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Agricultural Commercialization in Ethiopia

Trends, Drivers, and Impact on Well-Being

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Abstract

Agricultural transformation refers to a series of changes in agriculture that both reflect and drive rising income and economic development more broadly. While the macroeconomic patterns of agricultural transformation are relatively well documented, less is known about how it is manifested at the household level. Ethiopia makes an excellent case study as it has had one of the fastest growing economies in the world. This paper focuses on one aspect of this process: agricultural commercialization, that is, the process through which an increasing share of agricultural output is sold on the market rather than being consumed at home. The analysis uses three nationally representative rural household surveys carried out in 2012, 2016, and 2019, including a panel of 1,900 households. The results show that the share of marketed agricultural output has increased significantly over the seven-year period. Somewhat surprisingly, this increase is not due to a shift in crop mix toward more commercial crops but rather an increase in the degree of commercialization of each crop. Using a correlated random effects model, we find marketed share to be significantly related to age of the head of household, farm size, wealth, distance to road, rainfall, rainfall variability, and region. Although endogeneity is a challenge, descriptive statistics and regression analysis further suggest that agricultural commercialization contributes to higher income, largely because commercial crops generate higher returns per hectare than staple grains. The results indicate that there is no clear line between "subsistence" and "commercial" farms. A large majority of farms have some crop sales, while virtually none of them sell all their output. Similarly, the contrast between subsistence crops and cash crops can be misleading. For example, the value of staple cereal sales in Ethiopia is almost three times greater than that of coffee, the main cash crop. We draw lessons from the results for the design of programs to raise rural incomes by facilitating market-oriented agricultural production.

Keywords: Africa, Ethiopia, agricultural transformation, commercialization, poverty

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1. Introduction

Agricultural transformation describes a set of changes that occur in the agricultural sector as the economy expands and income rises. These changes include greater use of purchased agricultural inputs such as purchased seed and fertilizer, rising agricultural productivity, a decline in subsistence food production as farmers shift to growing for the market, and the expanding importance of non-farm activities and income. This is part of broader changes in the economy known as structural transformation, in which the agricultural sector grows more slowly than the rest of the economy so that its share in national output declines, along with a shift in labor from rural to urban areas and from agricultural to non-agricultural activities. At some point, the process of urbanization often results in a absolute decline in the rural population, leading to rising rural wages and growing average farm size, both of which contribute to improved standards of living in rural areas.

Agricultural commercialization refers to the gradual increase in the share of agricultural output that is sold, as opposed to being consumed directly by the farm household. This is a key component of the process of agricultural transformation. The immediate causes include rising agricultural productivity, generating a surplus which can be sold, and improvements in infrastructure which facilitate the sale of agricultural output. It is widely assumed that shifting from low-value staple food crops to higher-value commercial crops raises farm household income, although firmly establishing causality is not easy.

The patterns of agricultural transformation have been extensively researched at the national level, using cross-country analysis of the composition of gross domestic product (GDP), demographic data on urbanization, and employment data by sector. However, less research has been carried out on how these national trends are manifested at the household level.

This study will focus on the following research questions:

- Has the marketed share of crop production increased over time? Given the rapid economic growth in Ethiopia, we expect crop commercialization to have increased as part of the broader process of agricultural transformation.
- If so, how does the increase in commercialization vary across different types of households? For example, we would like to know whether the increase is limited to higher-income, larger

farmers in favorable locations or does it extend to poorer households with small farms in remote areas.

- What are the household-level determinants of crop commercialization, such as farm size, region, remoteness, sex of head of household, age of head of household, and income?
- Given that risk plays an important role in agricultural commercialization, is commercialization lower in areas characterized by low or unreliable rainfall?
- What are the household characteristics of more commercial farmers and how do they differ from more subsistence-oriented farmers? If risk is a major impediment to commercialization, we might expect households to start by marketing staple crop before moving toward non-perishable food crops and eventually high-risk perishable and non-food crops.
- Does commercialization contribute to higher income and better standard of living? Many programs assume that helping farmers shift into commercial agriculture will increase their income, but is this true?

The answers to these questions have important implications for the design and implementation of programs to increase income and reduce poverty in rural areas. Should the government and development partners promote agricultural commercialization to improve rural welfare? If so, should the programs be broad based or targeted at certain types of households and certain regions? And what are the constraints that prevent households from using commercial production to raise their incomes and standard of living?

This paper examines the trends and patterns in agricultural commercialization in Ethiopia over the period 2012 to 2019. Ethiopia makes a good case study for several reasons. First, it has experienced some of the highest rates of growth in per capita income of any country in the world. This makes it more likely that we can observe changes in agricultural transformation over a relatively short period of seven years. Second, the Ethiopian government has pursued a strategy of agricultural-led economic growth, making significant investments in rural infrastructure, creating an enabling environment for agricultural growth, and devoting resources to identifying and relieving obstacles to agricultural growth. Third, the study is facilitated by the availability of three highly comparable household surveys with relatively large samples (3,000 to 5,000 households) and a subsample of almost 1,900 households that form a panel.

The three surveys are the Agricultural Commercialization Cluster (ACC) Surveys of 2012, 2016, and 2019. They were carried out by the International Food Policy Research Institute (IFPRI) for the Ethiopia Agricultural Transformation Agency (ATA) with funding from the Bill and Melinda Gates Foundation. The Ethiopia ATA is a semi-autonomous development agency with the mandate to accelerate agricultural transformation in the country by testing new technology and institutional arrangements. The ATA was originally funded by the Bill and Melinda Gates Foundation and later attracted support from other international development organizations. The ATA focused on clusters of woredas in areas of high agro-ecological potential with the idea of improving the delivery and adoption of modern inputs, increasing crop and livestock productivity, raising the competitiveness of agricultural markets, and generally raising the standards of living in rural areas.

The paper is organized as follows. Section 2 describes previous theoretical and empirical research on agricultural commercialization with an emphasis on sub-Saharan Africa and Ethiopia. Section 3 provides an outline of the data and methods used in this study. Section 4 describes the results of the analysis of the three ACC Surveys. And Section 5 summarizes the results and discusses the implications for policy and programs.

2. Previous research on agricultural commercialization

One of the most salient characteristics of agriculture in low-income countries is the importance of subsistence food production. Most farmers grow crops and raise livestock on a relatively small scale, with farms of less than 2 hectares. A large share of their crop production consists of staple food crops, including cereals, cassava, and other inexpensive sources of calories. While few farmers are completely disconnected from the market, a large majority sell less than half of their crop production. In order to understand the agricultural commercialization, it is important to begin by explaining subsistence food production.

2.1. Economic rationale for subsistence food production

In an idealized world with perfect information, competitive markets, and no transaction costs, each farmer would produce the crop that maximizes profit, sell all of the crop, and use the revenue to purchase a utility-maximizing basket of consumer goods. Production decisions would be "separable" from consumption decisions in that the latter would have no effect on the former (Singh, Squire, and Strauss, 1986). Thus, an economic explanation for subsistence production must be linked to a violation of one of these assumptions.

For example, markets in the real world are characterized by transaction costs, that is the cost of getting to the market, finding a buyer, negotiating a price, and selling the product. Transaction costs are particularly important for small-scale farmers living in rural areas. In their seminal study, de Janvry et al. (1991) show that transaction costs (including the cost of transportation) between the farm and market creates a gap between the (higher) farm-gate purchase price and the (lower) farm-gate selling price of a staple food crop. The gap between the purchase price and the selling price will be large for farmers living in remote areas and relatively large for low-value staple grains. When transaction costs are significant, the shadow price of the crop at the farm level may well be too low to justify buying the commodity but too high to justify selling it. This creates a situation in which the rational farmer produces enough of a food crop for the consumption of the household, neither selling any of the production nor buying from the market. In other words, a farmer is "forced" to supply almost all his food requirements because of the high cost of selling crops or buying food. This breaks "separability" since now production decisions are influenced by consumption preferences. It also makes the farm-level supply inelastic to price changes over a range of prices and makes aggregate supply less responsive to prices. High transaction costs can also explain low use of purchased inputs like seed and fertilizer, which reduces productivity and income.

A second explanation is risk. Even without transaction costs, risk may be an obstacle to accessing agricultural markets. Most households avoid risk, but small farmers and others living at the margin of survival are particularly risk averse in their livelihood decisions because a negative shock to income could threaten their health and survival. Producing a food crop for own consumption certainly involves some risk: if the weather is bad, the harvest may be too small to feed the family. However, producing crops for the market involves multiple risks, including the risk of poor weather, the risk of a drop in the price of the cash crop, and the risk of an increase in the price of the food they need to buy. High-value crops such as vegetables introduce greater production risk (particularly if they are perishable) and high price risks because their prices tend to be more volatile. Thus, commercial crop production is likely to be riskier, which discourage farmers, particularly those that are more risk averse.

Third, producing some commercial crops may involve initial investments that are out of the reach of subsistence farmers. For example, switching from sorghum to vegetables is likely to involve higher costs for seed, fertilizer, and labor. And switching from a food crop to coffee requires a three-year wait before the first harvest. In economic terms, even if the investment is profitable, the farmer does not have the savings or access to credit that would be needed to cover the upfront costs. The lack of access to credit is linked to market failures such as lack of information on the part of lenders about creditworthiness of the farmer and the high costs of enforcing repayment.

In summary, economic theory suggests that, in an idealized world of competitive markets and perfect information, farmers who specialize in crops suited to their agro-ecological conditions and sell them will earn more than farmers producing a range of staple food crops for their own consumption. However, in rural areas of developing countries, most farmers grow a range of food crops for their own consumption and sell less than half of their crop output. Subsistence agricultural production can be explained by transaction costs, risk, and investment costs associated with commercial production. Relaxing these three constraints would allow farmers to produce for the market, thereby raising their income and improving food security.

2.2. Level of commercialization

A simple measure of commercialization is the proportion of farmers that participate in commercialization, meaning that they have some crop sales. Earlier research in Ethiopia estimated that about 57 percent of Ethiopian farmers were involved in selling crops (Pender and Alemu, 2007). In contrast, a recent study found that the share of farmers participating in the market was 90 percent in Malawi, 80 percent in Uganda, and 68 percent in Tanzania (Carletto et al., 2017).

A better measure of commercialization is the marketed share of crop production, which takes into account the degree of commercialization among those selling crops. Table 1 summarizes a number of studies on household crop commercialization by country and by crop type. The marketed share ranges from 17 percent to 72 percent, but roughly half of the estimates are in the range of 20-30 percent. In general, the literature suggests that a large share of farmers sell at least some crops, but most sell a relatively small share of their harvest.

Table 1. Estimates of the level of commercialization

Study	Country	Crop(s)	Marketed share of output (%)
Pender and Alemu (2007)	Ethiopia	Teff	24
Pender and Alemu (2007)	Ethiopia	Wheat	17
Gebremedhin & Jaleta (2010)	Ethiopia	All crops	25
Minot et al. (2015)	Ethiopia	Wheat	18
Mamo et al. (2016)	Ethiopia	Wheat	27
FAO (2019)	Ethiopia	Wheat	19
Muricho et al. (2017)	Kenya	All crops	37
Friesen and Palmer (2004)	Kenya	Maize	40
Carletto et al. (2017)	Malawi	All crops	17.6
Carletto et al. (2017)	Tanzania	All crops	27.5
Carletto et al. (2017)	Uganda	All crops	26.3
Agwu et al. (2013)	Nigeria	Cassava	29.6
Agwu et al. (2013)	Nigeria	Maize	24.0
Martey et al., (2012)	Ghana	Maize	53
Martey et al., (2012)	Ghana	Cassava	72
Martey et al., (2012)	Ghana	All crops	66

Note: It is not clear whether these figures represent the average marketed share or the total value of sales as a percentage of the total value of production. This distinction is discussed more in Section 3.2.

2.3. Determinants of agricultural commercialization

Given the variation in the commercialization, the next question is: what household and community level factors influence, or at least are correlated with, agricultural commercialization? At the household level, most discussion of commercialization starts from the premise that farmers must produce beyond their perceived consumption needs in order to participate in the market, which implies that higher productivity leads to higher degree of commercialization (Barrett, 2008; von Braun and Kennedy, 1994). Studies in many African countries have reported a positive correlation between levels of production and commercialization (e.g., Carletto et al. 2017, Pender & Alemu 2007, Gebremedhin and Jaleta 2010, Mamo et al. 2017). Thus, it is not surprising that many studies find that the degree of commercialization increases with farm size (Carletto et al., 2017). Research also found consistently strong positive associations, across multiple countries, crops and years, between crop sales, livestock ownership, credit access or other measures of wealth. Conversely, lower levels of output production are mainly associated with poor asset ownership and low adoption of production technologies.

Given the small farm size of many farms in sub-Saharan Africa and the difficulty of generating income above the minimum needed for subsistence, it is not surprising that studies generally find that farmers are risk averse (Guttormsen and Roll, 2014; Gebremedhin and Jaleta, 2010; Barrett, 2008; Aimin, 2010; Pandey, 2006). Risk aversion inhibits the adoption of purchased inputs, such as fertilizer and improved seed, because they involve certain costs and uncertain returns. For example, African average use of fertilizer is 11 kg of nutrients per hectare of arable land compared with the world average of 62 kg/ha (Obayelu et al., 2021). In this way, risk aversion reduces productivity and indirectly makes it more difficult to achieve marketable surpluses. There is evidence of this in research which shows a significant impact of the agricultural services on the intensity of input use, agricultural productivity and market participation of Ethiopian smallholders (Gebremedhin et al., 2009). Risk aversion can also directly inhibit production for the market because it exposes farmers to price risks and (for perishable crops) greater production risk.

Another set of factors influencing agricultural commercialization are related to access to infrastructure such as markets and roads. For example, long distance to the market leads to high costs of transportation, limiting both household level market participation and sales volume (Foster and Briceno 2010; Barrett, 2008). A study by Alene et al. (2008) in Kenya showed that transactions costs had a significant negative effect on the market participation of farmers in Kenya. Weak infrastructure and limited access to markets has also been identified as an obstacle to commercialization in developing Asian countries (Wiggins, 2018). Several studies find that poor access to roads is an important factor in reducing the level of commercialization (Key et al., 2000; Barret, 2007; Pender and Alemu, 2007; Alene et al., 2008; Yamauchi et al., 2009; Gebremedhin and Jaleta, 2010; Agwu et al., 2013).

2.4. Effects of agricultural commercialization

Agricultural commercialization has long been seen as a way out of poverty for smallholders (von Braun, 1995, Barrett, 2008, Gebremedhin and Jaleta, 2010). The effects of commercialization and smallholder agriculture has been the subject of several studies that typically focus on the impact on poverty and nutrition.

Studies exploring the impact of agricultural commercialization on income and poverty have found generally positive effects, though the magnitude depends on the local conditions. One of the largest studies examined the impact of agricultural commercialization on income using subnational surveys in seven countries: Guatemala, Kenya, Rwanda, Zambia, the Philippines, Papua New Guinea, and India (von Braun and Kennedy, 1994; von Braun, 1995). This study found that that commercialization significantly increased household income in six of the seven cases. A study conducted in Kenya found evidence that agricultural commercialization significantly increased per capita household expenditure among commercialized farms (Muricho et al., 2017). Studies in Kenya and the Central Africa Republic report a positive relationship between vegetable commercialization and welfare (Muriithi and Matz 2015, Ochieng et al., 2020).

Research on the impact of agricultural commercialization on nutrition has been somewhat more mixed. For instance, the summary of findings of early studies in Tanzania, Kenya, and Papua New Guinea is inconclusive, with the same crop type demonstrating either positive or no effects both between and within countries (Hitchings, 1982; Harvey and Heywood, 1983; Niemeijer & Hoorweg, 1994). In the seven-country study mentioned above, the impact of commercialization on nutrition was examined in six of the case studies, with three showing improve child nutrition and three showing no effect. More, recent studies in Africa seem to converge towards the importance of commercialization in improving household nutrition (Ogutu et al., 2017; Carletto et al., 2017; Montalbano, 2018). One study of Vietnam found mixed effects on nutrition, depending on the type of commercialization indicator used (Linderhof et al., 2019).

Higher income may not necessarily improve nutritional status for various reasons. There are cases where farmers prioritize non-food items, which often depend on knowledge, culture, and social groups (Radchenko and Corral, 2018). Some studies in the African context explore gender roles within the household (von Braun and Kennedy, 1994; Haddad et al., 1997; Fischer and Qaim, 2012). Incomes from cash crops (often male controlled) and from food crops (often female controlled) may be spent differently depending on the priorities of the member who earns it. According to Hoddinott and Haddad (1995), women tend to spend more on food and dietary quality than men, so nutrition impact depends partly on who earns the income. In sum, most research finds that agricultural commercialization has a positive effect on income and poverty reduction, while the impact on nutrition is mixed, with some evidence of a positive effect and some that is ambiguous or (occasionally) negative.

2.5. Agricultural policy in Ethiopia

After the collapse of its Soviet-inspired centralized planned economy, Ethiopia embarked on a more market-oriented strategy which would support the agricultural sector. Beginning in 1993, the government launched the Agricultural Development Led Industrialization (ADLI) strategy, with an emphasis on increasing agricultural productivity. A government document expressed this as follows: "the objective is to bring about a structural transformation in the productivity of peasant agriculture and the replacement of the command economy by an economic system driven by market forces" (MOFED, 1993).

Other development strategies followed including the *Plan for Accelerated and Sustained Development to End Poverty* (PASDEP) and two successive five-year *Growth and Transformation Plans* (GTPI and GTPII). Over the course of these strategies, the emphasis shifted from the productivity of smallholder agriculture toward increased agricultural commercialization as a key to further economic development. The second *Growth and Transformation Plan* stated that:

> Efforts have been made to implement strategies to improve productivity of smallholder farmers by disseminating effective technologies through the scaling up strategy, to conserve natural resources and improve irrigations, and to bring about a shift from subsistence agriculture to production of high value agricultural products. (NPC, 2016).

The latest major development strategy is the *Ten Year Development Plan: A Pathway to Prosperity*, which will run from 2021 to 2030. As stated in the description of the Plan:

> The main objectives of the agricultural development plan are to raise the incomes and livelihoods of farmers and pastoralists and end poverty by making agriculture more productive and competitive; to play a major role in the structural transformation of the economy, especially to satisfy the food and nutritional needs of the nation by modernizing agriculture; to supply raw material inputs for the industrial sector; to provide adequate quantities of exportable agricultural products that have added value… (FDRE, 2021).

Coupled with policy directives, there have been several major interventions that have sought to accelerate agricultural production and productivity as well as provide a safety net for more vulnerable farmers.

Beyond major policy documents, the Ethiopian Government has sought to better facilitate their stated agricultural goals with at least three major interventions. The Agricultural Growth Programs (AGP1 and AGP2) seek to increase production and commercialization in targeted, high potential woredas. As part of the AGP, the Agricultural Commercialization Cluster (ACC) initiative creates geographic clusters of primary agricultural commodities that are designed to support increasing production and productivity while better integrating commercialization activities of the locally targeted crops. While both AGP and ACC seek to enhance production in relatively high potential areas, the Productive and Safety Net Program (PSNP) is designed to improve food security and resilience for more marginalized rural households by creating a system to provide direct support to households vulnerable to food insecurity and hunger.

In the last 30 years, Ethiopian agricultural policy and interventions have transitioned from emphasis on increased productivity for poverty reduction to a more market-oriented approach that seeks to facilitate agricultural commercialization and diversification into high value crops as a way to raise income and improve the welfare of rural households.

3. Data and methods

3.1. Data

This analysis makes use of three rounds of the Ethiopia Agricultural Commercialization Cluster (ACC) Survey, carried out by the International Food Policy Research Institute for the Ethiopia Agricultural Transformation Agency (ATA). The analysis also uses rainfall data to construct indicators of weather risk.

Survey data

Each of the three ACC Surveys used a three-stage random sampling method for selecting households. They are designed to be representative of the rural areas of the four main regions of Ethiopia: Tigray, Amhara, Oromia, and the Southern Nations, Nationalities, and Peoples (SNNP). These four regions account for 86 percent of the population and more than 95 percent of the agricultural production in the country. The country was stratified by region and by ATA agricultural commercialization clusters (ACC). Within each ACC, we selected five woreda, two kebele in each selected woreda, and 15 rural households in each selected kebele. At each level, the units were selected using systematic random sampling. This would generate a sample of 150 rural households per ACC.

We also selected a sample of households in the four main regions but outside the ACCs by randomly selecting woredas, then two kebele in each selected woreda, and 15 rural households in each selected kebele. The non-ACC sample accounted for about 15-20 percent of the overall sample. In the 2016 and 2019 surveys, we followed the guidelines listed above but gave priority to woredas, kebeles, and households selected in previous rounds in order to maximize the number of panel households.

Because the number of ACCs increased over the years the survey was implemented, the sample size did as well, particularly between 2012 and 2016. The table below gives the main characteristics of the sample in each round of the ACC Survey.

Table 2. Characteristics of the sample of each round of the ACC Surveys

	2012 ACC Survey	2016 ACC Survey	2019 ACC Survey
Sample size (households)	3,000	4,991	5,311
Number of woreda	99	153	154
Number of kebele	200	334	355
Number of panel households	1,899	1,899	1,899

Sources: 2012, 2016, and 2016 ACC Surveys.

Figure 1 provides a map of the sample locations, with light dots used to indicate the woreda included in the full sample and dark dots to indicate those in the panel, included in all three rounds of the ACC Survey.

In each round of the ACC Survey, sampling weights were calculated as the product of three terms, one for each stage of the selection process. At each stage, the term is the inverse of the probability of selection. The sampling weights are used in the calculation of all averages and frequencies, but they are not used in the regression analysis.

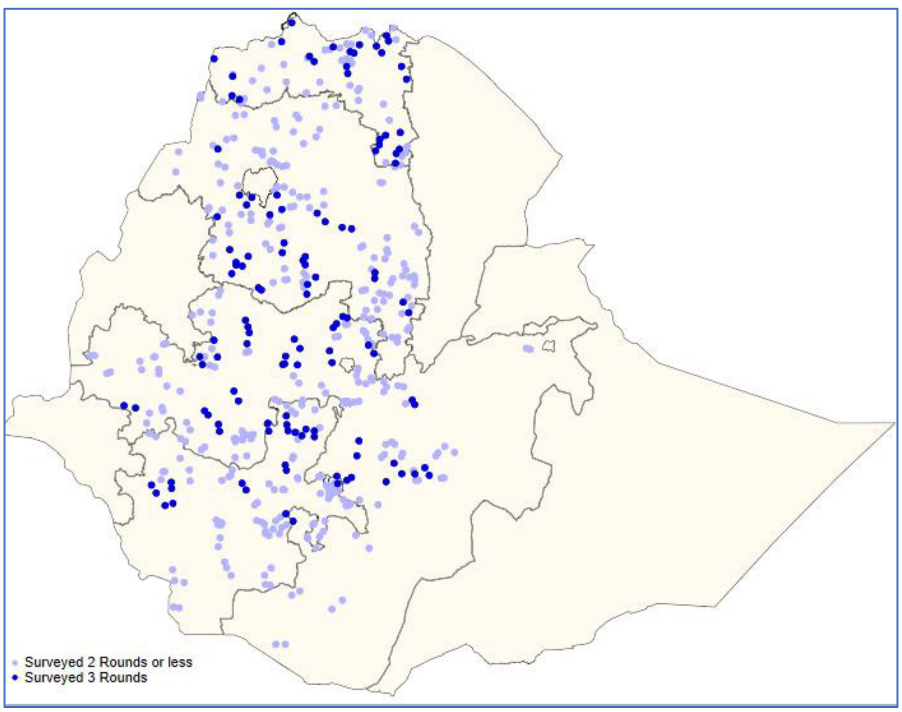

Figure 1. Map of the kebele in the full sample and those in the panel data sample
Source: GPS data from the 2012, 2016, and 2019 ACC Surveys.

The household questionnaire was quite similar across the three rounds of the ACC Survey, but there were some modifications, as shown in the table below. In the 2016 and 2019 rounds, the crop production module was expanded to include questions on production methods for selected crops targeted by the ATA. In 2019, the livestock module was streamlined, dropping questions about costs of production, purchase and sale of animals, home consumption, and use and sale of by-products. The 2019 livestock module was limited to collecting information on the number of each type of animal owned by the household. A food security model with questions on periods of food insecurity and level of diet diversity was added to the 2016 and 2019 questionnaire. And finally, the individual survey, with separate questions for the husband and wife, was added to the 2016 and 2019 versions of the questionnaire.

Table 3. Characteristics of the household questionnaire in each round of the ACC Surveys

	2012 ACC Survey	2016 ACC Survey	2019 ACC Survey
A. Characteristics of members	Yes	Yes	Yes
B. Housing and assets	Yes	Yes	Yes
C. Land ownership and use	Yes	Yes	Yes
D. Crop production	Yes	Yes + methods	Yes + methods
E. Crop input and labor use	Yes	Yes	Yes
F. Crop utilization & sales	Yes	Yes	Yes
G.Crop storage	Yes	Yes	Yes
H. Livestock	Yes	Yes	Only herd size
I. Non-farm income	Yes	Yes	Yes
J. Savings	Yes	Yes	Yes
K. Credit	Yes	Yes	Yes
L. Food & non-food consumption	Yes	Yes+food security	Yes+food security
M. Perceptions & opinions	Yes	Yes	Yes
O. Individual survey	No	Yes	Yes

Source: Questionnaires from the 2012, 2016, and 2019 ACC Surveys.

The ACC Surveys also included a community questionnaire, which was administered to woreda and kebele leaders where the household survey was implemented. However, the data from these interviews are not used in this paper.

Rainfall data

In addition to the survey data, the analysis makes use of rainfall data constructed from satellite imagery calibrated with data from weather stations. The Climate Hazards Group InfraRed Precipitation with Station (CHIRPS) is a database of rainfall covering 40 years and the spanning the area between 50° S and 50° N. The resolution of the data is 0.05°, so that each pixel is about 5.5 x 5.5 km. The CHIRPS data are generated by the Climate Hazard Center (CHC) at the University of California at Santa Barbara and the United States Geological Survey with funding from the United States Agency for International Development (USAID), the National Aeronautics and Space Administration (NASA), and the National Oceanographic and Atmospheric Administration (NOAA) (CHC, 2021).

3.2. Methods

This section describes the indicators used to measure agricultural commercialization, the research questions to be addressed, and the methods used to address those questions.

Indicators of commercialization

The main indicator of agricultural commercialization is the share of agricultural output that is sold. In this study, we focus on the commercialization of crop production, which represents the bulk of agricultural production in Ethiopia[1]. This indicator can be calculated at the crop level, the household level, or at the aggregate level. At the crop level, it is a simple ratio of quantities:

$$M_i = \frac{P_i X_i}{P_i Q_i} = \frac{X_i}{Q_i}$$

where M_i is the marketed share of crop i, P_i is the price of crop i, X_i is the quantity of sales of crop i, and Q_i is the quantity produced of crop i. At the household level, it is calculated in value terms:

$$M_h = \frac{\sum_i P_i X_i}{\sum_i P_i Q_i}$$

This has been called the household commercialization index (Strasberg et al., 1999).

The marketed share can be also calculated at the aggregate level, such as for the full sample or for all households of a certain type, such as female-headed farmers. Although previous research has not highlighted this point, there are two ways to calculate the aggregate market share of crops. The first is the average marketed share across households:

$$M_1 = \overline{M_h} = \frac{\sum_h M_h}{N}$$

where N is the number of households. The second way to calculate aggregate market share is the ratio of the value of total sales to the value of total production:

$$M_2 = \frac{\sum_h \sum_i P_{hi} X_{hi}}{\sum_h \sum_i P_{hi} Q_{hi}}$$

[1] Although it is possible to calculate the rate of commercialization for livestock production, the 2019 ATA survey did not include a module which would allow these calculations. Unlike the 2012 and 2016 surveys, the 2019 survey did not collect data on the purchase of livestock and livestock inputs, nor the the sale and home consumption of livestock and animal products.

The difference between M_1 and M_2 is that M_1 gives equal weight to each household (ignoring sampling weights for the moment), while M_2 gives greater weight to households with larger value of production. To distinguish the two, M_1 is called the average marketed share, while M_2 is called the ratio of sales to production. As shown in the box, the difference between M1 and M2 can be substantial because of the correlation between the value of production and the marketed share of the farm.

To illustrate the difference between M1 and M2, suppose that there are five semi-subsistence farmers and one large commercial farmer, as shown in the table below.

Farm number	Value of production	Value of sales	Marketed share
1	10	1	10%
2	10	1	10%
3	10	1	10%
4	10	1	10%
5	10	1	10%
6	50	35	70%
Total	100	40	

M1 is the average of the household-level marketed shares in the last column:

M1 = (10+10+10+10+10+70)/6 = 120/6 = 20%,

Box 1. Illustration of the difference between indicators of marketed share

M1 reflects the marketed share of the average farmer, while M2 indicates the share of total output that is sold, which is heavily influenced by large farmers, who tend to sell a large share of their output.

To calculate the value of production, it is necessary to use average or median prices for the same commodity in the kebele, district, region, or nation. To reduce the influence of outliers, we use the median rather than the mean. For the same reason, we typically use the lowest level price for which there are at least 5 or 10 observations. Again, to reduce the influence of outliers, the median price is used to calculate the value of both production and sales even if the household has a sales transaction.

Indicators of weather risk

As discussed in Section 3.1, we use CHIRPS data on rainfall. The data are first aggregated temporally to monthly totals over 1991-2019. We select the pixels that correspond to the 180 kebele that are included in the three-period panel of the ACC Surveys (the average kebele is about 37 km^2, while each pixel is approximately around 30 km^2). Finally, we focus on the rainfall during the main (meher) season, that is from April to September of each year. The minor (belg) season represents a small share of agricultural output, so it is excluded from our weather risk indicators.

For each round of the ACC Survey, we calculated three variables to represent the level of rainfall:

- The annual (meher) rainfall during the year prior to the ACC Survey, which would affect the size of the harvest being recorded in the survey.
- The average annual (meher) rainfall during the five years before the ACC Survey.
- The average annual (meher) rainfall during the ten years before the ACC Survey.

To measure the weather risk, we have two types of indicators. One is the variability of annual rainfall, calculated as the coefficient of variation of annual (meher) rainfall.

$$CV_a = \frac{s_a}{\mu_a} = \frac{[\sum(r_i - \mu_a)^2/(N-1)]^2}{\mu_a}$$

where s_a = the standard deviation of annual (meher) rainfall

μ_a = the mean of annual (meher) rainfall

r_i = the rainfall in year i

N = the number of years over which the CV is calculated

The other is the variability of monthly rainfall within the year. This measures the variation in monthly rainfall from the average monthly rainfall. The annual rainfall may show little variation from one year to the next, but if the monthly distribution of rainfall varies (for example, coming early some years and late others), this indicator will

$$CV_m = \frac{s_m}{\mu_m} = \frac{\left[\sum\left(r_j - \mu_m\right)^2/(M-1)\right]^2}{\mu_m}$$

where s_m = the standard deviation of monthly rainfall during the meher season

μ_m = the mean of monthly rainfall during the meher season

r_j = the rainfall in month j

M = the number of months over which the CV is calculated

These two measures of rainfall variability were calculated over five- and ten-year periods for each of the three rounds of the ACC Surveys.

Value of crop production and household income

To estimate the value of crop sales and crop production, we use average sale prices for the same commodity. If possible, we use the sales price for the same household and season. If the household has production but no sales of the crop, we use the average price for that woreda and season. If this is not available, we apply the average price for the woreda. And the last resort is to use the national average price for that commodity. At each level, the average price must not deviate too far from the national average to avoid outlier prices that may result from enumerator errors.

The calculation of income is based on the imputed value of crop production minus the cost of inputs such as seed and fertilizer, the net income from livestock production, net income from family-owned enterprises, income from wages and salaries, and other income such as rental and transfers received.

Analysis

The analysis of the three rounds of household survey data is carried out with descriptive statistics and econometric analysis. The descriptive statistics are useful for assessing the trends in commercialization over time and patterns in commercialization across different types of households. The results are easily interpreted, but we can only examine two or three variables at a time or can they be used to infer causality between variables. When examining descriptive statistics, we use the full sample of households in each round, taking advantage of the larger sample size and greater precision.

For questions related to causation, however, there is an advantage to econometric analysis of the balanced panel of households, that is, those that were interviewed in all three rounds of the survey. Econometric analysis with panel data allows us to control both observed and unobserved heterogeneity across households. There are three main approaches to econometric analysis of panel data.

- The random-effects model takes advantage of relationships between the dependent variable and the independent variables over time and across households. It generates coefficients for each independent variable that are a weighted average of the time-series and cross-sectional relationships, where the weights are the inverse of the variance of the respective coefficients. In other words, the stronger the relationships over time or across households, the more weight is given that relationship.
- The fixed-effect model relies entirely on the time-series relationship between the dependent variable and the independent variables. The estimated coefficients are equivalent to those that would result from including dummy variables for each household in the sample, which effectively control for all household characteristics, observed or unobserved. Thus, the fixed-effect model eliminates bias in the coefficients caused by time-invariant unobserved variables. The disadvantage, however, is that we cannot include any time-invariant characteristics (such as region) as explanatory variables.
- The correlated random effect model includes time-invariant variables, time-varying variables, and the household-means of the time variant variables. This model gives fixed-effect coefficients for the time-varying variables and coefficients for time-invariant variables based on the cross-sectional patterns.

However, the fixed-effect model and correlated random effect models do not address two other sources of bias. One is simultaneity bias, where the dependent variable influences one of the explanatory variables. The simplest way to avoid these biases is by selecting the explanatory variables that are not likely to be affected by the dependent variable. In our case, we avoid explanatory variables that are, for example, the result of farmer decisions, such as cooperative membership.

Another source of bias is confounding factors, meaning an unobserved variable that is correlated with both the dependent variable and one or more explanatory variables. For example, living near a town may increase off-farm income by offering employment opportunities and increase marketed share by reducing marketing costs. This could over-estimate the effect of non-farm income on marketed share. We can minimize this risk by thinking carefully about alternative paths of causal effects and avoiding explanatory variables that may have confounding factors.

Other ways to reduce the risk of simultaneity bias or confounding factors include instrumental variables and quasi-experimental methods. Instrumental variables regression involves finding a variable that is closely correlated with an explanatory variable but has no independent effect on the dependent variable. However, it is often difficult to identify a variable that is correlated with the endogenous explanatory variable but has not direct effect on the dependent variable. An instrumental variable regression model with weak instruments can easily generate a coefficient that are more biased than the ordinary least squares coefficient.

4. Patterns and trends in commercialization

In this section, we examine the patterns of crop commercialization across households and the trends in commercialization over the three rounds of the ACC Survey.

4.1. Characteristics of crop sale transactions

How do farmers in Ethiopia sell their crops? The results from the three rounds of the ACC Survey indicate that a large majority of crop sale transactions are to traders (74-83% over the three rounds), followed by consumers and other farmers (15-26%). Furthermore, traders have become more important over the three rounds. Few sales are to processors, cooperatives, or the government. The location of the transaction is generally at a kebele or woreda market (83-87%), followed by sales at the farm (6-12%). Woreda markets have become more important over time, suggesting that farmers are willing and able to travel farther to sell their crops. The travel time to the point of sale (when not at the farm) varies widely, but 44% of the sales took place within 30 minutes travel time and 74% within an hour of travel from the farm. Contract farming appears to be quite rare. Just 3% of crop sales were part of a contract or agreement with the buyer, and most of these were post-planting pre-harvest agreements. Finally, cooperatives do not play a significant role in crop marketing in Ethiopia. Although cooperatives are widespread in Ethiopia as part of government efforts to promote them, their main activity is the distribution of fertilizer, for which they are the only legal source for farm households. Among the 37% of rural households that have a cooperative member, most (80%) say the main reason is to access agricultural inputs. Only 5% of cooperative members mention assistance with crop marketing as an advantage of membership.

4.2. Trends in commercialization over time

How has the degree of crop commercialization changed over the three rounds of the ACC Survey? As discussed in Section 3.2, crop commercialization can be measured by the average marketed share across households (M1) or the share of total production that is sold (M2). Table 4 shows the overall trends in crop commercialization over 2012-2019 using the two indicators of commercialization, M1 and M2, and the two samples, the full sample and the panel households. It includes all farmers with crop production, whether they sold or not, but excludes households without crop production. We highlight three findings from this table.

First, the level of commercialization increased substantially between 2012 and 2019 according to all four measures. The final column indicates that commercialization increased by between 6 and 11 percentage points over this period. The average marketed share of crop production (M1) in the full sample rises between 2012 and 2016 but then falls slightly in 2019, while the other three indicators rise steadily across all three rounds of the survey.

Second, the average marketed share (M1) is much smaller than total sales as a share of total production (M2). The average marketed share is about 32-33 percent, in 2019 meaning that the average household sells roughly one-third of its crop production. However, M2 is about 49 percent in 2019, meaning that about half of all crop production was sold on the market. This relatively high figure suggests that the rural economy of Ethiopia is more commercialized than previously thought. As discussed in Section 3.2, M1 gives equal weight to each household, while M2 gives greater weight to households with larger crop production.

Finally, the table shows only modest differences in crop commercialization between the full sample (3,000-5,000 households per round) and the panel sample (1,899 households per round). For M1, the differences are 2-3 percentage points, while for M2 the differences are less than 1.4 percentage points.

Table 4. Crop commercialization over time (%)

Indicator	Sample	Year			Change over
		2012	2016	2019	2012-19
M1: Average market share (%)	Full sample	26.9	33.1	32.7	+5.8 ***
	Panel households	24.3	30.3	33.4	+10.1 ***
M2: Total sales as share of total production (%)	Full sample	38.6	46.0	48.5	+9.9 ***
	Panel households	38.4	44.7	49.1	+10.7 ***

Source: Analysis of 2012, 2016, and 2019 ACC Surveys.
Note: *** change over 2012-19 is statistically significant at the 1% level. ** at the 5% level.

The table only gives us the average values, but it is also useful to examine the distribution of households by the marketed share of crop production. Figure 2 gives this distribution for 2019, including all households with crop production. The share of producers that have no sales is 21 percent, roughly the same as in the 2012 and 2016 surveys. The proportion of farm households selling in the range of 1-10 percent of output is 5 percent, while the second most common category is those selling in the range of 20-29 percent.

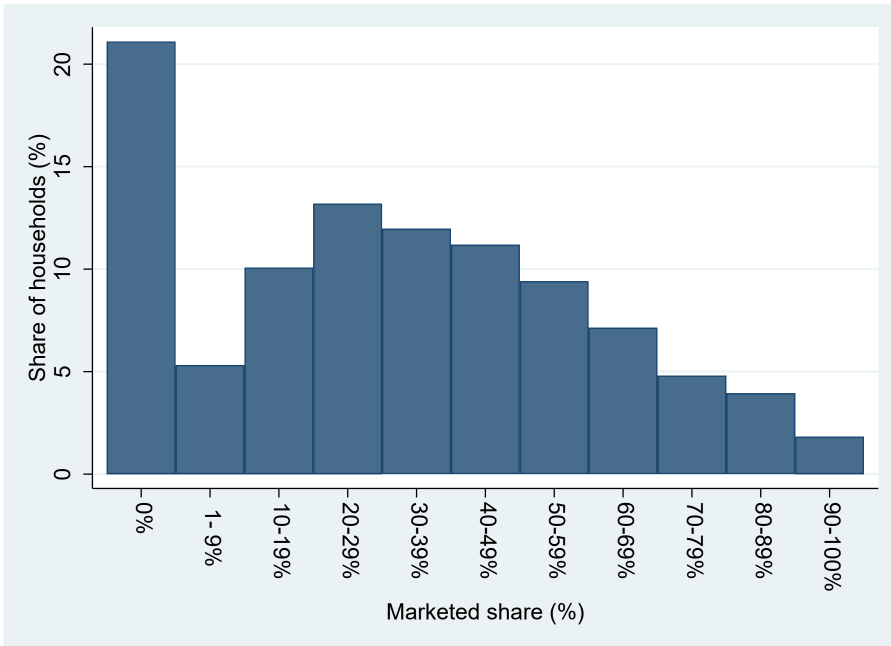

Figure 2. Distribution of households by marketed share in 2019

Source: Analysis of 2019 ACC Survey.

It is important to keep in mind that households can and do move between categories from one round to the next. For example, although roughly 20 percent of farm households had no crop sales in each round of the survey, they do not necessarily represent the same households. Looking at the panel data, for example, we find that only 5 percent of all farm households had no crop sales in all three years. Put another way, of the 20 percent of households with no crop sales in a given round, about three-quarters of them had crop sales in one or two of the other rounds of the survey.

Figure 3 shows the cumulative distribution of households by the share of crop production that is marketed for each round of the ACC Survey. Each point on the curved lines represents the percentage of crop-producing households (on the horizontal axis) that sell a given share of their output or less (on the vertical axis). Thus, the vertical red segment on the left side indicates the households with no crop sales account for 23 percent of all crop-growing households. The three vertical lines represent the mean values of the marketed share (M1) in each round of the survey. The fact that the cumulative distribution lines and the vertical mean lines shift to the right over time indicates that the marketed share has increased over time. Furthermore, this graph shows that the shift is not limited to the highly commercial households. For the period between 2012 and 2016, there is a rightward shift across the full range of marketed surplus, from those selling very little to those selling almost all. For the period 2016-19, the shift seems to be limited to those selling between 5 percent and 60 percent of their crop output, suggesting that the gains occurred among household with low to middle levels of commercialization, excluding highly commercialized households.

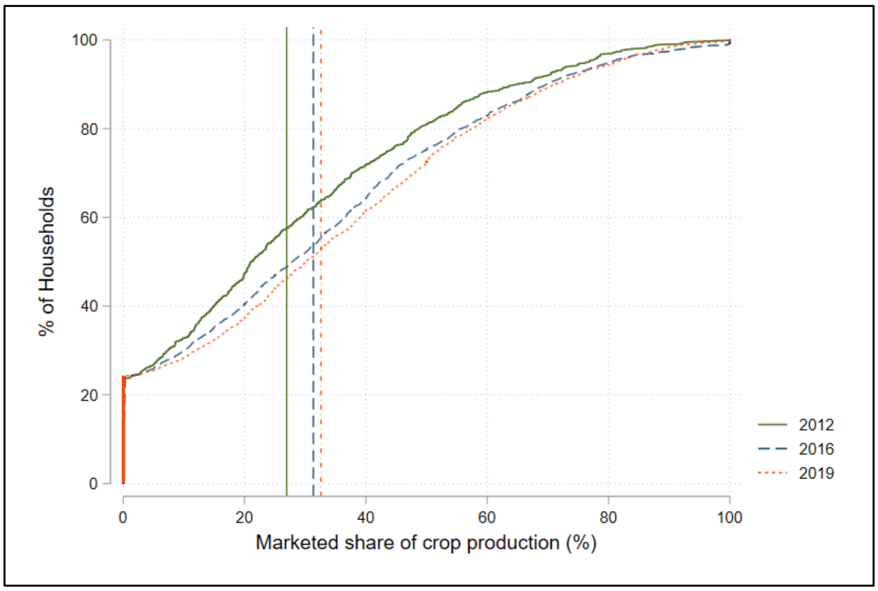

Figure 3. Cumulative distribution of marketed share by year

Source: Analysis of 2012, 2016, and 2019 ACC Surveys.

4.3. Patterns in commercialization across households

In this section, we examine how the marketed share of crop output varies across different types of households and regions. First, we present tables illustrating the relationship between marketed share and individual characteristics of households. Later, regression analysis is used to examine the determinants of crop commercialization in a more comprehensive way.

Relationship between marketed share and individual variables

Table 5 shows the average marketed share of crop production (M1) by round and by region. Farm households in Tigray are generally less commercialized than those in the other three main regions of Ethiopia. In 2012, the SNNP region was the most commercialized, probably because of the importance of coffee production. However, by 2019 Amhara and Oromia had caught up to the rate of the SNNP region. The last column shows that the increases in commercialization in Tigray and the SNNP region are statistically insignificant. On the other hand, farmers in Oromia and Amhara have experienced large and statistically significant increases in crop commercialization over this time.

Table 5. Patterns in market share of crops by region

	Year			Change
Region	2012	2016	2019	
Tigray	18.4	15.4	18.7	+0.3
Amhara	21.2	32.6	33.8	+12.6 ***
Oromia	29.3	30.3	33.5	+4.2 **
SNNP	35.9	34.6	34.5	-1.4
Total	26.8	31.0	32.4	+5.6 ***

Source: Analysis of 2012, 2016, and 2019 ACC Surveys.
Note: *** change over 2012-19 is statistically significant at the 1% level. ** at the 5% level.

Table 6 shows the patterns of crop commercialization for male- and female-headed households. The average marketed share of crop production is higher among male-headed households is 7-11 percentage points higher than among female-headed households. This is not surprising because female-headed households tend to be older, own smaller farms, and have lower per capita income, all of which are associated with being less commercialized. In the regression analysis presented later, we show that the independent effect of the sex of head of household on commercialization disappears when these (and other) factors are considered.

In addition to the differences in the level of commercialization by sex of head of household, it is worth noting that the increase in commercialization over 2012-2019 is large and statistically significant for male-headed households (+5.9 percentage points) but small and statistically insignificant for female-headed households. These results suggest that female-headed households are not participating as much in the trend toward greater crop commercialization.

Table 6. Patterns in market share of crops by sex of head of household

	Year			Change
Sex of head of household	2012	2016	2019	
Male	27.8	32.2	33.7	+5.9 ***
Female	20.7	21.6	22.6	+1.9
Total	26.8	31.0	32.4	+5.6 ***

Source: Analysis of 2012, 2016, and 2019 ACC Surveys.
Note: *** change over 2012-19 is statistically significant at the 1% level. ** at the 5% level.

Table 7 shows that the level of crop commercialization seems to vary with the age of the head of household. More specifically, it is lower among households whose head is 60 years or older. In addition, the change in commercialization over the period 2016-19 is large (almost +7 percentage points) and statistically significant for households with heads up to 69 years old, but statistically insignificant for those with older heads. Farm size and education are correlated with age, so this pattern may be related to these variables. The regression analysis (presented later) allows us to test for the independent effect of each age and other variables.

Table 7. Patterns in market share of crops by age of head of household

	Year			Change
Age of head (years)	2012	2016	2019	
20-29	27.8	33.7	34.6	+6.8 **
30-39	28.1	32.7	34.9	+6.8 ***
40-49	26.1	32.0	32.9	+6.8 ***
50-59	26.4	31.9	33.4	+7.0 ***
60-69	26.7	28.9	31.4	+4.7 **
70-79	27.2	21.1	25.0	-2.2
80 and above	19.3	16.5	18.1	-1.2
Total	26.8	31.0	32.4	+5.6

Source: Analysis of 2012, 2016, and 2019 ACC Surveys.
Note: *** change over 2012-19 is statistically significant at the 1% level. ** at the 5% level.

The relationship between the average marketed share of crop production and farm size is shown in Table 8. Across the farm-size categories, the average marketed share rises from about one-quarter in the smallest farms to close to one-half in farms with 5.0 hectares or more. This is not surprising because more land allows more crop production, making it easier to produce a surplus for sale. It is somewhat surprising that even farms with less than 0.5 hectares are able to sell (on average) about 25 percent of their crop output.

The last column shows the change in marketed share for each farm-size category. Households with at least 0.5 hectares and up to 5.0 hectares saw a statistically significant increase in commercialization over the period 2012-19. However, for very small farms (less than 0.5 ha) and large farms (over 5 ha), there is no statistically significant change in commercialization over this period. It is easy to understand that very small farms may not be able to (or wish to) commercialize given their limited production potential, but it is more difficult to understand why larger farms did not increase their level of commercialization over this period.

Table 8. Patterns in market share of crops by farm size

Farm size (ha)	Year 2012	Year 2016	Year 2019	Change
Less than 0.5	24.7	24.6	24.7	0.0
0.5 - 1.0	23.8	27.4	29.0	+5.2 ***
1.0 - 2.0	24.8	31.7	31.6	+6.8 ***
2.0 - 5.0	31.8	35.2	37.7	+5.9 ***
5.0 or more	47.8	46.8	48.1	+0.3
Total	26.8	31.0	32.4	+5.6 ***

Source: Analysis of 2012, 2016, and 2019 ACC Surveys.
Note: *** change over 2012-19 is statistically significant at the 1% level. ** at the 5% level.

As mentioned earlier, one factor that makes commercial crop production less profitable is the cost of getting crops to market and the cost of getting food from the market. Table 9 shows the averaged marketed share for households at different distances to a road, where distance is measured as a straight line to the nearest primary, secondary, or tertiary road. It is not surprising that the marketed share of crop production declines as distance to the nearest road increases. In 2012, the marketed share was 34 percent among those within 1.0 kilometer of a road, but less than 19 percent among those more than 4.0 kilometers from a road. Between 2012 and 2019, farmers in all three categories became more commercialized, but the change was statistically significant only for farmers more than 1 kilometer from a road. Furthermore, the largest increase in commercialization was among farms living more than 4 kilometers from a road. As a result, the differences in commercialization between those living near a road and those farther away have decreased dramatically over the period under study. This could reflect improved infrastructure, better taxi service, and/or wider ownership of motorbikes and mobile phones, which make distance less of an obstacle.

Table 9. Patterns in market share of crops by distance to road

Distance to road (km)	Year 2012	Year 2016	Year 2019	Change
Less than 1k	34.2	36.2	36.1	+1.9
1K to 4k	29.2	34.2	31.6	+2.4 **
Greater than 4k	18.8	28.8	31.3	+12.5 ***
Total	27.1	30.9	32.4	+5.3 ***

Source: Analysis of 2012, 2016, and 2019 ACC Surveys.

Table 10 shows the relationship between the marketed share of crop production and the quintile of per capita income. The quintile is defined separately for each round, so that 20 percent of the households fall in each category each year. The table indicates a strong correlation between per capita income and the marketed share of crop production. For example, in 2019, the poorest 20 percent of households sold an average of less than 17 percent of their crop output, while the richest 20 percent sold more than half of their crop output. On the one hand, richer households are better able to tolerate the risk associated with commercial crop production and better able to afford the additional input costs. On the other hand, more commercial crops generate higher monetary returns per hectare than staple food crops (as shown later), so commercialization also contributes to higher per capita income.

The last column of the table indicates that the third, fourth, and fifth income quintiles experienced large and statistically significant increases in the marketed share of crop production, ranging from 4.5 to almost 10 percentage point increases over 2012-19. However, the poorest 20 percent of rural households did not show any increase in commercialization over this period, and the second quintile experienced only weakly significant increases. In interpreting these results, it is important to recall that the table compares the poorest households in 2012 with the poorest in 2019, but they are not necessarily the same households.

Table 10. Patterns in market share by income quintile

	Year			Change
Per capita income quintile	2012	2016	2019	
Poorest	16.7	20.3	16.7	0.0
2nd	20.8	23.4	25.0	+4.2 *
3rd	23.8	27.2	31.0	+7.2 ***
4th	30.9	36.1	35.4	+4.5 ***
Richest	41.7	47.1	51.4	+9.7 ***
Total	26.8	31.0	32.4	+5.6 ***

Source: Analysis of 2012, 2016, and 2019 ACC Surveys.
Note: *** change over 2012-19 is statistically significant at the 1% level. ** at the 5% level. * at the 10% level.

As noted earlier, agricultural commercialization involves risks associated with the price of the commercial crop as well as the price of food crops. Furthermore, the production risks may be higher if the crop is perishable or requires purchased inputs. Thus, farmers are more likely to participate in commercial agriculture in areas where the weather risks are lower. We use CHIRPS rainfall data to examine the relationship between agricultural commercialization and the level and variability of rainfall. As explained in Section 2, the CV of inter-annual meher rainfall is the coefficient of variation of total rainfall over April-September across years. A low CV implies that total meher rainfall does not vary much from year to year. In contrast, the CV of intra-annual meher rainfall is the coefficient of variation of the monthly distribution of rainfall within each year. In this case, a low CV implies that the monthly distribution of rainfall between April and September is fairly stable.

Table 11 shows the variation of some of these rainfall indicators by region. As expected, Tigray has the lowest average rainfall, whether measured by the previous year or the previous five-year average. Amhara and Oromia have the highest average rainfall, while the rainfall in SNNP is close to the average. The last two columns show the coefficient of variation (CV) of inter-annual rainfall and intra-annual rainfall over the 5 years prior to each round of the ACC Surveys. According to both measures, the variability of rainfall is greatest in Tigray, with only small differences in rainfall variability among the other three regions. It is interesting to note that the average CV of inter-annual rainfall is just 13 percent, compared to the average CV of intra-annual rainfall of 25 percent. In other words, the distribution of rainfall within each year varies much more than the total annual rainfall varies between years.

Table 11. Rainfall patterns by region

Region	Mean meher rainfall in previous year (mm)	Mean meher rainfall over previous 5 years (mm)	5-year CV of inter-annual rainfall (%)	5-year CV of intra-annual rainfall (%)
Tigray	586	627	16	31
Amhara	937	1,014	13	25
Oromia	1,062	1,084	11	23
SNNP	992	990	13	23
Total	955	996	13	25

Source: Analysis of CHIRPS rainfall data.
Note: CV refers to the coefficient of variation. Rainfall data are from the meher season only (April-September) and only for the kebele where the ACC Survey was implemented. The time periods are relative to the three rounds of the ACC Surveys.

Having described some of the basic patterns in the rainfall indicators, we now look at how commercialization varies with the level and variability of rainfall. Table 12 shows the average marketed share across categories of 5-year average rainfall and across rounds. The general pattern is that the market share is higher among households that live in higher rainfall zones. There are some anomalies within each round, but the pattern of the cross-round averages in the last column is clear. The average marketed share is just 10 percent in zones with less than 500 mm, but it rises to almost 37 percent in zones with more than 1250 mm. This is not surprising as rainfall is often a binding constraint in Ethiopian crop production, so higher rainfall is associated with higher yields, allowing a larger portion to be sold.

Table 12. Market share by rainfall over previous 5 meher seasons

Rainfall	Year 2012	2016	2019	Total
Under 500 mm	12.7	7.7	8.6	10.0
500-750 mm	29.5	20.1	26.7	25.3
750-1000 mm	19.5	26.9	27.8	24.1
1000-1250 mm	24.8	35.2	43.0	32.3
Over 1250 mm	32.2	40.4	35.9	36.7
Total	24.3	30.3	33.2	28.7
N=	1,882	1,882	1,882	5,646

Source: Analysis of 2012, 2016, and 2019 ACC Surveys and CHIRPS rainfall data.

With climate change expected to increase the variability of rainfall, insights into the relationship between agricultural commercialization and rainfall variability seems increasingly pertinent. Table 13 gives the results for one measure of rainfall variability: the 5-year coefficient of variation (CV) of annual meher rainfall. In 2012, there is no apparent relationship between the market share and CV, but in 2016, 2019, and in the average across the three rounds, agricultural commercialization is inversely related to inter-annual rainfall variability. In zones with a CV of less than 5 percent, the average marketed share was 45 percent, but when the CV is above 15 percent, the average marketed share falls to 24 percent. It is likely that households who live in zones with unreliable rainfall are less willing to take on additional risk in the form of commercial crop production.

Table 13. Market share by CV of inter-annual rainfall over past 5 years

CV of inter-annual rainfall	Year 2012	2016	2019	Total
0-5%		46.2	44.4	45.4
5-10%	29.1	38.8	37.0	35.7
10-15%	21.7	26.8	33.7	25.4
15-20%	24.0	24.2	22.1	23.9
Over 20%	32.3	15.9	20.9	23.6
Total	24.3	30.3	33.2	28.7
N=	1,882	1,882	1,882	5,646

Source: Analysis of 2012, 2016, and 2019 ACC Surveys and CHIRPS rainfall data.

The other measure of rainfall variability is the coefficient of variation (CV) of intra-annual rainfall, which measures how much the monthly distribution deviates from the average monthly distribution. Again, we see an inverse relationship between rainfall risk and agricultural commercialization. Looking at the averages in the last column, a CV under 20 percent is associated with an average marketed share of 33 percent. As the CV rises, the marketed share declines to around 20 percent in the two highest-CV categories.

Table 14. Market share by CV of intra-annual rainfall over past 5 years

CV of intra-annual rainfall	Year 2012	2016	2019	Total
Under 20%	26.0	45.2	41.0	33.1
20-25%	23.0	36.7	36.7	30.8
25-30%	24.3	26.8	19.2	25.3
30-35%	19.3	19.7	31.2	24.6
35-40%	16.4	14.0	24.8	19.0
Over 40%		21.5	21.2	21.4
Total	24.3	30.3	33.2	28.7
N=	1,882	1,882	1,882	5,646

Source: Analysis of 2012, 2016, and 2019 ACC Surveys

Regression analysis of marketed share

The tables above show the marketed share of crop production for different types of households, examining one household characteristic at a time. Regression analysis allows us to estimate the independent effect of each characteristic on the marketed share of crop production while controlling for other characteristics.

Ideally, all the household characteristics should be exogenous; otherwise, the coefficients could be affected by endogeneity bias. From Table 10, we know that there is a strong positive relationship between per capita income and marketed share. However, it is risky to include income as an explanatory variable because income is probably influenced by the dependent variable, marketed share. In the regression analysis, we use an asset index instead of income per capita, reflecting the fact that tolerance of the risks associated with commercialization is probably related to the wealth of the household. The asset index is generated using principal components analysis and data on ownership of a series of consumer assets including radio, television, bicycle, motorbike, electric fan, and various furniture. Even if the level of commercialization influences income, the effect on wealth would be indirect and lagged since higher income is not always or immediately converted into ownership of consumer assets.

Table 15 gives the results of three regression models that estimate the marketed share of crop production as a function of various household and weather characteristics. The first column gives the results of the fixed-effect model, which only uses over-time within-household relationships to estimate the coefficients. The second column shows the output from the random effects model, which incorporates both within-household and across-household relationships but may be biased by unobserved heterogeneity across households. The third column gives the results of the correlated random-effects model, which gives fixed effect coefficients for variables that vary over time but also provides estimates of time-invariant variables such as region.

In the fixed-effect model, crop commercialization has positive and statistically significant coefficients for household wealth (as measured by the asset index), farm size, and the dummy variables for 2019. In other words, holding constant other variables, wealthier households sell a larger share of their crop production, as do households with larger farms. Furthermore, the marketed share of production was higher in 2019 than in 2012, even holding constant farm size

Table 15. Panel data regression analysis of determinants of marketed share

Variables	Fixed effect model	Random effects model	CRE model
Female-headed household	1.067	-0.242	0.361
	(0.55)	(0.21)	(0.19)
Age of head (years)	-0.095	-0.224	-0.088
	(1.89)*	(7.72)**	(1.80)
Education of head (yrs)	0.104	0.026	-0.029
	(0.85)	(0.27)	(0.31)
Education of spouse (yrs)	0.158	0.107	0.042
	(0.86)	(0.73)	(0.29)
Asset index	0.659	2.183	0.738
	(2.05)**	(9.01)**	(2.32)*
Farm land owned (ha)	1.355	3.186	1.324
	(4.76)***	(14.69)**	(4.69)**
Meher rainfall in prior year (mm)	-0.017	-0.007	-0.018
	(4.54)***	(1.89)	(4.74)**
Mean meher rainfall over	0.032	0.016	0.031
previous 5 years (mm)	(4.00)***	(4.04)**	(4.02)**
CV of inter-annual meher rainfall	-31.429	-30.025	-35.483
over 5 years	(2.66)***	(2.88)**	(3.04)**
CV of intra-annual meher rainfall	19.682	-7.393	23.625
over 5 years	(1.88)*	(0.82)	(2.28)*
yr2016	-0.090	2.814	-0.497
	(0.08)	(2.84)**	(0.44)
yr2019	2.921	5.107	2.451
	(2.73)***	(5.61)**	(2.33)*
Amhara		8.225	10.714
		(5.69)**	(7.50)**
Oromia		-4.282	-7.695
		(3.06)**	(5.38)**
SNNP		3.221	-1.354
		(2.15)*	(0.82)
Distance to road (km)		-0.467	-0.437
		(4.77)**	(4.49)**
Mean of female head			0.734
			(0.32)
Mean of age of head			-0.209
			(3.54)**
Mean of farm size			3.799
			(8.78)**
Mean of asset index			2.893
			(6.12)**
Mean of prev yr rainfall			0.084
			(7.38)**
Mean of 5-yr rainfall			-0.092
			(7.05)**
Mean of 5-yr CV ann rain			10.693
			(0.44)
Mean of 5-yr CV mon rain			-56.425
			(2.73)**
Constant	15.670	29.721	44.871
	(1.87)*	(9.11)**	(8.77)**
R^2	0.03		
N	5,200	5,200	5,200

Source: Analysis of panel data in ACC Surveys of 2012, 2016, and 2019. Note: * $p<0.1$; ** $p<0.05$; *** $p<0.01$

and household wealth. Regarding the weather variables, as expected, the marketed share is positively related to average rainfall over 5 years and negatively related to inter-annual variability in rainfall. Contrary to expectations, it is negatively related to the rainfall the previous year.

The random effects model shows similar results for household wealth, farm size, and the year dummies. In addition, the age of the head of household and distance to the nearest road have negative effects on marketed share. Finally, farmers in Amhara sell more of their output than farmers in Tigray (the reference region) while those is Oromia sell less, holding other variables constant. Regarding the weather variables, the marketed share is positively related to the 5-year average rainfall and negatively related to inter-annual variability in rainfall. As in the fixed effect model, intra-annual variability in rainfall is not statistically significant at the 5 percent level.

The correlated-random-effects (CRE) model is a hybrid between the fixed-effects model and the random-effects model. For variables that are fixed over time, such as region, the coefficient is based on the between-household relationship. For variables that vary over time, such as income, the model includes both the original variable and the household-level mean of the variable. Because of the presence of the household level mean, the coefficient on the original variable is equivalent to the fixed-effect coefficient. The coefficients on the household-mean variables indicate the difference between the within-household estimates and the between-household estimates.

As with the other two models, the CRE model indicates that crop commercialization is positively associated with household wealth and farm size. The coefficient implies that each additional hectare is associated with a 1.3 percentage point increase in the marketed share of crop production. Commercialization rates are 11 percentage points higher among households in Amhara and 8 percentage points lower in Oromia than in Tigray, after controlling for other factors. Distance to road is negatively related to crop commercialization, which each additional kilometer reducing the marketed share by 0.4 percentage points.

As in the previous models, several weather indicators are statistically significant. The marketed share of output is positively related to the 5-year average rainfall, with every 100 mm of increased rainfall being associated with a 3 percentage point increase in marketed share. Marketed share is negatively related to inter-annual variability in rainfall, with a 10 percentage point increase in the CV being associated with a 3.5 percentage point increase in marketed share.

The coefficient on rainfall of the previous year is significant and negative, contrary to expectations, though the magnitude is small.

As noted above, the coefficients on the household-level means of the time-varying variables (toward the bottom of Table 15) indicate the difference between the within-household effect and the between-household effect. These coefficients indicate that the between-household effect of age on market share is negative and significant. The between-household effects of farm size and assets on marketed share are even larger than the within-household effects. It should be noted that the between-household effect of last-year's rainfall is positive and significant, as expected. Finally, the between-household effect of intra-annual variability in rainfall is statistically significant (unlike the within-household effect) and negative, as expected. It is worth noting that the within-household cross-round variation in several of these variables (such as age, farm size, assets, and rainfall) is likely to be modest, which may explain why some are statistically insignificant or counter-intuitive.

4.4. Patterns of commercialization by crop

The previous section focused on the factors associated with the household level marketed share of crop production. In this section, we focus on crop-level patterns of commercialization.

Commercialization by crop

Table 16 gives the average marketed share of each crop in each round of the ACC Survey, which we have labeled M1. In 2012, the most commercialized crops were chat, "other crops", fruit, and coffee, all of which have marketed shares over 60 percent. Oilseeds and vegetables have average marketed shares over 40 percent, but almost all other crops have shares under 30 percent. The least marketed crops are millet, enset, barley, and sorghum (under 10 percent), followed by wheat, maize, black teff, white teff, other cereals, and faba beans (10-20 percent). This pattern is not surprising, given that the cereals tend to be the least expensive sources of calories, so it makes sense that they would be a large part of the diet for rural households.

The percentages are quite similar in 2016 and 2019. In fact, the Pearson correlation coefficient for the percentages in 2012 and 2019 is 0.91, indicating a close correlation between the two sets of percentages. Millet, enset, barley, and sorghum remain the least commercialized crops in 2019, and chat, coffee, and fruit remain among the most commercial crops.

The last column shows the changes in the average marketed share between 2012 and 2019. Fifteen of the twenty crops show an increase in the commercialization share. The largest increase is for vegetables, which rose from 44 percent in 2012 to 64 percent in 2019. Other crops showing large increases in marketed share are potatoes, oilseeds, and "other cereals" (including rice). The crops whose marketed share declined are faba beans, haricot beans, fruit, chat, and coffee.

Table 16. Average marketed share of production by crop and round (%)

Crop	Year			Change
	2012	2016	2019	
White teff	19.8	28.9	29.0	+9.2
Black teff	12.3	15.2	14.7	+2.4
Barley	7.5	12.8	14.1	+6.6
Wheat	12.1	17.0	21.8	+9.7
Maize	12.0	16.4	18.6	+6.6
Sorghum	8.0	10.8	13.5	+5.5
Millet	3.3	9.4	9.6	+6.3
Other cereals	16.4	23.5	30.7	+14.3
Faba beans	19.1	18.8	17.1	-2.0
Haricot beans	29.9	35.9	27.0	-2.9
Other pulses	29.1	30.6	35.5	+6.4
Oilseeds	57.0	73.5	75.4	+18.4
Vegetables	44.4	50.1	64.0	+19.6
Fruits	62.5	54.9	55.3	-7.2
Potato	20.8	31.1	39.6	+18.8
Other roots	32.6	14.9	50.7	+18.1
Chat	76.8	81.5	70.3	-6.5
Coffee	61.4	55.1	52.3	-9.1
Enset	3.8	7.2	7.5	+3.7
Other crops	69.2	65.2	57.5	-11.7
Total	27.7	32.3	33.5	+5.8

Source: Analysis of 2012, 2016, and 2019 ACC Surveys.

Table 17 is similar to the previous table except that it shows total sales as a percentage of total production (M2) rather than the average marketed share (M1). The same general patterns are found in this table: the staple food crops (including cereals and enset) are the least commercialized, while coffee, chat, oilseeds, fruits, and vegetables are highly commercialized. The main difference is that the proportion of total production that is sold (M2) is considerably higher than the average marketed share (M1). For example, the average marked share of coffee in 2019 was slightly over half, while the share of total coffee production sold was more than 70 percent. As discussed earlier, this is because M2 gives greater weight to households with more production, and these households tend to sell as larger share of their production.

Looking at the last column, potatoes, fruit, and other roots experienced dramatic increases in commercialization between 2012 and 2019, rising by more than 25 percentage points. Over this period, the increase in commercialization was almost 20 percentage points for wheat and sorghum and more than 10 percentage points for white teff, barley, "other pulses", and vegetables.

Table 17. Sales as a share of total production by crop

Crop	Year 2012	Year 2016	Year 2019	Change
White teff	24.4	33.4	37.3	+12.9
Black teff	17.3	20.5	22.5	+5.2
Barley	14.6	21.3	26.1	+11.5
Wheat	23.3	32.6	43.0	+19.7
Maize	27.3	31.5	35.3	+8.0
Sorghum	11.2	21.0	30.2	+19.0
Millet	10.1	16.2	17.7	+7.6
Other cereals	28.3	40.7	48.8	+20.5
Faba beans	30.5	30.4	29.6	-0.9
Haricot beans	45.6	60.5	41.2	-4.4
Other pulses	39.3	50.8	52.3	+13.0
Oilseeds	84.3	87.4	89.8	+5.5
Vegetables	74.3	81.8	85.1	+10.8
Fruits	48.8	62.8	78.0	+29.2
Potato	32.2	47.7	59.8	+27.6
Other roots	49.4	29.5	86.5	+37.1
Chat	79.6	96.3	84.3	+4.7
Coffee	76.4	79.5	71.9	-4.5
Enset	9.0	12.9	12.7	+3.7
Other crops	84.0	84.2	76.1	-7.9
Total	38.1	45.5	48.9	+10.8

Source: Analysis of 2012, 2016, and 2019 ACC Surveys.

Figure 4 shows the information in Table 18 in graphic form. In addition, the crops are sorted by the level of commercialization in 2012. For 16 of the 20 crops and crop categories, the marketed share in 2019 (orange squares) is greater than the share in 2012 (green circles). This shift to the right reflects increasing commercialization for most crops and crop categories.

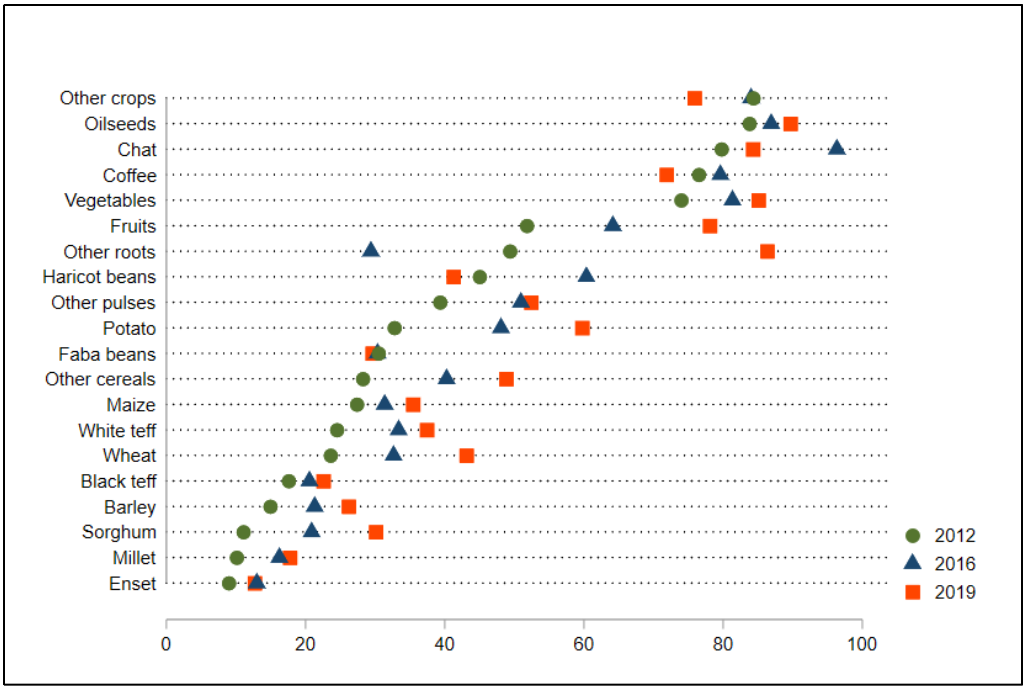

Figure 4. Total sales as a share of total production by crop (%)

Source: Analysis of 2012, 2016, and 2019 ACC Surveys.

Decomposition of crop commercialization

As discussed above, the agricultural sector has become noticeably more commercialized even over the relatively short period of 2012-2019. The average marketed share of crop production (M1) has increased between 6 and 10 percentage points over this period, depending on which sample of households we use. Similarly, the total value of sales as a proportion of crop production (M2) has increased between 10 and 11 percentage points over this period (see Table 4).

The increase in average commercialization can be caused by two trends. On the one hand, the increase in commercialization can be caused by farmers shifting from subsistence crops to commercial crops. This process, diversification toward high-value commercial crops, is usually given the most attention in the literature. On the other hand, the increase in commercialization can be the result of an increase in the commercialization of individual crops, even without any change in the crop mix.

This section examines the relative importance in Ethiopia of these two trends. In other words, how much of the increase in crop commercialization over 2012-2019 can be attributed to farmers changing their crop mix toward more commercial crops and how much is due to the increase in commercialization of individual crops?

Table 18 shows the 20 crops and crop categories organized by level of commercialization, measured by total sales as a proportion of the value of production (M2) averaged over the three rounds of the ACC Survey. The crops are sorted by level of commercialization and divided into three groups with low, medium, and high commercialization. The first column indicates the value of sales as a percentage of the value of production (the sorting variable). The second and third columns give the proportion of the total value of crop production in 2012 and 2019. The final column gives the change in the percentage between 2012 and 2019. If there is a shift from subsistence crops to more commercial crops, we will see negative changes for subsistence crops and positive changes for commercial crops.

The results show that the crops in the low-commercialization category have in fact declined in their contribution to the value of crop production, falling from 39 percent to 32 percent of the total. This is due to substantial reductions in sorghum and faba beans, as well as smaller declines in most other crops. In contrast, crops in the medium-commercialization category have increased their contribution to the total value of crop production, rising from 31 percent to 43 percent of the total. This increase is led by wheat, white teff, and other cereals (including rice). Finally, contrary to expectations, the crops in the high-commercialization category have declined in their contribution, from 30 percent to 25 percent of total crop value. Although vegetables and chat have increased in their contribution, this was more than offset by decreases in coffee, fruit, and other crops. In summary, there is evidence of farmers shifting production from staple food crops to somewhat more commercial crops, such as teff, wheat, and potatoes, we do not see a shift to high-commercialization crops like coffee.

Table 18. Level of commercialization and change in crop mix over 2012-19

Crop	Sales as a share of output (%)	Composition of the value of crop production (%) 2012	Composition of the value of crop production (%) 2019	Change in share of crop value
Enset	11.5	3.8	3.0	-0.8
Millet	14.7	0.9	1.8	0.9
Black teff	20.1	4.4	4.3	-0.1
Barley	20.7	5.1	6.4	1.3
Sorghum	20.8	8.5	2.9	-5.6
Faba beans	30.2	4.0	1.7	-2.3
Maize	31.4	12.3	11.9	-0.4
Subtotal	--	39.0	32.0	-7.0
White teff	31.7	9.0	11.3	2.3
Wheat	33.0	11.8	18.7	6.9
Other cereals	39.3	1.4	4.0	2.6
Potato	46.6	2.5	3.9	1.4
Other pulses	47.5	5.1	4.6	-0.5
Haricot beans	49.1	0.9	0.8	-0.1
Subtotal	--	30.7	43.3	12.6
Other roots	55.1	1.1	1.2	0.1
Fruits	63.2	3.3	1.3	-2.0
Coffee	75.9	8.3	4.7	-3.6
Vegetables	80.4	6.9	9.7	2.8
Other crops	81.4	6.7	2.4	-4.3
Chat	86.7	1.0	1.7	0.7
Oilseeds	87.2	2.9	3.8	0.9
Subtotal	--	30.2	24.8	-5.4
Total	--	100.0	100.0	0.0

Source: Analysis of 2012, 2016, and 2019 ACC Surveys.

This analysis sheds light on the changes in crop mix of Ethiopian farmers, but it does not quantify the contribution of changing crop mix on the overall rate of commercialization. The contribution of the change in crop mix can be estimated by asking: how much the average commercialization rate would increase if the level of commercialization for each crop remained at its 2012 level but the composition of crop production shifted as it did between 2012 and 2019? The result of these calculations (shown in Annex 1) is -2.0 percentage points. This means that the change in composition of crop production between 2012 and 2019 had a slightly negative effect on the overall increase in commercialization over that period.

The contribution of the increase in crop-level commercialization can be estimated by asking: what the change in overall commercialization would be if the commercialization of each crop changed as it did over 2012 to 2019, but the composition of crop production remained what it was in 2012? This can be calculated as the weighted average change in crop-level commercialization, where the weights are the share of each crop in the total value of crop production in 2012. The result of this calculation (shown in Annex 1) is 10.1 percentage points.

Given that the actual change in overall commercialization (M2) was 9.9 percentage points (see Table 4), this factor accounts for all (more than 100 percent) of the observed change in commercialization.

In summary, the results of the three rounds of the ACC Survey indicate that all the increase in crop commercialization that occurred in Ethiopia over 2012-19 was the result of increases in the commercialization rate of individual crops. The changes in crop mix by themselves do not contribute at all to the increase in the overall rate of commercialization.

5. Differences between subsistence and commercial households

This section examines the differences between subsistence and commercial households in Ethiopia. We divide the sample of farm households into three groups, those farm households selling 10 percent or less of their crop production, those selling in the range of 11-50 percent, and those selling more than 50 percent. The first and third categories each represent roughly one quarter of farm households, while the middle category accounts for slightly less than half of the farm households. About 6 percent of the rural households in the ACC Surveys do not grow crops, relying instead on income from livestock, small businesses, wages, and other sources. These households are excluded from the tables in this section.

5.1. Household characteristics

Table 19 shows some basic characteristics of farm households by level of commercialization. Commercial households (in the third column) appear to be somewhat younger, less likely to be female headed, and slightly more educated than subsistence households (in the first column), but the differences are not large. Commercial households own twice as much land, have more livestock, and live somewhat closer to a road. The crop income of the most commercialized category of farmers is four times as great as that of the subsistence farmers, and they earn more from livestock as well. However, highly commercialized farms with a high level of crop commercialization earn less from agricultural and non-agricultural wages and from remittances. The per capita income of highly commercial farmers is roughly 2.6 times greater than that of subsistence farmer. Furthermore, more commercial farmers have greater diet diversity, based on the number of food categories consumed over a week among 12 categories. Thus, the results suggest that highly commercialized households are, in general, better off than less commercial and subsistence farmers.

Table 19. Characteristics of farm households by level of commercialization

Variable	Marketed share of crop production 0-10%	11-50%	50-100%	Total
Household size	5.7	6.0	6.0	5.9
Age of head (years)	48.5	47.0	45.5	47.1
Femaled headed households (%)	14.4	8.7	8.7	10.3
Education of head (yrs)	2.8	3.2	3.6	3.2
Farm land owned (ha)	1.2	1.7	2.4	1.7
Number of plots	5.9	9.3	9.2	8.3
Livestock (TLU)	3.5	4.4	4.8	4.3
Distance to road (km)	4.3	4.0	3.4	3.9
Real value of crop production (birr)	12,737	28,706	54,160	30,560
Real value of crop sales (birr)	291	9,026	39,043	14,163
Marketed share (%)	1.3	29.7	68.9	31.5
Real crop income (birr)	11,061	24,271	44,139	25,501
Real livestock income (birr)	5,365	6,294	7,619	6,362
Real enterprise income (birr)	2,585	2,282	3,623	2,714
Real ag. wage income (birr)	229	137	115	158
Real non-ag. wage income (birr)	1,299	779	1,039	998
Real remittance income (birr)	488	320	264	355
Real per capita income (birr)	4,053	6,234	10,536	6,699
Real per capita expenditure (birr)	8,167	8,407	10,136	8,780
Household dietary diversity score	5.6	6.1	6.5	6.0

Source: Analysis of 2012, 2016, and 2019 ACC Surveys.

5.2. Composition of crop production and sales

Are the patterns of crop production and sales different for subsistence and commercial farmers? Table 20 gives the composition of the value of crop production for each type of farm household, averaged across the three rounds of the survey. Looking first at the last column, the most important crops in Ethiopia in terms of the value of production are wheat (14 percent of the total value), maize (12 percent), and white teff (10 percent). If we consider white and black teff together, then teff is tied with wheat as the most valuable crop in the country. These crops are followed by vegetables (8 percent), coffee (7 percent), and barley (6 percent). It is interesting to note that although coffee is the most important export crop in Ethiopia, it is ranked fifth most important in terms of the value of production.

We can identify several crops that are more important (as a share of the value of crop production) for subsistence farmers than for commercial farmers, including black teff, barley, wheat, sorghum, millet, and enset. On the other hand, some crops are much more important for commercial farmers, the most dramatic cases being coffee and vegetables. Coffee accounts for just 1 percent of the value of production among those farms selling in the range of 0-10 percent of their crop production, but 12 percent of the value of production among those selling more than half of their crop output. Similarly, vegetables represent just 2 percent for subsistence farmers but 15 percent among the highly commercialized farms. Other crops that are more important for commercial farmers than for subsistence farmers are oilseeds, chat, and "other crops".

Table 20. Composition of the value of crop production by level of commercialization

Crop	Marketed share 0-10%	11-50%	50-100%	Total
White teff	9	14	5	10
Black teff	6	5	2	4
Barley	12	7	3	6
Wheat	16	16	11	14
Maize	11	13	11	12
Sorghum	8	5	4	5
Millet	2	2	1	1
Other cereals	2	2	3	3
Faba beans	3	4	1	3
Haricot beans	1	1	1	1
Other pulses	5	6	4	5
Oilseeds	1	1	7	4
Vegetables	2	4	15	8
Fruits	3	1	2	2
Potato	3	4	2	3
Other roots	1	1	1	1
Chat	0	1	4	2
Coffee	1	4	12	7
Enset	12	5	3	5
Other crops	1	3	8	5
Total	100	100	100	100

Source: Analysis of 2012, 2016, and 2019 ACC Surveys.

Table 21 shows the importance of each crop in crop sales rather than production. Starting with the overall composition of sales in the last column, we see that vegetables are the most important source of crop sales revenue, accounting for 15 percent of the total. Vegetables are followed in importance by coffee (12 percent), wheat (11 percent), "other crops" (9 percent), and maize (8 percent). In other words, vegetables have become a more important cash crop than coffee, and wheat is close behind coffee.

The crops that are more important as a source of cash revenue for subsistence farmers than commercial farmers are black teff, barley, sorghum, millet, and enset, very similar to the list in the previous table. On the other hand, the crops that are a larger source of cash revenue for commercial farmers are coffee, vegetables, and chat. These three crops account for just 10 percent of the sales revenue of subsistence farms but they represent 40 percent of the sales revenue for commercial farmers who sell more than half of their production.

Table 21. Composition of the value of crop sales by level of commercialization

	Marketed share			
Crop	0-10%	11-50%	50-100%	Total
White teff	9	14	4	7
Black teff	6	4	1	2
Barley	5	4	2	3
Wheat	10	13	9	11
Maize	7	10	7	8
Sorghum	3	2	2	2
Millet	1	1	0	0
Other cereals	2	2	3	2
Faba beans	5	4	1	2
Haricot beans	3	2	1	1
Other pulses	10	8	4	5
Oilseeds	7	3	9	7
Vegetables	3	8	19	15
Fruits	2	2	3	3
Potato	4	6	3	4
Other roots	0	1	1	1
Chat	2	2	6	4
Coffee	5	7	15	12
Enset	2	1	1	1
Other crops	14	6	10	9
Total	100	100	100	100

Source: Analysis of 2012, 2016, and 2019 ACC Surveys.

6. Effect of agricultural commercialization on household welfare

The case for agricultural commercialization relies mainly on the hypothesis that it allows farmers to generate a higher income and maintain a better standard of living. This is based on the idea that commercial crops are high-value crops, generating a higher return per hectare than staple food crops which are often labeled low-value crops. The data from the ACC Survey help us test these hypotheses.

6.1. Economic returns to subsistence crops and commercial crops

Do commercial crops generate higher returns than staple food crops, such as cereals and enset? Table 22 shows the gross value of crop production per hectare for each crop and each round of the ACC Survey. All values have been deflated using the General Consumer Price Index to reflect prices of 2019. We are mainly interested in differences among crops, so we focus on the average values in the last column. The value per hectare of cereal crops ranges from 11 thousand birr/ha (sorghum) to slightly over 20 thousand birr/ha (wheat and “other cereals”). These are among the lowest gross returns among the crops listed. At the other extreme, the commercial crops of fruits and vegetables generate revenues of more than 115 thousand birr/ha, while chat and coffee offer 44-45 thousand birr/ha in revenue. There are some exceptions to this pattern, including enset, for which the gross revenue is 55 thousand birr/ha, considerably higher than other staple foods. In addition, oilseeds are grown mainly for commercial sale, but the gross revenue is just 12 thousand birr/ha. In general terms, however, the results confirm that commercial crops such as coffee, chat, fruits, and vegetables generate gross revenues per hectare that are three to seven times greater than those of staple food crops such as maize, sorghum, millet, and teff.

Table 22. Gross revenue per hectare by crop by round (birr)

	Year			
Crop	2012	2016	2019	Total
White teff	17,838	15,649	20,517	17,712
Black teff	11,880	12,613	16,810	13,372
Barley	14,658	13,852	18,860	15,358
Wheat	21,507	16,462	26,300	21,041
Maize	17,285	15,674	24,150	18,512
Sorghum	13,397	7,630	10,963	10,981
Millet	9,784	11,184	14,712	11,744
Other cereals	18,079	23,162	27,861	23,167
Faba beans	24,095	19,122	17,858	21,020
Haricot beans	15,329	23,426	14,595	19,234
Other pulses	22,100	18,763	15,245	18,774
Oilseeds	9,610	12,347	15,749	12,222
Vegetables	128,486	107,934	112,976	116,714
Fruits	71,774	179,719	44,352	115,089
Potato	42,194	35,752	35,594	38,357
Other roots	33,446	125,273	72,932	76,046
Chat	34,397	50,170	47,228	44,477
Coffee	43,090	47,301	42,915	44,715
Enset	57,656	51,294	59,736	54,826
Other crops	329,204	91,633	223,399	216,004

Source: Analysis of 2012, 2016, and 2019 ACC Surveys.

6.2. Returns per hectare of subsistence farmers and commercial farmers

A widely held hypothesis is that commercial farmers generate more revenue per hectare than subsistence farmers. To test this hypothesis, we use a non-parametric regression analysis known as local polynomial smoothing. Figure 5 shows the value of crop production per hectare as a function of the level of crop commercialization for the three rounds of the ACC Survey. The blue line represents the average value of crop production per hectare, while the grey area represents the 95 percent confidence interval around that mean. The green line indicates the average value of crop sales per hectare.

In 2012, the average value of production per hectare rises from less than 15,000 birr/ha for farms with no crop sales to 40,000 birr/ha for those with close to 100 percent sales. The rise in value per hectare is steeper as the commercialization rate passes 70 percent. It is worth noting that the gap between the blue and green lines represents the value of home production, crops grown and consumed by the same households. Up to the 40 percent commercialization level, the value of home consumption is relatively constant. For higher levels of commercialization, the value of home production declines to accommodate the rising rate of commercialization.

Figure 6 shows the same graph using data from the 2016 ACC Survey. Again, the value of production per hectare rises from close to 10,000 birr/ha among farms with no crop sales to about 40,000 birr/ha for those few farms that sell almost all their crop production. Similar to the previous graph, the increase in returns per hectare rises more steeply when the marketed share of the household passes 80 percent.

Finally, Figure 7 shows the pattern in the 2019 ACC Survey. In this case, the value of production rises from about 20,000 birr/ha for subsistence farms to almost 80,000 birr/ha among highly commercialized farms. Although the returns per hectare appear to dip down among farms with marketed shares above 90 percent, the wide confidence interval over this range indicates that the reduction is not statistically significant. Thus, data from all three rounds of the survey indicate that highly commercialized farmers have revenues per hectare that are about two to four times the level of subsistence farmers.

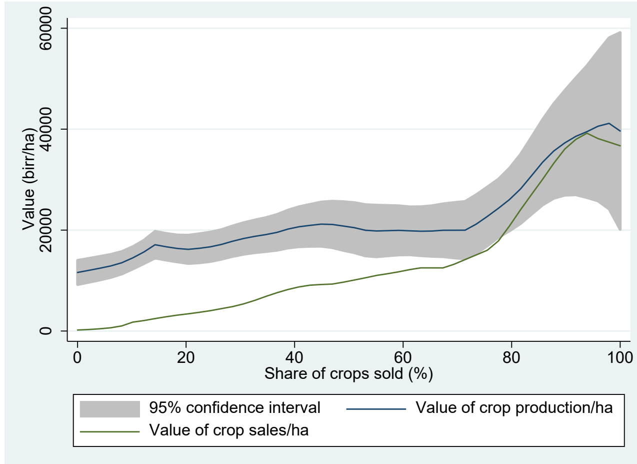

Figure 5. Value of crop production per hectare by level of commercialization in 2012
Source: Analysis of 2012 ACC Survey.

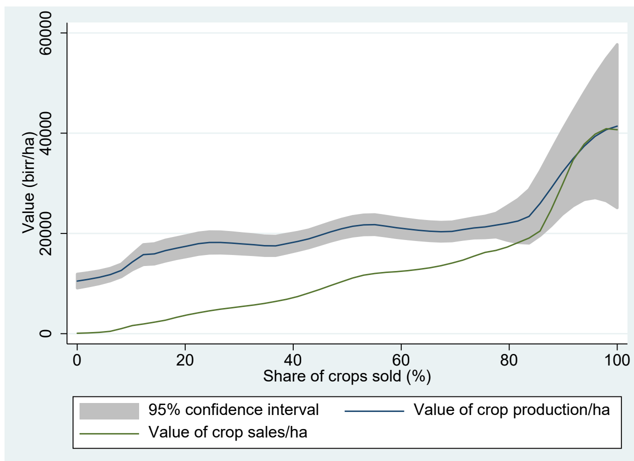

Figure 6. Value of crop production by level of commercialization in 2016
Source: Analysis of 2016 ACC Survey.

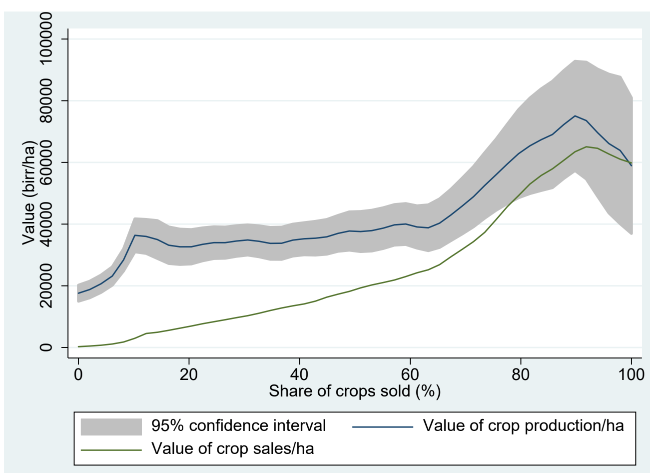

Figure 7. Value of crop production by level of commercialization in 2019
Source: Analysis of 2019 ACC Survey.

6.3. Impact of commercialization on income and diet diversity

In order to test the effect of crop commercialization on income and diet diversity, we estimate two models, one with the logarithm of real per capita income as the dependent variable and a second one with an index of diet diversity. The independent variables include various household characteristics including the level of crop commercialization.

Impact on income

Per capita income is defined as the sum of net income from crop production, livestock production, wages, business activities, remittances, and other sources divided by the household size. The values for each year are adjusted for inflation using the Ethiopia general consumer price index. It is expressed in logarithms to reduce the strong right-skew of the income variable, which results in non-normal error terms. We use the correlated random-effects model to estimate per capita income, as shown in the first column of Table 23.

The key result, however, is that the marketed share of crop production is positively and significantly associated with real per capita income. A 1 percentage point increase in commercialization is associated with a 1.1 percent increase in per capita income. This relationship is based on variation in the two variables for the same household over time, so it controls for all household characteristics, observed and unobserved. It may, however, be biased by reverse causation, to the extent that higher-income households are more tolerant of risk and therefore more willing to grow crops for market sale.

Other results suggest that SNNP is poorer than Tigray after controlling for other factors including farm size, distance to roads, and rainfall. Household size is negatively related to per capita income. The dependency ratio (the ratio of the number of household members under 15 years or over 65 years old to those 16-64) has a negative and statistically significant coefficient, implying that the higher the proportion of dependents in the household, the poorer it will be on average. The education of the head of household and the spouse are both positively and significantly related to per capita income. Not surprisingly, households with larger farms tend to have higher income, with each hectare of land associated with an 8 percent increase in per capita income.

Table 23. Panel-data regression analysis of the determinants of per capita income and diet diversity

	Real per capita income CRE model	Household diet diversity CRE model
Amhara	0.106	-0.392
	(2.16)*	(5.92)**
Oromia	-0.090	0.063
	(1.81)	(0.94)
SNNP	-0.366	-0.066
	(6.37)**	(0.85)
Household size	-0.116	0.015
	(11.88)**	(0.89)
Dependency ratio	-0.053	0.019
	(4.23)**	(0.97)
Education of head (yrs)	0.018	0.025
	(5.59)**	(4.89)**
Education of spouse (yrs)	0.026	0.040
	(5.15)**	(5.17)**
Female-headed household	-0.164	0.011
	(2.36)*	(0.09)
Farm land owned (ha)	0.078	0.090
	(7.76)**	(5.18)**
Meher rainfall in previous year (mm)	0.000	-0.001
	(0.57)	(4.81)**
Meher rainfall average over previous 5 years (mm)	0.002	0.002
	(5.88)**	(3.85)**
CV of inter-annual meher rainfall over 5 years	0.933	0.147
	(2.64)**	(0.24)
CV of intra-annual meher rainfall over 5 years	-0.034	1.415
	(0.12)	(3.00)**
Marketed share (%)	0.011	0.004
	(18.38)**	(3.99)**
Mean of household size	0.039	0.038
	(3.08)**	(1.92)
Mean of female head	-0.043	-0.096
	(0.51)	(0.71)
Mean of age of head	-0.001	-0.006
	(0.83)	(3.38)**
Mean of marketed share	0.003	0.004
	(3.04)**	(2.73)**
Mean of farm size	-0.003	-0.025
	(0.21)	(1.03)
Mean of prev yr rainfall	0.001	0.002
	(3.22)**	(4.16)**
Mean of 5-yr rainfall	-0.003	-0.003
	(6.67)**	(4.25)**
Mean of 5-yr CV ann rain	-0.054	-3.748
	(0.07)	(3.22)**
Mean of 5-yr CV mon rain	-0.371	0.501
	(0.55)	(0.52)
Constant	8.597	5.266
	(45.04)**	(20.42)**
N	5,089	5,096

Source: Analysis of panel data in ACC Surveys of 2012, 2016, and 2019. Note: * $p<0.1$; ** $p<0.05$; *** $p<0.01$

Some of the rainfall indicators have significant effects on per capita expenditure. The average rainfall over the previous 5 years is positively related to income, with a 100 mm increase being associated with a 22 percent increase in income. Against expectations, the inter-annual CV of rainfall is positively related to income. And the household-level mean of rainfall the previous year is positively associated with income, suggesting that there is a cross-sectional relationship even if the within-household relationship is not significant.

Impact on diet diversity

One argument that has been made is that agricultural commercialization increases income but may not improve nutrition if the additional income is spent on non-food items or non-nutritional food. To test this, we also estimate household diet diversity, defined as the number of food categories consumed by the household over the past seven days. A larger number indicates a more diverse and nutritious diet. As shown in the second column of Table 23, the main result is that the marketed share of crop production is positively and significantly associated with diet diversity, although the magnitude is small. A 10 percentage point increase in marketed share would increase the diet diversity by just 0.04, a negligible change relative to the mean value of 6.0.

7. Role of gender in agricultural commercialization

As shown earlier, female-headed households sell a much smaller share of their crops than male-headed household do. For example, in 2019, the average marketed share of crop production for female-headed households was just 24 percent, while that of male-headed households was 34 percent (see Table 6). This section explores several possible reasons behind this difference.

First, we consider the distribution of male- and female-headed households by the marketed share of crop production (households without crop production are excluded from this graph). Figure 8 shows that there is a dramatic difference in the proportion of households with no crop sales: just 19 percent of male-headed households had no crop sales, while 34 percent of female-headed households did not sell crops.

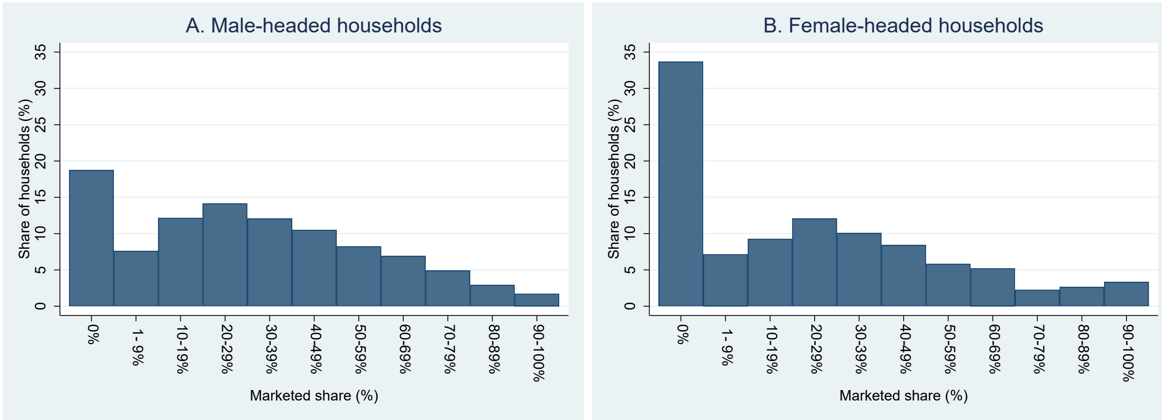

Figure 8. Distribution of households by marketed share by sex of head of household

Source: Analysis of 2019 ACC Survey.

Can the lower level of commercialization of female-headed households be explained by differences in the characteristics of male- and female-headed households? The characteristics of each group based on the pooled data over 2012-2019 are shown in Table 24. According to the ACC Survey results, female-headed households tend to have fewer members (4.0 compared to 6.0) and have older heads of household (51 compared to 47 years). Furthermore, female heads have received fewer years of formal education (0.9 compared to 3.4 years), smaller farms (1.4 ha compared to 1.8 ha), and smaller herds of livestock (2.4 compared to 4.4 tropical livestock units). These differences help explain the fact that female-headed households also have lower crop income, livestock income, enterprise income, per capita income, and per capita expenditure. The household dietary diversity, which measured the number of food categories consumed over the course of a week by the household, is also slightly lower for female-headed households. On the other hand, the data do not show any disadvantage for female-headed households in terms of agricultural wages, non-agricultural wages, and remittances, nor in the distance to the nearest road.

Among these variables, several are likely to help explain the difference in marketed share. As discussed above, the level of commercialization is associated with farm size, age of head of household, distance to road, and income level. Although there is no difference in the distance to the nearest road, the fact that female-headed households have smaller farms, older heads, and lower income all help to explain the lower level of commercialization.

The fixed effect and CRE regression analyses presented in Table 15 indicate that, after controlling for farm size, age, and income, the differences in the marketed share of crop production between male- and female-headed households is not statistically significant. This indicates that the lower level of commercialization among female-headed households is mainly due to differences in farm size, income, and age.

Table 24. Characteristics of male- and female-headed households

	Sex of head of household		
	Male	Female	Total
Household size (members)	6.0	4.0	5.8
Age of head (years)	47.1	51.2	47.7
Femaled headed households (%)	0.0	100.0	13.1
Education of head (yrs)	3.4	0.9	3.1
Farm land owned (ha)	1.8	1.4	1.7
Livestock (TLU)	4.4	2.4	4.1
Distance to road (km)	4.0	4.1	4.0
Real value of crop production (birr)	30,361	14,936	28,345
Real value of crop sales (birr)	14,076	6,888	13,137
Marketed share (%)	32	27	32
Real crop income (birr)	25,283	12,923	23,668
Real livestock income (birr)	6,505	3,724	6,142
Real enterprise income (birr)	2,834	1,951	2,719
Real ag. wage income (birr)	157	175	160
Real non-ag. wage income (birr)	1,000	1,047	1,006
Real remittance income (birr)	320	717	372
Real per capita income (birr)	6,524	5,410	6,378
Real per capita expenditure (birr)	8,693	10,298	8,903
Household dietary diversity score	6.0	5.7	6.0

Source: Analysis of 2019 ACC Survey.

8. Summary and implications

8.1. Summary

Farm households are not easily divided into "subsistence" and "commercial" farmers. In fact, there is a continuous distribution of farmers, from those who do not sell any of their crop production to those that sell all their production.

There are virtually no pure subsistence farmers. About 20 percent of crop farmers don't sell any of their harvest in a given year, but these households earn income from livestock, small businesses, and wages. Furthermore, virtually all rural households in the sample purchase food to supplement own production.

The average farm household in 2019 sold about one-third of the value of their crop production, but overall crops sales account for almost one-half of the value of crop production. The distinction between these two definitions of commercialization (which we call M1 and M2) has not been widely recognized in the literature. The reason for this difference is that the average marketed share gives equal weight to each household, while the marketed share of total crop production gives more weight to households with a larger harvest in value terms.

The average marketed share is lower in Tigray than in the other three main regions of Ethiopia. These differences persist in the regression analysis farm size, distance to road, and income are considered, but some disappear when controlling for rainfall and rainfall variability. This suggests that rainfall patterns are an important reason why commercialization is lower in Tigray.

The marketed share of crop production is higher among male-headed households than female-headed households. This is largely because female-headed households have smaller farms and lower per capita income. The gender gap in commercialization disappears in the regression analysis in a regression analysis in which these differences are controlled.

Crop commercialization declines somewhat with the age of the head of household. Household with heads over the age of 60 years sell a smaller share of output. These differences persist in the regression analysis when other factors are controlled.

Farm size is a strong predictor of the level of commercialization of a household. Farms with less than 0.5 hectares sell, on average, just one quarter of their crop production, while those with more than 5 hectares sell almost half of crop output. This relationship holds up in the regression analysis after controlling for sex and age of the head of household, education, distance to road, and income quintile.

Commercialization also varies with the distance to the nearest road, with farms more than 4 kilometers from the nearest road selling a smaller share of crop production compared to farms less than 1 kilometer from the road. Interestingly, this relationship seems to have weakened significantly between 2012 and 2019 so that distance is much less of a factor than it used to be.

Crop commercialization is positively correlated with per capita income. Households in the richest quintile by per capita income sell in the range of 42-51 percent of crop production on average, while those in the poorest quintile sell in the range of 17-20 percent. Because of endogeneity, we do not include per capita income as an explanatory variable in the regression model to estimate marketed share. However, household wealth, as measured by an asset index, is positively and significantly associated with the level of commercialization, holding other factors constant.

Finally, the marketed share of crops varies with the level and variability of rainfall. More specifically, crop marketing is positively associated with 5-year average level of rainfall and negatively related to the inter-annual variability of rainfall. Higher levels of rainfall presumably increase yields and generate a larger surplus available for sale. Higher variability in rainfall creates a risky environment, causing farmers to limit the additional risk they face from commercial production.

The marketed share of crop production increased between 2012 and 2019. The increase was between 6 and 10 percentage points, depending on how commercialization is defined, and which sample is used. This increase was observed across most categories of households, but not all. For example, the increase in commercialization occurred in households with low and high levels of commercialization, but the share of farmers not selling any crops remained stable at about 20 percent. The increase in the average marketed share was statistically significant in Amhara and Oromia, but not Tigray or the SNNP region. Male-headed households recorded a statistically significant increase in marketed share, while the increase for female-headed households was not significant. Households with older heads of households experienced smaller gains in commercialization than younger ones; for heads 70 years and older, the change was statistically insignificant. The increases in commercialization were concentrated among farms with 0.5 to 5.0 hectares, while farms both smaller and larger than this saw no change. Regarding distance, the greatest gains in commercialization were among farms more than 4 km from the nearest road. Finally, the increase in commercialization over 2012-19 was statistically significant for the third, fourth, and fifth quintiles by per capita income, but not for the poorest two quintiles.

All of the increase in commercialization was due to higher shares of each crop being sold, with no contribution from changes in crop mix. In other words, none of the increase in commercialization could be attributed to a shift toward more commercial crops. There was a shift from low-commercialization crops such as enset, sorghum, and faba beans to medium-commercialization crops including wheat, white teff, and "other cereals" (mainly rice), but this was offset by shifts away from high-commercialization crops like coffee and fruit.

The results of the analysis suggest that *it is a simplification to think of cereals as "subsistence crops" and coffee and other industrial crops as "cash crops".* Cereals account for over half of the value of production, but more surprisingly they represent 35 percent of the value of crop sales. Vegetables account for 15 percent of the value of sales, greater than the contribution of coffee (12 percent). Furthermore, the sale of wheat alone accounts for 11 percent of the revenue from crop sales, just slightly below that of coffee.

Although it is difficult to prove causality, there are various pieces of evidence indicating that crop commercialization raises farm income and improves household welfare.

- First, in general *commercial crops generate more revenue per hectare than staple grains and other food crops.* For example, coffee and chat generate more than twice as much revenue per hectare as any of the cereals. Furthermore, the returns to fruit and vegetable production are five times greater than those of cereals. There are exceptions to this pattern, however. Enset is a staple food with a low level of commercialization but generates a gross return similar to that of coffee. And oilseeds, a highly commercialized crop category, have a low return per hectare, similar to staple cereals. It seems likely that the returns per hectare are not a function of whether they are food crops or commercial crops. Rather annual crops that do not require much labor and are storable (including cereals and many oilseeds) have a low return per hectare, while those that are perishable (vegetables, fruit, and chat) or are tree crops requiring a multi-year investment (coffee and fruit) generate high returns per hectare.
- Second, *there is a positive correlation between the marketed share of crop production of a household and the average value of crop production per hectare*. In other words, more commercial farms generate higher revenue per hectare. Crop revenue per hectare is three times higher among the most commercial farms compared to the least commercial ones. Much of the increase occurs when the marketed share rises above 60 percent.
- Third, a regression analysis indicates that *the level of commercialization has a positive and statistically significant association with per capita income*, even after controlling for farm size, family labor, dependency ratio, distance to road, and other factors. By focusing on within-household variation in income and marketed surplus, the model also controls for unobserved heterogeneity across households.
- Fourth, a separate regression analysis suggests that *the level of commercialization has a positive and statistically significant impact on diet diversity*, even after controlling for other household characteristics.

8.2. Implications for development strategy

Should agricultural commercialization be promoted?

The most basic question is whether public policy and development organizations should promote agricultural commercialization. More specifically, should commercialization be encouraged because it allows farmers to raise their income and improve their standard of living? Or should it be discouraged because it exposes them to market risks and threatens food security? The evidence from the Ethiopia ACC Surveys of 2012, 2016, and 2019 suggest that *agricultural commercialization should be promoted because it tends to lead to higher incomes, mainly because it allows farmers to grow crops with a higher return per hectare.* Semi-subsistence farmers mainly grow staple grains such as maize, wheat, teff, and sorghum, whose value per hectare is modest (less than 20,000 birr/ha), whereas commercial crops can generate between two- and five-times as much revenue per hectare. This is further confirmed by the fact that revenue per hectare rises as the marketed share increases, and regression analysis confirms that this relationship holds even after controlling for farm size, distance to road, and household characteristics.

The effect of agricultural commercialization on nutrition and food security is less clear. Previous research has found a weaker connection between agricultural commercialization and nutrition (Carletto et al., 2017). This is probably because the link between higher income and better nutrition depends partly on how the income is used and who in the household makes decisions about the use of the additional income. In our analysis of the survey data in Ethiopia, we find a positive and statistically significant but quite small effect of crop commercialization on household diet diversity, a measure of the quality of the diet.

How much direction should farmers be given in commercialization programs?

Should farmers be given specific instructions on which crops to grow and sell on the market or should they be given guidance and training on how to make these decisions? The answer is based on our assumptions about the rationality of farmers. If we believe that there is a need to overcome their traditional ways of farming and excessive caution, then development programs should push farmers into agricultural commercialization. This view is based on the idea that agronomists and economists can identify optimal livelihood strategies for farmers. On the other hand, if we accept that farmers generally make rational decisions, then it would be better to implement programs that facilitate commercialization by introducing technology, providing information, and reducing transaction costs and risks. International experience and the results of the ACC Surveys suggest that *it is better to create conditions which alleviate constraints on agricultural commercialization than to push them into commercialization.* The survey data indicate that farmers that choose to commercialize generally have higher per capita income and slightly more diverse diets, but this does not imply that semi-subsistence farmers are being irrational, nor that all farmers would benefit from being induced to produce more for market sale. The patterns of commercialization largely follow what we would expect based on rational decisions of resource-constrained and risk-averse farmers working with incomplete information. Households with small farms, those with less rainfall, and those facing more variable rainfall are less commercialized because are less able to produce large surpluses of staple grain crops and it is too risky to convert to nonfood crops and rely on the market for food. Households that are far from the nearest road face large costs in selling their crops and buying food, so it is not surprising that they sell a smaller share of production. And households with fewer assets and lower income are less able to tolerate the risks associated with producing commercial crops. Thus, there is good reason to believe that less commercial farmers do not have any irrational attachment to traditional farming practices but a rational concern about the costs and risks of commercial production and relying on the market for their food.

How can we create conditions that enable agricultural commercialization?

The government and development organizations have a role in creating conditions which alleviate constraints on agricultural commercialization, facilitating the process among farmers. The results of the ACC Surveys suggest that *there are four main obstacles to agricultural commercialization: low productivity, transaction costs, risks, and capital costs*.

Low productivity is a constraint because if farmers cannot produce enough staple grains, they will be unable to generate a surplus for sale and unwilling to take the risk of allocating part of the land to nonfood crops for sale. The survey data shows that farmers do not insist on satisfying all their food needs before beginning to sell part of their harvest. Almost all rural households purchase some food, and many purchase staples grains. On average, over half of the value of food consumption is purchased. For farms with a marketed share under 50 percent (about three-quarters of Ethiopian farmers), the average value of crop production retained by the household (non-marketed food) is about 18,000 birr/year, though this varies by household size, location, and other factors. If good rains, fertilizer, or high-yielding seeds allow farmers to produce more than this, they will (on average) sell the surplus. *Efforts to raise productivity through agricultural research, extension services, and efficient input markets not only raise yields, but they allow farmers to sell a larger share of their harvest*.

We know that transaction costs are a constraint because the marketed share declines with distance to the nearest road. As discussed earlier, distance to the road or to a market has three effects on agricultural production patterns. First, it raises the cost of purchased inputs such as fertilizer, which reduces adoption and application rate, thus lowering crop productivity. Second, it increases the cost of marketing crops, reducing the effect sale price and the incentive to sell crops. Third, it raises the cost of purchasing food, which also discourages agricultural commercialization. The most obvious way to reduce transaction cost is by building and maintaining rural roads, which has been an important part of Ethiopian public investment in rural areas. However, transaction costs also include the cost of identifying a buyer, negotiating a price, and making the transaction. *Thus, in addition to a good road network, agricultural commercialization is facilitated by a competitive and efficient transportation and marketing system and the widespread availability of accurate information about agricultural prices.* The dissemination of mobile phones has improved the flow of information in rural areas, although telecommunication rates remain higher than in neighboring countries.

Risk is an important deterrent to agricultural commercialization. Farmers who produce staple cereals for their own consumption face production risks, often related to low rainfall, but only minimal market risks. On the other hand, producing a nonfood crop makes the farmer vulnerable to falling prices of the crop and rising prices of food that they must purchase. This explains why low-commercialization households are more likely to earn revenue from the sale of staple grains, for which production and price risk are lower. In contrast, high-commercialization farmers are much more likely to earn revenue from the sale of fruits, vegetables, coffee, and chat. These crops offer above-average returns per hectare, but also higher risks. They are able to tolerate these risks because they have more land, more assets, and/or higher income. The negative effect of variability in inter-annual rainfall on the marketed share of crop production further demonstrates that risk inhibits agricultural commercialization. Interventions to help farmers understand and manage production and market risks will facilitate agricultural commercialization. *Extension services, marketing information services, weather forecasts,* *contract farming, and crop insurance are all seen as different approaches to reducing the risks associated with adopting new commercial crops*.

Capital costs can be an obstacle to some types of agricultural commercialization. Producing a larger harvest of maize, sorghum, or wheat requires more inputs, such as seed, fertilizer, and labor, but it does not involve large fixed costs. However, production of vegetables may involve additional land preparation, stakes, irrigation, and other investments. Furthermore, tree crops such as fruit and coffee often need 3-5 years before they can be harvested. This explains the high return per hectare of coffee, vegetable, and fruit production. Credit programs have often been used to expand production of tree crops, but small-scale producers face a challenge in demonstrating that they can and will repay the loans.

Which crops should be promoted for commercialization?

In selecting a crop to promote commercialization, the first consideration is whether it is suited to the soil and agro-ecological conditions and whether it is close enough to the intended market. In addition, the crop characteristics must match the profile of the target farmers.

As noted earlier, farmers at a low level of commercialization (selling 10 percent or less of their output) may be considered at an earlier stage of crop commercialization. In general, they are more likely to have small farms, earn lower incomes, and perhaps live in a zone with a lower agricultural potential, making them particularly risk averse. Few of them produce coffee, vegetables, and other highly commercialized crops. Instead, they earn about 40 percent of their crop sales revenue from the sale of staple food crops. This suggests that, *for semi-subsistence farmers, increasing the yield of wheat, teff, maize, and other cereal crops is an important avenue for agricultural commercialization*. This strategy makes sense because these crops minimize their exposure to production risk because cereals are not perishable. It also reduces their market risk because they are selling the surplus of a food crop instead of selling a nonfood crop in order to purchase food.

Farmers able to tolerate somewhat more risk may be open to adopting non-staple crops that are not perishable, such as pulses and oilseeds. These crops are riskier than growing staple grains because the farmer must sell them and purchase food, but at least the crops themselves are non-perishable and their prices are less volatile than those of perishable crops.

Farms that sell more than half of their crop production (a group that includes about one-quarter of Ethiopian farmers) may be considered further along in the process of commercialization. These farmers probably have larger farms, earn higher income, and live in a higher-potential zone. Because their economic situation makes them less risk averse, *these larger farms may be more receptive to the introduction of riskier crops such as fruits and vegetables and crops requiring a larger investment such as coffee and other tree crops.*

In addition to the farmer profile, another consideration is the size, proximity, and quality requirements of the market. It is unfortunately all too common that a project promotes a perishable crop based on the market price in a nearby city, but farmers end up losing money because the high costs of transportation drive the farm-level price below the breakeven point or because the additional volume generated by the project pushes the price down. The risk of this kind of problem is particularly large when a single perishable crop is promoted on a large scale in a location that is not close to a large urban center.

Overall, the results of this study confirm that agricultural commercialization has the potential to increase farm income and improve the well-being of rural households. However, programs that promote agricultural commercialization need to recognize that subsistence production is not the result of ignorance of the benefits of commercialization. Rather, subsistence production is a rational response to constraints related to cost, risk, and lack of information. Programs to promote commercialization need to address these constraints by reducing the cost and risks associated with growing new crops; providing information about production methods, markets, and weather; reducing the time and cost of getting products to market; and addressing the risks associated with volatile prices of commercial crops and food. Even after addressing these constraints, some farmers will resist commercialization, and perhaps for good reason, if their farms are too small to generate a surplus, too remote to make commercial production profitable, or located in zones with unreliable rainfall. These households may be better served by other strategies to improve their standards of living, such as increased productivity in staple crops, non-farm activities, safety net programs, or migration assistance. The results of this study provide some guidelines for identifying households mostly likely to gain from crop commercialization and for addressing some of the key constraints faced by farmers engaging in commercial production.

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Annex 1: Calculation of the decomposition of the increase in crop commercialization

According to the ACC Surveys, the rate of crop commercialization increased from 38.6 percent to 48.5 percent, where commercialization is defined as the total value of crop sales as a percentage of the total value of crop production. We can decompose the growth in the marketed share of crop production into a) the part due to the increase in marketed share of each crop and b) another part due to the shift from less commercialized crops to more commercialized crops. The rate of commercialization can be calculated as follows:

$$M2 = \sum_c \frac{Q_c}{Q}\frac{S_c}{Q_c} = \sum_c P_c M2_c$$

where M2 is the total value of crop sales as a proportion of the total value of crop production

Q_c is the value of production of crop c

Q is the total value of production across crops

S_c is the value of sales of crop c

P_c is the proportion of crop c in the total value of production

$M2_c$ is commercialization of c, calculated as sales of c divided by production of c

The portion due to the change in composition of crops can be calculated as:

$$\sum_c (P_{c,2019} - P_{c,2012}) M2_{c,2012}$$

This is the change in marketed share we would get if the marketed share of each crop stayed the same as in 2012 ($M2_{c,\,2012}$) but the composition of production (P_c) changed as it did in the surveys. This is not easy to interpret, but you can see that if the importance of vegetables increased ($P_{c,\,2019}$-$P_{c,\,2012}$>0) and the marketed share of vegetables was high, this would increase the overall number. And if there were no change in the composition of production for all crops ($P_{c,\,2019}$-$P_{c,\,2012}$=0), then the total number would be zero.

The portion due to the increase in marketed share of each crop can be calculated as the sum over crops of the following:

$$\sum_{c} P_{c,2012}(M2_{c,2019} - M2_{c,2012})$$

This is the marketed share we would get in 2019 if the composition of production stayed the same as in 2012 ($P_{c,\ 2012}$) but each crop increased commercialization as it did in our surveys. This is the weighted average of the changes in crop-level commercialization where weights are the share of each crop in the value of production.

The table below shows the calculation of these two terms, with the sum in the last row of the final two columns of the table. It should be noted that the two components do not sum exactly to the actual change in the rate of commercialization. This is because there is interaction between the two components, so that the sum may be slightly greater or less than the actual change in commercialization.

Table A1. Calculation of the decomposition of the increase in crop commercialization

	Composition of value of crop production (%)		Marketed share of total output (%)		Change in composition of crop production	Increase in marketed share
Crop	2012	2019	2012	2019		
White teff	9.0	11.3	24.4	37.3	0.6	1.2
Black teff	4.4	4.3	17.3	22.5	0.0	0.2
Barley	5.1	6.4	14.6	26.1	0.2	0.6
Wheat	11.8	18.7	23.3	43.0	1.6	2.3
Maize	12.3	11.9	27.3	35.3	-0.1	1.0
Sorghum	8.5	2.9	11.2	30.2	-0.6	1.6
Millet	0.9	1.8	10.1	17.7	0.1	0.1
Other cereals	1.4	4.0	28.3	48.8	0.7	0.3
Faba beans	4.0	1.7	30.5	29.6	-0.7	0.0
Haricot beans	0.9	0.8	45.6	41.2	0.0	0.0
Other pulses	5.1	4.6	39.3	52.3	-0.2	0.7
Oilseeds	2.9	3.8	84.3	89.8	0.8	0.2
Vegetables	6.9	9.7	74.3	85.1	2.1	0.7
Fruits	3.3	1.3	48.8	78.0	-1.0	1.0
Potato	2.5	3.9	32.2	59.8	0.5	0.7
Other roots	1.1	1.2	49.4	86.5	0.0	0.4
Chat	1.0	1.7	79.6	84.3	0.6	0.0
Coffee	8.3	4.7	76.4	71.9	-2.8	-0.4
Enset	3.8	3.0	9.0	12.7	-0.1	0.1
Other crops	6.7	2.4	84.0	76.1	-3.6	-0.5
Totals	100.0	100.0			-2.0	10.1

Source: Analysis of the ACC Surveys of 2012, 2016, and 2019.

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