Future Agricultures

Commercialisation of Smallholder Agriculture in Selected *Tef*-growing Areas of Ethiopia*

Samuel Gebreselassie[†] and Kay Sharp[‡]

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[†] Research Fellow, Agriculture and Rural Development Division, Ethiopian Economic Policy Research Institute (EEPRI), Addis Ababa (sgebreselassie@eeaecon.org); [‡] Research Fellow, Rural Policy and Governance Group, Overseas Development Institute, London (k.sharp@odi.org.uk)

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1. Introduction

1.1. Commercialisation(s) in Ethiopia

The poverty-reduction strategy adopted by Ethiopia seeks to achieve growth through the commercialisation of smallholder agriculture. The Plan for Accelerated and Sustainable Development to End Poverty (PASDEP), Ethiopia's strategic framework for 2005/06 – 2009/10, relies on a massive push to accelerate growth. This is to be achieved by efforts in two directions: commercialisation of agriculture, based on supporting the intensification of marketable farm products (both for domestic and export markets, and by both small and large farmers); and promoting much more rapid non-farm private sector growth (MoFED, 2005). This study aims to contribute to this plan by identifying factors that can deepen and expand the scope of market participation of smallholders.

Commercialisation of agriculture is also a core research theme of the Future Agricultures Consortium. Future Agricultures' thematic work on agricultural commercialisation has observed that, in various countries, different modes of commercialisation co-exist and interact with each other (Leavy and Poulton 2007:17): hence the plural term, commercialisation***s***. In Ethiopia, we suggest that the following existing categories of farmer could benefit from enhanced commercialisation (or "market-oriented agricultural growth"). These four categories represent four potentially complementary "pathways" for commercialisation policy.

1. Smallholder family farms

- (Type A) Farmers in remote, drought-prone or low-potential areas, generally regarded as "subsistence-oriented" but in fact interacting with markets both as buyers and as sellers. The policy challenge posed by these farmers is to improve their terms of engagement with markets, as well as raising productivity and diversifying livelihoods.
- (Type B) Small farmers who are already market-oriented, producing crops partly or wholly for sale alongside crops for their own consumption. Such farmers tend to be in locations with favourable growing and marketing conditions, and tend to focus on specific high-value commodities.

2. Small investor-farmers

- Individuals or small groups of partners, often educated and urban-based; sometimes agricultural professionals with a background in government or development agencies or former state farms; often investing in farming as a secondary activity. These farmers are referred to in World Bank terminology as "emerging commercial farmers", suggesting an expected linear trajectory towards larger-scale agri-business. However, we suggest that they are in fact a separate category. In Ethiopia they have started to re-emerge only in the last few years, when access to land for such investments has been made possible.

3. Large-scale "agri-business"

- These are generally capital-intensive enterprises (though they also generate employment), and may be either private or state-owned. Examples are the large

export-oriented horticulture and floriculture ventures that have multiplied in Ethiopia in recent years.

The empirical research reported in this paper focuses on the "Type B" smallholders, that is farming households who are established growers of highly marketable crops, in areas already well-linked to markets. Two commodities were selected for the study: coffee and tef. Both are important to the national economy, and both are grown and marketed by millions of smallholders. As summarised in Table 1, the two commodities have both similar and contrasting characteristics. Both are labour-intensive crops with seasonal labour-demand peaks, met partly by migrant workers. Both are produced primarily by smallholders (although there are also a few large enterprises growing coffee). Both commodities command export as well as domestic markets, although tef has been primarily a domestic product in the past while coffee is a major national export. Most obviously, tef is both a food and a cash crop, and is therefore fungible either for farm consumption or sale. Coffee, by contrast, is a non-food crop grown primarily for the market.

Table 1: Commodity choice - characteristics of coffee and tef

Coffee	Tef
Non-food	Food (high value)
Primarily export market	Primarily domestic market
High policy attention & intervention *	Limited policy attention & intervention* (until recent years)
Large and small scale production	Small-scale production
Productivity strategy: niche markets (speciality and organic), low chemical inputs	Productivity strategy: intensification through purchased inputs (fertiliser and seeds)
Labour intensive with seasonal labour bottlenecks	
New institutions: Co-operatives and Unions	

** i.e. research and development, market support and control, etc.*

This paper reports the findings from tef-producing areas.

1.2. Tef in the Ethiopian economy

Tef *(eragrostis tef)* is a nutritious small-grained cereal, related to millet, which originates in Ethiopia and is thought to have been domesticated by Ethiopian farmers between 3 and 6 millennia ago. It fetches the highest market price of any food grain in Ethiopia and is the preferred staple cereal for the majority of consumers, both urban and rural. *Enjera* (a

thin, pancake-like bread), the traditional national food and still the daily staple for most of the population, requires tef flour.[1]

Tef is particularly interesting in the context of smallholder commercialisation and food security, since it has high value as both a cash and a food crop. Many poorer farmers with suitable land grow it almost entirely for sale, using the proceeds to buy cheaper staples; although, as they become more prosperous, they may retain more for their own consumption. It is grown entirely by smallholders, and has been actively marketed for many generations. Until recently its market was almost wholly domestic, within Ethiopia (and formerly Eritrea): however, a promising niche export market is now developing in Europe and America, based on tef's increasing reputation as a "super-grain", being gluten-free and high in protein and calcium as well as micronutrients such as iron and B vitamins. A Dutch website is currently marketing it (under a profit-sharing contract with the Ethiopian authorities) as "the grain that makes you stronger". It thus has potential to contribute to the PASDEP goal of export diversification, as well as raising food production and farmers' incomes.

Farmers' preference for growing tef is due to production characteristics as well as consumer demand. The crop has a wide altitude range, and its resistance to diverse biotic and abiotic stresses makes it "low-risk" for cultivation (Hailu et al., 2000). It also stores well, since the very small size of the grain makes it resistant to post-harvest damage by insects. Among Ethiopia's 11.3 million small grain farmers, about 46% (5.2 million) grew tef in 2005/06 (CSA, 2006). This makes tef the second most widely-grown annual crop after maize, which was cultivated by 6.8 million farmers. During the same year, tef was grown on over 2.24 million hectares which is a little over one fifth (21%) of the total land planted to grains. The average farmer cultivated tef on 0.43 hectare, on which he or she produced 4.2 quintals [2], implying an average yield of 9.8 quintals per hectare.

The national production of tef has increased tremendously over the last twenty years, from 11.8 to 21.8 million quintals (a rise of nearly 85%). However, this encouraging performance must be interpreted in the context of high population growth and poor conditions in the base year. *Per capita* production grew by only 23% (1.9% per year) over the same period, and has never exceeded 30 kg. [3] It is also a matter of concern that most (64%) of the growth in production is attributable to area expansion, while improved yields contributed only 12%. [4] This indicates the enormous difficulty of achieving broad-based agricultural productivity growth, which is critical to lift the majority out of poverty. Moreover, yield-induced growth in production is essential to allow agriculture to release land for increasingly important but competing activities such as urban and industrial development, and to prevent agriculture from expanding into forest and other unsuitable land (a threat to the long-term sustainability of the farming system).

[1] In lean times and in poorer households, tef is often eked out by mixing it with cheaper grains. However, some proportion of tef is essential for the proper fermentation of the *enjera* batter.

[2] 1 quintal (Qt) = 100 kg.

[3] Per capita national production of all grains was 183 kilogram in the same year (2005/06).

[4] This is despite the availability of tested tef technologies (seed varieties) that could double the existing yield level. The Ethiopian Agricultural Research Institute reported the existence of high yielding varieties even in 2000. There are tef varieties (like DZ-01-974, DZ-01-354 and DZ-Cr-37) which can yield up to 28 quintals under farm conditions and 32 to 46 quintals under experimental conditions. This exceeds the recent best performance (9.7 quintals) by over 3 times (Hailu et al., 2000).

In the current policy push for smallholder commercialisation, tef is one of the selected priority crops under the Ministry of Agriculture and Rural Development's 2004 master plan for enhanced market-oriented production.[5] Government support to producers, in terms of agricultural extension services, has grown substantially in recent years: in 2005/06 a little over one million tef growers (21% of the total) participated in the extension programme and received free technical advice as well as guaranteed access to modern farm inputs such as fertilizers, herbicides and improved seeds. In terms of area, 560,000 hectares (25% of the total area planted with tef) was under the extension programme (CSA, 2006).

1.3. Scope of the paper

An earlier version of this paper was presented at a parallel session on *Commercialisation of Smallholder Agriculture*, co-organised by Future Agricultures, at the EEA's 2007 Conference on the Ethiopian Economy. It is one of four linked outputs from that session, the other three being:

- a thematic framework paper discussing the meanings and definitions of commercialisation from conceptual and international perspectives (Leavy and Poulton);
- a brief overview of the policy context and the different (alternative or complementary) pathways of agricultural commercialisation in Ethiopia (Sharp, Ludi and Samuel); and
- an empirical paper on smallholder commercialisation in Ethiopia's coffee-growing areas, which parallels the present paper (Samuel and Ludi).

The paper is structured as follows. Section 2 outlines the methodology and objectives of the study. Section 3 discusses the survey analysis, focusing on household-level commercialisation within the selected study areas. Section 4 concludes with a summary of the key findings and a discussion of their potential policy implications.

2. Objectives and methodology

2.1. Objectives of the study

Within the overall purpose of contributing to the understanding of smallholder commercialisation as a means to poverty reduction, the specific objectives of this paper are:

(i) to assess the current scale of commercialisation in tef-growing areas, and to detect household and farm characteristics which might explain variation in the level of commercialisation among households;

(ii) to investigate the welfare situation of farmers operating at different levels of commercialisation; and

[5] The other priority crops in the master plan are wheat, barley, lentil, chickpea, fava and haricot beans, cotton, sesame, coffee and spices. Source: MoARD (FAC key informant interview).

(iii) to identify and analyse the factors that determine the extent of smallholders' participation in output markets.

2.2. Sampling and methods

Four major tef-producing *weredas* (districts) were purposively selected as the study areas, based on statistical evidence of the dominance of tef in the local farming system. Two of the weredas (Ada'a Lome and Bacho) were in Oromia Region, and two (Dejen and Enemay) in Amhara Region. Primary data were collected through a household survey and qualitative fieldwork.

For the household survey, a stratified two-stage sampling design was employed within each wereda. First, all *kebeles* (sub-districts) in the selected weredas were listed, and two were randomly selected. Twenty households were then randomly selected from each kebele (giving a target sample size of 160 households in eight communities). Since the study aimed to investigate gender-related disparities in agricultural commercialisation, the sample was stratified by gender of the household head. The actual sample size achieved was 155 households: the distribution by wereda and gender is shown in Table 2 below.

Table 2: Survey respondents by gender of household head

Wereda	Female	Male	Total	% FHH
Ada'a Lome	10	28	38	26%
Bacho	4	35	39	10%
Dejen	1	40	41	2%
Enemay	5	32	37	14%
Total	20	135	***N=155***	13%

A structured household questionnaire was used to collect quantitative data on production, consumption, and marketing of farm produce, as well as demographics, resource ownership, and off-farm activities. The survey was carried out in 2006, and collected data on the preceding agricultural year (the 1997/98 E.C.[6] production cycle, i.e. March 2005 to February 2006).

Both descriptive and econometric methods were used to analyse these household data. Descriptive methods including measures of average and a one-way ANOVA (analysis of variance) were employed to disclose the scale of commercialisation of agriculture and to test the existence of any statistically verifiable difference among farmers operating at different levels of commercialisation. Results from the discrete one-way analysis were further examined through multivariate regression models which helped to predict the determinants and outcomes of commercialisation.

Following preliminary analysis of the survey data, an exploratory qualitative study was conducted in one of the surveyed tef weredas, Ada'a Lome, in February 2007 (towards the end of the marketing season for tef). This wereda was chosen from among the study

[6] Ethiopian Calendar

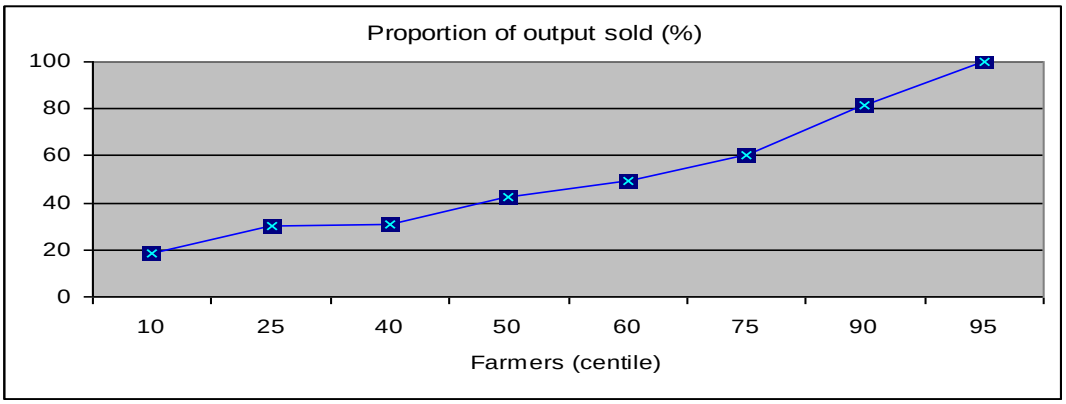
areas on grounds of logistics and accessibility, in order to maximise the time spent in field research. The methods used were key informant interviews, semi-structured focus group discussions and individual case interviews. Interviewees and focus group members were identified through local contacts, based on purposive criteria including age, gender, farming experience, and engagement in livelihood activities such as trade and wage labour. The overall purpose of the qualitative work was to investigate some questions raised by the survey, and to identify any important issues which had not been captured by the questionnaire (with a view to possible further research).

3. Findings

3.1. The scale of agricultural commercialisation

The survey data indicate that the average farm household in the four weredas sold a little over 49% of their total crop output (in value terms). A slight majority (about 58%) consumed more than they marketed, while 38% sold more than they consumed and the remaining 4% consumed and marketed an equal proportion of their output. Farmers operating at full commercial level (i.e. those who sold 100% of their production) constitute 5% of the sample, while another 7% operated at full subsistence level (i.e. consumed 100% of their production). About half of the surveyed farmers marketed less than 42% of what they produced. If we consider a farmer who marketed at least 50% of his or her output as commercially-oriented, then 40% of the sample could be so classified. Figure 1 shows the degree of commercialisation by centile of households.

Figure 1: Proportion of output sold



In general, these data indicate that the level of commercialisation in the study areas is considerably higher than the national average. [7] This is as expected, given the purposive selection of areas renowned for the production of tef (a highly-marketed commodity) and

[7] According to Gebremeskel et al. (1998) only 28 percent of the total national grain production (cereals, pulses and oilseeds) was marketed in 1996. A more recent study by the Ethiopian Economic Association in 2004, however, found that grain farmers who participated in the recent extension programme marketed on average about 33% of their output (5.7 quintals), while non-participants marketed 36% (4.7 quintals). These figures indicate the gross amount sold, without adjusting for any quantities of grain that farmers might have purchased towards the end of the cropping season.

with good access to major markets.

Despite this relatively high degree of market participation, the market size (in terms of the volume of transaction per seller) is thin. Fifty-seven percent of sampled households sold farm produce worth 2,000 Birr (about US$ 222)[8] or less, while the average farmer sold only 933 Birr's worth of produce. Fewer than a quarter (23%) of farmers sold produce worth 3,500 Birr or above. The marketed commodities were mainly tef, chickpeas and wheat.

As the grain market is characterised by many small sellers, competition among farmers is likely to be fierce. This problem arises mainly due to low per capita production, as confirmed by a single-equation regression model specifying trade as a function of production (see Box 1). The model indicates a significant and positive association between production and trade (both measured in value terms). The regression coefficient of 0.81 shows that for a unit increase in the value of production, earnings from trade rise by 0.81. The high coefficient of determination (r^2=0.63) also shows that about 63% of the variation in trade was explained by the volume of production, keeping other factors constant.

Box 1: Trade-production relationship among sampled households

$Y_i = -79 + 0.81X_i$	$P = (0.93)\ (0.00)$
$t = (0.12)\quad (16.23)^*$	$R^2 = 0.63$

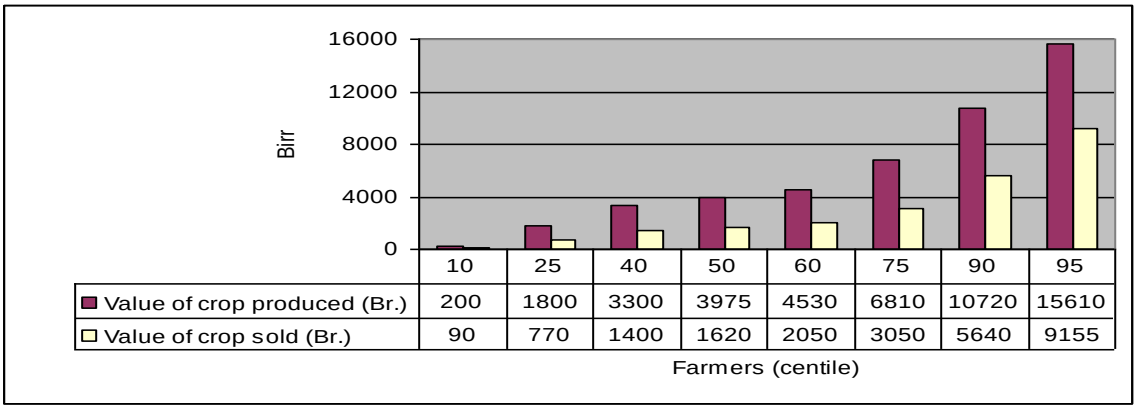
In general, econometric evidence suggests that the higher the level of production the higher will be the probability of farmers engaging in commercially-oriented agriculture. However, a simple correlation analysis suggests that the more a farmer sold, the lower the *proportion* of output marketed (r=0.12 or r^2=0.1). In other words, as the volume of marketed output increases the volume of output consumed on the farm also increases, but by a higher proportion. This finding, from cross-sectional analysis of households in a given period, is paralleled by observations from the qualitative fieldwork about the pattern of change over time. Farmers in Ada'a Lome observed that both production and marketing of grain crops have risen over the last decade or so, but that the volume marketed has risen less than the volume produced. For tef in particular, they considered this increase in home consumption of farm produce to be a sign of rising prosperity:

> "Before, we used to mix chickpeas, wheat, or sorghum for *enjera*, but now this has almost stopped – people here eat tef. Because of the increased production and better standard of living, people don't have to eat these inferior mixtures."
>
> [Interview with Kebele Chairman]

This type of relationship between marketed and consumed production is not unusual in a farming system dominated by poor smallholders. The potential tensions and synergies between commercialisation and food security for small farmers are particularly important, and deserve further investigation.

[8] US$1 = approx. 9 Birr.

Figure 2: The relationship between crop value produced and sold



3.2 Outcomes of commercialisation

Commercialisation of agriculture is not an end for farmers, but an intermediate outcome on the way to welfare goals. In the study, smallholders' welfare is represented in terms of consumption of basic food (grains), high-value foods (livestock products) and expenditure on clothes and shoes, durable goods, education and healthcare. Agricultural productivity is also considered as an intermediate outcome which farmers aim to improve through greater engagement in output markets.

Table 3: Welfare outcomes among farmers at different levels of commercialisation

	Degree of commercialisation			F-test
	Low (<30% of output sold)	Medium (30% -65% of output sold)	High (≥65% of output sold)	
Consumption of basic food (Br/person/week)	15.08	18.33	22.67	3.84**
Consumption of high-value food (Br/person/week)	1.18	1.38	3.03	2.15
Share of purchased food	16.49%	10.54%	16.05%	2.03
Annual expenditure on clothes and shoes (Br)	455.20	724.22	845.60	0.60
Annual expenditure on durable goods (Br)	863.20	1242.31	1795.24	1.42
Expenditure on education (Br/person/annum)	32.26	55.38	83.79	2.18*
Expenditure on healthcare (Br/person/annum)	0.93	6.78	4.58	1.51
Land productivity (Br/hectare)	3376.70	3244.13	4465.98	0.28
Labour productivity (Br/person-day)	31.73	53.80	46.57	0.15
N	22	76	26	

* and ** denote significance at 10% and 5% respectively.

Table 3 shows distinct differences in the welfare of farm households at different levels of commercialisation.[9] The most commercialised households (here defined as those who

[9] For the purposes of this analysis, the degree of household commercialisation is measured by a simple index defined as the ratio of the gross value of all crop sales to the gross value of all crop production:

sold 65% or more of their production) consumed one and a half times as much basic food per person as the least commercialised (i.e. those who sold 30% or less). This difference is statistically significant, implying that (keeping other factors constant) the observed difference in consumption of staple grains or root crops is associated with the variation in market participation. For high-value foods, consumption varies even more markedly between the most and least commercialised farmers, although this difference is not statistically significant. Similar differences are observed in expenditure on clothing and durable goods.

The most commercialised households also spent more on education and healthcare. On average, the least commercialised farmers spent only 32 Birr per person per year on education, while their more commercialised neighbours spent more than twice this (about 84 Birr/person/year). This difference is significant at 10%.

The agricultural productivity of sampled households also varies with their level of participation in output markets. Land productivity increases with the index of commercialisation. Labour productivity is also lowest among the least commercialised farmers, but there is no consistent pattern as the index of commercialisation increases.

Because productivity and other outcomes are determined by multiple factors, multivariate regression analysis is needed to verify these results. Further analysis should also consider the risk of high dependence on markets for food that comes with rising agricultural commercialisation. Keeping these caveats in mind, these initial results suggest that commercialisation of smallholder agriculture should not only be encouraged as a means to boost exports or stimulate local economies, but also as a way to help smallholders achieve welfare goals that can improve their living conditions.

3.3. Determinants of market participation

A smallholder's decision to enter and make use of markets is influenced by many household and macro-level factors. Macro-economic and trade policies, market reform, rural infrastructure improvement and the development of legal and contractual environments in which smallholders and processors may operate are among the major driving forces of increased agricultural commercialisation. However, not all smallholders

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Household Commercialisation Index (HCI) = (gross value of all crop sales / gross value of all crop production)*100

A value of zero would signify a totally subsistence-oriented household: the closer the index is to 100, the higher the degree of commercialisation. However, it is recognised that this measure has its shortcomings. The index value itself could be misleading, since a farmer who grows only one bag of maize and sells that bag (HCI = 100) would appear more commercialised than one who grows 50 bags and sells 30 (HCI = 60). It also neglects other components of farm output (such as livestock), the degree of market reliance for inputs, and broader dimensions of commercialisation such as profit motivation and engagement with labour markets. A detailed discussion of these conceptual and measurement issues can be found in Leavy and Poulton (2007).

operating in the same macro environment take part in output markets. Among those who do take part, the degree of participation also varies. This section investigates the microeconomic relationships between market participation (or non-participation) and household-level factors, using the household survey data and assuming the macroeconomic conditions are constant. Two separate questions were posed: why some sampled households did not take part in output markets at all, and why some marketed more of their production than others.

3.3.1 Why do some farmers not participate in output markets?

Small farmers take part in output markets either to capture the gains from specialization or out of necessity (to obtain cash for the purchase of essential consumption goods and agricultural inputs); or both. As it is rare to find a farmer who is not influenced by either of these factors, it is unusual to observe farmers who do not market any of their output. However, this could happen in rare circumstances where a farmer has nothing to sell (e.g. if they produce less than their consumption requirements) or where the household's cash needs are met from non-farming income including remittances or aid.

From a policy perspective, it is important to study smallholders who do not participate in output markets as sellers. The primary occupation of such households might be non-agricultural, or their agricultural livelihood might be precarious. These two possibilities have different policy implications. Understanding the factors that lead some farmers to stay in agriculture but not take part in output markets should enable policy makers to design programmes either to strengthen precarious farming livelihoods or to facilitate the smooth withdrawal of marginal farmers from the agricultural sector, thus allowing more productive farmers to cultivate larger farms.

The survey data indicate that about 7% of sampled farmers were not participating in the output markets as sellers. It is hypothesised that the level of farm production, the degree of household dependence on non-farm income, the cropping pattern (the proportion of subsistence food *versus* cash crops), and the age and health of farmers, could affect their ability or willingness to participate in output markets. As the sample size for non-participant farmers is small (only 12 households or 7% of the sample), it would be difficult to formulate a meaningful regression model (such as a logit model) which would help to identify factors affecting willingness or ability to participate in output markets.[10] However, a two-way group mean comparison test was made between market participants and non-participants. The results are presented in Table 4.

[10] This is mainly because of potential lack of variability among such a small number of cases.

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Table 4: Characteristics of market participants and non-participants

	Non-participants	Participants	T-test
Age of household head (years)	59	48	2.39**
Sex (% female headed)	12%	12%	0.04
Literacy (% literate)	38%	60%	1.26
Value of total farm outputs (crops) produced	641	6,602	2.52**
Total cultivated land (ha)	1.3	3.1	2.84***
Household labour size (man-equivalent) [11]	2.9	3.4	1.02
Farm size owned per labour unit (ha/ME)	0.4	0.8	1.65*
Labour spent on farming (man-days per ha)	58	82	1.92*
Value of total livestock owned (Br)	2,100.0	1,138.8	1.19
Specialization in cash crop (% of land planted to tef)	36%	75%	4.24***
Cash expenses for farming (Br)	75.0	639.6	1.86*
Participation in land markets (% participated)	62%	65%	0.16
Size of land rented-in	0.0	0.7	1.93*
Size of land rented-out	1.1	0.1	4.98***
Participation in non-farming activities,1=yes,0=no	38%	41%	0.20
Share of non-agricultural income in total income	39%	11%	2.96***
Per capita non-farm income (Br)	102.3	130.7	0.61
Cash income from own non-farming activities (Br)	350.0	295.0	0.31
Cash income from employment (Br)	0.0	359.6	0.93
Days worked for pay in the last 12 months	153.3	129.7	0.29
Value of any remittances, gifts or other transfers received	125.0	59.1	0.54
N	141	12	

*,** and *** denote significance at 10%, 5% and 1% respectively.

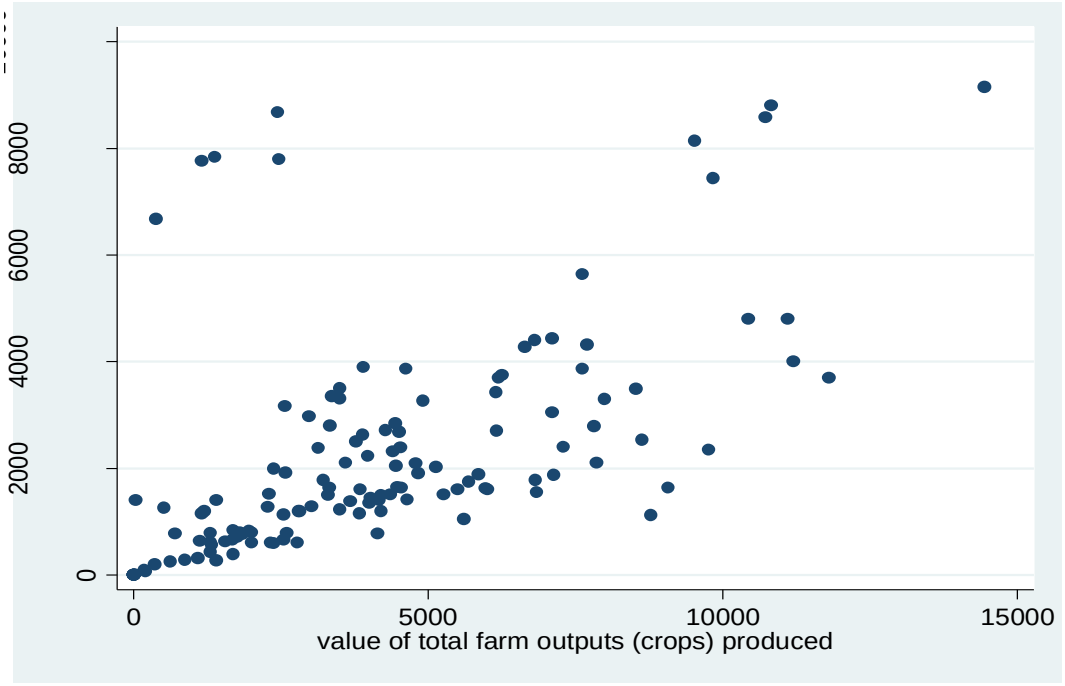
Farm household heads participating in output markets were found to be younger. The average age of participants is 11 years younger than non-participants, and the difference is statistically significant. This result is not unexpected, as risk-taking behaviour tends gradually to decline as people get older. Moreover, as farmers get older they may be unable to spend the time and energy needed for the production and marketing of cash crops.

The likelihood of market participation is high among smallholders specializing in tef (the major cash crop produced in the study areas). On average, market participant farmers allocated three quarters of their cultivated land to tef, whereas non-participants allocated only one third of theirs. Non-participant households also cultivated only a small proportion of their land: 62% of them rented out a significant part (about 85%, on average) of their 1.1 hectare. By contrast, participant households not only owned more land but also rented in additional plots. On average they cultivated about 3.8 hectare of land, 22% of which was rented in from someone else. All of these differences between

[11] See Annex 1 for the conversion factors used in calculating man-equivalent (ME) labour units.

the two groups are statistically significant.

Figure 3. Scatter plot of value sold against value produced [12]



Source: survey data

Another important issue for any study on commercialisation is its effect on employment. Keeping other factors constant, farmers participating in output markets follow more labour-intensive farming. They employ 44% more labour on a hectare of land (82 man-days, compared to 58 man-days/ha for non-participant farmers).

Similarly, farmers who did not participate in the output market (i.e. those who consumed all their output) spent much less money on farming than those who sold part of their production: 75 Birr on average, compared to 640 Birr for market participants. The difference is statistically significant.

Households' participation in non-farm activities, and especially the share of non-farm income in total household income, also seems to have an impact on their market entry decision. Keeping other factors constant, farmers who do not participate in crop output markets gain a significantly higher proportion of their income from non-agricultural sources. As the agricultural production of these households is low, non-farm activities might enable them to consume whatever they produce by supplying the cash required for other purposes.

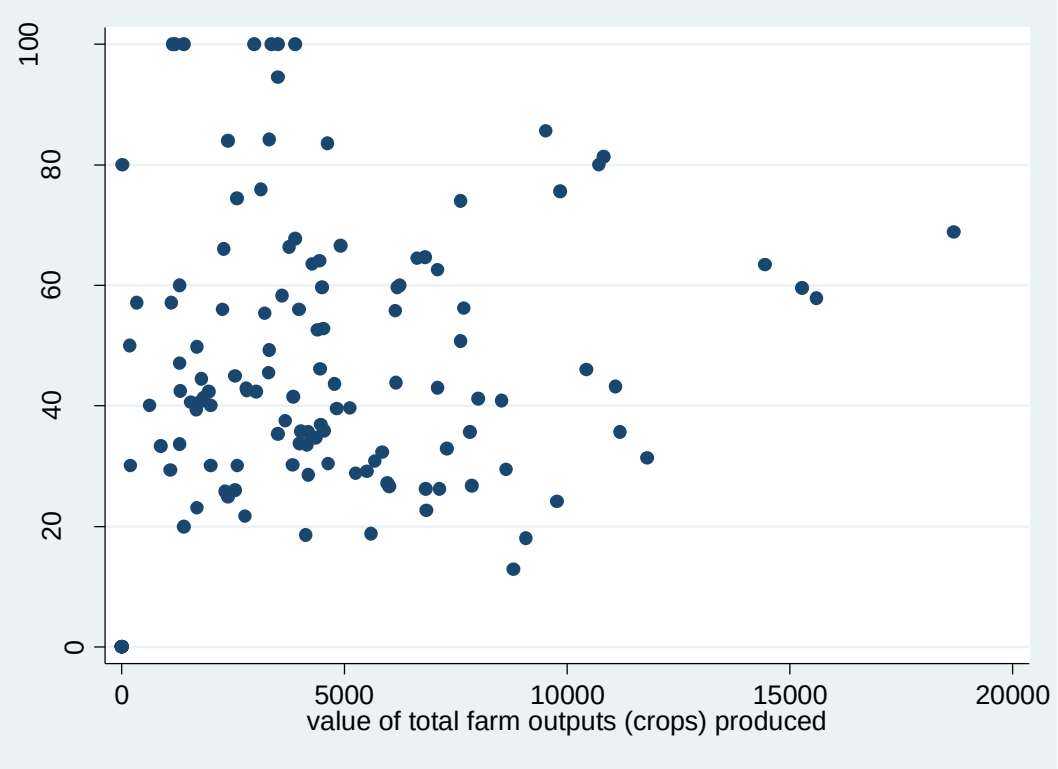
[12] Those outliers in the top left of the graph who appear to be selling more than they are producing are due to data errors.

The size of land owned and cultivated is very important in determining farmers' participation in output markets. As reported above, those who did not sell crops owned small farms; rented out most of their land; grew a small proportion of the high-value primarily cash crop (tef); and invested relatively little labour or cash in farming.

3.3.2 Why do some farmers sell more than others?

Although the amount that farmers supply to the market increases as farm production rises, the relationship is far from one-to-one (see Figure 2 above, and Figure 4). This implies that, for the same size of farm production, some farmers consume more on farm while others consume less and sell more. This section focuses on factors causing this variation in the degree of market participation among households who participate in output markets as sellers.

Figure 4: Plot of commercialisation index against total value of crop production



Source: survey data

The degree of farmers' participation in output markets could be measured either in terms of the *proportion* of output sold (the commercialisation index used above), or the total *value* of output sold. As seen in Figure 4, there is no clear correlation between the total value of output produced and the proportion sold, and in such circumstances the index could distort the extent of market participation. For instance, a farmer who produces 100 Qt of grain and sells 50 Qt would have a lower commercialisation index than one who

produces only 5 Qt but sells most or all of it. As Figure 4 illustrates, this is common in our sample. Therefore, the following analysis uses the value of output sold.

Table 5: The degree of market participation of sampled households

Percentile (N=141)		Income from marketing (Br)
10%	(i.e. up to 10% of sample earned less than, i.e. over 90% earned more than …. Br)	290
20%	(i.e. up to 20% of sample earned less than, i.e. over 80% earned more than …. Br)	760
25%	(i.e. up to 25% of sample earned less than, i.e. over 75% earned more than …. Br)	836
50%	(i.e. up to 50% of sample earned less than, i.e. over 50% earned more than …. Br)	1,788
75%	(i.e. up to 75% of sample earned less than, i.e. over 25% earned more than ….Br)	3,725
80%	(i.e. up to 80% of sample earned less than, i.e. over 20% earned more than … Br)	4,403
90%	(i.e. up to 90% of sample earned less than , i.e. over 10% earned more than …Br)	9,100
95%	(i.e. up to 95% of sample earned less than, i.e. over 5% earned more than …. Br)	17,500

The level of participation in output markets varies considerably among sampled farmers, as shown in Table 5. The top 20% of farmers, for instance, sold crops worth over 4,400 Birr, while the bottom 20% sold only about a sixth of this (760 Birr or less). The median gross income from crop marketing was Birr 1,788. The following section focuses on identifying the factors behind this wide variation in market participation.

Modelling the degree of market participation

We assumed that the quantity supplied to the market (measured in terms of cash earned from crop sales) is a linear function of a set of household characteristics, after inspecting the distribution of sampled households on a scatter plot of total value of output sold. As indicated in Figure 3, with the exception of some outliers and allowing for some level of difference among farmers, the general distribution follows a linear pattern. Hence a linear functional form could reflect the relationship between the dependent and independent variables.

Mathematically, the model or functional relationship is expressed as follows:

$$Y_i = a_i + \beta_i X_i + u_i \quad (1)$$

Where Y_i is the total value of output sold,

X_i are factors that affect quantity supplied to the market (i.e. the degree of farmers' participation in the output market)

a_i and β_i are estimable parameters, and

u_i is the error term.

The explanatory variables hypothesized to affect the total value of sales include:

- quantity of on-farm production,
- price of the commodity in time period t-1,
- household food self-sufficiency, measured as the proportion of own-produced food in total household food consumption,
- the degree of specialization in the major cash crop (tef), and

- farmers' participation in, and income from, non-farm activities.

Market transaction costs could also be an explanatory variable, but they are not directly considered for lack of data. However, the price received by farmers for their produce is expected to capture some of the effect of variation in market transaction costs, including access to market centres. The farm gate price of the major marketable commodity (tef) was therefore entered into the model as a lagged variable, since farmers' market-oriented production decisions are likely to be affected more by the price in the previous crop year than by the current price.

Farmers engage in non-farm activities to complement their farm income. Their participation and the level of income from non-farm activities could indirectly indicate their level of satisfaction with their farm cash income. Conversely, the level of cash income from non-farm activities could be used as a proxy for farmers' cash need from their farming operations, especially if access to non-farm activities is similar for sampled farm households.

Data on farmers' access to non-farm activities and their willingness to engage in such activities is not available. However, we do have data on whether farmers participated in non-farm activities and their income from such activities. These are incorporated into the model as independent variables. There are two competing hypotheses on the influence of non-farm earnings on marketed output. One says that if a farmer has sufficient non-farm income, he or she does not need to sell farm output and so will market less. The alternative hypothesis is that non-farm income enables farmers to sell food crops, knowing that they have cash to buy food when needed.

The propensity to sell could, however, vary according to the type of crop produced. Farmers' supply decisions for non-food cash crops (such as coffee) might be different from those for a food cash crop (such as tef), which can either be sold or consumed on the farm. Although the level of on-farm production and the farm gate price have a direct effect on supply to the market, in semi-subsistence farming, the degree of household food self-sufficiency is also a key factor in the degree of their participation in output markets. The assumption is that households that have already met their food requirement will be more willing to sell their output. However, this does not apply in farming systems dominated by a non-food cash crop. The level of household food self-sufficiency was incorporated into the model as an explanatory variable and hypothesized to affect the degree of smallholders' market participation positively or negatively.

We can estimate equation 1 by OLS under the condition that the error term and the regressors are not correlated. In our model, however, the value of output produced could be correlated with the error term, and, if so, it is potentially endogenous[13]. The literature

13 On the other hand, the set of the regressors (explanatory variables) should not be perfectly collinear as the classical linear regression model assumes. A collinearity test indicates the existence of weak collinearity among the regressors, especially between household food self-sufficiency and per capita food production, and non-farm income and its share in total household income.

indicates that the probability of correlation between the error term and a regressor (in our case, total value of output produced) is high when some factors explaining the variation in the dependent variable (in this case, total value of output sold) could also affect the regressor. Applying standard least squares (OLS) to equation (1) under these circumstances results in inconsistent estimates, that is, as the sample size approaches infinity the estimates of the parameters on average will not equal the population estimates. To remedy this problem we applied a two stage least squares, 2SLS (also called the instrumental variables (IV) procedure), where instead of the value of output produced another variable that can correlate with it but not with the disturbance term was substituted.

Because one of the possible causes of correlation between regressors and disturbance term is a simultaneous equation bias, it is also important to check for simultaneity between output sold and produced. In other words, output sold is determined by, among others things, the level of output produced; but is there any possibility for the level of output produced to be affected or determined by the amount of output sold? As the decision on the amount to produce precedes that on the amount to sell, the amount sold is unlikely to determine the amount produced in the same time period. However, the amount sold in the previous year (t-1) could be a strong determinant of the level of production in time 't'. In other words, there is no need to use a simultaneous equation. In time 't' the cause-and-effect relationship runs from output produced to output sold, and not the other way; but in time t-1, the likelihood for a reverse relationship is high.

Before proceeding with the 2SLS model, we tested empirically whether the value of output produced is indeed correlated (asymptotically) with the disturbance term or not. We followed a three step procedure. In the first step, we replaced X_1 (value of output produced) by instruments selected in the original regression (equation 1); estimated the model ('instrumenting regression') by OLS; and saved the residual. In step two the original model was estimated, and in step three we estimated the original model but using the residual from step one as an explanatory variable. The coefficient of the residual was found to be significantly different from zero, i.e. there is evidence in favour of the hypothesis that the value of output produced is correlated with the error term. Therefore, the 2SLS estimator is preferred.

In selecting instruments for the value of output sold, two equations were considered as simultaneous equations (i.e. the equation we are going to estimate and another equation for the value of output produced), Any 'exogenous' variables in the full system of equations were selected as instrumental variables for the total value of output produced. All variables hypothesized to explain the size of farm production (i.e. land, labour, ox power, cash expenditure on inputs, age, sex and literacy of household head) were considered as instruments to replace the value of output produced (which was found to be correlated with the error term). The validity and relevance of these instrumental variables was tested using an F-test and a Sargan or J-test. While the F-test validates whether these instruments are themselves endogenous or not, the Sargan or J-test checks whether they

are highly correlated with the variable they are instrumenting for (amount of farm production). The null hypothesis for the F-test was that the parameters associated with the selected instruments are jointly zero. The F-value with 6 and 97 df is 11.95 (F(6, 97) = 11.95, Prob > F = 0.0000), implying that all instruments are exogenous. But the Sargan or J-test with a computed chi-square (12.33) exceeding the critical chi-square indicates that at least one instrument is correlated with the error term. A systematic procedure identified household labour size as the variable which had a high degree of correlation with the error term. The chi-square was 1.478, which is lower than the critical chi-square either at 1%, 5% or 10%. The model estimation procedure continued with the remaining variables.

As the name suggests, in the 2SLS two OLS regressions were run to obtain the parameter estimates. The first stage estimates what is called a 'reduced form' relationship to obtain the predicted values and the second stage estimates the 'structural' relationship where the endogenous variable was replaced by the predicted values. By forming predictions for output produced (x) in the second stage through the instruments z we corrected for the correlation between the error term and output produced (x). The actual estimation, however, was not performed in two steps. Modern econometric software (in this case Stata version 9) allows the whole procedure to be estimated in one step.

$$Y_i = a_i + \gamma_1 Z_{1,t} + \ldots\ldots + \beta_1 X_{1,t} + \ldots\ldots + u_i \qquad (2)$$
$$T = 1,\ldots\ldots,T$$

where Z indicates the six instrumental variables and X the explanatory variables which are as defined in equation 1. Table 6 presents estimates from this (2SLS) regression model. The model was run for all weredas together and then separately for each wereda after testing whether these four weredas actually represent four distinct samples[14].

Table 6: Determinants of the degree of participation in output market

	All weredas	Sample Weredas			
		Ada'a	Bacho	Dejen	Enemai
Size of output produced[15]	0.67	0.81	0.57	0.44	0.36
	(13.3)***	(13.61)***	(7.60)***	(3.16)***	(2.2)8**
Farm gate price (lagged variable)	0.01	1.72	0.01	0.14	0.32
	(0.04)	(0.97)	(0.09)	(0.07)	(0.12)
Household market dependence for food	-16.11	-48.71	-8.47	-2.55	-16.39
	(2.21)**	(3.93)***	(0.59)	(0.18)	(0.71)

14 A chow test was carried out to see whether or not we do indeed have four different samples, as the significant variables on the location dummies would suggest. An insignificant F-statistic on the hypothesis testing the equality of these coefficients shows that the four areas do indeed represent four different samples.

15 This variable was instrumented by land, ox power, farm expenditure on inputs such as fertilizer, age, sex and literacy of farm household head as discussed above. Labour was a relevant instrumental variable but was not considered as it was found to be correlated with the structural error term.

Participation in non-farm activities	-277.39 (0.72)		-70.99 (0.07)	119.73 (0.15)	- 1291.42 (1.50)
Income from non-farm sources (per capita income)	-0.93 (1.87)*	-1.85 (3.12)***	37.14 (1.62)	0.39 (0.13)	0.11 (0.06)
Specialization in major cash crop (tef)	10.25 (1.74)*	26.43 (2.38)**	23.91 (0.179)*	2.55 (0.18)	17.04 (0.95)
Ada'a dummy	486.00 (1.11)				
Bacho dummy	874.31 (2.21)**				
Dejen dummy	177.72 (0.54)				
Constant	1176.09 (1.40)	3478.01 (2.13)**	512.27 (0.22)	457.20 (0.23)	1343.21 0.51
N	112	29	27	33	25
R-square	0.81	0.93	0.85	0.56	0.62
Adj R-squared	0.79	0.91	0.81	0.43	0.48

Model results

As reported in Table 6, the explanatory variables affect the degree of market participation of sampled households differently. The regression for all weredas indicates that the size of farm production and farmers' specialization in tef (the major cash crop) had a positive and significant impact on the degree of market participation, measured in terms of the amount of income from marketing. On the other hand, the effect of household food self-sufficiency was negative. This implies that households with a high dependence on markets for their food access also participate more in output markets. In other words, their participation in commodity markets is high both as sellers and buyers.

The quantity of farm production has a positive effect on the quantity supplied to market, conforming to prior expectation. The impact of non-farm activities is mixed. While the coefficient for farmers' participation in non-farm activities was statistically insignificant, the coefficient for income from these activities was negative and significant. These results imply that participation in non-farm activities alone is not sufficient to have any impact on a farmer's market participation (as a seller). However, as farmers earn more from non-farm sources, they are likely to sell less of their farm output. In other words, the likelihood of on-farm consumption of own products increases as farmers obtain more cash from non-farm sources. This finding supports the first of the competing hypotheses outlined above. The invalidity, in this case, of the alternative hypothesis (that non-farm incomes enable farmers to sell more of their crops because they can buy food on the market) may indicate problems or risks in food markets: farmers may not be confident of buying food easily when they need it.

Except for Ada'a wereda, regression estimates indicate only weak explanatory power of

most of the aforementioned variables. The exceptions are the size of farm production (which was consistently significant and positive in each regression model run for all sample weredas), and farmers' specialization in tef (which was positive and significant in Bacho Wereda). The exceptionality of Ada'a is likely to be associated with its easy access to major markets and non-farm employment (due to its closeness to major industrial locations).

3.4 Determinants of output in tef areas

As the quantity or value of output produced was found to be very important in determining both market entry and the degree of market participation across all sampled weredas, it is important to investigate separately the factors affecting the volume of farm output.

To estimate the determinants of farm output, the Cobb-Douglas (C-D) production function was employed. The C-D function is a multivariate nonlinear relationship between outputs (production) and inputs used in the production process. The C-D model enables us to transform the original non-linear relationship between output and inputs into a linear form that can be estimated within the framework of the classical linear regression model.

The C-D production function, in its stochastic form, may be expressed as

$$Y_i = \beta_1 X_i^{\beta i} Z_i^{\alpha i} e^{\mu i} \qquad (1)$$

Where Y is farm output expressed in terms of the value; Xi is a vector of physical inputs including land, labour and ox (draught) power; Zi is a vector of other factors that affect a farmer's work (such as age, sex, engagement in the land rental market, and off-farm activities); and u, e and βi are the stochastic disturbance term, the base of natural logarithm and the parameters to be estimated, respectively.

Equation 1 is non-linear, but if we log-transform this model, we obtain[16]

$$\ln Y_i = \ln \beta_1 + \beta_i \ln X_i + \alpha_i \ln Z_i + \mu i \qquad (2)$$
$$= \beta_0 + \beta_i \ln X_i + \alpha_i \ln Z_i + \mu i$$

where $\beta_0 = \beta_1$

Thus, equation 1 is non-linear in the variables Y, X and Z, but linear in the log of these variables. Thus, the model is linear in the parameters β_i and α_i, and is, therefore, a linear regression model. The properties of the C-D function are quite well known: β_i and α_i are partial elasticity of output with respect to physical and non-physical inputs such as age and sex. The sum of the parameters β_i and α_i gives information about the response of output to a proportionate change in the inputs.

[16] This model building is adopted from Gujarati (2003).

The independent or exogenous variables that are expected to affect the level of production are broadly classified into four groups:

1. Conventional or physical inputs, including land, labour and draught (ox) power for ploughing.

Non-conventional inputs, classified into:

2. Factors affecting the quality or effectiveness of the physical inputs, mainly farm labour. These include literacy, age and sex of the household head who is assumed to act as manager of the farm [17]. While sex and farmers' literacy were measured as dummy variables, the age of the farm manager (household head) is a continuous variable.
3. The use of modern farm inputs such as fertilizers, improved seeds and pesticides (measured by cash expenditure on the purchase and transport of these inputs).
4. *Area dummies* – included to capture the effects of living in a given wereda when compared to the other three weredas.

The results of the regression model are reported in Table 7. The first column presents the estimate of the simple CD production function in which only physical inputs are included. Land and oxen, which could also be used as proxies for capital stock, are found to be important in explaining the variation in the level of production among sampled households. The coefficient for land is statistically significant at 1%, while the coefficient for oxen ownership is relatively high but significant only at the 5% level. Cash expenditure on inputs such as fertilizer, pesticides, and peak-season hired labour also significantly affects the total value of farm output.

All three location dummies were significant, albeit with some differences in the level of significance. This implies a marginal difference in the effect of living in a specific wereda compared to the other three weredas. Farmers living in Ada'a district, which is nationally famous for the quality of its tef and has the best access to major urban markets including Addis Abeba, gained the most significant location-related benefit.

Among the personal characteristics of the farm manager (usually the head of the household), age and sex were insignificant in explaining the observed variation in the level of farm output. However, the coefficient for literacy of the household head is positive and significant, which implies a high probability of better production among farm households with an educated head (compared to households with illiterate heads). Participation in the credit market (defined as having received a loan of 100 Birr or more) also appears to play a significant role in enhancing the level of farm production.

[17] These are not the only factors to affect the quality or efficiency of labour. Others important but not considered for lack of data are farmers' access to information, health centres or electric power etc. Similarly, differences in the quality of farm land were not considered.

Table 7: Determinants of output in selected tef growing areas

	Physical inputs and location dummies (column 1)		Column 1 plus the nature of farm manager, and participation in credit market (column 2)	
	Coefficient	t-statistics	Coefficient	t-statistics
Constant	4.182	3.42***	3.526	1.91
ln (land)	0.525	1.89*	0.526	1.86*
ln (labour)	0.356	1.65*	0.294	1.35*
ln (oxen)	0.004	0.05	0.011	0.12
logcvpfi[18]	0.202	1.70*	0.164	1.35
Ada'a dummy	0.976	3.08***	1.105	3.33***
Dejen dummy	0.722	2.22**	0.709	2.17**
Enemay dummy	0.654	2.23**	0.635	2.15**
logage			0.204	0.50
Sex (dummy)			0.221	0.67
Head education (dummy)			0.374	1.63*
Participation in credit market (dummy)			0.479	2.08**
	F(7, 124) = 4.72		F(10, 120) = 3.66	
	Prob > F = 0.0001		Prob > F = 0.0003	
	R-squared = 0.5203		R-squared = 0.5514	
	Adj R-squared = 0.4725		Adj R-squared = 0.4962	

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

As indicated earlier, our intention in modelling the production function is principally not to identify the factors affecting farm production, but to uncover additional factors having an indirect effect on farmers' marketing decisions. The assumption is that any variable affecting farm output will also affect farmers' participation in output markets, as our analysis shows that the former significantly explains the latter.

There is strong evidence for the positive effect of improved access to factors of production (agricultural land, peak season labour and draught power) as well as working capital for the purchase of inputs on farmers' marketing decisions. Similarly, the positive effect of participation in financial markets suggests the importance of credit in helping to boost production, and, consequently, smallholders' participation in output markets.

[18] Cvpfi represents cash expenditure for the purchase modern farm inputs (fertilizers, improved seeds and pesticides).

4. Conclusions

4.1. Summary of survey findings

The degree of agricultural commercialisation

- The level of commercialisation in the study areas is far higher than the national average. The average farmer sold almost half (49.7%) of his or her crop production in value terms, compared to a national average in 2004 of about 33% (EEA 2006).
- The degree of commercialisation, however, differs widely across sampled households, which implies a correspondingly wide variation in the potential and constraints for further commercialisation. Therefore, any agricultural commercialisation strategy should be customized for different groups of farmers.

Production, consumption and trade

- Despite the relatively high degree of market orientation in the study areas, the size of market (per seller) is very thin.
- The volume of trade is constrained by low per capita production. Over 63% of the variation in trade among sampled households is explained by variation in production, keeping other factors constant.
- Although the amount that farmers supply to the market increases as the volume of production increases, the relationship is far from one-to-one. A simple correlation analysis suggests that the more a farmer sells, the lower the *proportion* of output marketed ($r=0.12$ or $r^2=0.1$). In other words, as the volume of marketed output increases the volume of output consumed on the farm also increases but by a higher proportion, so that the degree of commercialisation (measured in terms of the proportion of output sold) actually falls.

Commercialisation and farmers' welfare

Commercialisation of agriculture is not an end in itself for farmers, but an intermediate outcome on the way to welfare goals. A two-way analysis was carried out to shed some light on the welfare effects of commercialisation. Some of the findings are:

- The most commercialised farmers (here defined as those who sold 65% or more of their production) consumed one and a half times as much staple food per capita as the least commercialised (those who sold less than 30%). This difference is statistically significant.
- Households in the higher commercialisation category also spent more on education and healthcare. Households in the least commercialised category spent on average only 32 Birr per annum on education, while the most commercialised spent more than twice this (about 84 Birr/person/year). This difference is statistically significant at 10%.
- Agricultural productivity also varies with the level of participation in output markets (although this is not statistically significant). Land productivity increases with the index of commercialisation. Labour productivity is also lowest among the least

commercialised category of farmers, but the trend lacks consistency as the index of commercialisation rises.

These initial results suggest that commercialisation of smallholder agriculture should be encouraged not only as a means to boost exports and to stimulate or monetize local economies, but also as a way to help smallholders achieve welfare goals.

Determinants of market participation

About 7% of sampled farmers were not participating in the output markets as sellers. Although it is difficult to run a regression model on such a small sample size, results from a two-way analysis reveal significant differences between market participant and non-participant farmers:

- Household heads who participated in output markets were found to be younger - 11 years younger, on average – than their non-participant counterparts. This difference is statistically significant.
- The likelihood of market participation is high among smallholders specializing in the major cash crop, tef.
- The size of farmland owned and cultivated is very important to farmers' participation in output markets. In general, those who did not sell owned small farms (1.1 ha on average, about one-third the size of market participants' landholdings). Moreover, non-participant households cultivated only a small proportion of their land: 62% of them rented out a significant part of it (about 85% on average). By contrast, market-participant households not only owned more land but also rented *in* about 22% of their average cultivated area of about 3.8 hectares. All these differences between the two groups are statistically significant.

Determinants of the degree of household market participation

Regression estimates show that:

- Both the total value of farm production and the proportion of land allocated to tef (the major cash crop) had a positive and significant impact on a household's degree of market participation, measured in terms of gross income from crop sales.
- The effect of household self-sufficiency in food (measured as the percentage of consumption that is self-produced) was negative. This implies that households who depend more on the market for their food access also participate more in output markets. In other words, their participation in food markets is high both as sellers and buyers.
- The impact of non-farm activities on market participation is mixed. While the coefficient for farmers' participation in non-farm activities was statistically insignificant, the coefficient for income from these activities was negative and significant. These results imply that participation in non-farm activities alone is not sufficient to impact on a farmer's market participation (as a seller). However, the level of income from non-farm sources does impact on market participation.
- The likelihood of lower crop sales and higher on-farm consumption increases as

farmers obtain more cash from non-farm sources. This finding disproves (in this case) the alternative hypothesis that non-farm income encourages farmers to sell *more* of their crops and rely on market purchases for their food access.

4.2. Policy issues and further research needs

The findings of this study broadly support the PASDEP's dual strategy of increasing agricultural commercialisation while promoting non-farm economic growth. Higher levels of household commercialisation appear to be associated with better standards of welfare (including food consumption), confirming that smallholders can benefit directly from greater engagement with markets. At the same time, a minority of farmers even in these relatively commercialised areas are leading marginal and largely subsistence-oriented farming livelihoods, supplementing their production income through renting out land. Combined with the finding that higher non-farm incomes are associated with lower agricultural commercialisation, this underlines the importance of developing sources of non-farm employment alongside intensification of agriculture, in order to provide favourable conditions of exit from farming for some less productive farmers and landless youth. The suggested direction of change is towards a more diversified rural economy, aiming for higher returns from agriculture alongside a wider range of local income and livelihood options.

Land size and means of accessing land emerge, not surprisingly, as critical factors in household-level commercialisation. The survey findings show that there is a very active land rental market in the tef-producing areas, and the qualitative discussions in Ada'a highlighted both an absolute shortage of land and a rapid rise in rental prices. An open and well-regulated rental market is essential to ensure both adequate land access for commercialising farmers and a secure income for those (mostly poorer) landowners who are renting out their fields.

Further research into the factors that lead some farmers to stay in agriculture while not engaging with output markets would be useful. For example, given the finding that non-market participants are older, is this a lifecycle effect (meaning that the current generation of young farmers may also withdraw from marketing when they are older), or a generational shift? Would these farmers want to move out of agriculture if better options were available? Investigating such questions could assist policy makers in designing strategies to improve currently precarious farming livelihoods, while facilitating a smooth exit from farming for those who wish to take it.

It should of course be borne in mind that the study areas are not, and were not intended to be, "typical" or representative of the very varied Ethiopian smallholder sector. The findings presented here will not necessarily hold true in other areas or other farming systems, where conditions and opportunities may be very different. Continuing research into commercialisation(s) in Ethiopia should take careful account of relevant geographical factors, and of the various potential commercialisation pathways for different categories of farmer.

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Annex 1: Conversion factors for household size and labour-force

1. Adult equivalents (household size)

To compute household size in Adult-Equivalent (AE) based on consumption needs the following standard conversion factors were used. A male adult is assumed to require 3,000 kcal/day.

Age group (years)	*Male*	*Female*
< 10	0.6	0.6
10 – 13	0.9	0.8
14 – 16	1	0.75
17 – 50	1	0.75
> 50	1	0.75

Source: Institut pan-Africain pour le Developpement (1981) as quoted in Storck et al. (1991).

2. Man equivalents (labour-force)

To compute household labour force in Man-Equivalent (ME) the following standard conversion factors were used.

Age group (years)	*Male*	*Female*
< 10	0.0	0.0
10 – 13	0.2	0.2
14 – 16	0.5	0.4
17 – 50	1	0.8
>50	0.7	0.5

Source: These conversion factors were developed comparing between Here (1986), Johnson (1982), Ruthenberg (1983) and Nair (1985) as quoted in Storck et al. (1991).