Does agricultural commercialization increase asset and livestock accumulation on smallholder farms in Ethiopia?

Abstract

The transition of farmers from subsistence to market-oriented agriculture is meant to contribute to reduce hunger, increase wellbeing and achieve rural economic progress. While an impressive extant literature has analyzed agricultural commercialization effects on welfare from an income (expenditure) and consumption perspective, authors place less attention to the implications on asset holding which is a more robust long-term measure of welfare. Using chickpea production as a case, we assess the effects of commercialization on household asset ownership and livestock holdings on smallholder farmers in Ethiopia. We employ a household fixed-effects estimator to control for time-invariant unobserved heterogeneity and account for possible endogeneity using the two-stage residual inclusion approach. For comparison purposes, we also evaluate the income effects and examine impact heterogeneity using quantile regressions. Our results indicate a positive impact of agricultural commercialization on assets, livestock ownership and income. In terms of impact heterogeneity, we found commercialization to benefit all, though with higher gains for asset-rich households. Despite this rising asset inequality, we conclude that increased agricultural commercialization can contribute to economic development and reduce rural poverty.

Keywords: Agricultural commercialization, asset ownership, Livestock, income, panel data, Ethiopia

JEL codes: $D_{10,}$ $Q_{12,}$ $Q_{13,}$ Q_{18}

1. Introduction

A great majority of Ethiopia's poor people reside in rural areas and depend on agriculture for their livelihoods. Therefore, eradicating poverty through agriculture and economic transformation continues to be a top development strategy of the Government of Ethiopia (IPoA, 2019). Agricultural transformation has an enormous potential to support inclusive growth and development in rural areas (Pingali and Rosegrant, 1995; von Braun, 1995a), and if organized right, reduce income poverty and food insecurity of farmers (Ecker, 2018). But for poverty reduction to be successful, agricultural sector strategies and policies must ensure that farmers gradually transition towards commercial farming. This would enable them to receive a fair share commensurate to their efforts and resource investment (Collier and Dercon, 2013). Inclusive commercialization of agriculture, therefore, is an integral part of Ethiopia's economic transformation.

According to World Bank (2008), commercialization amongst smallholder farmers can be increased through participation in output markets as this incentive will increase their investments into farm productivity. To this end, commercialization is one way for enhancing agricultural profitability and increasing household incomes. Also, the Government of Ethiopia seeks support for its economic transformation through commercialized agriculture. For some decades now, Ethiopia has implemented the Agriculture-led Development Initiative (ADLI) which fosters industrialization through agricultural growth and market-oriented smallholder agriculture (National Planning Commission, 2016). ADLI encourages the production and commercialization of high-value crops, including coffee and dried legumes such as chickpea, to improve the income and welfare status of rural households while ensuring the sustainable management of natural resources (Dessie et al., 2012). Although the literature has identified smallholder commercialization as a necessary stimulator for economic growth, poor farmers, as von Braun (1995a) suggests, are often by-passed in this process leading to falling income levels and standards of living.

Thus far, a growing literature around the effects of commercialization on welfare exists with mixed results. Impacts vary in magnitude and are heterogenous across sub-populations (Hichaambwa et al., 2015; Mmbando et al., 2015; Ochieng et al., 2019; Ogutu and Qaim, 2019). This nuanced understanding partly results from the challenges in identifying causal impacts as well as heterogeneous and location-specific impacts of agricultural commercialization. This makes the debate on the impacts of commercialization on the welfare status of farmers and its ability to reduce poverty inconclusive, despite its relevance for

policy. A broader evidence base will allow for a better assessment of the potential contributions of commercialization accounting for differential effects for specific crop and location characteristics.

Most previous studies have analyzed commercialization just for the most advanced form of contract farming (Barrett et al., 2012; Bellemare, 2012) and supplying to supermarkets (Andersson et al., 2015; Michelson, 2013; Neven et al., 2009; Rao and Qaim, 2011) while we focus on chickpea as a domestic staple that is also exported (Tabe-Ojong et al., 2021). Moreover, chickpea has been described as pro-poor and environmentally friendly, with the ability to spur economic and agricultural growth and development in Ethiopia (Verkaart et al., 2017). With the adoption of modern technologies that generally tend to favor better-off households, it is intuitive to expect that some segment of the population will benefit more from commercialization than others, making it critically important to understand this heterogeneous impact pathway and guide policy development.

In this article, we focus on the effects of commercialization on two longer term welfare measures, namely asset and livestock holdings. As poverty is reflected in a lack of assets in most rural settings (Collier and Lal, 1984; Moser, 1998; Brockington, 2019; Mutonyi, 2019), we believe assets are important longer-term wealth measures as compared to income or consumption which are more prone to short term fluctuations (Brockington, 2019). Income tends to be more infrequent and lumpier since it depends on seasonal harvests. The lack of banking facilities or other vehicles for savings in most rural areas pushes households to invest in assets and other local investment strategies. Assets can also act as buffers and risk coping instruments in offsetting income shocks and stabilizing consumption (Carter and Lybbert, 2012; Verpoorten, 2009). Moreover, as argued by Carter and Barrett (2006), asset-based outcome approaches are a more forward-looking poverty measurement indicator than income and/or expenditure, as they show whether a household will remain in poverty in the future. For the purpose of comparison, we also analyze the impact of agricultural commercialization on income and per capita income to complement the assessment of longer-term effects.

Our contribution to the commercialization-effect debate is thus in four ways. Firstly, we provide additional insights on commercialization impacts on asset and livestock ownership for a legume crop in Ethiopia that is used both for local consumption as well as export. Secondly, we attempt to control for self-selection into commercialization and the probable reverse causality between commercialization and asset ownership using a household fixed-effects

estimator and the two-stage residual inclusion technique (2SRI) respectively. Our results here are robust to the use of instrumental variable estimators such as the two stage least square. Thirdly, our analysis is focused on the commercialization of a relatively easy to store grain legume which makes it more likely to be attractive to poorer households and thus have more inclusive effects compared to crops such as vegetables. Chickpea is a staple which is not only produced for home consumption but has traditional bearings on most farmers. They are also increasingly being exported, especially the improved varieties which are both disease resistant and have desirable market traits. Lastly, we estimate the heterogeneous effects of commercialization using quantile regression models like Ogutu and Qaim (2019) and Ogutu et al. (2020b). While we recognise their findings and thorough analysis on impact heterogeneity, our analysis expands the evidence base to provide a broader basis for policy action.

The remainder of this paper is organized as follows. Section 2 establishes a conceptual framework that guides our reasoning about the commercialization of smallholder farmers in Ethiopia. Section 3 presents the methods used for the farm household survey and the measurement of commercialization, outcome variables, and explanatory variables. The empirical and identification strategy is highlighted in section 4 while the results are presented and discussed in section 5. The article ends with a conclusion and policy implications in section 6.

2. Conceptual framework of commercialization

The relationship between commercialization and asset holding of households as an indication of welfare can be originally traced to early economist Adam Smith, who stated that households usually engage in production either for their consumption or for trading the surplus after consumption (Barrett, 2008). Theoretically, there is a consensus among researchers that commercialization is expected to increase welfare (Abdullah et al., 2019; Katerega et al., 2018; Muriithi and Matz, 2015), both at a household and an aggregate level by allowing for specialization and the ability to attain both producer and consumer surplus (Eskola, 2005). These gains usually translate into employment and income effects which are reflected in a household's welfare status (von Braun, 1995b; Jaleta et al., 2009; Mmbando et al., 2015; Muriithi and Matz, 2015; Tipraqsa and Schreinemachers, 2009).

In standard terms, agricultural commercialization is defined as the degree of household participation in both input and output markets (von Braun and Kennedy, 1994). It refers to a

continuous shift and transition from subsistence production to market-oriented production (Pingali and Rosegrant, 1995). As shown in Table 1, this transition is a continuum and a gradual process from a subsistent system through a semi-commercial system to a fully commercial system geared at profit maximization. When farmers commercialize their production, they transition from diversification towards specialization (World Bank, 2008). In this light, agricultural commercialization not only entails the sale of agricultural produce but also incorporates input use decisions based on the concept of profit maximization and product choice.

Table 1 Characteristics of food producers with increasing commercialization

Level of Market orientation	Farmers' objectives	Source of inputs
Subsistence system	Food-self sufficiency	Household generated (Non-trade)
Semi-commercial system	Surplus generation	Mix of trade and non-traded inputs
Commercial system	Profit maximization	Predominantly traded inputs

Source: Own presentation based on: Pingali and Rosegrant (1995, p. 172)

Since the increased focus on profit maximization is the basis of this transition, farmers make input and production decisions on a profit-making basis, thereby strengthening the vertical linkage of input with output markets (Olwande et al., 2015). From a theoretical viewpoint, commercialization encompasses the market-orientation of production and input use as well as the household decision to produce and consume (Sanginga et al., 2004). However, this process is not necessarily linear and pre-production plans may not always be followed based on changing circumstances and inherent risks materializing. Practically, market orientation may not imply participation especially when households make use of marketable commodities for home consumption (Gebremedhin and Jaleta, 2010). Similarly, as a result of surplus production, households may sell products that were originally intended for consumption (Bingen et al., 2003; Kaaria et al., 2008; Stifel and Minten, 2017). Understanding commercialization in this regard may thus be useful in achieving the economic transformation of farmers and aid in developmental policy.

3. Survey data and measurement of variables

3.1. Farm household survey

For this study, we utilize a three-wave panel dataset of smallholder farmers in the East Shewa zone of Amhara and Oromia regional states of Ethiopia. East Shewa is located in the central highlands of the country, northeast of Bishoftu which is 50km to the capital, Addis Ababa. Bishoftu is home to the Debre Zeit Agricultural Research Centre (DZARC) which offers production and marketing information to farmers, improved seeds, fertilizers, and other relevant farming information.

The first wave of the survey was conducted in 2008 through a multistage sampling procedure. The first stage was the selection of three chickpea producing districts (Minjar-Shenkora, Gimbichu, and Lume-Ejere) from the East Shewa zone. These districts were purposely selected based on their (agro-ecological) suitability and intensity of chickpea production. From the districts, 8-10 kebeles[1] were randomly selected based on the size of the district. Eight kebeles were selected in Gimbichu and Lume-Ejere and 10 kebeles in Minjar-Shenkora. From the kebeles, 20-30 households were randomly selected leading to a total of 700 households with Gimbichu, Minjar-Shenkora and Lume-Ejere constituting 23%, 36%, and 41% respectively of sampled households. Two additional waves were subsequently conducted in 2010 and 2014, with 661 and 631 households, respectively. 631 farm households in the original survey were observed through all three rounds. After deleting households that were missing critical information, we ended up with a balanced panel set of 614 households. This gives us an attrition rate of 12.2% which is relatively low compared to other household surveys in developing nations. Non-random attrition is problematic as it usually results in the collection of selective samples resulting to biased estimates. To verify and ascertain the validity of our estimates, we tested whether attrition is systematic or not. Following Baulch and Quisumbing (2011), we performed an attrition probit regression to test for attrition bias by specifying some of the baseline regression variables. Based on the non-statistical significance of all the regression coefficients (Table A i in the appendix) and the low pseudo R^2 of 0.06, we are confident that attrition bias is not an issue here.

In the three survey waves, information was collected on chickpea production, commercialization, adoption of improved chickpea varieties, institutional characteristics, various household income sources, asset holdings of the household as well as socioeconomic and demographic characteristics of the households. A group of well-trained enumerators administered the pre-tested survey instrument on a face-to-face basis to the farm households.

[1] In Ethiopia, a kebele is an administrative unit that is equivalent to a village. Our survey covered households in 26 different kebeles.

Chickpea is a high yielding, drought resistant tropical legume which is cultivated for both on-farm consumption and for export (Verkaart et al.,2017). It is also disease resistant and has specific market traits that make it sellable in both domestic and export markets (Tabe-Ojong et al.,2021). It is usually cultivated on residual moisture and grown in rotation with other crops such as teff and wheat. Being a legume, chickpea helps in the fixation of atmospheric nitrogen in the soil which is used by other plants. Thus, the cultivation of chickpea can be regarded as way of reducing the use of chemical fertilisers which have damaging effects on the environment. Coupled with the fact that chickpea is used as a nutritious proteinous food for many poor households, it has been described as pro-poor and environmentally friendly with the ability to spur economic transformation (Verkaart et al.,2017).

3.2. Measurement of outcome variables

The dataset contains information on the main productive and non-productive assets of households like the ownership of land, livestock, motorized cars, bicycles, tractors, rudimentary farm tools and informational assets like radios, television, and mobile phones. We divided assets into two groups: the total value of all household assets in 2005 PPP US dollars and livestock assets. The total value of all household assets excludes livestock. Since most households in rural areas store their wealth in the form of livestock, we separately considered them in the analysis as a potentially productive form of assets as it reflects the long-term abilities of the household to meet their consumption needs as well as their potential increase in value as they mature. Livestock assets are converted into tropical livestock units (TLU) using the Food and Agricultural Organization (FAO) conversion factors where a cattle equals 0.70 units, a sheep 0.10 units, a goat 0.10 units, and a chicken 0.01 units.

Household income comprises revenue from the sales of crops and livestock, remittances, salaries, and business income, with the most significant contribution from agriculture. Originally measured in Ethiopian Birr (ETB), we converted the nominal values to USD purchasing power parity (PPP) values using conversion rates gotten from the 2011 International Comparison Program of the World Bank. Further, to enable comparison across time periods, we report real values adjusted using the national consumer price index with base year being 2005. To understand aspects of welfare stability and prosperity, we examine the per capita income and per capita asset value of households.

3.3. Measurement of commercialization and other controls

Household commercialization was measured both as a binary decision of the household to participate in output markets as sellers and the actual sales intensity conditional on market participation in the past 12 months. As most of the households are producing chickpea, it is intuitive to expect that most of the households will at least participate in markets to sell some parts of their output and relax their financial constraints. Thus, using commercialization as a binary response variable would not generate sufficient insights. Likewise, using the actual amount of the chickpea sold in the last 12 months may not really capture how market-oriented households are. We therefore used a more standard measure of smallholder commercialization, the share of output that is commercialized, which is the ratio of sales to production/harvest (Carletto et al., 2017). This measure bounds the value of commercialization to be between 0 and 1 and enables comparison across households.

The choice of control variables likely to affect the outcomes of interest are obtained from extant literature (Hichaambwa et al., 2015; Michelson, 2013; Mmbando et al., 2015; Muriithi and Matz, 2015; Ochieng et al., 2019; Ogutu et al., 2020a; Ogutu and Qaim, 2019; Radchenko and Corral, 2017). These variables range from socio-demographic characteristics like age, gender, education, household size and dependency ratio to institutional and farm characteristics like access to cooperative societies and extension agents, walking distance to markets, as well as the area of cultivation. We also included year dummies and location-specific dummies to account for agro-ecological and farming system differences in the study sites.

4. Estimation strategy

4.1. Commercialization effects on assets and income

We aim to examine the effects of commercialization on asset holdings and income using a three-wave panel data set from smallholder households in Ethiopia. Since we have panel data, we estimate the following panel data model:

$$Y_{it} = \beta_0 + \delta CM_{it} + \gamma' \boldsymbol{X}_{it} + c_i + \varepsilon_{it} \quad (1)$$

Where Y_{it} is the outcome variable (assets, per capita assets, livestock ownership, per capita livestock ownership, income and per capita income) for any particular household i in year t, CM_{it} is the household commercialization level and $\boldsymbol{X}_{it}$ is a vector of the explanatory variables. The time-invariant unobserved heterogeneity is represented by c_i, while the time-varying stochastic error is reflected by ε_{it}. We estimate separate regressions for all our six

outcome variables. Our main interest lies in the parameter estimates for δ, which is the commercialization effect on our outcome variables. A positive estimate for δ implies smallholder commercialization is positively associated with our outcome variables after controlling for all confounding factors.

Estimating and obtaining unbiased estimates for the commercialization effect entails addressing two estimation challenges. Firstly, there are unobservable factors of household heterogeneity that influences commercialization and the outcome variables. This creates selection bias as some households will indeed commercialize and amass more assets and income than others. This unobserved heterogeneity is time-invariant and usually includes characteristics like motivation, risks, talents, choice, and abilities which are generally unobservable and impossible or hard to measure or have not been measured because of their qualitative nature. For instance, households with more skills and a high motivation may sell more in output markets than those with low motivation. This can possibly overstate the commercialization effect if not controlled for. Moreover, region-specific characteristics may be correlated with some of our outcome variables, like the asset level of households (Muriithi and Matz, 2015). Panel data analysis has the advantage over cross-sectional data analysis as it can control for this unobservable heterogeneity. There are usually two approaches to account for unobserved heterogeneity: the fixed effect (FE) and the random effect (RE) estimation models. The FE model allows for correlation between c_i and the other covariates ($\boldsymbol{X}_{it}$). It treats the unobserved heterogeneity as an unobserved random variable that is correlated with $\boldsymbol{X}_{it}$, hence controlling for individual heterogeneity and allowing for changes within households over time. Because of this, it has been heavily used for linear panel models. A random effect approach on the other hand models the distributions of the individual specific effect and a fixed effect in which the distribution of the individual specific effect is left completely unspecified. The RE assumes strict exogeneity (no correlation) of c_i with the explanatory variables and as a result measures the effect of time-invariant explanatory variables (Wooldridge, 2016). The main weakness of the RE model is its strong and restrictive assumption that the random effects are independent of the covariates. Testing this correlation using the Hausman test, we reject the null hypothesis of no correlation and thus proceed with the household level FE estimation as it controls for time-invariant unobserved heterogeneity.

The second estimation issue is the presence of time-variant unobserved factors that may affect our outcome variables of interest. The heterogeneity of households regarding institutional and

public service, information access and other observed and unobserved factors may possibly affect both commercialization and the outcomes of interest, making commercialization seemingly endogenous. Moreover, there could be issues of reverse causality between commercialization and our welfare indicators like the asset holding of households. While increased commercialization can lead to greater amassment of assets through higher incomes, some household assets may be used to improve agricultural production, possibly leading to improved productivity and commercialization. In this case, commercialization may be highly correlated with unobserved time-variant shocks.

We address this issue with the use of the two-stage residual inclusion (2SRI) approach. The 2SRI approach usually leads to the 2SLS in linear models (Verkaart et al., 2017), especially when the endogenous independent variables are linear in parameters. The 2SRI approach, also known as the control function (CF) provides a direct test for endogeneity. Besides, being easy to compute, it requires less restrictive assumptions than the maximum likelihood technique (Wooldridge, 2015). It addresses endogeneity by including the residuals of the endogenous variable obtained in the first stage model into the second-stage model, in the place of predicted probabilities. In doing so, it assumes the normality of the second stage model conditional on the endogenous variable and the residual from the first stage model. One particular caveat in using the 2SRI is that the same set of explanatory variables with the exception of the instrumental variables (IV) has to be used in the first and second stage regressions to obtain consistent estimates. The 2SRI involves running a commercialization model in the first stage on other covariates with the addition of instruments. In the second stage, the generalized residual obtained in the first stage is modelled together with the commercialization variable and other covariates. Selecting instruments is not a trivial process as it must be exogenous and satisfy the exclusion restriction. However, good instruments should usually involve some form of randomization so that they should be able to induce an exogenous variation for causal claims.

We use the average number of sellers in a kebele as the IV. It is constructed by counting the number of households in each kebele that sell their output to the market, excluding the household of interest. This was then divided by the total number of surveyed households in the kebele. This instrument has recently been used by some studies examining smallholder commercialization in Africa (Ogutu et al., 2020a; Ogutu and Qaim, 2019). Use of this instrument is motivated by the extant literature on the role of peer learning as well as social network and neighborhood effects on the adoption and market participation decisions of

households (Magnan et al.,2015; Anderson et al.,2015; Michelson, 2017). As transaction cost in most rural settings are high which in most cases deter farmers from participating in output markets, social networks have the potential to lower these transaction costs, enabling households to sell their farm produce.

Social networks reduce transaction cost in two main ways: first, it facilitates the flow of information which reduces fixed transaction costs and improves the market awareness of households especially pertaining to prices and buyers. Secondly, it improves coordination which reduces transportation costs in the use of rural transport and market infrastructures. Most markets are distant from households making it difficult to sell large quantities of farm produce without the use of rural transportation facilities which are in some cases not existent or poorly organized. Moreover, less than 2% (according to our sample) of farm households own any motorized means of transportation (average number of motorized transport and bicycles is 0.01 and 0.02 respectively). Peer learning can also improve commercialization through an exposure effect. Households who observe the engagement of their neighbors in output markets may also be encouraged to participate in markets especially after observing the accruing commercialization gains.

Our instrument satisfies the instrument relevance condition as it is highly correlated with the commercialization level of household (table A ii in the appendix). But could the average number of sellers in the kebele directly affect the outcome variables? We have no cause to believe this relationship except through the commercialization pathway. Moreover, as the instrument is constructed at the kebele level, we worry less about correlation with household level, time-varying errors, arguing that the instrument may be valid, especially after controlling for unobserved heterogeneity and observed covariation. Notwithstanding, we still performed a correlational analysis to further confirm and ascertain the exogeneity of the instrument. We correlate all outcome variables with kebele average number of sellers. None of the correlation coefficients are statistically significant, suggesting that the condition for instrument exogeneity may be fulfilled. We thus maintain the uncorrelation of our IV with household level, time-varying errors. At this point, it should be stressed that there is no empirical strategy to test the validity of a single instrument, nevertheless as our instrument satisfy the two instrument validity conditions, our cautious causal results should be in order.

4.2. Heterogeneous effects

To further understand the effects of commercialization on various asset and income groups, we perform quantile regressions. Understanding the heterogeneous impact of commercialization can aid in policy development by identifying policy options that meet the needs of a more diverse socio-economic grouping of households or avoid negative effects on the most vulnerable groups which are often the intended target. Quantile regressions generally offer more insights on impact heterogeneity by making it possible to examine the effect of any covariate on the conditional distribution of the dependent variable, rather than just the mean conditional value. As we have panel data, we use the quantile regression for panel data model (QRPD), which is capable of controlling for unobserved heterogeneity. The model is represented as:

$$Y_{it} = \boldsymbol{X}'_{it}\partial_{\varphi} + c_i + \varepsilon_{it}, (y_{it}|\boldsymbol{X}_{it}) = \boldsymbol{X}'_{it}\partial_{it} \quad (2)$$

$(Y_{it}|\boldsymbol{X}_{it})$ is the conditional quantile of Y_{it} at quantile φ, which ranges between 0 and 1. $\boldsymbol{X}_{it}$ indicates the vector of commercialization and other control variables while ∂_{φ} is the vector for the parameter estimates. We estimate the effect of commercialization at five different quantiles (∂_{φ}= 0.10, 0.25, 0.50, 0.75 and 0.90) using the same covariates as in the treatment equation. Following Powell (2016), we estimate the QRPD model using the within-individual variation as identification and maintaining the non-separable disturbance property.

5. Results and discussion

5.1. Descriptive statistics

Disaggregated into the three-panel waves and a pooled sample, Table 2 shows the summary statistics for the main outcome variables and explanatory variables used in the regression models. A great majority of the households are smallholder farmers who operate farm sizes of about 2 hectares. Across the three panel rounds, households report a pooled mean income level of $4233.25 with an associated per capita income of $751.33. In terms of asset ownership, households owned livestock equivalent to 3.43 TLU with variation over the panel rounds. The average age of a household head is about 49 years with a mean educational level of 1.84 years of formal schooling. The average household size is approximately 6 with a dependency ratio of about 3. About 90% of households are male-headed.

The proportion of households who participate in output markets increased from 65% in 2008 to 71% in 2014 (see Figure A i). Nevertheless, the mean sales quantity of crops reduced from 502 Kg in 2008 to 492 Kg in 2010, but finally rose to 521Kg in 2014. The area of land

cultivated showed a varying trend over the study interval from 2.28 ha in 2008 through 2.31 ha in 2010 to 2.05 ha in the 2014 survey rounds. In terms of the transaction cost items, households either walk an average distance of about 9 km to sell their farm produce or they commute using motorized transportation providers incurring a cost of about $6 on average.

Table 2 Selected household socio-economic characteristics

Variable	Description	2008		2010		2014		Pooled	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Income	Household income per year ($ PPP)	4443.21	5241.95	4253.56	6720.65	4004.98	5289.59	4233.25	5750.73
Per capita Income	Per adult equivalent income ($ PPP)	813.69	779.35	782.29	783.27	658.03	886.35	751.33	816.32
Assets	Total household assets ($ PPP)	320.36	1029.53	444.03	661.20	1796.72	2963.49	853.73	1967.28
Per capita assets	Per adult equivalent asset	57.61	183.12	79.73	135.18	345.41	537.70	160.92	361.43
Livestock owned	Total value of all livestock (TLU)	3.60	1.55	3.74	1.41	2.94	1.08	3.43	1.71
Per capita livestock	Per adult equivalent livestock ownership	0.96	0.66	0.98	0.64	0.94	0.68	0.96	0.65
Land cultivated	Total under cultivation (hectares)	2.28	1.24	2.31	1.29	2.05	1.28	2.21	1.27
commercialization	Total quantity sold (Kg)	502.31	978.77	492.10	630.88	521.63	744.02	505.35	797.48
Age	Age of the household head (years)	46.96	12.19	48.66	12.03	51.75	11.90	49.13	12.20
Education	Education of household head (years)	1.71	2.64	1.95	2.61	1.86	2.71	1.84	2.65
Gender	Gender of household head (dummy)	0.94	0.24	0.94	0.23	0.91	0.28	0.93	0.25
Household size	Number of household members	6.28	2.25	6.35	2.35	5.74	2.10	6.13	2.25
Dependency ratio	Number of dependents	2.93	1.74	4.24	2.75	2.17	1.41	2.59	1.60
Cooperative distance	Distance to cooperative (Km)	3.12	3.17	2.64	3.06	2.97	2.89	2.90	3.05
Distance to extension agent	Distance to extension agent (Km)	2.48	2.24	2.13	1.96	2.41	2.23	2.38	2.23
Kebele average number of sellers	Average number of sellers in the ward	0.23	0.08	0.21	0.06	0.27	0.12	0.23	0.08

Source: Own calculation from survey data

5.2. Asset, livestock and income effects of commercialization

The results of the first stage of the two-stage residual inclusion approach are reported in Table A ii (Appendix). Including the residual term from the first stage in all the outcome regressions, to test and control for possible endogeneity, we fail to reject the null hypothesis of commercialization being exogenous in the livestock and per capita livestock regressions. However, we reject the null hypothesis of no exogeneity in the income, per capita income, asset and per capita asset regressions. Therefore, we include the residuals as additional covariates to control for this endogeneity.

The effect of commercialization on the outcome indicators are estimated using the household fixed-effects estimator (Table 3) with the inclusion of control variables. The empirical results confirm that smallholder commercialization increases assets, and as a consequence, contributes to welfare improvements in the long term. The commercialization effect is positive and significant across both the asset and the per capita asset outcome. This implies that a 0.1 increase in chickpea commercialization leads to an increase in the asset value of households by $99.2 or $8.9 per capita. These results are expected given that households who commercialize may invest more into assets as they represent to a large extent rural wealth. These results are in line with Michelson (2013) who found the participation of smallholder farmers in horticultural supply chains to increase the productive asset stocks of households.

Table 3 Effect of commercialization on asset livestock and income

	Asset		Per capita Asset		Livestock		Per capita Livestock		Income		Per capita Income	
	OLS	CF	OLS	CF	OLS	CF	OLS	CF	OLS	CF	OLS	CF
Commercialization (0-1)	299.979** (143.133)	992.015*** (138.858)	0.142 (0.180)	0.354** (0.191)	1899.87** (994.269)	2099.87** (994.269)	225.321 (625.321)	331.662*** (809.056)	0.016 (0.038)	0.070* (0.042)	54.866** (16.126)	89.325*** (24.354)
Other controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F value	11.56	14.73	9.71	10.31	3.15	7.57	5.95	6.19	20.20	21.98	15.08	19.02
Observation: 1842												

Notes: Other controls include area of cultivation, household head dummy, dependency ratio, age of the household head, Educational level of the household head, household size, distance to extension agents, distance to cooperatives, and walking distance to market. Standard errors are in parentheses. ***p<0.01, **p<0.05, *p<0.1. For the full model results, see Table A iii - Table A v (Appendix)

The effect on livestock values is less than the commercialization effect on assets. This possibly indicates a refocusing of households towards other forms of saving and investment. The commercialization effect on livestock ownership is 0.354 and significant at the 0.05 level. A point increase in the amount of chickpea commercialized leads to an increase in livestock ownership by 0.35 TLU, keeping all other factors constant. While the effects are observably small, they represent net commercialization gains of 10.2% on livestock ownership, implying that the ownership of productive assets like livestock increases with commercialization. The investment of households in productive assets like livestock can be seen as a form of rural diversification in the saving and investment options of households. The ownership of livestock in most rural communities represents wealth, both from an income and a cultural perspective. When faced with liquidity constraints, households may sell some of these livestock to relax their financial constraints (Carter and Lybbert, 2012).

Commercialization also increases household income and per capita income. This finding corroborates previous analysis by Ogutu and Qaim (2019) who examined the impacts of commercialization on income and multidimensional poverty in Kenya and found commercialization to increase per capita income and reduce income poverty as well as multidimensional poverty. Similar results were also obtained by Muriithi and Matz (2015) who found vegetable commercialization in Kenya to increase the income and per adult equivalent income of smallholder households both when controlling and not controlling for unobserved heterogeneity.

5.3. Heterogeneous effect of commercialization on assets and livestock

We now test the hypothesis that the effect of commercialization on the long-term welfare of farm households differs significantly between the various asset groups. Table 4 report the quantile regressions for assets, livestock and income at 5 different income distribution points (0.10, .0.25, 0.50, 0.75 and 0.90). We include the same set of explanatory variables like in the direct effect models above and also control for time-invariant unobserved heterogeneity. Importantly, commercialization benefits all the asset quantiles. The coefficient of commercialization is positive and statistically significant in all the asset quantiles. However, in absolute terms, the benefits are largest for the higher asset and per capita asset quantiles. It is worthwhile noting consistency of the increase along the quantile. The same is true for livestock and per capita livestock, where the least commercialization effect is on the 75^{th} livestock quantile and increases significantly to the 90^{th} quantile.

Table 4 Effect estimates for commercialization quantile regression

Quantiles	Q10%	Q25%	Q50%	Q75%	Q90%
			Commercialization effect sizes		
Dependent Variable					
Assets	242.777***	332.881***	559.93***	948.685***	1197.855***
	(16.191)	(36.626)	(75.579)	(197.681)	(175.199)
Per capita	12.121***	16.794***	69.380***	90.893***	122.237***
assets	(11.315)	(12.520)	(21.564)	(46.220)	(56.192)
Livestock	0.497	0.667	0.038	0.861**	0.119
	(0.847)	(0.681)	(0.749)	(0.945)	(1.575)
Per capita	0.049	0.128	0.022	0.046*	0.070**
livestock	(0.155)	(0. 125)	(0.147)	(0.203)	(0.324)
Income	588.592***	833.058***	1394.524***	1854.75***	2473.784**
	(49.342)	(81.759)	(94.382)	(951.838)	(536.192)
Per capita	183.616***	268.709***	345.252***	649.899***	680.806**
income	(38.609)	(59.830)	(81.272)	(93.555)	(117.829)
	Household Fixed effects: Yes				
	Observation: 1842				

Notes: Standard errors are in parentheses. ***p<0.01, **p<0.05, *p<0.1..

Overall, the findings are in the same direction enabling us to conclude that commercialization has a positive and differential effect within the sampled households. Despite the benefits on all households, we observe a greater impact on the asset richer households. In other words, households with assets and livestock higher than the median asset and livestock levels have a greater commercialization gain than their counterparts. As we move along the asset and livestock distribution, commercialization effect not only increases, but is also statistically significant, highlighting that asset-rich farmers obtain the greatest benefit from commercialization. Looking at the income and per capita income quintiles, we also observe commercialization increases income and per capita income across all quantiles. However, the absolute gains are larger for the richest households than for their counterparts.

In all these regressions, we test for equality of slope parameters (if there are significant differences between the quantile effects and the mean effects estimated by the CF) for all quantile estimation results. Table 5 shows the Wald test for the equality of the quantile

coefficients in comparison to the CF approach. We observe significant differences between the CF approach and the QRPD, hence giving more credence to the estimated heterogeneity effects.

Table 5 Wald test for equality of slopes

Outcome	Wald test F statistic of QRPD vs CF
Assets	14.73***
Per capita assets	19.02***
Livestock	10.31***
Per capita livestock	21.98***
Income	7.53***
Per capita income	5.95***

Notes: Standard errors are in parentheses. ***p<0.01, **p<0.05, *p<0.1

Judged by our specific case analysis, we conclude that commercialization is a significant strategy for increasing household welfare in rural societies. As it represents asset increases for all households, commercialization can be regarded as a significant policy tool for increasing the long-term welfare conditions of most households, for the case of chickpea production in Ethiopia. Despite observing the biggest gains on income and asset-rich households, we can safely suggest that smallholder commercialization contributes in building the asset levels of households which can smoothen income consumption in times of shocks (Carter and Lybbert, 2012). However, disparities between households are increasing at the same time, hence the likelihood for economic inequalities remains.

5.4. Robustness checks

To confirm our study findings, we performed two robustness checks. First, we employ some IV regressions as an alternative identification strategy. Recall that in the empirical strategy section, we argue that in linear models, the CF approach leads to standard IV estimators such as the 2SLS, especially when the endogenous independent variables are linear in parameters. We test this possibility by running different IV regressions with the use of the same IV as in the CF approach. Table 6 shows the results for assets, livestock and income. Over all the regression models with the use of the IV estimator, we still find a significant and positive effect of commercialization on the various welfare outcomes.

Table 6 Effect of commercialization on assets and income (IV estimation)

	Assets (1)	Livestock (2)	Income (3)
Commercialization (0-1)	1030.837***	0.820***	2285.45***
	(518.401)	(0.336)	(965.646)
Other controls	Yes	Yes	Yes
District dummies	Yes	Yes	Yes
Household FE	Yes	Yes	Yes
Year dummy	Yes	Yes	Yes
Wald chi 2	82.64	42.12	20.10
Observation	1842	1842	1842

Notes: Other controls include area of cultivation, household head dummy, dependency ratio, age of the household head, Educational level of the household head, household size, distance to extension agents, distance to cooperatives, and walking distance to market. Standard errors are in parentheses. ***p<0.01, **p<0.05, *p<0.1

As a second robustness check, we perform some variable transformations to see whether results are driven by the nature of our outcome variables. We do two kinds of transformation: log-transformation of the asset and income variable as well as an inverse hyperbolic sine transformation (IHS) of the livestock ownership variable (Bellemare and Wichman, 2019). While we perform log transformations because of the large standard deviation of income and assets, we use the IHS because of the presence of zeros in livestock ownership as some households owned no livestock. Akin to log-transformations, the IHS efficiently manages these zeros by retaining them. We now run the models with these transformed outcomes. The results presented in Table 7 depict the same sign and direction of relationship as the earlier regressions. The results are unchanged, enabling us to confirm that our results are robust to various outcome variable transformations and the positive impact of smallholder commercialization on income, assets and livestock ownership.

Table 7 Effect of commercialization on assets and income (Log transformation and IHS)

	Assets (1) Log	Livestock (2) IHS	Income (3) Log
Commercialization (0-1)	8.612***	0.066*	2.563***
	(0.358)	(0.039)	(0.219)
Other controls	Yes	Yes	Yes
District dummies	Yes	Yes	Yes
Household FE	Yes	Yes	Yes
Year dummy	Yes	Yes	Yes
Wald chi 2	11.54	9.67	28.59
Observation	1842	1842	1842

Notes: Other controls include area of cultivation, household head dummy, dependency ratio, age of the household head, Educational level of the household head, household size, distance to extension agents, distance to cooperatives, and walking distance to market. Standard errors are in parentheses. ***p<0.01, **p<0.05, *p<0.1

6. Conclusion and policy implication

We examined the effects of commercialization of chickpea production in Ethiopia on assets and livestock holdings. This represents a less studied, though important, aspect of welfare dynamics in rural economies as it is indicative of longer-term effects. We sought to understand how commercialization impacts the asset and livestock holdings of farm households in the Shewa region of Ethiopia using a unique panel data set. Because of self-selection into commercialization, and possible reverse causality between commercialization and our 6 outcomes of interest (assets, per capita asset, livestock ownership, per capita livestock ownership, income and per capita income), we employed the household fixed effect estimator and used the 2 stage residual inclusion approach to control for time-invariant unobserved heterogeneity and endogeneity. Mindful of possible impact heterogeneity, we also evaluated the heterogeneous effects of commercialization on income and per capita income, which until now only received little attention.

Although this study only represents one specific crop in one region of Ethiopia, our results are relevant for agricultural development plans. The results are indicative of the positive effect of agricultural commercialization on assets, per capita assets, livestock ownership, and per capita livestock while also confirming the income and per capita income effects. We find stronger effects on non-livestock assets despite commercialization increasing livestock ownership of farm households. Household investment in assets, especially livestock can to a large extent be seen as a form of rural diversification strategies with the ability to relax the liquidity

constraints of households. Since livestock ownership represents wealth in most rural communities, the investment in these productive assets can also be seen as an improvement in welfare. Using the quantile regression framework to establish heterogeneous effects, we found commercialization to benefit all households, with the continuously bigger commercialization gains along the wealth spectrum of farmers. Despite this rising asset inequality, we conclude that commercialization can be regarded as an important strategy in increasing smallholder incomes and building rural wealth. However, the effects of the unequal gains should be of policy concern and strategies to mitigate a further falling behind of the poorer households should be mitigated.

The analysis calls for the promotion of agricultural commercialization through two pathways. Firstly, investment into rural (market) infrastructure and improving smallholder access to markets through the provision of better farm to market connections such as roads as well as market information systems (radio and short messaging systems). This would significantly reduce transaction costs and make markets more attractive to farmers especially the disadvantaged farmers. Secondly, market support schemes and programs that target productivity increase and the provision of rural credit for agricultural purposes should be encouraged and directed to marginalized farmers as this may reduce the rising inequality. Moreover, this may also increase marketed surplus which will enhance market participation of poorer households. The knowledge side of this should not be neglected as information plays a big role in improving commercialization. Better organization of farmers into business groups and support by extension agents would reduce fixed transaction cost items like search costs for markets and bargaining costs.

While we are confident of our estimates as we employed panel data and controlled for many confounding factors with various identification techniques, we are careful not to over-interpret the results in a causal fashion, since the employed identification strategy may not be perfect. Moreover, our results may only be region-specific with a lot of bearings to mostly agricultural societies and rural settings. Despite this, the realities in Ethiopia can generally represent most rural agricultural settings in Africa especially with similar results having been found for other settings (Ogutu and Qaim, 2019; Muriithi and Matz, 2015). We thus believe this additional evidence will allow a better assessment of policy options for broader contexts.

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Appendices

Table A i. Test of Attrition bias

Variable	Coefficient	S.E
Commercialization	0.004	0.006
Age of the household head	0.0015	0.005
Education level of household head	0.037	0.066
Gender of household head	-0.274	0.196
Walking distance to market	0.006	0.008
Household size	-0.040	0.025
Distance to cooperative	0.001	0.017
Distance to extension agent	-0.005	0.027
District dummies	Yes	
Time dummies	Yes	
Pseudo R squared	0.0624	

Notes:***p<0.01,**p<0.05,*p<0.1, p values are shown in parenthesis.

Table A ii. Reduced form model of the factors affecting commercialization

Variable	Coefficient	Standard error
Kebele average number of sellers	1.418***	0.290
Area of cultivation (hectares)	0.014***	0.003
Head male (dummy)	0.035	0.029
Dependency ratio	0.004	0.063
Age (years)	-0.008	0.006
Education (years)	-0.002	0.004
Household size	0.001	0.004
Distance to extension agent (Km)	0.003	0.004
Distance to cooperative (Km)	-0.004	0.003
Distance to market (Km)	-0.008	0.001
Year dummy	Yes	
Constant	-339.449***	117.821
Household fixed effects	Yes	
Observations	1842	

Notes: ***p<0.01, **p<0.05, *p<0.1

Table A iii. Effect of commercialization on asset and per capita asset (full model)

	Asset		Per capita Asset	
	(1)	(2)	(3)	(4)
	OLS	CF	OLS	CF
Commercialization (0-1)	299.979**	4822.466***	54.866**	992.015***
	(143.133)	(752.876)	(16.126)	(138.858)
Area of cultivation (hectares)	83.621***	-106.664***	12.791***	-19.959***
	(19.101)	(30.689)	(3.451)	(5.660)
Male head (dummy)	114.656	-639.029	35.664	-79.415
	(194.361)	(400.882)	(34.944)	(73.937)
Dependency ratio	-78.824**	-43.864	-6.559	10.947
	(40.471)	(55.153)	(7.341)	(10.172)
Age (years)	8.613**	52.634***	1.883**	8.880***
	(4.338)	(12.226)	(0.778)	(2.255)
Education (years)	139.508***	128.691***	24.395***	18.347**
	(19.329)	(45.805)	(3.470)	(8.448)
Household size (number)	-12.781	-97.747**	-29.733**	-55.169***
	(29.825)	(46.659)	(5.393)	(8.605)
Distance to extension agent (Km)	32.990	17.494	2.197	-2.463
	(26.482)	(30.782)	(4.829)	(5.677)
Distance to cooperative (Km)	-35.849*	-41.255*	-7.018**	-5.053
	(19.608)	(24.077)	(3.570)	(4.440)
Walking distance to market (Km)	9.170	31.481***	1.646	6.594***
	(7.971)	(11.309)	(1.444)	(2.082)
Residual from first stage		4822.466***		-1021.075***
		(752.876)		(141.49)
Constant	-149.553	-2045.925***	119.173**	-215.141*
	(317.534)	(695.246)	(57.085)	(128.229)
Other controls	Yes	Yes	Yes	Yes
Household FE	Yes	Yes	Yes	Yes
District dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
F value	11.56	14.73	15.08	19.02
Observation	1842	1842	1842	1842

Notes: Standard errors are in parentheses. ***p<0.01, **p<0.05, *p<0.1

Table A iv. Effect of commercialization on livestock and per capita livestock ownership (full model)

	Livestock		Per capita Livestock	
	(1)	(2)	(3)	(4)
	OLS	CF	OLS	CF
Commercialization (0-1)	0.142	0.354**	0.016	0.070*
	(0.180)	(0.191)	(0.038)	(0.042)
Area of cultivation (hectares)	0.508***	0.241***	0.091***	0.046***
	(0.027)	(0.035)	(0.005)	(0.007)
Male head (dummy)	0.330	0.705	0.031	0.220**
	(0.296)	(0.466)	(0.060)	(0.103)
Dependency ratio	-0.018	-0.058	0.004	-0.005
	(0.055)	(0.063)	(0.011)	(0.014)
Age (years)	0.008	-0.022*	0.003**	-0.005**
	(0.006)	(0.013)	(0.001)	(0.003)
Education (years)	0.091***	0.018	0.014**	-0.009
	(0.030)	(0.053)	(0.006)	(0.012)
Household size (number)	0.259***	0.256***	-0.136***	-0.145***
	(0.042)	(0.054)	(0.007)	(0.012)
Distance to extension agent (Km)	0.030	0.009	0.005	0.001
	(0.033)	(0.035)	(0.007)	(0.792)
Distance to cooperative (Km)	-0.015	-0.039	-0.005	-0.008
	(0.025)	(0.027)	(0.005)	(0.006)
Residual from first stage		1.153		0.162
		(0.985)		(0.198)
Constant	0.646	3.340***	1.164***	1.775***
	(0.487)	(0.808)	(0.099)	(0.178)
Other controls	Yes	Yes	Yes	Yes
Household FE	Yes	Yes	Yes	Yes
District dummies	Yes	Yes	Yes	Yes
Year dummy	Yes	Yes	Yes	Yes
F value	9.71	10.31	20.20	21.98
Observation	1842	1842	1842	1842

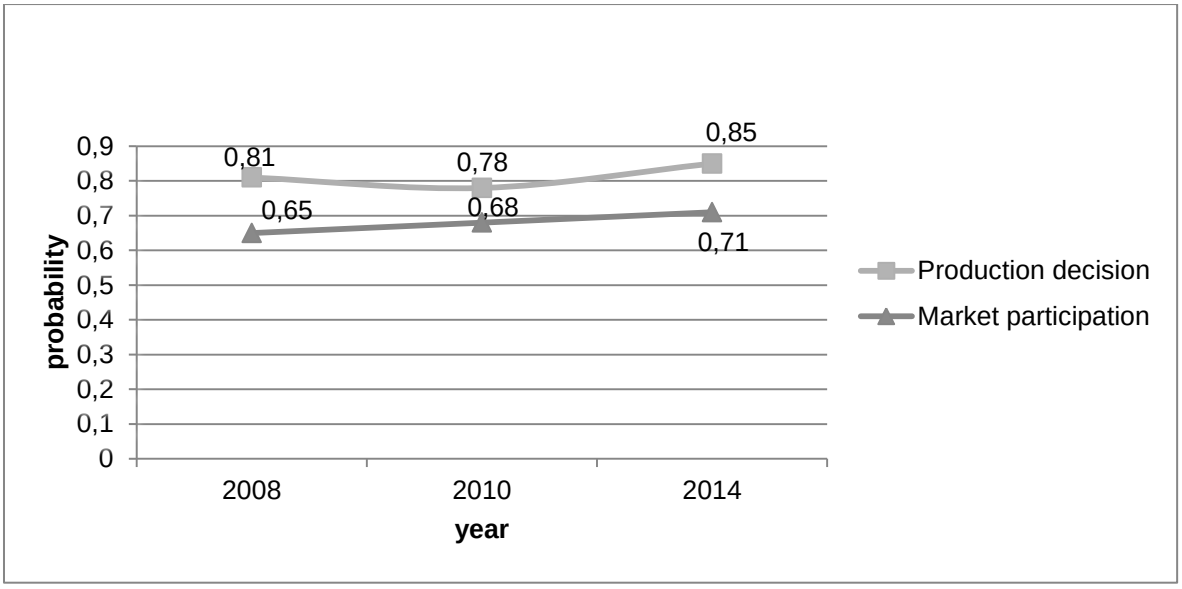
Notes: Standard errors are in parentheses. ***p<0.01, **p<0.05, *p<0.1

Table A v. Effect of commercialization on Income and Per capita Income (full model)

	Income		Per capita Income	
	(1) OLS	(2) CF	(3) OLS	(4) CF
Commercialization (0-1)	2199.87**	3129.68***	331.662	803.761**
	(994.269)	(440.781)	(809.056)	(705.571)
Male head (dummy)	2822.39	3619.229	2108.053	2130.189
	(2426.461)	(2385.806)	(1974.461)	(1973.095)
Dependency ratio	-804.804**	-373.113	-412.337	-319.843
	(327.925)	(328.274)	(266.839)	(271.460)
Age (years)	-28.084	-195.688***	-22.201	-41.324
	(67.962)	(71.174)	(55.302)	(60.176)
Education (years)	-1090.21***	-	-1140.856***	-1161.292***
	(274.758)	1315.392***	(223.476)	(225.446)
		(271.863)		
Household size (number)	156.354	-32.421	-714.265***	-836.792***
	(278.551)	(274.964)	(226.662)	(229.650)
Distance to extension agent (Km)	-185.495	-243.951	-117.990	-120.204
	(186.376)	(183.234)	(151.658)	(151.509)
Distance to cooperative (Km)	-7.981	142.686	-19.692	12.921
	(144.225)	(143.369)	(117.359)	(118.507)
Residual from first stage		-3041.98***		-6821.351**
		(4485..961)		(3775.799)
Constant	939.524**	6221.889	8041.099**	5708.645*
	(4101.35)	(4054.778)	(3337.352)	(3421.918)
Other controls	Yes	Yes	Yes	Yes
District dummies	Yes	Yes	Yes	Yes
Household FE	Yes	Yes	Yes	Yes
Year dummy	Yes	Yes	Yes	Yes
F value	3.15	7.57	5.95	6.19
Observation	1842	1842	1842	1842

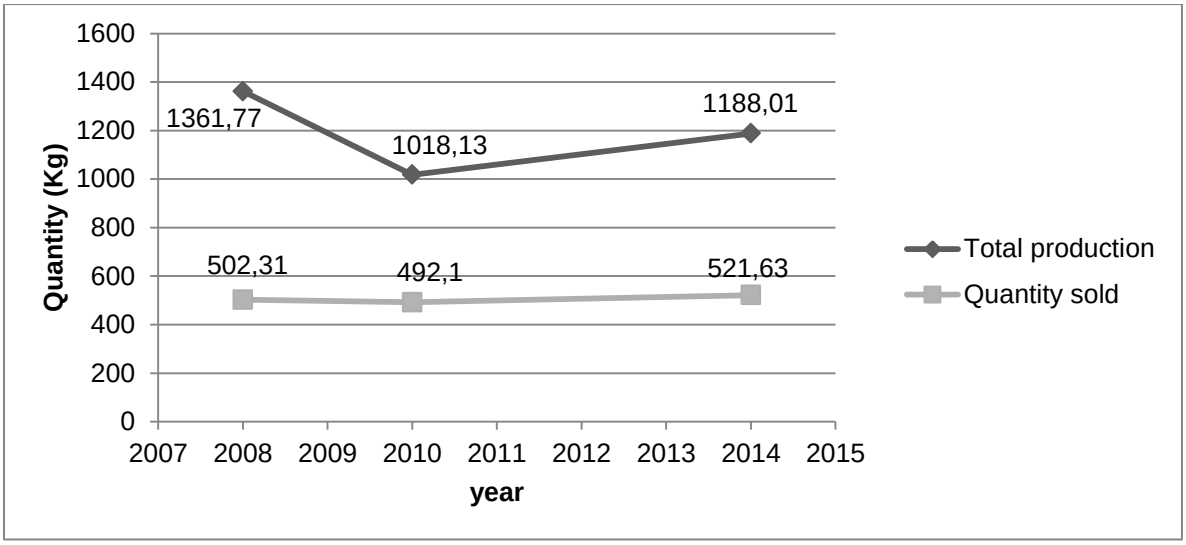
Notes: Standard errors are in parentheses. ***p<0.01, **p<0.05, *p<0.1

Production and commercialization trends



Source: Own calculation based on 2008, 2010, and 2014 ICRISAT survey data.

Figure A i. **AII Trend of production and commercialization**



Source: Own calculation based on 2008, 2010, and 2014 ICRISAT survey data.

Figure A ii. Distribution of quantity produced and quantity sold