Farm Households' Choice of Crops, Commercialization, and Risk in North Shewa, Ethiopia

By

Mohammed Endris Harun

A Dissertation Submitted in Partial Fulfillment of the Requirements For A Degree of Doctor of Philosophy in Development Studies (Rural Development)

Supervisor: Belaineh Legesse (PhD)

Addis Ababa University

College of Development Studies

Center for Rural Development

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Statement of the author

I, the undersigned, certify that this is my original work and that all sources and materials used in the dissertation have been correctly acknowledged. At neither this nor any other university has it ever been presented.

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In memory of the late Professor Workneh Negatu

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ABBREVIATIONS

ADLI	Agricultural Development Led Industrialization
ATA	Agricultural Transformation Agency
BOFED	Bureau of Finance, Economy and Development
CSA	Central Statistics Agency
ECX	Ethiopia Commodity Exchange
EEA	Ethiopian Economic Association
FAO	Food and Agriculture Organization
FGPB	Farmers' Green Production Behavior
FDRE	Federal Democratic Republic of Ethiopia
FML	Fractional Multinomial Logit
GOE	Government of Ethiopia
GTP	Growth and Transformation Plan
HFIAS	Household Food Insecurity Access Scale
IDP	International Displaced People
MOFED	Ministry of Finance and Economic Development
MSP	Minimum Support Price
NUS	Neglected and Underutilized Species
OLS	Ordinary Least Square
SNNP	Southern Nations Nationalities and People
SSA	Sub-Saharan Africa
PSNP	Productive Safety net Program
VAT	Value-Added Tax
WUE	Water Use Efficiency
WFP	World Food Programme

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ABSTRACT

The world is currently facing a challenge due to rising food prices. It is acknowledged that increasing smallholder farmers' productivity and commercializing their operations are important techniques for addressing food security. Ethiopia is utilizing a variety of policies to increase agricultural GDP contribution and achieve food self-sufficiency. Investigating the process of farmers' decisions in relation to risk is more important to connect these policies with the governments' pro-poor efforts. This study focused on crop selection, risk, and mung bean in this aspect. Crop choice is a method for effective land use, stabilizing food prices, and establishing a wholesome food system. A total of 400 smallholder farmers were selected using a Multi-stage random sampling technique from kewot woreda of North Shewa, Ethiopia and surveyed using an interview questionnaire. Crop producing activities covered 72% of the total income. The study also showed that market-related issues including transportation, weak enforcement of land contracts, and shortage of wage laborers during harvesting have a detrimental impact on agricultural income. Additionally, the results showed that households had obtained land through redistribution and acquisition. The study also found that women were insufficiently involved in agricultural decision-making. Mung bean is found in the crop mix of 64% of farmers. The higher profit per hectare is seen in mung beans, although the maximum calorie density per hectare is found in sorghum. Mung beans are also positively correlated with selected commercialization

indices. Sorghum, teff, onion, and mung bean were identified as the dominating crops, accounting for 95% of all cultivated area, according to the crop choice study. Appropriate econometrics methods were applied to each objectives. According to the crop portfolio choice results, 73% of respondents said they preferred marketing to consuming when choosing their crop portfolio. Despite greater respondent heterogeneity in the risk assessment of onions, mung beans were shown to be a crop with higher risk. Result on the variables that affect how risky farmers' crop portfolio choices are, shows that livestock ownership and education have a positive association with portfolio riskiness whereas irrigation use and being male headed household had a negative correlation. This study's primary contribution is the way it explicitly addresses the risk assessment of the farmer. The main policy conclusion is that, through insurance and crop-specific subsidies that focus on calorie-revenue tradeoffs, farmers can make decisions about their crops without being constrained by risk or their own consumption.

Key words: Crop choice, Risk, Commercialization, Farm decision, Kewot, Ethiopia

CHAPTER 1: GENERAL INTRODUCTION

This chapter includes the background and context, the reviewed related literature, the framework, the research targets, objectives, and inquiries, the significance, and eventually the limitations that were encountered.

1.1 Background of the Study

The lives of small-scale farmers are nevertheless restricted by a number of hindering factors, despite the fact that several sectors of the economy have experienced growth (World Bank, 2022). Small and decreasing farmland due to big family sizes and rapid population increase are the main restrictions. Likewise, developing countries have a variety of goals that they wish to achieve (Zeresa, 2021). These include enhancing farm household incomes, enhancing food security, enhancing sustainable resource use, enhancing gender equality, and enhancing agricultural production. The fact that the prices paid for agricultural products are primarily set by local markets is only one example of how intertwined farming is throughout different regions of the world. Agriculture's future may lie in regional specialization (Giller, 2021).

In the next ten years, it is expected that climate change will significantly influence the yields and distribution of staple food crops throughout Africa and elsewhere. Agriculture is thought to be the activity most at risk from climate change, according to some forecast reports (Raza, 2019). Climate change's possible effects could either improve or hinder crop-growing conditions in different regions which could lead to changes in the types of crops grown in a particular area. According to FAO (2014), Ethiopia's' agricultural development strategy built on the contributions of both corporate farmers and smallholder farmers in order to increase domestic food supplies. To eradicate hunger, it is planned to increase per person food production,

especially cereal yields, by half, mostly by using more fertilizer. It's crucial to discover an effective crop selection and crop mix to lower production risk and increase production because the countries' diverse agro-climatic zones make the region conducive to cultivating a variety of crops (Ayal & Filho, 2017).

To accelerate the commercialization of agriculture and the growth of the agro-industrial sector in order to achieve food self-sufficiency, the Ethiopian government has implemented a number of agricultural policies, including market liberalization and agricultural financing (MoFED, 2017). Despite the government giving agriculture a lot of attention, agriculture failed to fulfill its productivity and export projections (Welteji, 2018). In early 2020's Ethiopia adopted geographically focused approach (also known as economic corridors or clusters) to facilitate Agricultural Commercialization (ATA, 2022). The method focuses on identifying the primary and priority goods in which Ethiopia has a competitive advantage and selecting the suitable *woreda* groupings that might be "clustered" for these goods. These strategies and implementation plans will be centered on producing a particular output and comparing the market prices of various crops that might be grown in that particular area.

Africa is home to more than one-third of all people who experienced extreme food insecurity globally in 2021 (FAO, 2022). Over 20.1 million Ethiopians, including 2.73 million internally displaced people (IDPs) and 1.88 million returnees are food insecure in a number of different regions. Even in years with plentiful rainfall, Ethiopian farmers cannot meet demand for food. Water scarcity is a significant problem for the dry land tropics and a significant contributor to food insecurity there. One strategy for addressing water scarcity is to improve Efficiency of Water Use

(WUE) by changing the irrigation type, the crops chosen, and other management techniques (Montazar & Zadbagher, 2010).

Significant modifications in agricultural production systems are demanded as the world population is projected to increase to over 9 billion people by 2050 and over 10 billion by the end of the century. Smallholder farmers make up more than two-thirds of the world's poor and food insecure (Sibhatu and Qaim, 2017). African farmers struggled with food insecurity, poverty, and extreme climatic conditions like drought and flood (Khatiwada et al., 2017). They also faced minimal revenue from agricultural productivity as small-holder farming is reportedly essential to "a sustainable future for agriculture, eradicating hunger and poverty, achieving social cohesion, employment, and sustainable use of natural resources" (FAO, 2013). There is a consensus that increased employment and faster poverty reduction are two benefits of strong agricultural growth rates for the economic development of low-income countries.

1.2 Review of Related Literatures

A brief survey of related literature is presented in this section. This chapter examines the issues facing Ethiopian agriculture, provides data on agricultural output, and demonstrates how these issues are related to overall economic development, food security, and poverty. It examines how decisions made by rural farm households affect the sector's performance as well as how these decisions are affected by production and price risk and household characteristics. The pertinent theoretical underpinnings for the issues being studied are also offered. In essence, it presents the study's target crop, the mung bean, then locates, analyzes, and synthesizes pertinent literature in relation to the study's topic. It explains how knowledge has changed with

regard to farming decisions, crop selection, and risk, as well as the methods used, models created. The conceptual framework for the study, which was developed based on the examined literature, is presented at the end.

1.2.1 Agriculture and the economy

Eighty percent of Ethiopia's exports come from agriculture, which also employs an estimated 75 percent of the nation's workers. Ethiopia's economy has historically been driven by the agriculture sector, but in recent years the rise of the service sector has replaced it. The National Bank of Ethiopia (2022) estimates that for the fiscal year 2020/21 in Ethiopia, the contributions of agriculture, industry, and services to the GDP were respectively 32.5%, 29.3%, and 39.6%. To find Agriculture which used to be considered as a foundation for the remaining sectors with traditional technologies and a low input, low output production strategy and dominated by rain-fed mixed farming is far below than expectations. Typically, 60% of the sector's output comes from crop production, followed by 27% from livestock, and 13% from other sources. The government has given agriculture a lot of attention as well. The level, however, fell short of expectations.

Ethiopia has a widening trade deficit, with total imports rising by 12.5% annually on average during the last 10 years. Growing agricultural exports should make up for rising imports, which are to blame for the rise in the trade deficit (Gemechu, 2018). Among the top 10 export categories, coffee, tea, and spices saw the highest growth, increasing by 49% from 2020. The government of Ethiopia continues to keep very little in the way of foreign exchange reserves. The agricultural sector led in exports with USD 1.5 billion, or 81 percent of the anticipated income. Manufacturing only generated USD 197.5 million as opposed to the anticipated USD 289.3 million.

Seventy-two percent of the USD 78.6 million in export revenue that was anticipated was generated by the sales of meat and dairy products. Low exports are a result of domestic consumers placing a higher value on the goods than international consumers do. In order to help producers, the Ethiopia Commodity Exchange (ECX) functions as a mechanism for export crops. Along with coffee and spices, mung bean is one of the crops that can be traded through it.

Productivity of grain crops in the country suffers from large yield gaps arising from many factors (Belachew et al., 2022). Farmers' yields remain far lower than those from on-farm trials and on-station trials and the calculated water-limited yield potential. Van Loon et al. (2018) results reveal substantial legume yield gaps, losing the exploitable legume yield gaps on existing cropland but in Ethiopia yield gap closure on existing cropland alone would not be enough to obtain legume self-sufficiency by 2050.

Gideon (2015) presented report on major agricultural risks at Ethiopia through Agricultural Risk Assessment Study (RAS) showed different risk categories. The first one was, natural risks, including weather, droughts and floods most frequent, impact covariant and effects on production as well as loss of human lives. Hailstorms, temperature variability, earthquakes, volcanic activity – less frequent and effects localized but can be severe. The second one was biological risks, such as crop and livestock pests and diseases which is frequent and severe impact including high livestock mortality but also high revenue losses due to export restrictions imposed by importing countries. The third one was market related risks related with volatility in input and output prices and potential changes in demand/supply. The other risk type researcher showed was policy risks explained through output market interventions (e.g. price uncertainty due to distribution of subsidized imported wheat); change in

policy of regional governments and farmers' inputs uptake capacity. In addition, other risks mentioned also include, health risks, death, accidents affecting farmers/household members; land access uncertainty.

Table 1: Crop risks and their management

Risk type	Strategies	Description
Production risk	Risk-reducing inputs	Fertilizers and compost for low productivity, herbicide and pesticides use, to reduce the risk of crop injury etc.
	Risk-reducing technologies	Like, drought-resistant seed for crop; bird-damage resistant seed for cereals; disease- and pest-resistant varieties
	Selecting low-risk activities	A farmer may sacrifice an enterprise that has a high potential for return but also associated with a high risk
	System flexibility	Making decisions in response to changing circumstances in farm enterprise.
	Diversification	Diversification in enterprise spreads risk and is a successful risk management strategy in agriculture.
	Different locations	Works on the understanding that the same crops grown in different areas will not meet the same chance risk
	Use successive periods of time	Staggered planting can be used to manage household food supply and also to reduce the risk
	off-farm activities	Farmers may take part-time work in towns or on commercial farms or daily laborer.
Marketing risk	Spreading sales	Selling parts of the product different times during the year.
	Direct sales	Selling directly to final consumers may be a way to enhance profitability and reduce risk.
	Contractual agreements	Price uncertainty could be greatly reduced if farmers could make advance contracts with buyers of farm products
	Forward pricing	Buyer and producer agree on a price for the sale of crops or livestock in advance of delivery
	Market price information	Farmers should track symmetric price information relevant to their products
	Insurance	Some farmers can insure their farms against major risks, which have a low chance of occurrence but may have very adverse consequences.

Source: (Kahan, 2008)

High variability is another problem for Ethiopian productivity. In the majority of Ethiopia's rural areas, national yield variations caused by climate variability are widespread (Hailu et al., 2016). Table 1 demonstrates the types and management strategies of risks faced by Ethiopian farmers. According to Yami et al. (2020)'s simulation analysis, a 20% increase in maize yield may bring down the price of the crop by 81%. This illustrates how closely pricing and production changes are related. Adugna (2023) states that for particular crop kinds, price differences between surplus and deficit locations may be seen. If these variances are not managed, the costs associated with them will only increase.

Risk management has become increasingly important in all aspects of the agricultural sector, to reduce the probability of an unfavorable event occurrence and adverse consequences. There are several strategies that farm operators can use to reduce the farm exposure to risks being classified into modern/formal and traditional risk management tools (Kahan, 2008). In reality farmers and communities respond to climatic risks by employing various risk management strategies in order to maintain a certain level of welfare. Thus, this review was conducted with the objective, to identify the major types of risks and to assess major risk management strategies used by small holder agricultural households in Ethiopia.

1.2.2 Agricultural policies of Ethiopia

Between the service, agricultural, and industrial sectors, there has been ongoing discussion about which should dominate Ethiopia's economy. In the past, the government has implemented the ADLI and GTP programs, with the main principles of agriculture led and reciprocal growth, respectively. Agriculture is among the main

significant sectors in the recently launched ten-year economic growth plan of Ethiopia (GOE) (2021-2030). Over the following 10 years, the agriculture sector is anticipated to increase at a 6.2% annual rate (MoA, 2020). Public spending on sectors that benefit the poor has increased from 57% in 2004–2005 to 23% in 2016–17. The percentage of spending that has changed to be in favor of the poor and development is depicted in Fig. 1. In the coming years public investment in agriculture is expected to increase the new approached need to be adopted.

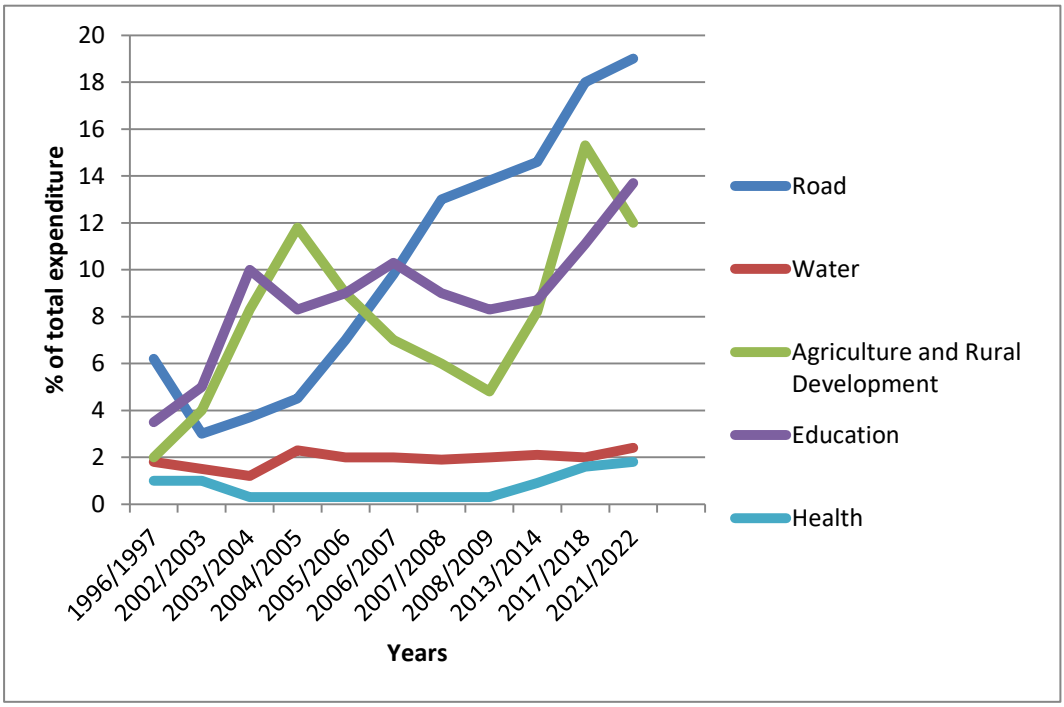

Figure 1: Trends in Pro-poor expenditure
Source: Von Brown et al. (2013), World Bank (2023)

The first Growth and Transformation Plan (GTP I), which was officially launched in 2006 E.C., included the Agricultural Transformation Agenda as a platform for addressing the most pressing systemic bottlenecks impeding the achievement of the government's goals and targets for the agriculture sector.

Agricultural policies play a crucial role in addressing food security and poverty. Dzingirai (2021) provide the role of entrepreneurship in reducing poverty in agricultural communities. The results revealed that entrepreneurship plays a catalytic role in poverty reduction in agricultural communities through food security, skill transfer, employment creation, income generation, and a decrease in food costs. Policies leading to higher food prices are likely to increase poverty, even after accounting for wage and productivity effects (Arndt et al., 2008). Emami et al. (2018) found Agricultural mechanization as a key to food security in developing countries: strategy. Developing countries tend to design their own strategies in food security given the challenges they face in all aspects of their economy, including feeding a growing population, reducing poverty, protecting the environment, managing the effects of climate change, and fighting malnutrition. Kwaw-Nimeson & Tian (2021) after exploreing the agricultural producer price – agricultural sustainability nexus based on the moderating impact of public investments on agriculture, they underscore the importance of well-designed agricultural policies in addressing poverty and ensuring food security.

For the purpose of stabilizing domestic prices and promoting oilseed, plus, and coffee exports that may have a favorable influence on social welfare; the Ethiopian government has placed limits on the export of cereal products. The government has implemented export controls and tariffs on many agricultural commodities as part of its agricultural export policies. Following a drop in coffee prices on the world market, the tax on coffee exports was eliminated in 2002. To lower the cost of food for urban consumers, the government prohibited the export of important food grains. In an effort to lower domestic grain prices, teff, wheat, maize, and sorghum export bans were implemented in the past. A few agricultural inputs, including tractors, combine harvesters, insecticides, and herbicides, have been imported and made available to

farmers by private businesses. Farmers' fertilizer distribution is handed to cooperatives as a monopoly (Habte et al. 2020).

1.2.3 Agricultural risk

Agriculture is characterized by high variability of production outcomes coming from unpredictable events. For agricultural producers it is difficult to predict with certainty the amount of output they will obtain, this is due mainly to several factors that are not within their et al., 2013). Climate change is a significant and growing threat to the global agricultural system, food security and nutritional outcomes (Musafiri et al., 2021). The adverse effects of climate change in East African countries are more severe mainly due to the interaction of multiple factors, including high population growth, extreme poverty, poor infrastructure, overdependence on rain-fed agriculture, poor availability and quality of meteorological data, and knowledge gaps ulture, poor availability and quality of meteorological data, and knowledge gaps (Drammeh et al., 2019).

Table 2 listed the agricultural risks facing Ethiopia along with their corresponding scores; up until recently, drought had the highest score. Findings from (Lakew, 2003) suggested that real private consumption, real private sector credit, and real exchange rate were important long-term predictors of the country's exports. Initiatives by the Ethiopian government aim to reduce output market risks. The following are some of the tools being developed to reduce output market risks: The first is mass marketing carried out by cooperatives. Agricultural and rural development and growth plans continue to be heavily reliant on cooperatives (Bernard and Taffesse, 2012). Another option would be to employ food reserves to lessen the effects of significant shocks to the food supply or to engage in forward contracting with cooperatives, which has been

shown to help reduce inter-year pricing risks. Promotion of agriculture insurance is one of the initiatives to manage weather hazards in Ethiopia. The low degree of farmer awareness and the high cost (premiums, particularly for weather-indexed products, are expensive and changeable) contribute to the limited uptake.

Table 2 Ethiopian agriculture risk assessment scores

Risk	Mean Yearly Severity	Mean frequency	Worst case scenario	Score
Drought	high	high	Very high	4.25
Plant disease and pest	medium	high	Very high	3.85
Price risk	high	medium	Very high	3.85
Erratic rainfall	medium	Very high	low	3.4
Exchange rate variability	low	high	medium	2.87
Input risk	medium	high	high	3
Flood	low	Very high	low	1.93
Wild fire	medium	medium	Very low	1.55

Source: adopted from Platform for agricultural risk assessment report, 2016

1.2.4 Farm decisions

According to Carroll and Johnson (1990), decision-making is the process through which an individual, group, or organization defines a choice or judgment to be made,

obtains and assesses data regarding alternatives, and chooses from the available options. Each alternative's fundamental qualities have a significant impact on how likely a decision-maker is to select it (Siebert et al., 2021). Senkondo (2000) asserted that smallholder households generally act logically when comparing several options and selecting the best one. Decision making is a process by which a person, group, or an organization identifies a choice or judgment to be made, gathers and evaluates information about alternative outcomes, and selects from among these options. The likelihood of any given outcome is thus dependent on the biophysical and socio-cultural environment, as well as the characteristics of the specific decision maker and the relative values he or she attaches to it (Mendola, 2017).

According to Singh et al.'s (1986) basic agricultural home model, the household derives utility from consumption. In order to condition the household's consumption in a way that maximizes utility, a set of household characteristics (HH) are used. When the situation calls for action, this interaction between the organism, or from a subjective standpoint, the self, and the environment or scenario allows a development of my action-oriented model for making judgments in difficult or unresolved situations. Discussion centers on beliefs about the environment (bE) and beliefs about government. This suggests that it is impossible to study production behavior without simultaneously studying the consumption side of the model as decisions regarding production and consumption are made concurrently (Van Der Velde et al., 2007).

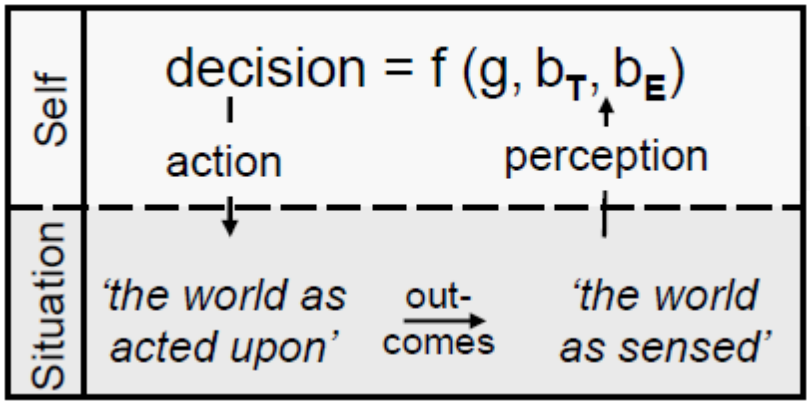

Figure 2 Action-oriented model of decision making.

Source: Adopted from von Brown et al. (1995)

The theoretical model has developed over time to reflect the pertinent farm household activities. At the heart of household models is the question of separability, or whether the household's decisions regarding its production, consumption, and labor are made simultaneously or jointly (non-separably). This question is further explored in relation to the question of unitary and collective decision making with a clear focus on the makeup of the household. The fundamental paradigm was modified in a variety of ways in more contemporary agricultural household literature. Additionally, plot, household, and village characteristics including rainfall determine the choice to subject a piece of farmland to any sustainable farming practices (Teklewold et al. 2013).

The decision of farmers to adopt and employ sustainable agricultural technology on farmland can be significantly influenced by weather-related information, particularly information on the volume, timing, and distribution of rainfall (Teklewold et al. 2013). According onto the local meteorological conditions, farmers vary the intensity of their tillage. Accordingly, farmers may be able to increase their farm revenue by

putting their farms into more than one cropping year, especially for crops with a short growing season (Barrett and Carter, 2013).

1.2.5 Agricultural commercialization

The Ethiopian government has acknowledged the value of agriculture in promoting household and national food security and reducing poverty. As part of the Growth and Transformation Plan (GTP), the government has articulated a clear vision for the sector with the goal of encouraging investment and productivity of the sector, bringing together development partners to deliver effective development aid to the sector, and transforming Ethiopian agriculture.

There are numerous markers of commercialization, which can take many different shapes. According to Leavy and Poulton (2007), this lack of understanding of what commercialization actually entails could lead to misunderstandings and prevent the implementation of policy. While many people believe that the transition from subsistence to semi-commercial to fully commercialized agriculture typically takes a long time, some authors (Pender and Alemu, 2007) view output market participation as a sign of commercialization. According to these writers, a household's position in the output markets is frequently determined by factors other than the crop type, such as the amount of surplus production that is available for marketing, location, and commodity-specific transaction costs. Examples include Salami et al. (2010), and Kirsten et al. (2012), who mostly focused on cash crops and horticultural food crops and determined commercialization level by the proportion of production marketed.

Sales-to-output and sales-to-income ratios, net and absolute market positions (either as a buyer, net seller, or autarkic/self-sufficient household), income diversification,

and level of specialization in agricultural production were recently used by Gabremedhin et al. (2009) to measure the level of household commercialization. This author claims that the sales-to-output ratio calculates a household's total gross value of all agricultural sales as a proportion of its total gross value of agricultural production.

Despite the fact that the majority of the literature treats market orientation and market participation as interchangeable concepts, the majority of analyses of the factors influencing smallholder commercialization are based on studies of the factors influencing output market participation (von Braun et al. 1994; Jaleta et al. 2009; Otieno et al. 2009). Gebremedhin et al. (2009) distinguished between market orientation and market participation, measured both, and integrated the results to determine the level of commercialization of families. This study, which adopted market orientation to better depict the commercialization decision, considers commercialization as a decision made before the start of production, regardless the consequence includes crop failure.

Smallholders' poor market participation has been attributed to a number of factors, including the low prices farmers receive for basic food commodities and their desire to increase their return. As a result, there appear to be opposing trends on the supply and demand sides of the market. There are several factors that affect smallholder farmers' ability to participate in the market, and they can be roughly divided into external and internal factors. Transaction costs (Goshu et al., 2012) must be proxied and taken into account in the model (Gebreselassie & Ludi, 2008). Other external elements that might have an impact on the commercialization process include production and market-related hazards and agro-climatic conditions (Pender et al., 2007). Like population growth and demographic changes, technological

advancements and the development of new commodities, the growth of market institutions and the non-farm sector, the expansion of the overall economy, the cost of labor increasing, and macroeconomic, trade, and sectoral policies affecting prices among other driving forces. The fundamentals of indicators are shown in Table 3, which can be used to change and suggest new indications.

Table 3: Characteristics of commercialized food producers

Market orientation level	Farmers goals	Input source	Production mix	Livelihood
Subsistence system	Family food security	Own production	Diversified	Predominantly agricultural
Semi commercial system	High production	commercial plus own	Moderately Diversified	Agricultural and non-agricultural
Commercial system	Profit	Mostly from commercial sources	Mono-cropping	Predominantly non agricultural

Source: Adapted from Pingali and Rose grant, (1995)

1.2.6 Empirical literature

Factors influencing crop choice are multifaceted and can significantly impact agricultural outcomes. Ubabukoh & Imai (2022) highlighted the impact of crop choices on technical efficiency and poverty among farmers in Nigeria, emphasizing the importance of factors such as access to free inputs, non-farm income, and seed selection from previous growing seasons (Ubabukoh & Imai, 2022). Similarly, Kephe

et al. (2020) emphasized the influence of socioeconomic and climatic factors on the choice of oilseed crops among smallholder farmers in Limpopo Province, shedding light on the complex interplay of variables in crop selection (Kephe et al., 2020). Furthermore, Zizinga et al. (2017) delved into the factors influencing farmers' choices for climate change adaptation practices in South-Western Uganda, revealing the significance of household characteristics, climate change shocks, and agricultural inputs in shaping crop choice decisions (Zizinga et al., 2017).

Crop production and price risk are crucial factors for farmers and policymakers in agricultural decision-making. Farmers' decisions regarding crop insurance products are influenced by various factors, including perceived yield risk, structural and demographic variables, and the importance of risk management activities (Sherrick et al., 2004). The impact of risk and risk behavior on agricultural production decisions has been highlighted, emphasizing the significance of risk in acreage decisions for crops such as corn and soybeans (Chavas & Holt, 1990). Furthermore, the perception of production and price risk has been identified as a key factor in risk management strategies for specific crops, such as shallots (Hasan et al., 2017). The complexity of crop price fluctuation in spot and futures markets presents challenges for crop price risk management, underscoring the need for effective risk mitigation strategies (Ye et al., 2017).

The significance of whole farm revenue insurance as a risk management instrument in crop production has also been highlighted, emphasizing the importance of comprehensive risk management approaches (Marković & Kokot, 2018). In addition to production risk, the impact of price risk on revenue protection insurance and the use of futures markets for crop price insurance in China further underscore the importance of addressing price risk in agricultural risk management (Tiwari et al.,

2021). The dynamic nature of cropping systems and the potential for increased adaptability amid an uncertain future have been emphasized, highlighting the role of diversified cropping systems in reducing production risk (Hanson et al., 2007). Furthermore, the possibility of converting systemic crop yield risk into "poolable" risk has been explored, indicating potential avenues for mitigating systemic risk in agriculture (Xu & Hayes, 2016). Overall, the references provide insights into the multifaceted nature of crop production and price risk, highlighting the importance of risk management strategies, the impact of risk on agricultural decisions, and the need for comprehensive approaches to address production and price risk in agriculture.

Farm commercialization is a complex process influenced by various factors. Studies have explored the impact of agricultural commercialization on food security, particularly among smallholder farmers. Research in Vietnam has examined the relationship between agricultural commercialization and food security, considering indicators such as cash crop production share, crop output market participation share, and crop input market participation share Linderhof et al. (2019). Similarly, investigations in Zimbabwe have focused on the impact of agricultural commercialization on household food security, shedding light on the implications for smallholder farmers (Madududu et al., 2021). Furthermore, studies in South Sudan and Ethiopia have delved into the factors influencing the commercialization of horticultural crops and pulse producers, providing insights into the determinants of commercialization among smallholder farmers (Ater et al., 2021; Tilahun et al., 2019).

Additionally, research in Rwanda has highlighted the role of women empowerment in agriculture and its influence on household farm commercialization of maize, potatoes, and beans (Uwineza et al., 2021). Studies in Zimbabwe have also explored the

determinants of agricultural commercialization among smallholder farmers, offering valuable insights into the factors shaping commercialization in this context (Pamela et al., 2022). Moreover, assessments of the impacts of climate change on commercial farms in South Africa have provided valuable insights into the implications for specialized horticulture, crop, livestock, and mixed farming systems (Tibesigwa et al., 2016). Furthermore, research in Indonesia has examined the transition from subsistence to commercial intensive farming and its potential to enhance the welfare of farmer households (Mariyono, 2019). Additionally, studies on the commercialization of pigeon pea production have identified determinants and constraints, contributing to a deeper understanding of commercialization dynamics (Falola et al., 2022). These studies collectively provide valuable insights into the multifaceted nature of farm commercialization, encompassing food security, horticultural and pulse crop production, women empowerment, climate change impacts, and the transition from subsistence to commercial farming. Understanding the determinants and implications of farm commercialization is crucial for developing effective policies and interventions to support sustainable agricultural development.

In the realm of farm decisions and agricultural policy, a multitude of factors come into play, influencing the choices made by farm households and the broader implications for agricultural systems. Research has delved into the dynamics of joint farm decision-making within households, highlighting the influence of gender-differentiated preferences on farming decisions such as crop choice and labor use Malabayabas & Mishra (2022). Additionally, studies have evaluated the effects of agricultural policy reforms on off-farm labor decisions, providing insights into the impact of policy changes on the labor dynamics of farm households (Serra et al., 2005). Furthermore, empirical investigations have considered the determinants of off-farm participation decisions of farm households, shedding light on the factors

influencing rural farm households' decisions to engage in non-farm production and off-farm labor supply (Beyene, 2008). Moreover, research has explored the labor decisions of farm couples, estimating discrete-choice models of farm work, off-farm work, and hired farm labor, providing valuable insights into the labor dynamics within farm households (Benjamin, 2006).

Agricultural policy has also been examined in the context of off-farm work participation, with studies focusing on survival strategies for small farms, including agritourism and off-farm work, and their implications for farm households (Khanal & Mishra, 2014). Furthermore, the Common Agricultural Policy (CAP) in the European Union has been scrutinized, emphasizing its role in ensuring food security, improving the effective supply of agricultural products, and increasing farmers' income and agricultural production efficiency (Qian & Chen, 2018). Additionally, the spatial differentiation of farm diversification and its relationship to rural attractiveness and vicinity to cities has been explored, providing insights into the interplay between policy-driven strategic farm decision-making and rural development (Lange et al., 2013). Intra-household decision-making in agriculture has been a subject of study, revealing significant gender differences in perception of decision-making over the adoption of agricultural practices and consumption expenses (Acosta et al., 2019). Moreover, the impact of agricultural policies on poverty reduction, agricultural exports, and diversification activities for farm households has been investigated, offering valuable insights into the multifaceted effects of policy interventions in agriculture (Quintana et al., 2017; Patil et al., 2020; Khanal et al., 2019).

Several studies found that if limiting factors like a lack of capital, a lack of basic skills (farming and commercial), and high transaction costs, a lack of infrastructure, a lack of knowledge, and a lack of education could be overcome, commercializing

smallholder farms could increase incomes and welfare outcomes and lift smallholder farmers out of poverty. Pender and Alemu (2007) claimed that a major cause in higher sales is the increased production of teff and maize. In addition, factors including improved access to trade routes, land, animals, and farm machinery all contribute to the expansion of production and commercialization of these commodities. According to Samuel and Sharp (2007), smallholders that engage in a lot of market activity have a better chance of enjoying higher standards of welfare. Similar to this, the authors stated that promoting a few large companies may not have as much of an impact on decreasing poverty as increasing the level of commercialization of smallholders.

According to a research by Mahelet (2007) using data from the North Omo Zone of the Southern Nations Nationalities and People's region (SNNP), the amount of land and the number of workers employed are significant determinants of agricultural sales in the region. The study also discovered that other elements like technology (such as irrigation) and moving production to high-value crops could be very beneficial in raising smallholder farmers' incomes and lowering their levels of poverty.

According to recent studies, the sorts of crops that farmers decide to grow and sell are becoming more and more influenced by climate change, which is described as unpredictable yearly rainfall patterns and temperature fluctuations (kristjanson et al., 2017). Using plot-level panel data, Bezabih and De Falco, (2012) investigated the patterns of farmers' crop selections for a multiple-crop portfolio, where production risk considerations and rainfall uncertainty are anticipated to be important drivers. They discovered that whereas seasonal rainfall variability has a less consistent effect, annual rainfall variability significantly affects the cumulative riskiness of crop portfolios at the household level.

Similar to this, Kurosaki (2018) showed that farmers' crop choices are influenced by price and yield risk using data from the Punjab region of Pakistan. Traditional methods for restoring soil productivity (renewing soil nutrients) and maximizing the yield from cultivated land in unpredictable circumstances include crop diversity, crop sequencing or rotation (Amede et al. (2008); Benin et al. (2004)), and intercropping (Corbeels et al. 2000). Farmers also frequently practice planting early-maturing crop kinds (short-season crops) and safeguarding crops against moisture shortage and yield loss.

In different study, Muller (2014) tested separability of consumption and production decisions of farm households in Ethiopia using agricultural household model and rejected separability between agricultural production decisions and consumption decisions where he captured non-separation from the observation of a correlation between demographic composition and observed farm employment.

1.2.7 Conceptual framework

A conceptual framework is created to address the aims and research challenges mentioned in the chapter before. The framework given on figure 3 served as a direction for the creation of hypotheses and inter-variable interactions. In accordance with (Van Rijn et al., 2012), Figure 3 illustrates the broad avenues through which agricultural transformation may possibly affect both agricultural production and risk portfolio. The production pattern, productivity, social well-being of the household, and impact on sustainability are all thought to be affected by the household's decision-making process, which ultimately improves food security. Farmers first decide on what to grow or chose to grow mung bean, then work on its value chain development.

To investigate the links between mung bean uptake and smallholders' commercialization indicators, the livelihood concept is used as a starting point. The end result is viewed as dietary variations and marketing advantages (e.g., Thornton and Herrero, 2001). According to Zhou et al. (2013), commercialization indicators are crucial for increasing income and reducing poverty. The conceptual framework takes into account how crop choice is affected by risk and household market orientation, which in turn affects life expectancy as a key indicator. agricultural household models (Singh, Squire, and Strauss 1986; de Janvry, Fafchamps, and Sadoulet 1991) are theories of induced technical and institutional innovation in agriculture that explain changing management systems in terms of changing microeconomic incentives faced by farmers as a result of changing relative factor endowments.

Third-order effects of commercialization can be separated from first-order effects. The primary first-order influences on household welfare are those related to income and employment. The health and nutritional components of the second-order consequences depend typically on the level of revenue achieved through the level of commercialization already in place. The macro-economic and environmental consequences that transcend the level of the household are referred to as third-order (or typically known as higher order) effects. Cash crops also help to stimulate agricultural innovation over time by raising money for agricultural investments and hastening the establishment of institutions that facilitate further commercialization.

Smallholders are both producers and consumers of agricultural goods, and like other micro entrepreneurial households, they make their production and investment decisions within the context of their overall household economic portfolio (Chen and Dunn, 1996). Farmers' production decisions and welfare are affected by the existence

of risk. There are many sources of risk for farmers (OECD, 2009), reflecting the variability of production (mainly due to weather risks) and of prices (mainly due to market risks) and are rated by farmers separately.

The analysis of decisions regarding production and consumption at the farm level can be viewed from a promising angle by using farm household models (Singh et al., 1986). Farm households are regarded as the primary sources of agricultural production decisions. Farmers must choose which products to grow, in what proportions, using what techniques, and during what seasons. The farmers' goal is to maximize their utility, which frequently departs from pure profit-maximizing behavior. For instance, avoiding risk and securing family consumption are significant goals that must also be considered.

The most significant external elements influencing farm household decision-making are thought to be agro ecological and environmental issues. But because the study is constrained to a set of comparable circumstances, households must make selections from identical crop set. *Kebeles* were chosen intentionally by comparing their agro-climatic characteristics.

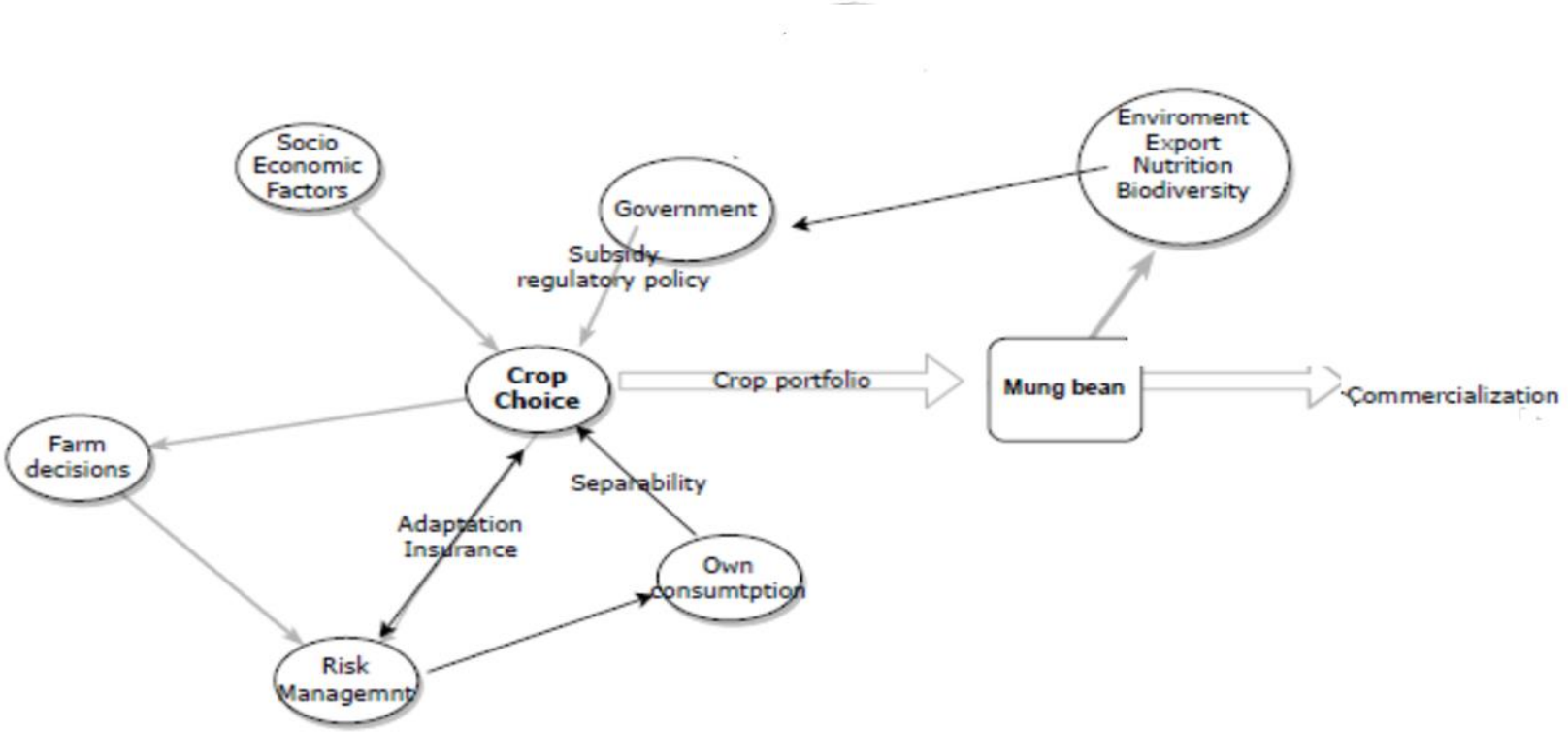

Figure 3: A conceptual framework for farm household decisions, their link and outcome

Source: Adapted from Ogutu et al. (2017); Kokoye et al. (2013)

1.3 Statement of the Problem

Since agriculture is a crucial sector for Ethiopia's economy, it must be transformed effectively if the nation is to meet its domestic food needs and improve economic performance. Ethiopia's population is expected to reach 145 million by 2030, according to World Bank (2022), necessitating the need for better decision-making procedures built on stronger institutional and human planning and execution capabilities. It forces the need for centralized agriculture and necessitates the employment of crop-specific distorting policies by the government. It is crucial to consider trade-offs between crops that might be cultivated in similar agro climatic zones as well as the advantages of each crop (Lencucha et al., 2020). Understanding the factors affecting crop choice and related issues is essential to making regulatory policies effective in addressing the question of why good policies never come to pass as planned.

There are pro-poor measures like fertilizer subsidy, safety net and export limitations implemented by the Ethiopian government; however it is uncertain whether such policies will have the desired results. The various approaches must be assessed in order to create policies that bring about sustainable changes and comply with farmers. If effective, crop policy could have an impact on consumers and producers at the same time, affecting inflation and productivity, respectively. It may be claimed that as a result, how policy is handled in various circumstances would have a significant impact on how the country evolves in the future. In Ethiopia, few methods are used for selected crops depending on their characteristics and economic significance. Among the frequent forms of intervention on which authors have opinions are subsidies and regulations. The policy researches need to put more emphasis on how these limits and subsidies should be placed, to which crops and to what extent or how much.

Farmers are often believed to be able to increase their revenue through agricultural commercialization by specializing in crops for which they have a comparative advantage. However, just 10% of agricultural farmland in Africa is used for cash crops, while in Eastern and Southern Africa only 30% of small-scale farmers sell staple grains (AGRA, 2016). Additionally, trade in agricultural products among African countries remains below 20% of all agricultural trade in the continent, which is the lowest rate in any area (Balineau et al., 2021). Countries should take advantage of their comparative advantages across various crops and agro-climatic zones in order to reverse this trend and enhance and diversify the trade in agricultural commodities. This calls for a thorough analysis of the agricultural productivities of crops that could be produced in particular areas.

Numerous studies that looked at farm household commercialization decisions made use of a broad taxonomy of food and cash crops. However, these viewpoints oversimplify the idea by leaving out important components like the purpose of production and the dynamic and contextual nature of the agriculture market, as claimed by Jaleta et al. (2009) and Dureti et al. (2023). The classification of cash crops also lacks the market dynamism necessary for price fluctuations to affect early plans for what to consume and sell. Every crop is sellable should the farmer decide to do, which is based on the price and own consumption demand. Commercialization necessitates the separation of decision-making from risk and consumption (Radchenko, 2018). More commercialized households are also said to be becoming more reliant on local marketplaces for own consumption by (Yanse, 2018). To have farmers decision purely commercial his farming decisions should not be interfered by risk, own consumption and other exogenous factors.

Farmers' preferences for crop types and the impact of location on crop choice and rural livelihood in Northern Ethiopia are also important factors to consider (Asrat et al., 2010; Nuru & Seebens, 2008). Moreover, investigating the drivers of income diversification among rural households in the Ethiopian central highlands can provide valuable insights into the socio-economic factors influencing crop choices (Getahun et al., 2023). These references collectively provide a comprehensive understanding of the diverse factors influencing crop choice in Ethiopia, encompassing socio-economic, environmental, and psychological determinants. By synthesizing these sources, a holistic understanding of the determinants of crop choice in Ethiopia can be achieved, contributing to the development of effective agricultural policies and interventions.

The study on production and price risk of crops enable to comprehensively analyze the multifaceted factors influencing crop production and pricing, encompassing climate change, market access, adaptation strategies, and crop diversity. Understanding smallholder farmers' dynamics of crop choice is crucial in assessing the impact of climate change on crop production and price risk (Belay et al., 2017). additionally, the assessment of production practices of smallholder potato farmers in Wolaita zone, southern Ethiopia, provides insights into the impact of production practices on crop yield and pricing (Gebru et al., 2017). Moreover, the study on crop biodiversity, productivity, and production risk in Ethiopia offers valuable insights into the relationship between crop diversity and production risk, contributing to a comprehensive understanding of the factors influencing crop production and pricing (Bangwayo-Skeete et al., 2012). Furthermore, understanding the seasonality of diet costs and its implications for food system performance in East Africa, including Ethiopia, provides valuable insights into the seasonal variation in local food environments and its impact on crop pricing and production (Bai et al., 2020).

Comprehensive analysis of determinants of crop production and pricing, contributes to the development of effective agricultural policies and interventions.

Understanding factors affecting farm productivity and commercialization helps increasing overall national GDP and help acheieve food security (Chaka et al. (2012) Tschopp et al., 2021; Roba, 2021). Furthermore, exploring the commercialization of specific agricultural products such as wheat, maize, and pulse crops among smallholder farmers in Ethiopia. Understanding the dynamics of commercialization of these crops, including market access, area coverage, and production levels, is essential for assessing the economic implications and challenges faced by smallholder farmers in the commercialization process (Anteneh & Asrat, 2020; Wassihun et al., 2020; Tilahun et al., 2019.

Additionally, Understanding the experiences and prospects of commercialization models such as contract farming provides valuable insights into the challenges and opportunities for commercializing specific agricultural products in Ethiopia (Ali, 2018). In conclusion, the motivation for the study on farm commercialization in Ethiopia is driven by the need to understand the dynamics of commercializing specific crops. Further research is needed to understand the challenges and opportunities of transitioning from staple food to market-oriented crop production in Ethiopia. This can include an analysis of the factors influencing farmers' decisions to engage in market-oriented production providing valuable insights for evidence-based policy formulation, market development, and inclusive agricultural growth.

Efficiency of alternative investment options on agricultural performance and household welfare study, which employs an economy-wide model, provides insights into the impact of public spending on agricultural productivity and rural

commercialization in Ethiopia (Aragie & Balié, 2020). Factors influencing decision-making processes found affecting technical efficiency and productivity of maize producers in eastern Ethiopia (Seyoum et al., 1998) supporting the importance of joint decision-making within farm households. Naazie et al. (2023) on agro-ecological intensification for climate change adaptation, which reports the existence of policies and programs aimed at enabling farmers to adapt to climatic events in Sub-Saharan Africa. There is a need for further research to understand the crops specific role in the economy ideas, paradigms, and institutions that could shape agricultural policy making, particularly in the context of achieving food self sufficiency Nutrition-Sensitive Agricultural Policies

The agricultural landscape in North Shewa, Ethiopia, is characterized by diverse crop choices and commercialization strategies, influenced by various factors such as market barriers, climate variability, and household dynamics. Despite the significance of crop choice and commercialization for farm households in North Shewa, Ethiopia, there is a lack of comprehensive understanding regarding the interplay between these decisions and their implications for risk exposure and resilience. The complex dynamics of market barriers, climate variability, and household characteristics contribute to the riskiness of crop choices and commercialization strategies, impacting the food security and livelihoods of farm households. based on the reviewed litrature, there are several research gaps in the determinant factors of crop choice in Ethiopia. While existing studies have addressed various aspects of agricultural decision-making and crop diversification, there are opportunities for further research to enhance understanding and inform policy interventions.

The low and very erratic rainfall, both between and within seasons, is the main factor limiting crop yields in Ethiopia's dry land regions. The continuous climate change is

now making this worse. The characteristics of mung beans include rapid growth in warm climates, early maturity, minimal water needs, and great soil fertility increase through nitrogen fixation (Yagoob, 2014). Such crops are important for Sustainable intensification which aims to reconcile food production and protection of the environment (Pretty, 1995). But it is worrisome to have its production limited to few areas of North Shoa, South Wollo and Gambella with very little contribution of Oromia and Benishangul Gumuz regions[1].

1.4 Research Questions

Particularly, the following research questions have been addressed in this study:

➢What are the deciding factors that affect farmers' decision on which crops to plant?
➢What are the determinants of farm household level crop portfolio riskiness?
➢Is the impact of mung bean production on agricultural commercialization positive?
➢How do crop specific policies affect crop choices made in agriculture?

1.5 Objectives

1.5.1 General objective

The general objective of this study was to identify factors determining crop choice and risk and its effect on agricultural commercialization.

[1] http://www.2merkato.com/news/alerts/2816-ethiopia-ecx-added-mung-beans-to-its-trading-floor

1.5.2 Specific objectives

The study specifically aims to address the following objectives, which include

1. To identify factors influencing farmers' crop choice decisions
2. To analyze factors affecting riskiness of households' crop portfolios
3. To investigate how mung bean production is associated with commercialization
4. To examine the interactions between farming decisions and crop specific policies

1.6 Delimitation

Due to the cross-sectional nature of the study, farmers' own ratings as a consequence of their cumulative experience are employed to measure riskiness. Only teff, sorghum, onion and mung bean are given a risk rating in order to simplify this comparison and make it proportional. Since the study area has a similar agro-ecology and all the selected crops are presumed to be well-known in the study area, it is assumed that all of the main crops chosen are readily available and that they can all be chosen even if they are not growing the particular crop during that particular season. Vegetables and other closely similar crops are not included in the crop choice category because the area allotted is so limited. Farmers wish to keep the identities of the people to whom they are selling mung beans a secret, thus the study is exclusively focused on the producer side.

This study has its own limitations due to time and financial resource limitations. It is restricted to a single poll in which respondents provided cross-sectional data. As a result, despite efforts to derive conclusions regarding the long-term behavior of some variables, the overtime patterns of significant variables and their dynamic linkage are not addressed. The study does not take into account agro-climatic conditions because

the target crop, the mung bean, is climate-specific. Quantitative risk assessment simply consists of an index that is created from verbal risk assessment; comparison numbers are used instead of percentage losses or fluctuations. Even yet, the study makes the most of every opportunity to maximize the scientific contributions it can make.

1.7 Significance of the Study

Selection of crop types and the management of associated risks are crucial for the economic sustainability of farms. The dissertation aims to explore the multifaceted relationship between crop choice and risk management in agricultural practices. This involves understanding the factors influencing farmers' decisions, the impact of crop diversity on poverty levels, and the role of crop insurance in mitigating risks. Identification and estimation of calorie- revenue trade off help to uncover motivations in government attempts of redirecting farmers' crop choice. The significance of crop choice in relation to global changes in diets and the consequences for land requirements for food will be addressed, justifying the interconnectedness of crop choice with broader food supply dynamics. The investigation of factors influencing crop choice also help facilitate adoption of crops like mung bean for the future and help bring trade exchange balanced across different levels of localities.

The study delves into the economic determinants of crop riskiness rating on farms, as well as its link with commercialization outcomes. The examination of farmers' perceived riskiness provide necessary information for national agricultural insurance policy and help financial institutions set premiums for crop base farm insurance. Additionally, assessement of the process of commercialization and its indicators provides a comprehensive understanding of the socio-economic, geographical, and

environmental factors influencing farm households' commercialization strategies, and their marketing involvement in North Shewa, Ethiopia. Emphasizing the need for adaptive frameworks for crop selection for farmers financial gain.

The study on crop riskiness, crop choice, and farm decisions holds significant importance in understanding the multifaceted dynamics of agricultural decision-making. Crop comparisons and crop choice analysis sharpens agricultural public investment decisions and formulate pro poor agricultural policies by subsidizing crops with higher nutritional value but less revenue.

1.8 Structure of the Dissertation

The Dissertation is presented in Article-based format with six chapters. The first chapter begins with an introduction that aims to give the reader a clear picture of the study's overarching topic and its context. This chapter includes a presentation of the study's goals, research questions, significance, scope, and limitations. The critical evaluation of related literature that follows the discussion of the problem's theoretical and conceptual underpinnings as well as empirical evidence is the first chapter's continuation. The article on crop choice is offered in the second section, and the article on risk analysis is presented in the third section. The fourth article examines the factors that influence the determining factors of having mung beans in their crop mix and their relationship to commercialization, and the fifth piece examines how farm decisions are made and link with crop-specific policies. Each chapter presents pertinent socioeconomic and core demographic characteristics of respondents, as well as variable types and data analysis procedures, individually. The sixth chapter ends with a summary of the findings' implications, a conclusion, and suggestions for additional research.

1.9 Ethical Considerations

Because this study used people as a source of data, ethical questions must be carefully evaluated. To ensure that data collection went smoothly, woreda development agents were used as part of the data collection team from the beginning of the study. This speed up data collection, made it simpler to communicate with respondents, and increased respondents' self-confidence. The purpose of the study was clearly explained to the respondents, who were also informed that participation was entirely optional and that all information provided would be kept private. The people who collected the data were trained to help respondents understand certain questions.

CHAPTER 2: DETERMINANTS OF CROP CHOICE IN NORTH SHEWA, ETHIOPIA: A FRACTIONAL MULTINOMIAL APPROACH

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ABSTRACT

Rapid population growth and climate change remain challenges of addressing food security in Sub-Saharan Africa. Improving productivity and commercialization of smallholder famers are recognized as effective strategies in addressing food security and sustainable agriculture. Crop choice is a tool for efficient utilization of land, stabilizing food prices and creating a balanced food system. Despite the presence of national agricultural output growth in Ethiopia in late 2010's, there is widespread concern that the contribution of agricultural output to gross domestic product is below its potential. To find ways to increase smallholders' crop production and productivity and achieve food security, this study investigated factors determining crop choice in North Shewa Ethiopia. A total of 392 farmers were selected using a Multi-stage random sampling technique. Results from descriptive statistics revealed that major sources of income were crop production activities. The study found sorghum, teff, onion and mungbean as dominant crops covering 95 % of the total cultivated land. The finding also indicated that land allocation for each crop is interdependent between crop types and between households through their socio-economic facts. The Fractional multinomial model indicates that market distance and irrigation use were found to influence all four crop shares. The analysis also predicts the association of each variable with each crop share in the form of average marginal effects. The key policy implication is that optimal crop choice and sustainable crop production could easily be achieved through market related mechanisms like insurance and contractual farming.

Key words: Fractional Multinomial Logit, Smallholder farmers, Land Allocation

2.1 Introduction

Across the developing world, most of the poor and hungry live in rural areas, where smallholder agriculture is dominant. Agriculture is the foundation of Ethiopia's economy, accounting for over 40% of Gross Domestic Product (GDP), engaging more than 80% of its labor force and is the source of most of the country's food crop production and 90% of the export value (World Bank, 2011). According to Salami *et al*. (2010), from the total crop production, 95 % is generated by smallholder farms, producing mainly for home consumption and using traditional technologies. This shows the potential of agricultural development in rural Ethiopia to facilitate greater national food security and emulate overall economic growth. The Ethiopian government formulated a plan for accelerated and sustained development to end poverty (PASDEP) by promoting the commercialization of agriculture. As one strategy for accelerating the sector's growth, it intends to encourage farmers to switch from low-value to high-value products in order to enhance their cash incomes (MoFED, 2010).

The lowland regions of Ethiopia, known as *kola* or *bereha*, make up the majority of the country's land area is arid or semi-arid. In some regions, the inter-annual rainfall variability coefficient might reach up to 30%. (Bewket, 2007), leaving farmers living in this area more vulnerable and causing repeated droughts. Ethiopia's vulnerability to the adverse impacts of climate change due to heavy dependence on rain-fed agriculture and high population growth makes effective adaptation of agriculture to climate change crucial to achieving food security (Lobell et al., 2011). Fafchamps (1992) showed that price and yield risk affect the crops that farmers choose. The ongoing liberalization of global agricultural markets has recently increased the level of focus on the actions of agricultural producers who are at risk.

Ethiopia's crop agriculture is intricate and involves wide variations in the crops grown across the nations' various ecologies and regions. The five major cereals (teff, wheat, maize, sorghum, and barley) make up the majority of the acreage grown in Ethiopia and are the country's main sources of food and fiber. Pulses are the second-most significant crop group (in terms of acreage) after cereals (Taffesse et al., 2012).

It is thought that a farmer's decision-making process for selecting a crop is implicit, internal, cyclical, and recurring, which improves understanding and assessment of producing terrains (Christine et al., 1998). The farm home, which serves as the fundamental decision-making unit for the farm, makes important choices that affect agricultural production, particularly on the use of land and other resources. These choices are typically driven by the farming households' aims, ambitions, and values (Wallace & Moss, 2002). They are also influenced by socioeconomic, institutional and climatic constraints including those beyond the farmers' control. Factors influencing crop choice decision-making processes, particularly in the face of climate change, have been studied using different econometric approaches and models (Wang et al., 2017; Muluberhan et al., 2017). Studies on crop choice in the literature are diverse and focus on the impact of crop choice on income or overall production. This study intends to fill this gap by investigating crop choice determinants and proportion of land allocated to each. Therefore, the objective of the study is to identify factors affecting crop choices of smallholder farmers.

The aims, aspirations, and values of farming households typically serve as the driving force behind the type and scope of crop choice decisions (Wallace and Moss, 2002). In addition, they are constrained by current socioeconomic and environmental factors, such as long-term changes in soil fertility, which are beyond the farmers' control (Fabiyi, 2013). In addition to that, Mottet *et al*. (2006) found technological change

(introduction of tractors) playing a significant role in explaining crop choice decisions. The study through identification of factors with strong relationships to crop choice, would help to move farmers from producing low value to high value crops based on specific comparative advantage in order to enhance their productivity and income from agriculture. It also help to facilitate and mange introduction of new crops into their crop mix and support efficient response to climate change.

2.2 Materials and Methods

2.2.1 Data and the study area

The study site is located in the north shewa zone of Amhara regional state of Ethiopia. It has a predominantly *kola* [2]agro-ecology. The economy is based on crop production supplemented by livestock production. Agriculture is the dominant economic activity engaging 92% of the labor force (CSA, 2015). Crop yields are consequently low due to the risk and post-harvest inefficiencies. Although the big harvest is the *meher* from the *kremt* rains, agriculture is rainfed, with two rainy seasons: *kremt* and *belg*. The major crops grown in the area are sorghum, maize, teff, mung bean (*masho*), tobacco, fruits and vegetables. Most families also rear livestock. On the other hand, animals are kept as a source of revenue through the production of milk, butter, meat, and eggs. Oxen supply the traction power for the cultivation of agricultural lands. This kola livelihood zone has fertile soils.

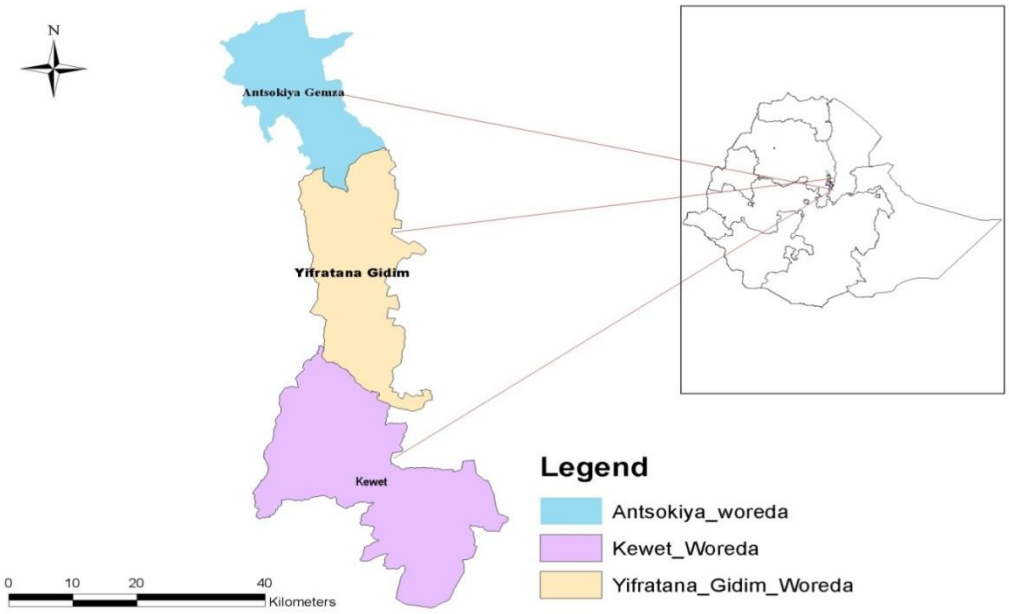

Figure 1: Map of the study area Source: Extracted from GIS (2022)

2.2.2 Population, sample size and sampling techniques

The study was carried out in kewot *woreda* of North Shoa Zone with total population of 118,381 (CSA, 2015). Using a Multi-stage random sampling technique, 392 households were selected from 5 *kebeles* (Table 4). Initially, Kewot *woreda* was selected, considering the potential growing area of the taget crop (mung bean), Secondly, the 5 *kebelles* out of 15 were randomly selected from the *woreda*. Finally, 400 farm households were selected using proportionate random sampling where 8 of them were dropped due to technical replicate filling, incomplete and a questionnaire with missing sheets. The required sample size was computed using equation 1 which is developed by (Yamane, 1967). The data were collected in the 2017/2018 season through trained enumerators using a pre-tested questionnaire (see Appendix B).

$$n = \frac{N}{1+Ne^2} \qquad 1$$

Where: n = sample size e = error limit N = Total household number

Table 4 Household numbers selected at random for the study

Kebelles	Abay atir	Yelin	Tere	Kure Biret	Shoarobit	Total
Population	8,112	6,855	9,415	5455	5873	35710
Sample households	91	77	105	61	66	400

Own survey, (2018)

2.2.3 The Fractional Multinomial Logit

To analyze the socio-economic factors affecting smallholder farmers' crop choice in the study area, the fractional multinomial model (fmlogit), which fits by quasi maximum likelihood, was used. The fractional multinomial model is the expansion of the multinomial logit to fractional responses which considers the proportion of land allocated in addition to the crop type chosen (Mullahy & Robert, 2010). This technique allows examination of shares of land allocation instead of yes or no responses. The proposed model by Papke *et al*. (1996) has dependent variables that each range between 0 and 1 and must always, for each observation, add up to 1 with a multivariate generalization.

2.2.4 Model Specification

The multinomial logit describes a technique for comparing the response probabilities for several categorical variables through use of a pivot outcome, which is the difference between one and the sum of expected shares for all other outcomes. Likewise, the fractional multinomial logit model defines a pivot outcome as well, but

again, its dependent variables are fractional outcomes (i.e., crop shares), not response probabilities. Defining j = 0 as the pivot outcome, the fractional multinomial model also must establish expressions for every outcome within the logit framework.

$$\mathrm{E}\left[\frac{\mathrm{Sj}}{\mathrm{x}}\right] = G(\beta 0 + \beta \mathrm{kX\,k}) = G(\mathrm{Z}) = \frac{\exp(\mathrm{z})}{[1 + \sum \exp(\mathrm{z})]} \qquad 2$$

$$\mathrm{E}\left[\frac{\mathrm{S0}}{\mathrm{x}}\right] = G(\beta 0 + \beta \mathrm{kX\,k}) = G(\mathrm{Z}) = \frac{\exp(\mathrm{z})}{[1 + \sum \exp(\mathrm{z})]} \qquad 3$$

Use of the pivot outcome equation (3) to estimate multiple outcomes makes it possible to evaluate the effect of explanatory variables on several crops simultaneously. Therefore, when joined together, the fractional multinomial logit model estimates coefficients which predict the expected share of several categorical outcomes within a defined interval, such as the share of cultivated land that a Malian household devotes to various crops.

The log likelihood function is a function of the predicted values and estimated using equation 4

$$lnL_i = Y_{0i} lnL_i Y_{b0i} + Y_{1i} lnL_i Y_{b1i} + \cdots + Y_{ni} lnL_i Y_{b0i} \qquad 4$$

Notice that in a multinomial logit model the ys are just 0 or 1, so in that case their function is to pick, for each individual i, which yb should enter in the log likelihood function.

2.3 Results And Discussion

2.3.1 Descriptive Statistics

Data characterizing the surveyed households is given in Table 5. The average age of the farm household heads was 41 years, with a minimum of 20 and a maximum of 68 years. The result depicts that the farm households were in active working age and were relatively younger, tending to adopt new crops, take a risk and have the ambition for higher income and commercialization (Thomas et al., 2017; Milkias & Abdulahi 2018). Family size ranged from 2 to 9 people with average family size of 4.14 members, which is slightly lower than regional average of 4.3 (CSA, 2015). The increasing family size especially in rural areas causes the land holding of each household to decrease influencing crop choice e (Worku, 2018).

The gender composition of the sample households indicated that about 90% of the households were male-headed and the remaining 10% were female-headed. UNESCO (2017) & Luh (2017) outlined that education has a profound effect on agricultural production and effectively copes with dynamic life changes. In this study, the educational outcome of the household heads is captured as “Illiterate,” “Read and write” and “High school completed.” The largest category of education was the “Read and write” group comprising 73% and the remaining 20% and 6% of the sampled household heads were under “Illiterate” and “High school completed” groups, respectively. Twenty percent of the respondents were found without any education despite Ethiopia’s attention and much effort to cut illiteracy to below 5% (MoFED, 2010).

Table 5: Summary statistics of the respondents

Variable Mean	Category	frequency	percentage
Educational Status	Illiterate	80	20.41
	Read and write	288	73.47
	High school completed	24	6.12
Marital Status	Single	24	6.12
	Married	360	91.84
	Divorced	0	0
	Widow	3	2.04
Gender of the household head	Male	351	89.54
	Female	41	10.4
Travel to a nearby city	Frequently	32	8.16
	Weekly	144	36.73
	Monthly	216	55.10
Irrigation use	Yes	304	77.55
	No	88	22.45
Credit involvment	Credit users		66.6
	No credit		33.4
Extension access	Extension users		95
	Not part of Extension		5
Average distance to nearby market (km)	To local market		7
	To Shoarobit market		12
Average transport cost (in birr)			38

Own survey, (2018)

Credit and extension services are vital for farmers to use modern technologies and cope with seasonal problems such as food shortage. However, as the descriptive results in Table 5 show, 66.6% of the sample households had no access to credit service or were not involved in credit service. On the other hand, about 95% of the respondents had access to extension service, from this, only 25% of the respondents used fertilizer which is against previous result where higher extension service contact found directly associated with higher utilization of modern inputs in cash crop areas (Smitowe et al., 2010). Farmers use the local market and Shewa Robit city as a major trading center. On average sample respondents had a distance of 7 and 12 Kms away from local and Shewa Robit city markets, respectively, with the average quintal transport cost of 38 birr to Shewa Robit. Respondents also mentioned Debrebrhan, Dessie and Addis Ababa markets as their direct market destinations.

2.3.2 Land use

This section presents land-use related issues as they in one way or another influence farm decisions and are an indispensable resource in agricultural production. Evidence shows that cropping systems practiced by farmers were significantly derived by farm size and land characteristics (Conway et al., 2018). Overall, the average land-holding of the sample respondents was found to be 1.4 ha with a standard deviation of 0.17 ha. The maximum land size of sample households was 4.75 ha while the minimum was 0.6 ha. The sample average was higher than the national figure, 1.2 ha implying relatively better land-holding in the study area (CSA, 2015). This larger land-holding invited huge labor from the north and south Wollo and this is evident from the large labor market observed in the study area, but due to the high temperature and less suitability of the area, laborers prefer working temporarily rather than permanently

settling there. Participants of the group discussion also supported that the area is less preferable due to its high temperature, diseases and inter-ethnic conflicts.

Table 6: Farmers description of their land characteristics

Land description	Plain	271	69 %
	Moderate	113	29 %
	Sloppy	8	2%
Marginal land	Yes	56	15%
	No	320	85%
Location of farm sites	One site	32	8.2%
	Different sites	360	91.8%
Land acquisition	Inherited	56	15.9%
	Purchased	64	34%
	Redistribution	224	57.4%
Land arrangement	Only own land	304	77.5%
	Rent	56	14.3%
	Share cropping	32	8.2%

Own survey, (2018)

Land attributes have a significant role in crop choice and other farm decisions. Sixty nine percent of the sampled respondents reported that their land was plain, while 29% and 2% reported moderate and sloppy, respectively. The less marginal land utilization (two percent) supports environmental sustainability. Furthermore, 80% of the respondents claimed that land available for rent has medium fertility and rated the

availability of land for rent as high, that, in turn, contribute to sustainable production. More than 90% of land rent is legally documented and few land-related disputes appeared in the past years. Sixty seven percent of the respondents say there was no change in their farm size in the past ten years, while the remaining 33% reported reduction in farm size owned due to inheritance to siblings and taken away by government for rail way construction. The low land transfer through inheritance which is 15% when compared to purchase and redistribution could indicate native youths' reduced involvement in land ownership.

As shown in Table 6, majority (74%) of the farmers acquired their farm plots through inheritance and redistribution, while 24.6% acquired through purchase and rent. Fifty seven percent of the farmers acquired land through redistribution, implying farmers are working on relatively better quality land, in which most of the land associated with redistribution and resettlements are less fragmented and less exploited. On the other hand, acquisition through rent and gift were not common among respondents. From the total land cultivated by sample respondents, 77.5% of the farmers cultivated their own land while 14.3% cultivated using different share cropping arrangements and labor. In the informal discussion farmers claimed that "Typically, landowners inquire about and oversee the kind of crop we are cultivating as well as other activities related to their land, which occasionally results in disagreement". Indicating the high level of interference by the land owner specifically on the type of crop to be cultivated.

2.3.3 Farm practices and problems

Farm practices are part of decisions and play a crucial role in influencing farm efficiency. In the study area, 91% of the farmers reported that they apply rotation

despite only 55% of them believe as an effective strategy for land productivity than fertilizer and compost use. Eighty percent of the respondents reported that they changed the crop type they used to grow at least once in their farming years. This could be an indicator of flexibility in their farm decisions, where 18% of the respondents indicated marketing problem and 32% production decline as a reason for the change they made. Table 7 presents major crop production problems, which are ranked using Rank Aggregation (RA), a process of combining multiple ranked lists into a single ranking, (weight). Based on this, marketing problems and irrigation take first and second problems faced by farmers of the study area. Lack of support takes the last and from the group discussion, they indicated that they wanted constant contact with development agents, in the form of discussion not order or instruction. For smallholder farmers, fertilizers are often unaffordable, resulting in adverse impact. The application rate of inorganic fertilizer is around 27 kg/ ha, which is slightly lower than the national average of 32 kg (Negash & Israel, 2016). Conflicts are common in the area affecting farmer's productivity. The authors witnessed serious conflicts in that short stint during data collection which is exacerbated as the area is a border between the Afar and the Amhara regional states.

Table 7: Major crop production constraints

Constraint	Total weighted score	Rank
Marketing problems	1740	1st
Lack of Irrigation	1302	2nd
Financial problems	1293	3rd
Shortage of land	910	4th
Lack of technical support	406	5th

Own survey, (2018)

2.3.4 Cropping system

The study identified teff, sorghum, onion and mung bean as the major crops grown in the study area covering about 95 % of the total land allotted to crop production. The other crops cultivated included maize, tobacco, mango, banana and vegetables. The amount of land that was set aside for crop cultivation revealed the relative value of crops to the farmers. In this regard the share of the cultivated area allotted to each crop is presented in diagram 2, where 35% of the total area is covered by sorghum, higher when compared with the national teff coverage of 25% (CSA, 2015). The dominance of sorghum production in the study is clear but not unique as most dry land farmers prioritize sorghum for their own consumption but the surprising fact is it is also the highly traded crop in the area. Next to sorghum, teff, onion and mung bean covered 24.00%, 16.98%, and 13.49% of the total crop production, respectively.

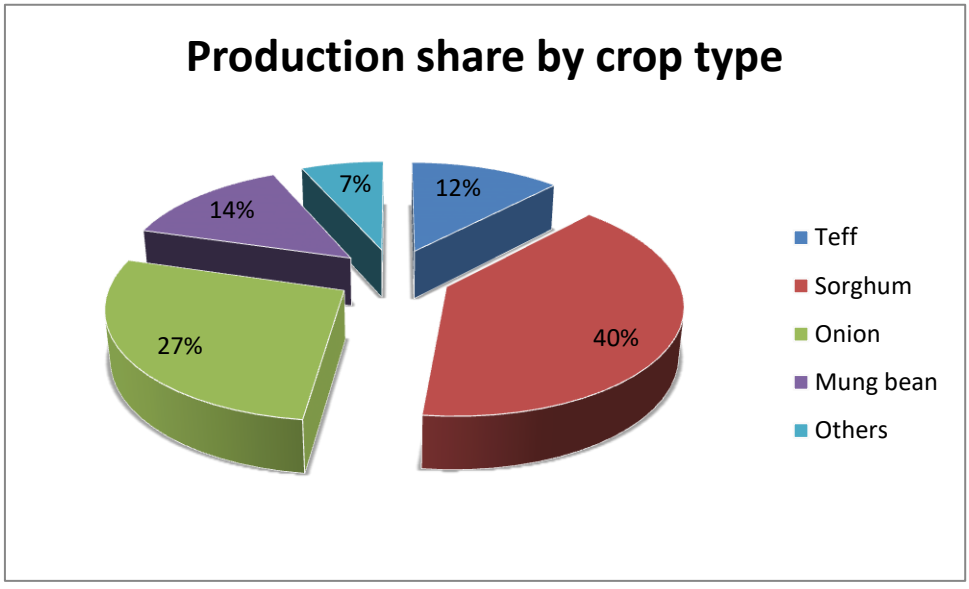

Figure 2: Share of each crop category from the total production (own survey, 2017/18)

2.3.5 Determinants of crop choice

Results of fractional multinomial logit

Table 8 summarizes some basic descriptive statistics about the dependent variables. The dependent variables are the crop shares for the portfolio of crops chosen by a household. The portfolio of crops for the study area consists primarily of sorghum, teff, mung bean and onion. The shares of a household's total cultivated hectares devoted to each of these crops are represented by sorghum share, teff share, mung bean share, and onion share, respectively. This makes four dependent variables. The standard deviations show heterogeneity of crop shares between households. The minimum value of crop shares which is zero for all crops indicates the presence of households not allocating any land for that specific crop, and a maximum value of 1 for sorghum and teff revealed the presence of households which allocate all of their land to one crop only, Minimum and maximum values of 68% and 72% for mung bean and onion respectively suggest that farmers are not growing mung bean and onion alone despite the existence of either teff or sorghum alone.

Table 8: Summary Statistics for Dependent Variables

Variable	Mean	Std.Dev.	min	maximum
Sorghum Share	44 %	0.21	0	1
Teff Share	17 %	0.18	0	1
Mung bean Share	18 %	0.16	0	0.72
Onion Share	21 %	0.19	0	0.68

Own survey, (2018)

The fractional multinomial model converged on a log pseudolikelihood of -461.37 with a Wald chi-square value of 15106.73 (see Appendix E). The result in Table 6 shows the fractional logit function fits into the multinomial logit quasi-likelihood function. The dependent variables from the literature were considered at the start then selection of the variables was done based on best fittness after multiple regressions (see Appendix F). Table 9 presents the average marginal effects of the independent variables on crop shares. Average marginal effects that are statistically different from zero at 5% and 1% levels are up for discussions. Of the model's 33 coefficients for average marginal effects, 24 are significant at 5% and 1% level. Furthermore, because crop shares must always sum to one as they are defined by the sum of total land allotted, the sum of the average marginal effects for any independent variable is zero; since one has to reduce the other to increase the one. Table 2 provides details on the variables used for the estimation.

Table 9: Average marginal effects derived from the Fractional Multinomial Logit

variable	Teff share		Mung bean share		Onion share		Sorghum share	
	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE
Household size	-.0004571	.0087	.0118465	.00696	-.0046397	.00438	-.0067452	.00763
Market distance	.0000619***	.00001	.0000468***	.00001	-.0000327***	.00001	-.0000759***	.00001
Animal ownership	.0054858**	.00116	.0033739**	.00132	-.0001621	.00065	-.0086975***	.00155
Irrigation	.1009955***	.02359	.120868***	.0209	.1103266***	.01343	-.3323049***	.02835
Extension contact	-.1891024***	.04433	.0932263***	.02069	.1974501***	.0143	-.1015741	.05204
HH Gender	.1505237***	.02267	.0618968**	.02609	-.1383243***	.02668	-.0739776	.06663
T cultivated land	-.0429517**	.01849	.0054544	.01318	.0162822***	.00506	.0211988	.01142
Education	.023984	.02689	-.1597338***	.03724	.0318356	.01726	.1038815***	.03757
Marital Status	-.2588266	.1904	.1593623	.12281	.0591349	.011073	.0402666	.09008
Land type	.1295786***	.01918	-.0348439	.02005	-.0138408	.01018	-.08088 ***	.01964
Farm location	-.0593509	.05374	-.0199534	.05962	-.013917	.05648	.0932354	.05309

ML fit of fractional multinomial logit Log pseudolikelihood = -461.37602 Prob > chi2 = 0.0000
Number of obs = 392
Wald chi2(33) = 15106.73

Source: Own survey, (2018) Note: **significant at 5% and *** significant at 1 %

Effect by Crop Type

For teff, market distance, animal ownership, irrigation and land type were found to have positive and significant effects on increased land allocation, while household size and extension contact were significantly associated with reduced land allocation for teff.

For mung bean, the share of land allocated was positively and significantly influenced by market irrigation extension and marital status. Education was the only significant variable that negatively affected mung beans' share of land.

Irrigation, extension, land size and marital status were significant variables positively affecting land allocation to onion while market and gender affected onion area share negatively.

Allocation of land for sorghum is significantly affected by market distance, animal ownership, irrigation, gender land ownership, all negatively except education which has a positive and significant effect.

Discussions

A kilo meter increase in market distance resulted in an increment in area share of teff and mung bean by six and four percent, respectively, while it created a reduction in area share of onion and sorghum by three and seven percent, respectively. The decrease in mung bean and onion land share when it is distant from the market is due to their short life span than teff and sorghum. Recent moves by Ethiopian Commodity Exchange (ECX) to sort marketing problems for selected crops had a positive effect but found not sufficient. Farmers owning more animals tended to allocate 0.5% and

0.3 % more land for teff and mung bean, respectively by reducing 0.8% of land from sorghum which had a significant and negative coefficient. This could be related with wealth where households with high number of animals preferred teff for their own consumption due to their relative wealth. This is in line with the results found by Mottaleb and Rahut (2018) which established that poor household heads seem to have less resources and capability to invest into intensive crops.

Access to extension services was also significant and negatively related to the share of land allocated to teff and positively related to the land allocated to mung bean and onion. As shown in Table 5, the coefficients suggest that farmers having one week more additional extension contact have allocated a 19% less land share for teff while allocating 9% and 19% more land for mung bean and onion, respectively. Since the study area is a potential production site for mung beans because of its climatic suitability and source of foreign exchange, development agents could convince farmers to allot more land to mung beans. Irrigation users allocated 10%, 12% and 11% more land area for teff share, mung bean share and onion share, respectively, to allocate the reduced 33% for sorgum share which has a negative coefficient than those with no access to irrigation. This could be related to the high revenue those trio crops, mung bean, teff and onion could generate, unlike sorghum. The result matches the finding of Dagninet and Adugnaw (2019), where high welfare gains found from the production crops motivate irrigation use.

The result indicates coefficients of 0.15, 0.062 and -0.138 for teff share, mung bean share and onion share, respectively. This shows male-headed households allocated 15% and 6.3% more land to teff and mung bean shares, respectively and 13.8% less land to onion than their female counter parts. Land size is positively associated with onion share with a coefficient of 0.16 while a coefficient of -0.43 showing a negative

link with teff share. The results indicated that a 1 hectare increase in area of cultivated land induces a 16% increase in area share allotted for onion and a 43% reduction of share allocated to teff. This is consistent with the findings of Nigussie *et al*. (2015) where they found a strong association between onion and land size.

2.4 Conclusion

The study identifies teff, mung bean, onion and sorghum as dominant crops cultivated in the area. The land owned found to be fertile and mostly acquired through redistribution. It shows the area is less degraded and has potential for higher production and productivity. The study finds that land allocation for each crop is interdependent differently across the selected variables. Access to market and irrigation are found significantly affecting crop shares of all the four major crops. The remaining variables are found selectively affecting crop shares, where allocation to one crop type is made by reducing share of another crop with different combinations. The significance of the marketing variable needs further investigation as to how to intervene to sort out marketing problems.

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CHAPTER 3: FARMERS' RISK RATING AND CROP PORTFOLIO CHOICE IN KEWOT WOREDA, NORTH ETHIOPIA

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https://jgiass.com/uploads/issue_papers/Farmers%E2%80%99-risk-rating-and-crop-portfolio-choice-in-Kewot-Woreda,-North-Ethiopia.pdf

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Abstract

Production risk and marketing risks are considered as critical factors in influencing farm decisions. This study is concerned with assessing crop risk rating by farmers and its impact on their crop portfolio choice. A total of 392 farmers who were selected using "Multi-stage Random Sampling" technique and qualitative data from discussions were employed in the analysis. The risk rating was done using a three-stage rank and Ordinary Least Square econometric regression was applied to identify the determinant factors. Results from descriptive statistics revealed that 73% of the respondents prioritize marketing over consumption in their crop choice decisions. Mung bean was identified as a riskier crop while onion risk rating showed higher variation among respondents. Findings on determinants of riskiness of the farmers' crop portfolio choice showed that livestock ownership, education and number of crop types found positively associated with riskier crop portfolio while irrigation use and gender of the household head associate with portfolio riskiness negatively. The major contribution of this study is its explicit treatment of farmers own risk rating and farmers also rated crops not grown by them. The key policy implication is that to manage marketing issue better and achieve optimal crop choice, there is a need to develop marketing insurance and promote pre-contract for riskier crops.

Keywords: Risk variation, consumption decision, contract, farm household, insurance

3.1 Introduction

Climate change is becoming key issue with agriculture and food security as there is a wider concern among researchers that weather variability has negative impact on the performance of agriculture (Rosenzweig & Parry, 1994; Peker et al., 2019). This is particularly true in low-income countries like Ethiopia, where agriculture is mostly rainfed and institutional capacities are low. In the dry land parts of the country where crop yields are principally limited by high rainfall variability, it could affect millions (Hope & Lingard, 1992). The gradual liberalization of the global agricultural markets has recently increased the level of focus on the actions of agricultural producers who are at risk (Deressa et al., 2008). Since Climate change is likely to increase vulnerabilities and hazards, risk management will be the focus of the future agriculture.

Since agriculture is a key sector in Ethiopia, its effective transformation is essential for meeting the country's domestic food requirements and to increase its performance in the economy. Commercialization of the sector is important to link smallholder farmers to markets, and create opportunities for off farm activities. Generally, the level of commercialization in Africa is very low as only 10% of the crop farmland is used for cash crops and only 30% of the small-scale farmers sell staple grains in Eastern and Southern Africa (AGRA, 2014), which in itself is not sufficient to lead to improved food security. Promotion of production and utilization of crops that matures fast and require small amount of moisture such as mung bean is identified as innovative strategy for enhancing adaptation in crop production in drought-prone lowland areas of the country (Bewket et al., 2015).

Rural households in low-income developing nations face several economic and social dangers every day. (Mogues, 2016). All management decisions are subjected to risk where price, yield and resource uncertainties are major parts of agricultural activities and systems. Fafchamps (1992) shown how crop decisions are heavily influenced by price and yield risk. Farm production decisions, such as crop choice, remain part of risk

management strategies (Just & Candler, 1985). Existing studies analyzing risks of smallholder production sees generally crop diversification as risk minimizing action (e.g., Dorward et al., 2005; Deressa et al., 2008) and use crop riskiness index from panel data to analyze risk (Bezabih & Di Falco, 2012). But according to Pedersen (2013) the risk perceived and subjectively assigned by the decision maker is important in analyzing decisions. Unfortunately, not much research has been conducted to determine farmers own risk rating and its link with crop choice. The aim of this study is to investigate risk behavior of farmers and analyze its link with choice of crops.

3.2 Materials And Methods

3.2.1 The variables and estimation technique

The first objective is estimation of crop riskiness based on farmer's rating using a three-scale rating for three components of risk that are production, output price and input price. Crop specific riskiness is estimated by adapting methods from (Garvey, 2001) and using Sum-score (Bauer & Curran, 2016) which is given in (2).

$$[(Price\ riskiness\ +\ production\ riskiness\ +\ input\ riskiness)/3] \qquad (2)$$

Crop portfolio riskiness at a household level is by using the riskiness measures of each crop multiplied by the land allotted to each. To this end, the single index measure developed by (Bauer & Curran, 2016), where riskiness of the crop portfolio is estimated from crops riskiness index computed multiplied by land allotted for each crop using (3).

$$[\ \textstyle\sum_{i=1}^{I=n} Ri * Li] \qquad (3)$$

Using crop portfolio riskiness as a dependent variable Ordinary Least Square regression model is used to identify factors affecting crop portfolio riskiness. Ordinary Least Square (OLS) is an econometric model used to identify direction and coefficient values for

relationships between dependent and independent variables. OLS is chosen because the dependent variable is continuous. The functional form of the OLS model is given as follows:

$$Y = \beta 0 + \sum \beta i \, Xi + \varepsilon \qquad (4)$$

Where Y is the dependent variable, β_i represent coefficient values, X_i stands for explanatory or independent variables (see table 2), and ε is random error.

3.3 Results and Discussion

3.3.1 Descriptive statistics

Data characterizing the surveyed households is given in table 5. The average age of the respondents was 41 years, with a minimum of 20 and a maximum of 68 years. The result depicts that the farm households were in active working age and were relatively younger, tending to adopt new crops, take a risk and have the ambition for higher income and commercialization (Thomas et al., 2017; Milkias & Abdulahi, 2018). Family size ranged from 2 to 9 people with average family size of 4.14 members, which is slightly lower than regional average of 4.3 (CSA, 2017). The increasing family size especially in rural areas causes the land holding of each household to decrease influencing crop choice (Worku, 2018).

3.3.2 Drivers of farmers' crop choice

Although risk, land features and socio-economic factors influence farm decision made by the household, additional factors like households' concern of family consumption, market associated problems, and institutional variables are recommended to be considered in investigating what influences farm decisions (Hunadanol, 2013). In this regard this study addresses the three issues separately.

The results in Table 10 showed that 73% of the respondents choose marketing as their primary objective in crop choice decisions. Even though consumption ranked second behind markets as a driver for smallholder farmers' choice of crop production the difference is higher implying that farmers in the study area are more commercialized. The low figure to government and NGO interference shows that in the study area decisions are done exclusively by the household and less dependence on institutions.

Table 10. Priority in farmers' choice of crops for production

Reason	**Primary choice**
Marketing	73%
Consumption	24%
Past experience	2%
Government and NGO interference	1%
-Market access to crops for consumption	Easy 85% Difficult 15%
-Crop market price rating	0% Cheap 75% Medium 25 Expensive

One of the most complex issues in crop choice decision is whether production and consumption decisions of agricultural households are separable or not. In addition to the difference between marketing and consumption shown in table 4, this study attempts to check independence of production and consumption decisions using indicators. Thus, the separability could be shown as 85% of the respondents say they can easily get the crop they want for consumption including crops not produced in the area (see table 4) and

75% of the respondents judged market crop prices as medium, this is supported by focus group discussion participants also. The findings are in line with the result of Negassa & Jabbar (2008) where no link was found between household's taste for different crops and household land allocation across crops associated with higher market integration. This shows consumption decision and agricultural production decisions must only be linked through profit effects.

3.3.3 Crops and their primary purpose

Households make a choice on what crop to grow among crops that could grow with in the climatic and land features. In the making of these choices farmers usually characterize crop with certain objective which is in their mind ahead of the crop season, which is either for home consumption or marketing. In this study farmers were asked their primary motivation for growing the major crops in the area which is presented in table 11.

Table 11. Summary of farmers reasons of crop choice

Reason	Rank	Crops associated
Family consumption	1	Sorghum
Cash income	2	Sorghum, onion, Teff, Mung bean
Past experience/ tradition	3	Sorghum, onion
Intervention (Government or NGO)	4	Mung bean

In this study, sorghum is found as a crop preferred primarily for home consumption and associated also with past experience as it is considered as cultural crop where 92 percent of the respondents produced it. All major crops generate cash income despite their

difference in their allocation to market and consumption. Mung bean is the only crop associated with intervention as it is a newly introduced crop and contributing to foreign exchange extension workers are advising farmers to grow it.

Crop choice changes with time is captured as 80% of the farmers said they switched in the past due to productivity and marketing reasons or expect to switch in the future looking on productivity and market.

3.3.4 Measuring riskiness

A farmer's choice of risk management strategies is of vital importance for the viability and continuation of the farm business. Reducing the risk portfolio is among the commercialization strategies ultimately affecting crop choice. Under this to capture farmers' risk attitudes first riskiness score is estimated (table 12) from their own rating and examined how their crop portfolio look like in terms of riskiness. Empirically, how farmers decide under risky conditions is best analyzed by taking into account their risk perceptions and risk attitudes or preferences. For commercialization to be effective crop choices should not depend on the risk attitudes and consumption preferences.

Important risks associated with each major crops produced in the study area are presented on table 6 along with their risk management strategies. For mung bean its perishability is the most important risk and farmers make pre contract directly with exporters as a strategy. For onion still the major risk is marketing problem but the way they address is different as unlike mung bean, onion is supplied for local market, farmers use own or family vehicles to directly collect production and take to markets with less or no involvement of whole sellers and brokers. While the risk associated with teff is production risk which is linked with disease.

Table 12. Major risks by crop type

Variable Crop type	Most important risk	Risk management strategies
Mung bean	perishability	pre contract
Onion	market	market linkage
Teff	disease	chemicals
Sorghum	disease	diversification

Risk analysis encompasses the assessment, management, and communication of risk as well as how risks are perceived and compared (Birthal & Hazrana, 2019). One of the objectives of this paper is to generate riskiness measures of the selected crops and table 13 provides riskiness score of the 4 crops grown in the study area which is estimated using equation 1 and 2. Based on respondents rating mung bean and onion are found to be the riskier crops and looking on the standard deviation onion has 0.75 showing that farmers have more diversified opinion on rating riskiness of each crop, while looking on the deviation on risk types farmers have relatively wide opinion on price risk than production and input price risk. Similar results were reported by (Mintewab & Mare, 2012) where they found considerable variation in riskiness and returns across crops.

Table 13. Riskiness scores by crop type

Crop type	Riskiness score	Standard deviation
Mung bean	6.8	5.83
Teff	4.66	4.61
Sorghum	3.9	3.57
Onion	6.2	7.14

3.3.5 Crop portfolio riskiness and its determinants

Ordinary least square model used to identify the factors that influence riskiness of crop portfolio. To reduce the effect of Endogeneity the dependent variable riskiness is measured as a ration of land allotted to each crop. The model's possible multicollinearity was examined using the Variance Inflation Factor (VIF) (see appendix G) as well as correlation coefficient among explanatory variables was detected, where both tests confirmed no multicollinearity problem in the regression. Furthermore, maximum likelihood parameter estimation indicated (R^2) value of 47 percent and statistically significant.

The model result (see table 14) indicates that irrigation use, livestock ownership, education, marital status, and number of crop types grown were found to be determining farmers risk behavior.

Irrigation is significant at 95% and found negatively influencing portfolio riskiness. This shows high price risk than production risk in the study area. Similar results are found by (Sebastien & Erdlenbruch, 2012) where irrigation is found as one of risk mitigating strategies and irrigation users found with less risk portfolio. Such result is significantly and positively related to the need to urgently address price risks.

Livestock ownership is used as an indicator of wealth allowing them to invest in new technologies and take risk. The result indicates that households owning more livestock involve in production of more risky crops. Literatures (Negassa & Jabbar, 2008; Luh, 2017) also suggested that cattle are major means of wealth accumulation in rural areas and one of the risk mitigating strategies.

Table 14. Logit regression result on determinants of crop portfolio riskiness

Variable	Coefficient	Standard error	z	P>|z|
Distance to market	.0013374	.0008724	1.53	0.125
Gross animal	-.077413	.0729041	-1.06	0.288
Irrigation	-4.813386*	1.878017	-2.56	0.010
Livestock ownership	22.591***	2.275335	9.93	0.000
Sex of the household head	-.4457313	2.505608	-0.18	0.859
Cultivated land size	-1.134045	.8677063	-1.31	0.191
Education	4.898128***	1.877191	2.61	0.009
Marital status	-7.628093***	2.694636	-2.83	0.005
Land type	.612325	1.148657	0.53	0.594
Farm location	1.732456	2.394569	0.72	0.469

Number of obs = 392
F(12, 379) = 30.22
Prob > F = 0.0000
R-squared = 0.4890
Adj R-squared = 0.4728

(Note: *, **, and *** represents statistical significance at the 10, 5 and 1 percent level, respectively.)

Source: Own survey, (2018)

There is a positive relationship between educational level and portfolio riskiness 5% significance levels. The results suggest that as farmers with higher educational level prefer riskier crops than uneducated farmers, and this could be down to risk management and information accessed and analyzed by the educated farmers. This result is parallel to the findings by (UNESCO, 2017; Christine et al., 1998) who confirmed the positive and

significant impact of farmers' education on farmers' decision of choosing diversified crops such as cereals in combination with high-value crops, for example, cash crops and vegetables under irrigation agriculture.

With regard to the parameter of marital status, it is statistically significant and has positive relationship with portfolio riskiness. The results indicate that married household heads prefer less risky crops in their crop portfolio choice. This may be explained by the focus of married household heads on less risky crop targeting family consumption. The finding is consistent with (Mottaleb & Rahut, 2018) who found that married households are risk-averse and not willing to take risks.

3.4 Conclusion

Marketing motives and own consumption need found as main drivers of crop choice where consumption objectives forced farmers to make decisions against higher value crops.

Crop perishability in storage and price fluctuations are found as major crop production risks in the study area, significant variation in risk rating across households is found while based on respondents rating mung bean and onion are found as more risky than teff and sorghum.

The study obtained irrigation use, livestock ownership, education, and marital status significantly influencing riskiness of crop portfolio choice. Irrigation users, illiterate farmers and women headed households are found with less risky crop portfolio. Policymakers should prioritize addressing price risk related issues in the form of loan and insurance. Despite irrigation users are expected to go for riskier crops, the choose the less riskier crops which affect efficiency of irrigation schemes negatively.

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CHAPTER 4: DETERMINANTS OF MUNG BEAN ADOPTION AND ITS EFFECT ON AGRICULTURAL COMMERCIALIZATION. THE CASE OF KEWOT WOREDA, NORTH SHEWA, ETHIOPIA

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Abstract: Ethiopia’s agriculture is the main contributor to the export economy with a 80% share of total exports and 37% GDP. When it comes to global trade Ethiopia's market share is quite little despite its strategic location for the Middle East's mung bean market and ideal climate zones for its production. Mung bean could play a bigger role in helping to diversify and exploit location since Ethiopian agricultural export up to now has mainly been dependent on a few products, such as coffee and sesame. This study looked into the factors influencing mung bean adoption as well as how household involvement in the crop influences commercialization indicators in north Ethiopia. For this study, data from 400 randomly chosen houses were used. Mung bean was found in the crop portfolio of 63% of the farmers who were sampled. The adoption of mung bean was found to be significantly correlated with the kind of land purchase, irrigation use, distance to market, and number of crop varieties. Significant disparities between mung bean producers and non-growers was found in terms of marketing specialization, amount consumed from own production, and stickiness to comparative advantage. This demonstrates how crucial mung beans are for nutritional diversification, commercialization, and adaptation to climate change. The role of mung beans could be improved by using contract farming and insurance to manage their significant price fluctuation.

Keywords: Commercialization, price volatility, mung bean, climate change adaptation

4.1 Introduction

Although developing countries' percentage of global trade has increased over the past 20 years, Africa and Ethiopia's percentage of global trade has stayed below 3 and 0.3%, respectively (Eshetu & Mehare, 2020). Agribusiness is heavily dependent on agricultural products, which are volatile in price. Although the potential for all other industries is much lower, they may nonetheless present some specialized opportunities. When compared to other sub-Saharan African nations, Ethiopia's agricultural export performance has often been characterized as subpar (Zhang, 2021). Since food imports increased from 58% to 68% during the past 20 years despite the absence of irrigation facilities, transformative grain production is essential to lowering reliance on imported food.

Agriculture's commercialization can take many different shapes and be described in various ways. Smallholder participation in commercial input and output markets, the kind of crops they raise, and their objectives can all be used to characterize smallholder commercialization in agriculture (Gollin, 2010). Taking part in output markets can help smallholder farmers become more commercialized, as the related incentives will encourage them to make larger investments in the productivity of their farms, according to the World Bank (2008). Adjimoti and Kwadzo (2018) investigated how households in central Kenya and northern Tanzania varied in their farms and diets. The quantity of crops cultivated by a household was positively correlated with the variety of the household's food in both Kenya and Tanzania. The availability of inputs and knowledge regarding the commercial crop production process, as well as farmers' willingness to accept the risks involved in growing crops for the market, all contribute to an increase in agricultural commercialization with development (Minot et al., 2022).

Globally, considerable implications of climate change on the agricultural sector have been regularly projected by climate impact studies (Gornall et al., 2010). Farmers are expected to switch from low-yielding crops to new ones that will fare better in the new

climate. Crops that were traditionally referred regarded as "orphan crops" are increasingly receiving attention as the world adjusts to climate change, notably dry land pulses like pigeon pea and mung bean (Mabhaudhi et al., 2019). These climate-smart crops are full of nutrients, use less water, improve the soil, and aid smallholder farmers in arid and semi-arid regions of the world in coping with weather fluctuation. In addition to providing greater nourishment per drop for people and animals, these crops also help soils by fixing nitrogen.

Agricultural commercialization is the process of gradually increasing the proportion of agricultural produce that is sold rather than directly consumed by farm households. Institutions like ECX have been developed to help and facilitate agricultural commercialization; but, because they primarily concentrate on marketing issues, their options are limited from the beginning. Additionally, comparable approaches to helping farmers through extension, loans, and input must be advanced to address the issues unique to the particular crop and farmers. Mung bean distribution is growing recently (Kaysha et al., 2020), however it is done so only through individual efforts with no assistance from the government during the adoption stage. Utilizing additional indices would increase the effectiveness of commercialization, which was used to be judged in sales percentage only.

The subgenus Ceratotropis of the genus Vigna contains the annual edible legume known as the mung bean. Mung bean was believed to have been domesticated in India, per Singh et al. (2011). According to Tateishi (1996), mung beans have a wide geographic distribution in their wild forms, ranging from North and East Australia through North and East Asia, New Guinea, Central and East Africa, Madagascar, and Madagascar. Globulin and albumin are the main mung bean storage proteins. The three types of globulins consisting of basic type (7S), vicilin type (8S) and legumin type (11S) globulins were all present in the mung bean seeds and sprouts (Yu et al., 2020). About 90% of the world's mung bean production is generated in Asia, with India being the leading producer

(Tomooka and Vaughan, 2002). In contrast to cereals and other pulses, the regions for mung bean have grown by 2.5% annually during the past 20 years.

Mung beans have a large potential for crops cultivated in drier cropland farming areas and for crop rotation systems, according to Ashraf et al. (2003) and Rahim et al. (2010). The best time to seed mung beans is often in the summer when there has been enough rain to support growth, however this crop is prone to waterlogging. It is grown using a number of agricultural methods, such as relay cropping, which uses the moisture left over after cereals, intercropping, multiple cropping, and solitary cropping (Rehman et al., 2009). The mung bean offers all the benefits in terms of being profitable, nourishing, and contributing to exports.

4.2 Econometric Model

In this study, the dependent variable is a binary variable that can have a value of 1 if the farmer adopted mung beans or 0 if not. Individual characteristics of the farmer, family-level variables, farm variables, institutional and social variables, and farm variables were all independent variables (Table 1).

The binary logit model was used to examine the variables that factors affecting smallholder farmers' adoption of the mung bean; the model is suited for evaluating binary choice decisions.

The following are possible expressions for a binary logit model including estimation likelihood of choice of market facilitators, where (Y) is a function of explanatory variables (X);

$$Py = Prob\,\gamma = 1 = f\,\beta\,'Xi\;Py = Prob\,\gamma = 0 = 1 - f\,\beta\,'Xi \quad (1)$$

Where is a variable that indicates the presence of mung beans in the crop mix, with equal to 1 when mung beans are used and equal to 0 when mung beans are not used. A person's adoption of mung beans is affected by a collection of explanatory factors called xi, where i is one of 1, 2, 3,..., M variables.

Yi = f gi can be used to explain the factors that led smallholder farmers to choose mung beans as one of their crops. Where Yi stands for the response for each individual when there are only two options. The functional relationship between an individual's reaction and the latent factors (gi) that impact the likelihood of an individual decision to include mung bean in the crop mix is shown by f. gi is the latent factors influencing individual decision on their choice of marketing. When a choice is chosen favorably, the dependent variable in this model changes to the natural logarithm of the odds:

$$\ln \frac{Pi}{1-pi} = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \cdots + \beta_x X_{ki} + e_i ln \qquad (2)$$

where i is the i^{th} observation in the sample; pi is the probability of i^{th} observation in the sample of adoption; (1-pi) is the probability of i^{th} observation in the sample of non-adoption; 0 denotes the intercept parameter and e_i denotes the error term; 1, 2,..., k are the regression coefficients of the independent variables; k is the number of independent variables; x_{1i}, x_{2i},..., x_{ki} are the Table 1 contains a list of the independent variables.

4.3 Results and Discussions

4.3.1 Rural income

This section examines the contributions of farm and off-farm incomes to the net incomes of rural households; the results show the growing importance of the non-farm component. The breakdown of net household income for households in the study region is shown in Table 15. Agriculture, which can contribute up to 61.4% of total household income, is a

major source of income for people living in rural areas. The results also demonstrate that crop revenue, which accounts for nearly 49% of all household income, is the main source of income.

Table 15 Shares of different sources of rural household income

	Source of income	Income	Percentage share	
Farm income	Crop income	9219840	49%	61.4 %
	Livestock income	2333184	12.4%	
Non-farm income	Own business	6698496	35.6%	38.6 %
	Transfer income	564480	3%	
	Total income	18,816,000		

Source: own computation (2018)

Only 3% of the income is derived from local or foreign remittances, which indicates that fewer family members live abroad and that fewer of their children work for the government. The fact that rural households derive around 38.6% of their income from non-farm sources illustrates how significant non-farm income is to rural family income in the current study. An average household's primary non-agricultural income comes from wage work, own business, transfer income, and migration income.

Off-farm employment is another strategy that could boost farmers' income and well-being. It also helps to lessen income uncertainty in rural communities. Occupational diversity supports income averaging by spreading risk across a range of professions. By reducing income uncertainty, farm households have the possibility to invest in more

advanced agricultural technologies. An economic examination of the effects of off-farm activities on agricultural productivity and output was conducted in a previous study (Ahmed & Melesse, 2018). Increased income diversity, according to the author, increases agricultural output on a per-acre basis. For every 1 percent increase in off-farm the farm, agricultural output increases by an average of 0.34 percent.

4.3.2 Mung bean facts, advantages, variations

In the research area, mung bean production was reported in both irrigated and rain-fed farming methods. The characteristics of mung bean production in the research region are shown in Table 16. The cultivars grown include the Boreda, Arkebe, and Rasa N-26 varieties. Sowing is done in early June. Mung beans are typically grown by farm households for 5.6 years, making them a new crop in the region. According to Ainembabazi and Mugisha (2014), farming experience is a learning process that can make it easier for people to embrace and use dynamically developing technologies. Mung beans matured in an average of 74 days, making them a fast-maturing crop that can protect farmers from low rainfall or drought.

Mung bean productivity is below the global average, so more effort is needed. Similar conclusions were reached by (Assefa et al., 2022b), who explained the low productivity of mung beans in Ethiopia by a number of biological and non-biological factors as well as other production limitations. Cooperatives only receive 8% of revenues, and 92% of those sales go to exporters. The government had to publish a letter forcing sales to only be made through ECX because there was no mung bean available through ECX in 2017. Later years saw an improvement in supply to ECX, but this makes it very challenging to trace the entire value chain.

Table 16 Facts about mung bean production in the study area

Features	Indicators
Sowing	Early June
Variety	Boreda, Arkebe, and Rasa N-26 varieties
Average years of growing mung bean	5.6 years
Maturity	65-90 days average 74days
Mean production and productivity	2-37
Risk associated	Geting black (color change), weight loss
Percentages	100% sold, 0% consumed
Pest	*Nekez, ageda korkur, tinign, bird rat*
Disease	*Akenchira, kinche arem, Deha nekay, Etse faris*
Contractual agreement	Difficult to trace the full value chain
Sales	Consumer 0%, Cooperative 9%. Exporter 91%

Source: Own survey, (2018)

Mung bean was chosen by farmers because of its higher revenue, but the risk of it having a short shelf life, becoming black (changing color), and losing weight reduced their ability to bargain on the market. Since practically all of it is not consumed locally, including by the farmers who grow it, there are significant marketing issues as a result. One possible explanation for this is that it generates the most revenue and there are no known meal types other than a very small amount of *nifro* consumption. Despite being high in protein, vitamins, and fiber, even this modest own consumption is concerning.

According to the empirical investigation, buyers of commodities, particularly in the grain market, set a variety of criteria for choosing products on the market. The prominent features among these requirements are purity (does not mix with other needless things), test, and grain size, color, and test. Similarly, it was noted that dealers in the mung bean market take seriously three factors—color, grain size, and foreign matter (purity)—to determine the quality of the item. The sample farmers confronted various obstacles when trying to grow rnung bean. Untimely rain and disease occurrence were identified to be the main restrictions.

4.3.3 Mung bean production distribution in Ethiopia

Mung bean is a recently introduced pulse crop growing in a small region and in less quantity in Ethiopia. However, as soon as it becomes popular among farmers and is listed as a crop traded on the ECX, its production spreads to other regions of the nation. Mung bean is mostly produced in Ethiopia's Amhara Region North, Shewa zone, and in some sections of Benishangul Gumuz. However, Amhara region has recently been introduced, much like any other area in Ethiopia (see diagram 5). Mung bean, along with enset, is considered the future crop due to its drought resistance, high export demand, and capacity to grow in water-stressed areas (see annex E).

This is not to mean that high-value crops are correlated with food insecurity as incomes from the cultivation of these crops can be used to relax household liquidity constraints households may be facing. Although green mung beans are frequently consumed in various other nations, even individuals who cultivate them rarely eat them in Ethiopia. Additionally, there is a very minor amount of production, which is mostly focused in the North Shewa and South Wollo zones of the Amhara area as well as in a few *woredas* of the Benishalgul Gumuz region (ECX, 2021).

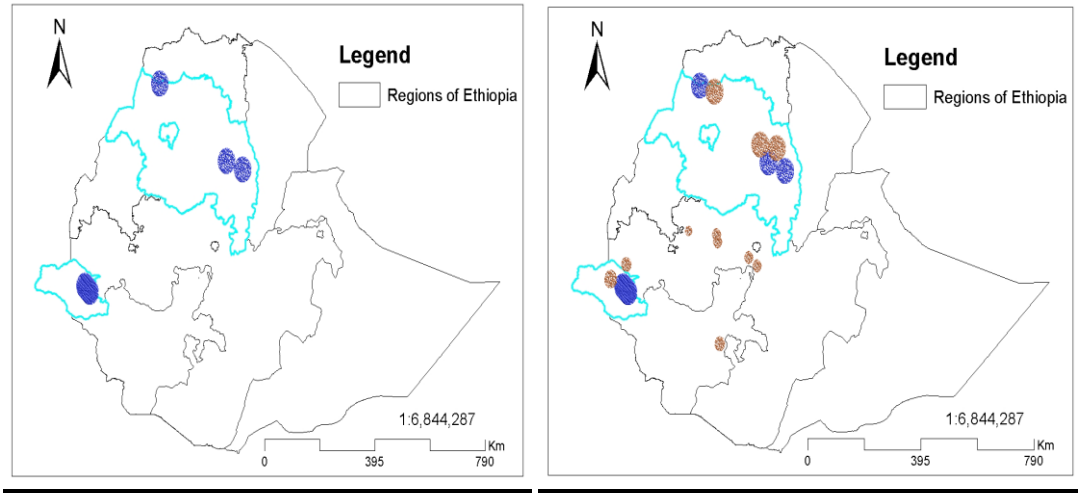

Figure 6: Mung bean distribution Data Source: ECX (2018-2022)

The distribution of mung bean production in Ethiopia is depicted on Figure 6. Mung bean cultivation recently expanded to new places in Ziway and Modjo, which were not previously home to the crop. In 2010, mung bean was only present in a relatively small number of locations across the nation. Although its distribution followed that pattern because of how well it adapted to a warm climate, it is still quite sparse compared to the large expanse of Ethiopia's Kolla areas. The average temperature might change as a result of climate change, which may affect the crops that grow best in a particular region.

Forecasts of how climate will affect agriculture cannot merely be based on how climate will impact a given crop's output. Crop switching must be included in the projections. To put it another way, the projections must take into account the fact that farmers will alter the crops they sow to optimize earnings in each new climate. We investigate statistically how farmers will modify their existing decisions in response to future climate by comparing choices made by farmers who encounter various environmental situations across the landscape.

4.3.4 Variability of mung bean prices

Given the significance of prices for production decisions, the price behavior of mung beans in Ethiopia over a one-year period from July 2022 to July 2023 is investigated. Figure 7 shows evidence that the price of mung beans is unstable and that it fluctuates for two consecutive months without returning to a stable level. Such price behavior is probably going to affect how inputs are allocated, prevent agricultural investment, and slow the rise of agricultural production (Assouto et al., 2020). Income stabilization for growers of cash crops is a key concern for national policies, and price stabilization programs using seasonal fixed producer prices are a useful tool to reduce price risks for growers and to enable farmers to adjust risk-sharing mechanisms while still facing stable prices (Staritz et al. 2018).

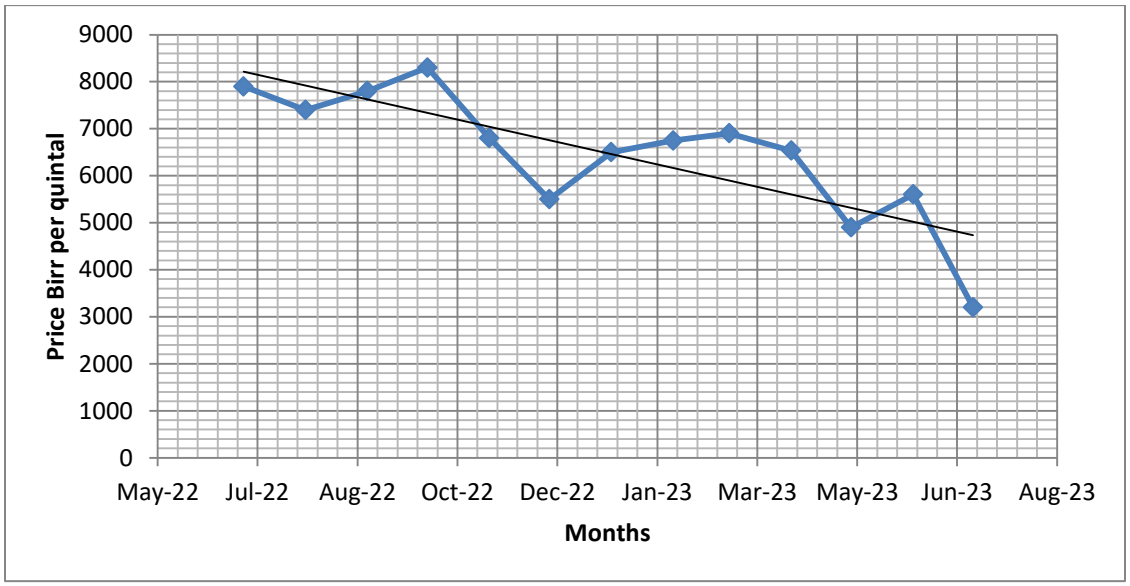

Figure 7: Trends of mung bean prices (2022/2023) Source: ECX monthly prices

The other worrying development is the sharp drop in mung bean prices, which went from 8000 to 3000 in just one year. Increased national mung bean production, which was described in the section before, could be the cause of the fall. Due to the unsustainable nature of such a fast price decrease and the intense competition in export markets, quality

issues need to be addressed further. Long (2021) contends that a nation's ability to export agricultural goods is simply one factor in determining how competitive its agricultural products are; another factor is sustainability.

4.3.5 Adoption factors for mung beans

The Logit model was estimated to find the variables that affect farmers in the research area's propensity to include mung beans in their crop mix. Table 17 displays the Logit model's maximum likelihood estimates. To estimate the parameters of the variables that are predicted to influence the decision to include mung beans in the crop mix, mung beans are utilized as a dependent variable. The estimated model for identifying factors impacting mung bean adoption has an R^2 value of 0.66, meaning that the model's variables account for 66 percent of the variation. The multicollinearity problem is investigated using both correlation and VIF and is determined not to be a concern. The statistical significance of the following variables ranged from 1% to 5%.

Distance to the market is one of the marketing variables that was examined and found to be significant. The positive relationship demonstrates that mung bean growers face high transportation costs due to their remote locations, which has a substantial impact on their product perishability. According to Gebru et al. (2021), cash crops are more likely to be embraced in regions with easy access to markets (close proximity to markets). It suggests that because mung beans are so perishable, post-harvest storage is required.

Table 17: Results of a logit model regression on mung bean adoption

Variables	Coef.	Std. Err	. z	P>|z|
Plot charactersitics	1.841296	1.65125	1.12	0.265
Land acquisition	-2.578157***	.7179306	-3.59	0.000
Land type	-.7787706	.6134727	1.27	-0.204
Education	-1.310443	1.537452	-0.85	0.394
Marital status	2.404109	1.390937	1.73	0.084
Size of land cultivated	.4112987	.5023488	0.82	0.413
Age of the household head	.0556196	.0357118	1.56	0.119
Gender of the HH head	-.8210401	1.159852	-0.71	0.479
Number of crop types	3.864975***	.5124837	7.54	0.000
Family size	.1236972	.1913331	0.65	0.518
Livestock ownership	1.420852	1.553405	0.91	0.360
Distance to local market	.0011217**	.0004493	2.50	0.013
Irrigation	-3.803886**	1.62157	-2.35	0.019
Constant	-7.215536	2.618488	-2.76	0.006

Logistic regression	Number of obs	=	392
	LR chi2(13)	=	337.13
	Prob > chi2	=	0.0000
Log likelihood = -83.845618	Pseudo R2	=	0.6678

Source own survey, 2018

Land acquisition: Given that the predicted coefficient for land acquisition is negative, it can be inferred that people who obtained land by purchasing it were far more likely to adopt the mung bean than people who acquired it by redistribution were. This might be as a result of the disparity in wealth that enables them to take on hazardous productions. The outcome is consistent with (Zhang et al., 2022) study findings where increased land

costs-explicit and implicit-cause agricultural operators found planting more crops for cash.

Number of types of crops grown: This means currently farmers growing more than one found significantly associated with mung bean adoption. The reason could be to farmers are using diversification as a buffer for mung bean riskiness. Similar results were found by Dessie et al. (2019) where crop diversification found motivating farmers to grow marketable crops.

Access to irrigation: At the 95% confidence level, the result is significant and the coefficient of access to irrigation is negative. The negative coefficient implies that irrigation has a detrimental impact on the uptake of mung beans. It may be due to the mung bean's lower water demand. The outcome is consistent with research by Aung and Lee, 2021, who found that only 6% of farmers with irrigation access choose mung bean.

4.3.6 Commercialization indicators

It is difficult to distinguish between "commercial" and "subsistence" farmers in agricultural households. Farmers are actually distributed continuously. As cash crop vs category and using percentage sales as the primary measurement of commercialization lacks the sharp end for efficient agricultural commercialization, measuring commercialization and crop marketability remains challenging. This study looks into additional characteristics or markets to capture the level of commercialization from various angles. Table 18 lists the many indications that have been discovered from literatures along with the parameters for each variable that might be utilized as a proxy.

Table 18 Commercialization indicators

Indicator	Proxy as commercialization attribute	Reference
Sales/ produced	Proxy for marketing involvement	(Tafesse et al., 2020)
Number of crop types	Proxy for specialization	(Li et al., 2017)
Amount consumed from own production/total production	Proxy for separability of consumption and production	(Kebede, 2022)
Frequency to market	Proxy for market attachment	(Carletto et al., 2017)
Mono-cropping, cluster	proxy to Stickiness to comparative advantage	Dureti et al. (2023)

Source: Own computation (2019)

Mung bean contribution to commercialization

Using the chosen metrics, the contribution of the mung bean to commercialization is identified in this study. To capture differences between mung bean producers and non-growers, each index is compared using t test. The results are given in Table 19. The computation is attached as Appendix E.

Table 19 contribution of mung bean to selected commercialization indexes

Indicator	Mung bean growers	Mung bean non-growers	T test
Sales/ produced	56.1	54.2	-0.9550
Number of crop types	3.2	1.8	-15.61***
Amount consumed from own production	20	25	-7.64***
Stickiness to comparative advantage	40	0	8.6***

Source: Own computation (2019)

(mung bean is considered as a crop with comparative advantage)

It can be observed from the table that mung bean growers are significantly differs in the three indicators selected.

Number of crop types represent specialization and diversification. The result showed negative where mung bean growers had higher crop specialization. Crop specialization plays a significant role in influencing agricultural efficiency and commercialization. Crop specialization has been a subject of interest in agricultural research, particularly concerning its impact on efficiency and commercialization. Studies have shown that crop specialization can lead to increased agricultural productivity and commercialization opportunities. For instance, research in the Northern Savannah Ecological Zone of Ghana found a positive relationship between crop specialization, agricultural productivity, and commercialization (Sekyi et al., 2021). This suggests that focusing on specific high-value crops can stimulate productivity and create market opportunities for farmers.

Consumption from own production can significantly influence commercialization strategies in agriculture. When farmers consume what they produce, it can impact their decisions regarding market engagement and commercialization. In this regard mung bean

growers are found with less consumption from own production justifying its contribution to farm commercialization parameters.

The concept of comparative advantage is crucial in the commercialization of agriculture. Comparative advantage refers to a country's ability to produce goods or services at a lower opportunity cost than other countries. In the context of agriculture, comparative advantage influences decisions regarding crop specialization, trade, and commercialization strategies. Farmers often specialize in crops where they have a comparative advantage, meaning they can produce those crops more efficiently or at a lower cost compared to other crops or regions Kurosaki (2003).

4.4 Conclusions and recommendations

Mung bean is little known in Ethiopia and its acceptance was found to be poor nationwide, with only few areas growing it. Despite mung bean is common in the study area and considered climatically suitable, only 65% of the farmers include mung bean in their crop choice. Mung beans have been recognized for their potential health benefits, such as antioxidant and antidiabetic activities, which contribute to their value in the market. mung beans possess desirable agronomic traits and processing characteristics that contribute to their commercialization. The commercialization of mung beans is influenced by various factors, including their nutritional and health-promoting properties, agronomic traits, and processing characteristics. Utilization of irrigation and the variety of crops was found significantly influencing mung bean adoption. Other commercialization indicators are observed to be significantly higher due in mung bean adopters. The other issue, the stability of mung bean prices, might be addressed by contract marketing.

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CHAPTER 5: CROP ATTRIBUTES, FARM DECISIONS AND CROP SPECIFIC POLICIES IN THE CONTEXT OF SUSTAINABILITY OF PRODUCTION IN ETHIOPIA

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ABSTRACT

Ethiopia's government has created a number of policies and programs to address the urgent issue of rising food prices. The majority of these initiatives focus on boosting agricultural productivity and output to provide year-round access to food. Extension and regulation initiatives aiming at influencing the production and marketing are frequently used in conjunction with them. These objectives, however, are not always aligned in practice, as seen by persistent complaints from recipients and unintended policy outcomes. This study produced a crop usefulness index from dietary and profitability measurements with the intention of creating the optimal crop-specific policy. Multiple objectives could be met using tradeoffs among different crop benefits. This study also summarizes major findings from previous crop-related policies and linked them to specific crop characteristics. It is advised that policies be adjusted to reflect the value, character, and utility of crops.

Key words: Pro-poor Policy, Tradeoff, Subsidy, Agricultural Policy

5.1 Introduction

Both industrialized and developing nations have used agricultural policies to boost agricultural output, social welfare, and economic redistribution. Numerous agricultural policies are advised in a large body of literature in order to increase agricultural output and rural social welfare. Agriculture's economy is significantly impacted by agribusiness policies (Shikur, 2020). Developing nations use agricultural policy to keep the cost of agricultural products below market rates, allowing consumers to buy food at reasonable prices. To enhance crop yield and social welfare, many Asian and Latin American countries have implemented various price support and stability measures. The price instability that has harmed output since the 1960s is routinely controlled in Asian nations through the deployment of price support policies. These techniques have sped up the implementation of advances from the Green Revolution that enhanced crop productivity (Hazell, 2010).

The current agricultural policies in Ethiopia are shaped by various factors such as demographic conditions, livelihood practices, land-tenure, and broader changes in agricultural development policies (Tadesse et al., 2014). The country's emphasis on varietal improvement of crops, organizational reforms in the research system, and seed sector is crucial for agricultural development (Spielman et al., n.d.). To enhance agricultural efficiency and food security, Ethiopia needs better infrastructure development that meets socio-economic demands (Feyissa, 2022). Additionally, the impact of Large-Scale Agricultural Investments (LSAI) on local livelihoods in Ethiopia requires more attention (Alemu & Tolossa, 2022). Additionally, GoE imports food products using public funding, such as wheat, sugar, rice, and cooking oils, to fill the local supply shortfall and stabilize the home market. These imported food products are sold at discounted prices by means of regional cooperative unions and consumer associations (MOFED, 2022). The government of Ethiopia is also making continuing and encouraging efforts to change the food system, including requiring the fortification of staple foods and establishing multi-sectoral nutrition projects. The Ethiopian government

implemented a number of policy measures, including monetary, fiscal, and structural ones, to curb price increases, but inflation rates are still in the double digits.

No matter who may legally be the owner of such property inside the home, the household head in Ethiopia practically has ultimate control over decisions on the use and disposal of property. Despite the wide variety of cultures, religions, and patrimonial traditions that constitute Ethiopia, both within and between regions, this system is applicable throughout the whole nation (Torkelsson and Tassau, 2008). Due to the increasingly uncertain climatic circumstances and market prices for agricultural inputs and products, more research is needed to fully understand these pathways (Barrios et al., 2008). This is especially true when trying to find compromises and win-win scenarios for agriculture's numerous objectives, including soil protection, carbon sequestration, time and labor savings, yield, revenue, and nutrition (Remans et al., 2011). Understanding the decision-making process' patterns will speed up policy implementation and reduce the cost of supervision.

Ethiopia's external debt to GDP is increasing and forcing the nation to become one of the world's Heavily Indebted Poor Countries (Siddique et al., 2016). Today, debt and economic policy are closely related. This could force the nation to reduce its support for agriculture, which in turn would require only supporting certain crops in a systematic manner (Hemathilake & Gunathilake, 2022). Finding crop-specific solutions and ranking crop kinds according to particular criteria could be helpful in this approach. Utilizing income diversification to manage risk rather than insurances costs a comparative advantage. In order to determine the relative importance of crops, this study will use productivity and dietary metrics, as well as trade-off usage gaps in crop-related policy. Both diversifications are used to be solution for adaptations but losing efficiency for insurance covered and lack of long term investments.

5.2 Methodology

5.2.1 Tradeoffs

Comparing calories produced by each crop form certain area: help to compare amount of calories produceed per hectare of land when growing different kinds of crops.

Comparing the profit per land allotted: help to compare amount revenue generated per hectare of land when growing different kinds of crops.

Based on the two values crop usefulness index will be ranked: help to detect the presence and degree of trade-off between calorie and revenue.

5.2.2 Game theory approach to farm decision to policy link

Using the game theory rationality assumption, the decision-making of farmers was examined. The choice of that could be cultivated and its link with the strategic options A1, A2, A3,... And that will be presented in the form of a payment matrix. Table 20 will display this matrix.

Table 20: Pay of matrix of strategies

	S			
A	S_1	S_2	. . .	S_n
	P_1	P_2	. . .	P_n
A_1	R_{11}	R_{12}	. . .	R_{1n}
A_2	R_{21}	R_{22}	. . .	R_{2n}
.			.	.
.			.	.
.			.	.
A_m	R_{m1}	R_{m2}	. . .	R_{mn}

A = Set of strategic alternative Ai (for $i = 1,2, \dots, m$)

S = Set of faced condition by Sj (for $i = 1,2, \dots, n$)

R = Set of payoff Rij by choosing strategic alternative Ai if facing Sj situation. P = Probability distribution of S

Source: Adapted from Adeoye (2012)

Making decisions about strategic alternatives involves deciding what crop will be planted. Assuming all farmers are rational and work to maximize their profits, the set of conditions they encounter includes risk and regulatory interventions. According to Adeoye et al. (2012), there are various characteristics to consider when utilizing game theory to determine the optimum strategic alternative for managing farming hazards.

Prior to establishing the risk management practices of farmers in accordance with the selection criteria, the measurement function must be built. According to Maximax standards, the farming industry is one that bears little risk. It shows that they are ready to take on any farming risks Adeoye (2012). The Maximin Criteria state that farmers are risk averse and would not be at all prepared to take this risk if anything terrible occurred or if they received the lowest price. The maxima criteria is a tactic for the optimistic person. The decision-maker will select the choice that, after accounting for all potential maximum rewards, will result in the best result. These constraints will produce results that are consistent with decision-makers that favor the greatest rewards and don't hesitate to take risks (Pazek, 2009).

5.3 Results and Discussion

5.3.1 Productivity, calorie and revenue comparisons

It is feasible to assess trade-offs between two dimensions by figuring out how much of one dimension must be lost to make up for a change in the other when comparing the effect of these alterations on the rating. The two biggest tradeoffs are the calorie-revenue tradeoff and the risk-return tradeoff. Due to urbanization and population expansion, there is a decreasing amount of arable land; therefore, a quantitative approach to yield and other attributes will be crucial for optimal exploitation and future algorithm improvement.

Although each crop has a distinct function to play and set of traits, this study evaluates each crop's relevance based on its productivity, dietary advantages, and economic impact. One can evaluate the contributions of different crops to food security by creating index-based calorie contribution and revenue per hectare. This could guarantee that commercialization benefits both equity and efficiency: Germond (2013b) proposes a division between national and farm level interests, with the former focusing on feeding more people through crops on the same amount of land, which may be approximated by

calories per ha, and the latter, which might be represented as revenue per ha, optimizing revenue through crops. Instead than concentrating on trendy crops, this index will help to determine the type of food security actions.

Table 21: Calorie and revenue comparisons

Crop type	Productivity	Price per Q	Calorie per kg	Calorie per ha	Revenue per ha
Teff	14	2700	3660	62220	27000
Sorghum	25	1845	3390	91530	46125
Onion	90	2800	400	37200	644000
Mungbean	14	2506	3500	45500	35000

Source: Own computations, (2018)

The study discovered a trade-off between revenue and caloric content for the chosen crops. According to table 22, sorghum has the highest caloric content per hectare while mung beans have the lowest, even if onions yield more money than the other crops. Both the focus group discussion and the interview with development agents made it clear that while there is some lobbying on the part of development agents to influence crop choices, the most effective way to carry out such interventions would be through compensations. The index value was 0.3, which indicates that sorghum now provides 220 more calories while giving up 1 birr in revenue that onion growing could have produced. Farmers that choose to grow more caloric-dense crops will experience lower profitability from a food security perspective. If the government were to encourage sorghum farmers, either that revenue loss could be made up for or 200 more calories could be made affordable by subsidizing 1 Birr.

5.3.2 Investment

Looking on farmer's asset ownership only 6% of their asset is directly linked to agriculture. Even the richer farmers are found with no pump and modern farm equipment despite owning vehicles and other business firms. This will lead all agricultural investments are either forced or none and lead to long term investments on agriculture is expected only from government. Such lack of investments on agriculture could contribute to rural urban gap. Part of agricultural revenues should be forced to be reinvested on agriculture and in the area of production geographically.

The basic goal of commercializing agriculture is to increase farmer income. However, there are questions about how farmers are spending their extra income and their investments which are trading on non-agricultural commodities and transport vehicles. 60% of the farmers in this survey have investments, which are not primarily related to agriculture. Financial flow needs to be partially managed as a sector. Although agriculture should help other sectors flourish, in our country it has a propensity to become financially dry. Any legislation might ensure that even a tiny amount of the additional revenue stayed in the production region as well as in the sector, allowing long-term agricultural investments like irrigation and soil management to be self-financing and better correlated with a balanced urbanization rate. Theoretically, production and conservation goals may be more effectively aligned if resource users were paid to protect environmental features (Anrrew et al, 2023).

5.3.3 Farmer-government Playoff

Table 23 lists the strategies available to farmers, along with the results of each strategy. In this instance, the government has made ensuring the availability of food a top priority, and farmers are viewed as rational producers looking to maximize their financial yields.

Table 22: Farmer playoff table

Farmer	No condition; No intervention	All farmers are expected to grow one crop highest revenue per ha	Mono cropping and specialization
	Condition; Risk	Market prediction (experience)	Multiple cropping
	Subsidy	Making revenue of all crops equal	Mono cropping

Source: Own computations, (2018)

Agricultural subsidies are an important factor affecting farmers' production decision-making behavior, and they are an effective incentive that significantly affects farmers' green production behavior (FGPB) (Chen et al., 2017). On the one hand, agricultural subsidies can reduce the expected cost of farmers adopting green production technology and then increase the expected net income of farmers, thus promoting FGPB (Pietola, 2001). On the other hand, subsidies for means of production can reduce the real prices of polluting factors of production, which will make farmers increase their investment. Table 5 lists many strategies that the government could employ to strengthen crop choice. One popular strategy is the application of restrictions, which the Ethiopian government did when producing wheat (see Appendix D), although farmers criticized this approach, and its viability is called into doubt. If farmers paid/subsidized the gap between what they would have earned if they had grown what they wanted and what they got from wheat, would provide better results.

Table 23: Government playoff table

Government	No intervention	Free market but distorted	Inflation and food insecurity
	Restrictions	Market prediction (experience)	Not sustainable and high supervision cost
	Subsidy	Cost and market distortion	Food security Food price stability

Source: Own computations, (2018)

Policy alternatives

Here policy options that could be available are presented on table 24, where tradeoffs estimated in the previous sections can be efficiently exploited. This is only from the study area point of view for the national interest it is subject to inclusions and comparisons of all crops and all ecologies and productivities.

5.3.4 Crop related policies

The United Nations Food and Agriculture Organization (FAO) estimates that 828 million people, or 10% of the world's population, go to bed hungry each night, an increase of 46 million from the previous year. The future outlook for hunger suggests that it will continue, with more extreme weather events having a destructive impact. According to Ellis (1993), farm families work toward a number of objectives at once, such as ensuring a sufficient supply of food and other necessities for the family, as well as optimizing

monetary gain. "Even if the price of food commodities increased globally, country-level price rises vary because different countries have distinct policies. (Tothova, 2023)

For instance, several nations use consumer subsidies to fix prices for consumers and protect them from market swings at the expense of the national budgets for a limited number of products. The resilience and capacity of nations to adapt to food shocks are weakened by cumulative global economic shocks, particularly sharp market disruptions and skyrocketing food prices. In several significant food crises, economic shocks have superseded conflict as the main cause of acute food shortages and malnutrition.

Table 24: Crop specific policy

Crop type	Advantage	Policy type	Policy Recommendation	Subsidize form
Sorghum	Higher calorie per area of production	Food security and income transfer	Subsidize	Inputs+ cash+ government purchase
Onion	High earning	-	No compensation	
Mung bean	High earning	Macro- economic stability	Subsidize	Subsidize insurance
Teff	High earning	Regulations	Free	N/A

Source: Own (2018)

Farmers have adequate knowledge of their produce, but they have limited knowledge of integration, which is crucial. In this study, specific investment decisions made by the government for Ethiopian agriculture were examined, along with the beneficiaries of those initiatives. In addition, how the government uses institutions and regulations to sway farmer decisions in favor of its own interests, along with the resulting price and trade distortions, are all studied. Public spending must promote equitable resource allocation, lower inequality, and follow the correct transfer of resources.

Fertilizer subsidy

To help farmers with supply issues and price increases in the fertilizer market, the government is looking into loan options and subsidies. However, these subsidies are becoming burdensome because the government requested 21 billion birr for a one-year fertilizer subsidy (see Appendix D), which has a significant negative impact on the budget deficit and is also unsustainable. This study suggests fertilizer subsidies for only those crops that contribute more to food security, as measured by the crop usefulness index, in order to address this problem.

Social payments like school meals and safety nets are more crucial now than ever because of the crisis of food security and the increase of food prices. To ensure food security, the government might pay for half of it in kind. This enables the establishment of a food bank and the use of wheat subsidies rather than payments between the government and farmers (see Appendix D).

Insurance subsidy

Since risk is the issue to be addressed, the government should change and subsidize insurances for other crops like mung bean and coffee because they are highly profitable. In this regard, the government is focusing on expanding insurances and creating an agricultural bank (see Appendix D), which is great, but insurance may be subsidized at commercial banks until that time. Additionally, by making each production activity underinsured, this will assist farmers in concentrating on a particular activity rather than viewing income diversification as risk mitigation. There are insurance subsidies in many nations, but they vary greatly in terms of coverage, government engagement, subsidy level and rate, implementation standards, and institutional framework.

Table 25: Policy framework recommendations

Existing policy	Problems/what could be achieved	Policy alternatives
Safety net	Food security/inflation	Make ½ of it using in kind (from subsidized crop)
Fertilizer subsidy	Reduce government expenditure	Only for selected crop for subsidy
Crop choice manipulations	National plan and climate change adaptation	Compensate using revenue trade off from higher revenue crop in the same area
Agriculture investment	Enable to have Community financed irrigation schemes	More financial restrictions that could keep with in the sector
Insurance	Reduction of vulnerability	Make sure every productivity has insurance coverage
Farm clusters	Avoid conflicts and reduce cost of governance	Promote centralized specialization

Source: Own computations, (2018)

5.4 Conclusion

The government discovers an easier approach to accomplish its pro-poor goal by using agriculture policy. But for this to be in line with liberalization and sustainable, there must be clear crop purposes. Crop related policies are found implemented by the government of Ethiopia with the objective of securing higher productivity and achieving welfare. Those policies are not crop and area specific. The policies are found less sustainable because of farmer government links.

All crops do not deserve subsidy the one having higher contribution to food security should get subsidies. Profitable crops areas should finance their own improvement research and adaptation.

Availability of dietary important crops in the market enabled farmers to meet the family's need and focus on commercialization.

Farmers' investment decisions were not directly associated with agriculture which will affect long term investment in agriculture and aggravate rural urban balance. Women involvement in decisions in production and marketing activities had a wider difference.

Crop produced are found with different attributes which lead to trade off among this benefits. Both calorie-revenue and Risk-revenue tradeoffs existed. Mung bean found with the highest revenue and highest risk and sorghum found with higher calorie. Crops have been discovered with a range of attributes, and strategies for sustainability and lowering intervention costs could take advantage of these. Increased independence in agriculture should result from rising food prices.

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CHAPTER 6: SYNTHESIS, CONCLUSION AND RECOMMENDATIONS

Smallholders' binding constraints, including risk and access to land, can encourage participation in profitable value chains and contract farming. Our findings offer suggestive evidence that may serve in targeting smallholders to join profitable value chains and other comparable contexts. For example, despite the limited land resources young farmers usually own, they are more likely to participate in high-value and profitable value chains, which insinuates that supporting young farmers get access to land and financial resources may increase their participation in profitable value chains and contract farming. This chapter has focused on discussing synthesis on how policies are extracted from crop and site specific variables.

6.1 Synthesis/ General Discussions

This dissertation has involved an empirical investigation of process of crop choice and its association with risk and commercialization. This encapsulates theoretical reasoning from decision theories and economic choice models. The central research question underpinning this dissertation was: how do crop choice associate with risk, commercialization and policies? The basic objective of this study was to characterize those links along with associated socio-economic factors. To address this research objective comprehensive review of potential theories and empirical findings were thoroughly captured in chapter 2. A multi-stage random sampling technique was used to select 392 farm households. The analysis is structured into four articles with crop choice serving as the central theme and appeared as chapter 3, 4, 5, and 6. The findings are summarized in this present chapter in an endeavor to address the theoretical and practical implications as well as contributions of the study.

The choice of crops by farmers is influenced by various factors such as exposure and vulnerability to production risks, risk preferences, and policy incentives. The trade-off between risk and returns in farmers' crop choices, considering the variation in exposure

and vulnerability of crops to production risks such as droughts, floods, and pests. The importance of considering risk preferences of crop type and specialization of crop producers in designing effective crop insurance programs and alternative farm policies. Additionally, the possibility of subsidizing crop insurance in reducing risks in crop production and marketing, which in turn influences crop choices were addressed. Policy also plays a significant role in shaping crop choices. How government agricultural decisions affects farmers' choice of land use, crop mix, and input use, highlighting the impact of policy on crop selection. The study is important in understanding how policy development may have affected policy application, indicating the need to consider the implications of policy decisions on crop choices. Overall, farmers' crop choices are influenced by a complex interplay of factors including exposure to production risks, risk preferences, policy incentives, and economic considerations. Understanding these dynamics is crucial for designing effective crop insurance programs, alternative farm policies, and sustainable agricultural practices.

The first article (Chapter 2) provides detailed analysis of factors determining crop choices by farm households. The issue of crop choice highly influenced by consumption and risk than its revenue and productivity is indeed a multifaceted problem influenced by various factors. While recent research has attempted to address the problem, their crop choice categories have methodological flaws that limit their validity. Fractional multinomial model is chosen to analyze crop choice due to its ability to provide a more comprehensive understanding of the complex decision-making processes involved in agricultural land use. The fractional multinomial model allows for the incorporation of household-specific characteristics, such as farm size, which serves as a proxy to control for household-level production, consumption, and marketed surplus taking shares of each crop as a dependent variable. Independent variables were tested for the presence of multicollinearity and found free. After several regressions the model showed higher r^2 value of 66% indicating higher fitness.

The second article (Chapter 3) dealt with crop production risk and price risk and its association with their portfolio choice. This study aims to address the following two research questions: how do farm households rate riskiness of each crops grown? And what variables influences riskiness of their crop portfolio choice? Economic model of farmers behavior under risk whether production or price applying utility approach was adapted to predict its link with various socio-economic variables. The advantage of this approach is that the analysis focuses on decisions that people actually must make in the course of their economic activities. There is some evidence that risk is influencing their crop choice aka their commercialization, which can be interpreted as farmers are using crop choice as risk mitigation costing their productivity and financial gain. The result found gender, land size and irrigation access significantly impacting farmers' risk decisions in terms of crop portfolio. The result also showed that few informal contracts are found to be an important household adaptation to risk and resource sharing strategies but are unsustainable and exploitive by exporters. Building on the idea of reducing risk influence crop insurance is recommended to make them achieve efficient crop choice and higher commercialization.

The commercialization of farming in Ethiopia is a topic of growing interest due to its potential impact on the country's agricultural sector. Several studies have highlighted the importance of commercialization for smallholder farmers' welfare and the overall agricultural performance in Ethiopia. The agricultural commercialization cluster initiative in Ethiopia aims to improve livelihoods, food quality, affordability, import substitution, export, agro-processing, and job opportunities The level of commercialization among smallholder farmers in Ethiopia has been a subject of empirical investigation The level of farm commercialization can be measured using various indicators such as market participation In the third article (chapter 4), the study showed additional indicators for the overall achievement of commercialization. Indices are extracted from relationships developed by various authors. The concept of comparative advantage plays a crucial role in agricultural trade patterns and the commercialization of crops. Comparative advantage indicates whether it is economically advantageous for a country to expand production and

trade of a specific commodity, while competitiveness indicates the private commercial performance of individual farms.

To explore the tradeoff between calorie intake and income in farm production, it is essential to consider the relationship between household income and nutritional outcomes. Studies have shown that the calorie-income elasticities are generally small, indicating that changes in income have a limited impact on calorie intake. The final article (chapter 5) examines and measured calorie and revenue attributes of each crop and trade off in between the two. The decision-making processes of farmers are influenced by a range of factors, including risk preferences, as well as the impact of policy changes and environmental conditions. In this regard the study examined the link between farmers' decisions and agricultural policy using crops attributes and national objectives. The study found personal perceptions and risk aversion as motivations to farmers' to purchase policy-based crop insurance if the premium is subsidized as startup. It is recommended to the government to consider aligning mung bean production with the objectives of the Agricultural Export Policy to increase the share of agriculture exports. This may involve providing support for mung bean producers to enhance productivity and quality, thereby contributing to the export target. The study strongly indicated the need for crop and area-specific policies to address the diverse agricultural and environmental contexts.

6.2 General Conclusions and Recommendations

The study identifies teff, mung bean, onion and sorghum as dominant crops cultivated in the area. The land owned found to be larger than national average and fertile and mostly acquired through redistribution. It shows the area is less degraded and has potential for higher production and productivity.

The study area found to be highly productive with less pressure on land with limited irrigation use. Their production had a market destination of which stretch up to mekelle in the north and Addis.

Crop income was found as the main source of income where crop grown in the area are limited in number but with proportion with in farm households which is far from specialization where 92 percent of the farmers grow more than one crop. Third, the results suggest that sorghum is the “safe” crop, grown more by vulnerable households, and millet is a marketable coarse grain.

Crop revenue and own consumption need found as main drivers of crop choice where consumption objectives forced farmers to make decisions against higher value crops. Among the crops commonly growing in the area, socio economic factors found significantly influencing land allocation for each crop.

Crop choice are influenced by a wide range of factors, including access to inputs, own consumption need, past experience, and socioeconomic variables. Understanding these determinants is crucial for developing effective agricultural policies and strategies that support sustainable crop choices and agricultural productivity.

Crop production is found to significantly influenced by risk. The risk differs to each specific crop and the rating of risk for each types of risk significantly varied across household. Risk rating of each crops by households found significantly influenced by socio economic factors. Crop perishability in storage and price fluctuations are found as major crop production risks in the study area

Mung bean is found adopted by 65 percent of the farmers in the study area. All the farmers in the study area are found food secured. There was significant difference in commercialization indicators between mung bean growers and non-growers. Mung bean productivity is found less than the global average and less associated local consumption.
Mung bean is found with qualities to comprehend with climate change. Its production is increasing both by production and new areas of adopting mung bean. This expansion is helping adaptation and foreign currency. The study identified huge potential of mung

bean to be a future crop. With increase temperature water shortage and its nutrient content. Its production is increase both by production and area expansion.

Farmers investment decisions were not directly associated with agriculture which will affect long term investment in agriculture and aggravate rural urban balance. Women involvement in decisions in production and marketing activities had a wider difference.

The commercialization of Ethiopian farmers has been the main target of Ethiopian national policies and considered as a long-term potential to contribute to overall agricultural development, economic growth, and poverty reduction in the country. The role of mung bean in enhancing commercialization among north Ethiopian farmers has been significant. In addition, a shift in the farmer's crop mix and distribution has been noted.

Crop related policies are found implemented by the government of Ethiopia with the objective of securing higher productivity and achieving welfare. Those policies are not crop and area specific. The policies are found less sustainable because of farmer government links.

Crop produced are found with different attributes which lead to trade off among this benefits. Both calorie-revenue and Risk-revenue tradeoffs existed. Mung bean found with the highest revenue and highest risk and sorghum found with higher calorie. Crops found with different qualities and tradeoff among these attributed which could be exploited by policies for sustainability and reduction of intervention costs.

The assessment of commercialization of farms and their growth potential, as well as the classification of farming systems, is crucial for understanding the dynamics of new farm commercialization. Additionally, their choice in relation to comparative advantage, level of specialization and marketing involvement depth, as well as nature of their investment, play a significant role in evaluating the commercialization level of farm households.

In the existing Mung bean market, there is no efficient and productive system that supports the farmers to improve the livelihood as well as to obtain the value what the market offers and these expose them to deal with the illicit traders.

6.3 Contributions of the Study

6.3.1 Major contributions to knowledge

The study made contributions to the academia in a number of ways. Most significantly applied new models, provide indices, question cash crop category and forward new policy insights. Those breakthrough contributions are summarized on table 26.

Commercialization indexes- Rather than connecting commercialization to a selective crops named cash crops and taking sales only as a sole indicator must replace with indicators like its connection with the bank, specialization and consumption behavior need to be considered.

Despite crops have national importance based on their Macroeconomic and consumption contributions, this study develops area specific and multidimensional index in Crop usefulness index to support policy making.

The study concludes that it is incorrect to use crop choice as an adaptation measure. This study demonstrates how risk and consumption are avoided from crop choice decisions using insurance and subsidy, respectively. Risk and personal consumption shouldn't in any way influence crop choice decisions.

This study introduced risk by exclusively using farmers own risk rating and this could help in efficient premium estimations for crop insurance.

Fundamentally, from econometric model utilization point of view, this study lay ground for deployment of Fractional multinomial model using crop shares and employ game theory analysis only using strategy outcome play off.

The study contributed to methodology by developing/ extracting new indices for commercialization from already established conceptual relationships contextualized and applied for measurement of commercialization. The study introduces application of farmers own risk rating in risk analysis. Its also formulate tradeoffs among important attributes by adapting calorie and renue measurments for crop specific use.

Moreover, the study has also contributed to the development of conceptual relationships in capturing riskiness measurnment. scientically riskiness of a specific crop could be unique but in farmers perception it is subject to heterogeneity with different level of variation. Labeling few crops as cash crops also questionable as all crop has the potential fulfill those markeing indicators. In this study crop importance for specific area is introduced by ranking using certain attributes like food security contribution and revenue generating potential. The study checked the impact of various risk mitigating techniques on production and commercialization.

6.3.2 Implications to policy making

This study investigated determinants of crop choice, decisions and risk but also looked policy gaps where the findings are fit in and help produce efficient policies. The identified gaps and policy remedies applying the identified results are presented as follows.

Crop choice plays a pivotal role in agricultural commercialization, particularly in the context of transitioning staple food crops to market-oriented production. The evolving nature of crop commercialization, with mung bean emerging as a market-oriented crop in

Ethiopia. However, the distribution to date has not been satisfactory, indicating a need for a more coordinated and indicator based effort.

Crop choice is among coping strategies and nutrient management practices adopted by farmers in response to production risks. comprehensive impact of risk management strategies on commercialization and market participation.

Agricultural policy found shaping commercialization behavior and market participation. To reduce dependency on food aid and achieve higher food crop production policies and interventions should focus on enhancing commercialization and socioeconomic development.

Results suggest that in the market, under this arrangement, consumers always buy their staple food at higher than equilibrium price. This is especially concerning when the consumers are also poor smallholder producers – who are cash constrained and sell their output to traders at harvest at below long run equilibrium prices. Due to temporal arbitrage and collusion among genetically close traders, markets do not perform efficiently.

The benefits of contract farming to for subsidizing crops like sorghum would enable government reduce inflation and fill price gaps. Even those producers of unsubsidized crop indirectly would subsidized when used crops like sorghum for their consumption and could focus on their crop detaching consumption from crop choice decisions and promotes specialization.

Mung bean despite having high revenue found with short shelf life and market risk. These findings have important policy implications, pointing to the direction that addressing smallholders' binding constraints, which is risk scarcity, this could be minimized through contract marketing and insurance.

The mung bean marketing system and market chain should be productive to bring considerable change on the marketability of the product and the productivity. Managing the price volatility of mung beans requires a comprehensive approach that integrates economic analysis, technological advancements, quality parameters, and sustainable agricultural practices. By considering these factors, stakeholders in the mung bean industry can work towards stabilizing prices and ensuring a sustainable market for mung beans.

Food security goals may dominate profit motives while this reverses after ensuring food security goals are achieved. Finally, factors associated with risk portfolio. the intricate relationship between food security and profit goals in agriculture underscore the need for holistic approaches that consider economic viability, environmental sustainability, and social equity.

Investment must be supervised across sectors and geographical areas and must be regulated. Agriculture should finance conservation works, its own technologies, and research works at household/farm level.

Another important finding relevant for policy is the apparent trade-off between high-value and low-value crops. While the high-value crops are more profitable with greater abilities to increase welfare and reduce poverty, the low-value crops may be more inclusive and with greater implications for household food security. In this case subsidy is required to welfare and pro poor policy.

Wheat farmers could be subsidized and the subsidy shall be paid in the form of government purchase and part of it could be paid as part of safety net part of it could be used for export and could be supplied to the market with price tackling inflation.

Subsidized insurance could help make every production activity under mandatory insurance.

The production and price risk of crops play a significant role in farmers' decision-making processes. Understanding the trade-offs between risk and returns, the impact of insurance markets, and the strategies for managing production and price risks is crucial for informing agricultural policies and supporting farmers in making informed crop choices

The relationship between crop risks and financial sector development is influenced by a range of factors, including credit risks, financial inclusion, productivity, and sustainability. Understanding these dynamics is crucial for developing policies that support the resilience of the agricultural sector within the broader context of financial sector development.

Crop insurance should be the sole action for agricultural risk management, not others like diversification. The management of crop risk by financial institutions is a critical aspect of agricultural finance. Availability. This financial institutions should word on its aces to farmers with manageable premiums.

6.4 Future research directions

The mung bean marketing system and market chain should be productive to bring considerable change on the marketability of the product and the productivity.

For all crops grown in the nation, a crop usefulness index needs to be created. this would help efforts in boosting national calorie availability.

The identification of locations must take into account the comparative advantages of each crop in each location, from *woreda* to country-wide.

Research must be done primarily on behavioral research on how to introduce crops that are not typically produced in the area.

It is necessary to conduct research on meal types and food processors for recently introduced crops that will complement the culture and crop's nature.

Further research on the optimal crop for land allocation is required, and plans for non-agricultural investments must be coordinated with them.

Multiple-risk crop insurance programs have proven expensive to governments and have not lived up to their expectations, highlighting the complexities and challenges associated with managing crop risks through insurance programs. In this regard, the responsiveness of farm investment to price changes need to be studied considering farm heterogeneity and behavioral parameters.

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APPENDICES

APPENDIX A List of published articles

CHAPTER 2 (Paper 1): DETERMINANTS OF CROP CHOICE IN NORTH SHEWA, ETHIOPIA: A FRACTIONAL MULTINOMIAL APPROACH

Harun, M., & Legesse, B. (2023). Determinants of crop choice in North Shewa, Ethiopia: A fractional multinomial approach. *African Journal of Food, Agriculture, Nutrition and Development*, *23*(04), 23180. https://doi.org/10.18697/ajfand.119.22360

CHAPTER 3 (Paper 2): FARMERS' RISK RATING AND CROP PORTFOLIO CHOICE IN KEWOT WOREDA, NORTH ETHIOPIA

Harun, M., & Legesse, B. (2023a). Farmers' risk rating and crop portfolio choice in Kewot Woreda, North Ethiopia. Journal of Global Innovations in Agricultural Sciences. *Journal of Global Innovations in Agricultural Sciences*, *11*(01), 49-54. https://jgiass.com/uploads/issue_papers/Farmers%E2%80%99-risk-rating-and-crop-portfolio-choice-in-Kewot-Woreda,-North-Ethiopia.pdf

CHAPTER 5 (Paper 3): CROP ATTRIBUTES, FARM DECISIONS AND CROP SPECIFIC POLICIES IN THE CONTEXT OF SUSTAINABILITY OF PRODUCTION IN ETHIOPIA

Harun, M. E., & Legesse, B. (2023). Crop Attributes, Farm Decisions and Crop Specific Policies in The Context of Sustainability of Production in Ethiopia. Economics of Agriculture, 70(4), (pp. 1009-1024). https://doi.org/10.59267/ekoPolj23041009E

APPENDIX B. Questionnaire

1`Questionnaire for PhD Research Survey on:

Commercialization, Crop Choice and Risk in Smallholder Farm Households: Evidence from Mung Bean Production in North Shewa, Ethiopia

College of Development Studies, Addis Ababa University

Dear Respondent, this questionnaire is prepared for sole purpose of academic study, to the fulfillment of PhD degree in Rural Development. The investigator wants to assure you that this data is confidential and will only be used for the mentioned study, and the investigator also guarantees that this study as well as the information given by you will not have any link with **tax**, **food aid**, **safety net** and other non academic purposes. !!!!!

Code …….. Date ……..

Name of the woreda/ Kebele …….

Enumerator …… Signature ……

I. Demographic & Socioeconomic Characteristics

1. Household Head's Sex ……. 2. Age …… 3. Religion ……

4. Educational status ☐ Non Literate ☐ Read and Write ☐ Formal grade completed

5. Household size ……

6. Marital status ☐ Single ☐ Married ☐ Divorced ☐ widow

7. Occupation ☐ Farming ☐ Trading ☐ Handicraft ☐ Other…….

8. List of Household Members (Other than head)

	Name	Type of relation	Sex	Education	Age
	1.				
	2.				
	3.				
	4.				
	5.				
	6.				
	7.				
	8.				

9. Household monthly income sources:

	Income type	Tick ✓	
		Yes	No
	crop income		
	Livestock		
	Selling wood		
	Onfarm wage labour		
	Trade		
	Wage labor (Non Agricuture)		
	Handicraft		

	Remittance		
	Safety net		
	Other Specify……		

10. How many of the household members have migrated to urban …….

11. Domestic water source

☐ Pipe water ☐ Hand dugwel ☐ Interior tap water ☐ spring water

II. Resource Endowment

21. Animal resources in the homestead:

S.n.	Type	Yes or no Tick ✓	Number
1	Cow		
2	Bull		
3	Sheep and Goat		
4	Chicken		
5	Donkey/mule/horse		
6	Bee hive		
7	other		

Farm loan

22.Did you take farm loan? ☐ Yes ☐ No

If Yes, how much ……..

Loan from

☐ Traders ☐ Government ☐ Neighbor or family ☐ credit association

Purpose of the loan …….

Are you a member of Equb? ☐ Yes ☐ No

Distance to local market ……. Distance to the nearby city ……. (Hr or Km)

How many times do you travel ☐ frequently ☐ weekly ☐ monthly

Your travel to the nearest output markets ☐ on foot ☐ by pack animals ☐ by car

1. Farm Characteristics

Total area of land cultivated ……..

Description ☐ plain ☐ moderate ☐ sloppy

Do you have uncultivated land / marginal ☐ Yes ☐ no

Type of Land Ownership

☐ Own ☐ Rent ☐ Share cropping

Location of your farm ☐ one site (kutagetem) ☐ different sites

How you acquire your land

☐ Inherited ☐ Purchased ☐ Redistribution

Inherited from ☐ Husband relatives ☐ wife relatives

Who is the land cultivated by?

☐ Yourself ☐ others

☐ Rent ☐ share cropping other ……

Output share:

☐ Equal share ☐ Equal share after subtracting input costs ☐ other …….

Do you have plots for trial/ demonstrations of new crop?

☐ Yes ☐ no

Your participation in the **land market**

☐ rented in ☐ rented out

Do You / Renters interfere with the decisions (In case of land renting)

Regarding crop grown on the land ☐ Yes ☐ no

Regarding Fertilizer use ☐ Yes ☐ no

Availability of land for rent ☐ High ☐ Low

Is the land available for renting fertile ☐ Yes ☐ no

Land rent ☐ legally documented ☐ oral agreement

Did you experience land dispute in the last 10 years ☐ Yes ☐ no

Your personal judgment about land market

……
…
…….

Change in farm size in the last 10 years

☐ The same ☐ decreased ☐ increased

If decreased, the reason

☐ Taken by government for investment

☐ Inherited to family

☐ Other, mention ……

2. Farming Practices and Farm production

Do you have favorite crops to grow? ☐ Yes ☐ no

Which crops and why …….

……..

……..

Do you change the crop type you used to grow (ever)? ☐ Yes ☐ no

Reason ……..

Do you have a **plan/ expect** to change your production (crop type) in the future?

☐ Yes ☐ no

If yes, the reason ☐ decline of production

☐ Marketing problems

Other …….

Which one you are practicing?

☐ Sole planting ☐ Crop rotation ☐ Intercropping

How effective are these strategies in reducing production and market risks

☐ Very effective ☐ Not very effective

When you tell your wife about which crop you are going to grow?

☐ Never tell ☐ Tell for some crops

☐ Tell all the time

Do women have role in crop choice decisions?

☐ Yes ☐ no which crops do they prefer? …….

Women choose ☐ crop consumed at home ☐ crop of high market price

☐ Crops of high nutrition ☐ other ……

Which crops are more managed by women ……

Which Farm activities are done mostly by women

……..……
……

Women marketing involvement

Crop types sold
……

Purchase of family's food crops ☐ only women ☐ both

From which you get farming advice

☐ Extension agents/ DA's ☐ Media

☐ Neighboring Farmers

☐ children

Do you use hired labour ☐ Yes ☐ no

How you rate payment for labourers ☐ high ☐ medium ☐ Very low

Nature of Labor employment ☐ Permanent ☐ casual

List of Farm equipments used

……..

……..

Contacts with government extension agent last one year ☐ Frequent ☐ rare

Do you use irrigation	what kind of irrigation
☐ Yes ☐ no	☐ Stream ☐ diversion ☐ other ……..

Do you feel Fertility of your soil is declining? ☐ Yes ☐ no

What do you think is the reason …….

What happened to the agricultural production in the last 5 years?

☐ Increased ☐ Decreased ☐ Did not change

Do you use improved seed ☐ Yes ☐ no

From where you get the seed ……..

Do you feel the quality of seeds brings better production

☐ Yes ☐ no

Do you use organic fertilizers/ manure

☐ Yes ☐ no

How do you characterize the local market near to you?

All kinds of crops are available in the market ☐ Yes ☐ no

Market prices are very high ☐ Yes ☐ no

How you rate the influence of the following factors on your **crop choice** decisions

Reason	High priority	Considered with low	Not considered

		priority	
Family consumption requirement			
Past Experience			
Expected outcome (Profit)			
Intervention (Gov't or NGO)			

Main problem of agriculture in your area

☐ Lack of irrigation water ☐ Marketing problems

☐ Disease and pest ☐ Storage/ post harvest losses

Your opinion about Additional problems of crop production in your area and how to be solved

……
……Specific

Farm production

	Crop type Produced	Qt/ha Kg/ha	Land allotted	Fertility status Of the land	Labour demand **high/low**	Was there any crop damage **Yes/ no**	Fertilizer use **Yes/no**	**Tick ✓**		
								consumed	**sold**	**stored**
Main season	1.									
	2.									
	3.									
Belg season	4.									
	5.									
	6.									
Vegetables	7. 8. 9. 10.									

Sold farm products

Crop type	Amount	Unit price	Gross	Marketing channel
1.				(market/cooperative/agent)
2.				
3.				
4.				
5.				
6.				
Animal products Egg Milk and butter Chicken Sheep and goat Livestock Honey				

Risk rating (farmer's own rating)

Crop type	Production fluctuation Tick ✓		Market price fluctuation Tick ✓		
	high	low	high	medium	constant
1. Bean pea lentil					
2. Maize					
3. Teff, sorghum barley					
3. Masho (mung bean) 4. Ethiopian cabbage and pepper					
5. Tobacco 6. Onion and garlic					
6. Vegetables					

7. Fruits					

7. Data on Consumption

Which months of the year your food consumption dropped?

……

In the last 3 year how can you rate food security in your household?

☐ Improved ☐ not significantly changed

☐ Decreased but not significantly ☐ seriously declined

How do you compare the present decade with the previous ones in terms of food security and living standards?

☐ Much better ☐ slightly better ☐ Same ☐ Worse

Crop type	**Amount consumed**			**Crop type**	**Amount consumed**	
	In Kg/ In Birr	**(Own, purchased, gift or gov't)**			In Kg/ In Birr	**(Own, purchased, gift or gov't)**
teff				carrot		
millet				Cabbage		
Wheat				fruits		
barley				coffee		
sorghum				others		
Rice				**Additional food items**		
peas & Chickpea				Salt & sugar		
bean				oil		
maize				honey		
pepper				chicken		
Onion				Egg		
potato				Beef/lamb		
tomato				butter and milk		

8. Mung Bean related (Only for Mung Bean growers)

When did you start growing mung bean …….

How you grow masho ☐ sole planting ☐ Inter cropping if so, with what crops ……

Total masho production

Production kg	Productivity kg/ha

Inputs used

Seed amount ……. Source …….. price ……

☐ Local seed ☐ improved seed

Name of the variety …….

Fertilizer ……

Labor demand

Sowing ☐ high ☐ low …… days

Weeding ☐ high ☐ low …… days

Harvesting ☐ high ☐ low …… days

Storage loss ☐ high ☐ medium ☐ very low

How long does masho take to mature? …….. Months

List risks associated with masho production?

…….....

Pest associated with masho production ……..

Disease associated with masho production ……..

Do you apply special farm management practices for masho ☐ Yes ☐ no

If Yes, what kind

……

Allocation of masho production ☐ consumed amount ……. ☐ Sold amount……..

If consumed, what is the kind of the meal …….

If sold, to whom do you sell your production?

Firm	**Tick ✓**	Amount/percentage	price
Direct to consumer			
Cooperatives			
Wholesalers			
Exporters			

If **total/much** production sold the reason

☐ No convenient meal ☐ high profit ☐ other ……

Total income from masho … birr Do you have contractual agree]ments ☐ Yes ☐ no

THANK YOU VERY MUCH FOR YOUR TIME.

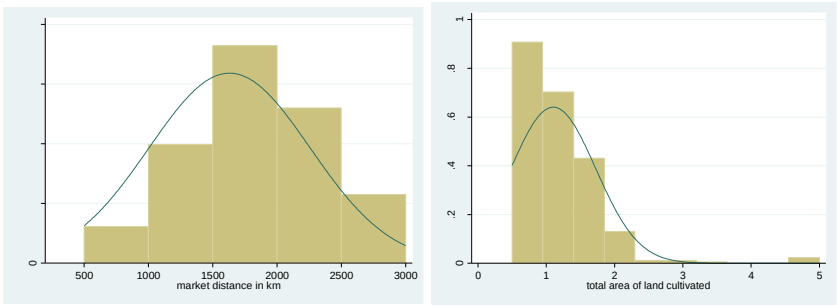
APPENDIX C FM logit stata outputs

```
. fmlogit   onshare sorgshare tefshare mashare, eta( hhno marketdis grossan irrigation
livestock sex1 landcul edu2 marital2 landtype farmloc)


Iteration 0:   log pseudolikelihood = -509.22106

Iteration 1:   log pseudolikelihood = -465.51655

Iteration 2:   log pseudolikelihood = -462.16152

Iteration 3:   log pseudolikelihood =  -461.5296

Iteration 4:   log pseudolikelihood =  -461.4034

Iteration 5:   log pseudolikelihood =  -461.3823

Iteration 6:   log pseudolikelihood = -461.37741

Iteration 7:   log pseudolikelihood =  -461.3763

Iteration 8:   log pseudolikelihood = -461.37606

Iteration 9:   log pseudolikelihood = -461.37602


ML fit of fractional multinomial logit            Number of obs   =        392

                                                  Wald chi2(33)   =   14424.35

Log pseudolikelihood = -461.37602                 Prob > chi2     =     0.0000

------------------------------------------------------------------------------
             |               Robust
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
eta_sorgshare |
         hhno |   .0377597   .0517167     0.73   0.465    -.0636031    .1391226
    marketdis |   .0002117   .0000845     2.50   0.012      .000046    .0003773
      grossan |  -.0149006   .0074126    -2.01   0.044     -.029429   -.0003721
   irrigation |  -2.400689   .4697231    -5.11   0.000     -3.32133   -1.480049
    livestock |  -14.66842   .6457649   -22.71   0.000    -15.93409   -13.40274
         sex1 |   .8589712   .1818543     4.72   0.000     .5025433    1.215399
```

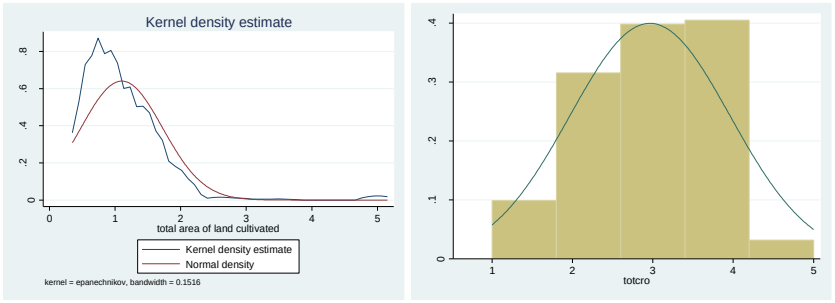
landcul	-.1372513	.0503853	-2.72	0.006	-.2360047	-.0384979
edu2	-.178399	.2360019	-0.76	0.450	-.6409543	.2841562
marital2	-.8606211	.2350283	-3.66	0.000	-1.321268	-.3999741
landtype	-.0038188	.1086171	-0.04	0.972	-.2167043	.2090668
farmloc	.330758	.6635229	0.50	0.618	-.9697229	1.631239
_cons	16.65968	.627234	26.56	0.000	15.43033	17.88904
eta_tefshare						
hhno	.0482616	.0808887	0.60	0.551	-.1102773	.2068005
marketdis	.000686	.0001273	5.39	0.000	.0004365	.0009354
grossan	.0309034	.0102164	3.02	0.002	.0108795	.0509272
irrigation	-1.168938	.5617084	-2.08	0.037	-2.269866	-.0680097
livestock	-15.24946	.6727491	-22.67	0.000	-16.56802	-13.93089
sex1	2.246193	.3255253	6.90	0.000	1.608175	2.884211
landcul	-.4059822	.1314403	-3.09	0.002	-.6636006	-.1483639
edu2	-.2586114	.316167	-0.82	0.413	-.8782874	.3610645
marital2	-1.86284	.3795017	-4.91	0.000	-2.606649	-1.11903
landtype	.8393457	.1738123	4.83	0.000	.4986798	1.180012
farmloc	-.1631413	.7468461	-0.22	0.827	-1.626933	1.30065
_cons	13.88267	.7911327	17.55	0.000	12.33208	15.43326
eta_mashare						
hhno	.110409	.0534395	2.07	0.039	.0056695	.2151485
marketdis	.0005931	.0001182	5.02	0.000	.0003615	.0008247
grossan	.018779	.0115886	1.62	0.105	-.0039342	.0414923
irrigation	-1.060419	.5692773	-1.86	0.062	-2.176182	.055344
livestock	-13.76335	.6863545	-20.05	0.000	-15.10858	-12.41812
sex1	1.360317	.2532709	5.37	0.000	.8639147	1.856718
landcul	-.1503887	.0830302	-1.81	0.070	-.3131249	.0123476
edu2	-1.050736	.326094	-3.22	0.001	-1.689868	-.4116033
marital2	.3865009	.4091075	0.94	0.345	-.4153352	1.188337

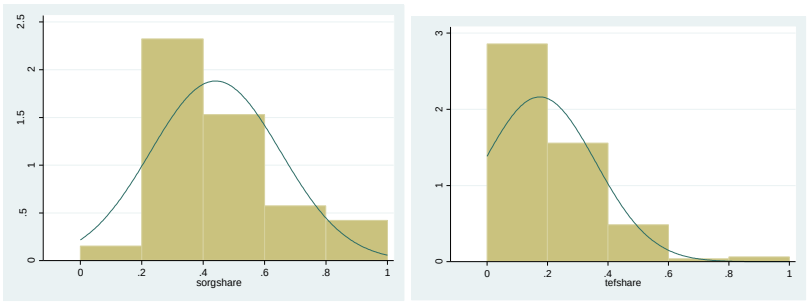
```
     landtype |  -.0244418   .1619197    -0.15   0.880    -.3417986    .2929149
      farmloc |   .0514565     .80925     0.06   0.949    -1.534644    1.637557
        _cons |   12.20586    .846993    14.41   0.000     10.54578    13.86593
------------------------------------------------------------------------------


. mfx


Marginal effects after fmlogit
      y  = predicted proportion for outcome onshare (predict)
         =  .09152216
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
    hhno |  -.0046397      .00438   -1.06   0.289  -.013218  .003938    4.8852
market~s |  -.0000327      .00001   -4.53   0.000  -.000047 -.000019   1631.38
 grossan |  -.0001621      .00065   -0.25   0.804  -.001442  .001118   8.84949
irriga~n*|   .1103266      .01343    8.22   0.000   .084008  .136646    .77551
livest~k*|   .1974501       .0143   13.81   0.000   .169421  .225479   .938776
    sex1*|  -.1383243      .02668   -5.18   0.000  -.190613 -.086036   .895408
 landcul |   .0162822      .00506    3.22   0.001   .006359  .026205    1.1014
    edu2*|   .0318356      .01726    1.84   0.065  -.002001  .065673   .795918
marital2*|   .0591349      .01073    5.51   0.000    .03811   .08016   .918367
landtype |  -.0138408      .01018   -1.36   0.174  -.033787  .006105   1.30867
 farmloc |   -.013917      .05648   -0.25   0.805  -.124615  .096781   1.91837
------------------------------------------------------------------------------
(*) dy/dx is for discrete change of dummy variable from 0 to 1
```

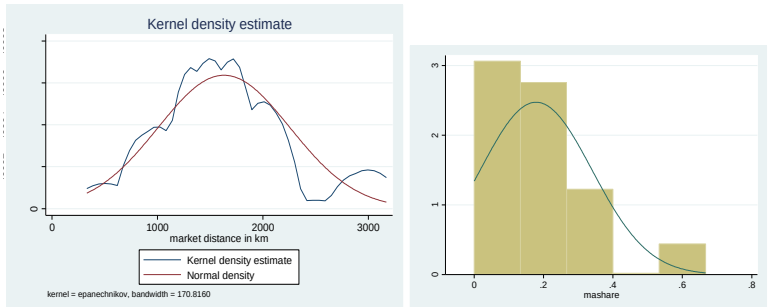
APPENDIX F Normality adjustments



histogram marketdis, normal bin(5)







VIF

Variable	VIF	1/VIF
irrigation	2.65	0.377905
sex1	2.53	0.394657
edu2	2.47	0.405393
marital2	2.35	0.426270
hhno	1.99	0.501341
farmloc	1.85	0.539796
croptyp	1.71	0.584070
marketdis	1.28	0.778639
livestock	1.28	0.779808
landcul	1.26	0.796607
grossan	1.24	0.805656
landtype	1.21	0.824141
Mean VIF	1.82	

```
ttest croptyp, by(masha)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
      no |     135    1.837037    .0666728     .774668     1.70517    1.968904
     yes |     257    3.264591    .0562281    .9014047    3.153863     3.37532
---------+--------------------------------------------------------------------
combined |     392    2.772959    .0553044     1.09497    2.664228     2.88169
---------+--------------------------------------------------------------------
    diff |           -1.427554    .0914096               -1.607272   -1.247837
------------------------------------------------------------------------------
    diff = mean(no) - mean(yes)                                   t = -15.6171
Ho: diff = 0                                     degrees of freedom =      390

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 1.0000
```

Logit result of adoption

```
logit masha farmloc2 redist landtype2 edu2 marital2 landcul age sex1 croptyp1
>  hhno livestock marketdis irrigation
Iteration 0:   log likelihood = -252.40999
Iteration 1:   log likelihood = -102.34298
Iteration 2:   log likelihood = -86.348002
Iteration 3:   log likelihood = -83.933737
Iteration 4:   log likelihood = -83.846002
Iteration 5:   log likelihood = -83.845618
Iteration 6:   log likelihood = -83.845618
Logistic regression                               Number of obs   =        392
                                                  LR chi2(13)     =     337.13
                                                  Prob > chi2     =     0.0000
Log likelihood = -83.845618                       Pseudo R2       =     0.6678
------------------------------------------------------------------------------
       masha |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    farmloc2 |   1.841296    1.65125     1.12   0.265    -1.395094    5.077686
      redist |  -2.578157   .7179306    -3.59   0.000    -3.985276   -1.171039
   landtype2 |  -.7787706   .6134727    -1.27   0.204    -1.981155    .4236138
        edu2 |  -1.310443   1.537452    -0.85   0.394    -4.323794    1.702907
    marital2 |   2.404109   1.390937     1.73   0.084    -.3220766    5.130295
     landcul |   .4112987   .5023488     0.82   0.413    -.5732868    1.395884
         age |   .0556196   .0357118     1.56   0.119    -.0143742    .1256134
        sex1 |  -.8210401   1.159852    -0.71   0.479    -3.094308    1.452227
    croptyp1 |   3.864975   .5124837     7.54   0.000     2.860526    4.869425
        hhno |   .1236972   .1913331     0.65   0.518    -.2513087    .4987032
   livestock |   1.420852   1.553405     0.91   0.360    -1.623766     4.46547
   marketdis |   .0011217   .0004493     2.50   0.013      .000241    .0020024
```

```
  irrigation |  -3.803886    1.62157    -2.35   0.019    -6.982105   -.6256676
       _cons |  -7.215536   2.618488    -2.76   0.006    -12.34768   -2.083394
------------------------------------------------------------------------------
```

mfx

```
Marginal effects after logit
      y  = Pr(masha) (predict)
         =  .87814164
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
farmloc2*|    .113936        .057    2.00   0.046   .002226  .225646   .081633
  redist*|  -.2644262      .08344   -3.17   0.002  -.427974 -.100879   .571429
landty~2*|  -.0750762      .05524   -1.36   0.174  -.183351  .033199   .691327
    edu2*|  -.1068655      .10425   -1.03   0.305  -.311201   .09747   .795918
marital2*|   .4555984      .33281    1.37   0.171  -.196704   1.1079   .918367
 landcul |   .0440126      .05182    0.85   0.396  -.057557  .145582    1.1014
     age |   .0059518       .0044    1.35   0.176  -.002678  .014581   40.4898
    sex1*|  -.0689709      .08021   -0.86   0.390  -.226184  .088243   .895408
croptyp1 |   .4135868      .07731    5.35   0.000   .262069  .565104   1.83673
    hhno |   .0132367      .02071    0.64   0.523  -.027359  .053832    4.8852
livest~k*|   .2321493      .34301    0.68   0.499  -.440132  .904431   .938776
market~s |     .00012      .00004    2.79   0.005   .000036  .000204   1631.38
irriga~n*|   -.238612      .08195   -2.91   0.004  -.399229 -.077995    .77551
------------------------------------------------------------------------------
(*) dy/dx is for discrete change of dummy variable from 0 to 1
```

.

APPENDIX E Correlation matrix

| mame edu1 marital1 hhno grossan kebelle sex1 livest~k market~s citydis travel landcul landtype marginal
---+---

mame	1.0000												
edu1	0.1057	1.0000											
marital1	0.1311	-0.3253	1.0000										
hhno	0.1945	0.3312	0.2309	1.0000									
grossan	-0.1574	0.1704	-0.2889	-0.1559	1.0000								
kebelle	0.0605	-0.0222	0.0195	-0.0626	0.0740	1.0000							
sex1	-0.0741	-0.0746	0.4529	-0.0881	0.1819	0.0386	1.0000						
livestock	0.0544	0.3021	-0.0422	0.2152	0.2111	0.0214	-0.0436	1.0000					
marketdis	-0.0353	0.1465	-0.1950	-0.2072	0.1661	0.0041	-0.1843	-0.0707	1.0000				
citydis	0.2443	0.4978	0.1954	0.5514	-0.3454	-0.0246	-0.1984	0.3855	0.0842	1.0000			
travel	-0.1555	-0.2429	0.0191	-0.0748	0.0897	-0.0238	0.0062	0.1685	0.0909	-0.2308	1.0000		
landcul	0.1495	0.1233	0.0966	0.3975	-0.1241	-0.0115	-0.0240	0.1704	-0.2436	0.2321	0.2768	1.0000	
landtype	0.0828	-0.2012	0.1571	0.0969	-0.0925	0.0085	0.1292	0.1094	-0.1796	0.0595	0.1857	0.3073	1.0000
marginal	-0.1822	-0.2158	-0.2513	-0.3055	0.3752	0.0829	0.1038	-0.4201	0.1683	-0.7396	0.1900	-0.1338	-0.2605	1.0000
farmloc	0.2021	-0.0504	-0.0422	-0.1105	-0.1528	-0.0723	-0.0436	-0.0294	0.1898	-0.0634	0.4789	0.1704	0.1094	0.0700
irrigation	0.3401	0.4897	-0.1120	0.1388	0.0345	-0.0329	-0.1156	-0.0780	0.2731	0.2067	-0.1019	0.0523	-0.3786	0.1857
hiredlabor	0.2723	0.2021	0.0212	-0.1692	0.1755	0.0519	0.0069	-0.1574	0.4057	-0.0224	-0.3440	-0.0059	-0.3158	0.2107
irrtype	0.3519	0.2498	0.1789	0.3826	-0.2362	-0.1069	0.0085	0.2310	0.0708	0.5703	-0.1045	0.1435	0.0885	-0.4486
mashogrow	0.1572	0.0906	0.2626	0.1885	-0.2015	0.0129	0.1162	-0.1204	-0.2497	0.1939	-0.1627	0.0793	0.1215	-0.0847
femalehh	0.0689	0.2277	0.1334	0.6598	-0.2441	-0.0583	0.1320	0.1597	-0.1861	0.2902	-0.0747	0.1473	-0.0056	-0.1260