) areas.[14]

6. Size of Operated Farms and Smallholder Farming Systems

As observed in the above analyses, size of operated household farm is a key factor of production, technology adoption and commercialization under Ethiopian rural context. Households in the study areas can be categorized into three farm size groups: (i) small size farm size, 0.50 ha and less; (ii) medium size farm, 0.51 ha - 2.0 ha., and; (iii) large size farm, above 2.0 ha. The role of size of operated farms can also be demonstrated in terms of its association with technology use, soil quality, manure use, and commercialization (Table 6). As shown in the table, large size farm holders are significant users of fertilizer, improved seeds and manure, and they commercialize the largest proportion of food crop produced compared to medium and small size farm holders. Thus, size of operated farm is a crucial factor in the intensification and commercialization of smallholder farming systems in Ethiopia. For a farm household to be sustainably food secure and user of modern improved productive technologies, consolidation of small and fragmented holdings into larger and viable size is therefore essential. This has a clear implication on policies and institutions required to ensure a long-term and secure marketing of land-lease holdings.

Table 6: Distribution of improved seeds, chemical fertilizer, manure, soil quality and commercialization by operated farm size groups

Item	Small farm	Medium farm	Large farm	F-value
Fertilizer, kg.	1.41 (11.868)	23.69 (59.472	27.83 (62.898	5.530***
Improved seeds, kg.	.00 (0.000)	.42 (3.772	2.67 (13.690)	3.940**
Manure use, kg.	16.972 (80.194	74.66 (151.583)	140.92 (278.429)	9.985***
Soil quality index	2.19 (0.595)	2.15 (0.478	2.17 (0.475)	0.247

[14] *Kola*, is an agro-ecology characterized with high temperature, lowland and semi-arid conditions, while W*urch* is an agro-ecology with low temperature, highland and sub-moist conditions.

Commercialization index (CI)	.06 (0.095)	.08 (0.112	.10 (0.129	3.428**

Note: *** =sig. at 1 %; ** = sig. at 5 %

7. Summary and Concluding Remarks

Commercialization of farm production is considered as an important strategy of transforming low productivity subsistence production of small farm holders into surplus - and market-oriented production systems. Data from the study areas of South Wollo in Northeastern Amhara region reveals that the amount of marketed food crops is substantially low (8 % of the total produced food crops). In terms of participation in food crop marketing, commercialization ranges from 36 % in poor cropping year (2000) to 51 % in relatively better cropping year (2001).

Access to marketplace (physical proximity) has been found to significantly affect farmers' commercial participation. Farm households nearer to market participate in food marketing than those far from market place. In the absence of means of transportation, farmers walk to market, in which case long distances to market play a disincentive to marketing. The importance of local and federal governments' efforts to improve roads and transportation services and market infrastructure is clear in stimulating participation of smallholders in marketing. Institutions and policies that encourage private investment in transportation service are also of a paramount importance. Marketing cooperatives would also have important role in facilitating input and output marketing.

Above all, the study asserts the major importance of surplus production or increased production in stimulating participation in food marketing. Enhanced food production is a very critical factor in promoting farm commercialization as also repeatedly indicated in various studies (see section 2). This warrants the need of investigating factors that determine food production. The Cobb-Douglas model estimation of food production clearly showed that size of farm cultivated with food crops and fertilizer are the most important and significant factors that determine food production. Since improved seed and fertilizer are highly co-linear in application, the findings underscore the

importance of markets and service delivery in multiple inputs. This result implies the need for forging appropriate policies that promote land mobility (marketing) in order to create conditions for increasing farm land operated by efficient farmers, by rationalizing the existing leasehold marketing and improving tenure security through efficient land institutions. This accompanied with aggressive technological change in smallholder farming through availability and accessibility of appropriate technologies like chemical fertilizer complemented with improved seeds and water irrigation (wherever necessary and feasible) is necessary to enhance the production side of farm commercialization. Technological change accompanied by change in human capital is a fundamental force to bring the anticipated production increase and farm commercialization.

In connection with this finding, the study attempted also to examine the pattern and constraints of fertilizer use in smallholder farming systems in South Wollo. According to this study, oxen holding, farm size and credit are the most important positive factors. Associated with larger farm size are benefits from economies of scale. As fertilizer is an expensive input for smallholders, the positive role of credit and the importance of strengthening credit service are clear. On the other hand, the study shows that applying fertilizer is feasible for farming located in suitable agro-ecology like Jamma compared to other case areas (e.g. Bati, Legambo). In agro-ecologies that are not suitable for agriculture, other options like non-farm income activities and animal farming are worth considering (Little et al, 2006).

Overall, rationalizing the existing land tenure policies and institutions in such a way to enhance production, technological change and commercialization is an important step that needs consideration by regional and federal governments. In connection with this, agricultural planning that prioritizes agro-ecologies for different agricultural and non-agricultural activities would be helpful.

References

Adewumi, M.O. and Omoresho, O.A. (2002). Analysis of production objectives of small-scale rural farming households in Kwara State, Nigeria. *Journal of Rural Development*, Vol.25, No.2 winter.

von Braun, J. and Kennedy, E (1994). Agricultural commercialization, Economic development and Nutrition. Food Policy Statement No. 19, IFPRI

von Braun, J., de Haen, H. and Blanken, J. (1991). Commercialization of agriculture under population pressure: effects on production, consumption, and nutrition in Ruwanda. Research Report 85. Washington, D.C.: IFPRI

Crawford, E., Kelly, V., Jayne, T.S., and Howard, J. (2003). Input use and market development in Sub-Saharan Africa: an overview. *Food Policy* Vol. 28, No. 4: 2777-292.

CSA (Central Statistical Authority, Ethiopia), (2002). Ethiopia: Statistical abstract, 2000. Addis Ababa

Damite, Demissie and Negatu, Workneh, (2004). Determinants of rural livelihood diversification: evidence from Southern Ethiopia. Quarterly Journal of International Agriculture, Vol. 43(2004) No.3, pp267-288.

Dembele, M., Staatz, J.M., and Weber, M.T. Policy synthesis, No.68, MSU (http://www.aec.msu.edu/agecon/fs2/psyymind.htm.)

Demeke, Mulat, Ali, S. and Jayne, T.S. (1997). Promoting fertilizer use in Ethiopia. The implications of improving grain market performance, input market efficiency, and farm management. Working Paper 5, Grain Market Research Project, Ministry of Economic Development and Cooperation, Addis Ababa, Ethiopia.

FAO. (1998). Ethiopia soil fertility initiative: concept paper. Investment Centre division of FAO/World Cooperative Program.

FDRE (Federal Democratic Republic of Ethiopia). (2001). Food security strategy. Addis Ababa

Hayami, Y. (2001). Development economics, 2nd Edition. Oxford: Oxford University Press

Hinderink, J and Sterkenburg, J. (1987). Agricultural commercialization and government policy in Africa. London and New York: KPI

Holden, Stein and Hailu Yohannes (2002). Land redistribution, tenure insecurity, and intensity of production: a study of farm households in Southern Ethiopia. *Land Economics*, Vol. 78, No. 4, November

Little, P., Stone, P., Mogues, T., and Castro, P. (2006). Moving in Place: Drought and Poverty Dynamics in South Wollo, Ethiopia. *Journal of Development Studies*, Vol. 42: 200-225

Maddala, G.S. (1992). Introduction to econometrics. Second edition. New Jersey: Prentice Hall, Inc.

MOFED (Ministry of Finance and Economic Development of Ethiopia). (2002). Ethiopia: sustainable development and poverty reduction program. Addis Ababa, MOFED

Negatu, Workneh. (2004). Agricultural technology, food production, and household food security in South Wollo and Oromia zones of Amhara Region, Ethiopia. In: Summary proceedings of the Workshop on the BASIS/IDR research programme in Eastern Amhara Region, Ethiopia, Peter little and Workineh Negatu (eds.). Held at Bahirdar,

Amhara Regional State. 17-18 June, 2003. Papyrus Hotel, Bahirdar, pp.32-40: http://WWW.basis.wisc.edu

Pender, J, Place, F. and Ehui, S. (1999). Strategies for sustainable agricultural development in the East African highlands. EPTD Discussion Paper No. 41, IFPRI, Washington, D.C.

Strasberg, Paul J., T. S. Jayne, Takashi Yamano, James Nyoro, Daniel Karanja, and John Strauss. (1999). Effects of agricultural commercialization on food crop input use and productivity in Kenya. MSU, Policy synthesis No. 41

World Bank. (2001). China overcoming rural poverty. A World Bank country study. Washington, D.C.: The World Bank

Appendix 1: Descriptive Statistics of Major Variables, 2001/02 cropping year

	N	Minimum	Maximum	Mean	Std. Deviation
Distance to Main Market, minutes	420	4.00	300.00	99.7512	50.60825
Age of household head	420	10.00	91.00	47.7024	15.45119
HH Labor (Adult Equivalent)	420	.00	8.40	2.8363	1.26923
HH Size (Adult-equivalent consuming units)	420	.70	10.70	4.1317	1.62785
Total operational holding (ha.)	420	.00	4.63	1.4644	.98205
Livestock ownership other than oxen (TLU)	420	.00	24.35	2.0411	2.52907
No. of Oxen Owned	420	.00	5.00	.7429	.86600
Improved seed used, kg.	420	.00	95.00	.9114	7.48626
Non-farm Income (revenue from own business plus wage labor employment), Birr	420	.00	4729.00	381.8412	710.82177
Total Farm cash income, Birr	414	.00	5440.00	595.6344	656.13704
Cash credit received, Birr	420	.00	2422.00	98.2307	230.87015
Total food crop production, kg.	411	.00	89508.00	967.1607	4418.89306
Fertilizer (Dap+urea) applied	420	.00	400.00	20.8667	55.75091

Appendix 2: Amount and user percentage technological inputs in 2000/01 and 2001/02 cropping years

Technological input	Woreda	N	2001/02 cropping year		2000/01 cropping year	
			Mean	Number of users (%)	Mean	Number of users
Fertilizer, kg.	Bati	110	0.00 (0.000)	0 (0.00)	0.51 (3.397)	3(2.73)
	Jamma	104	80.90 (87.271)	62 (59.62)	87.60 (76.837)	73(70.19)
	Dessie zuria	100	3.50 (13.771)	8 (8.00)	8.83 (20.199)	24 (24.00)
	Legambo	106	0.00 (0.000)	0 (0.00)	2.90 (12.214)	6(5.68)
	Total	420	20.87 (55.751)	70 (16.67)	24.66 (53.888)	106(25.24)
Improved Seed, kg.	Bati	110	0.00 (0.00)	(0.00)	0.71 (4.532)	6(5.45)
	Jamma	104	3.20 (14.454)	7 (6.73)	8.97 (18.117)	24(23.08)
	Dessie zuria	100	0.50 (3.518)	2(2.00)	3.32 (8.804)	15(15.00)
	Legambo	106	0.003 (0.029)	1(0.94)	1.58 (6.695)	7(6.60)
	Total	420	0.91 (7.486)	10(2.38)	3.60 (11.224)	52(12.38)

Note: Herbicides were not used in all *woreda*, while insecticides were provided to a considerable number of farmers freely by the local government to control the insect epidemics in Bati woreda in 20001/01. In 2001/02 neither herbicides nor insecticides were used in all the *woreda*. Figures in parentheses are standard deviations.