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# Impact of Contract Farming on Smallholders in Ethiopia: The Case of Chickpea Growers

A thesis submitted in partial fulfilment of the requirements  
for the Degree of Master of Commerce (Agricultural)

at

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by

Samuel T. Seba

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Contract farming (CF) is an institutional arrangement by which agribusinesses replace or supplement primary agricultural production with supply from smallholders. In developing countries where farms are typically small and resource poor, questions have been asked about its impact on smallholders, particularly the poorest. This study examined these aspects of a Contract Farming Arrangement (CFA) between a chickpea processing firm and a farmers' cooperative union in central Ethiopia. A random sample of 95 growers was drawn from a list of CF participants. In addition, a representative sample of 114 households was drawn from seven counties where the CFA was active. A subset of non-participating households with characteristics similar to those of participants was identified as a control group using propensity scores predicted by a logit model. The logit model indicated that the CFA was biased against farmers who were relatively poor, risk averse and short of farming skills and experience. However, there was no evidence that participation was influenced by gender, education, farm size or household labour endowments. Univariate comparisons revealed significant differences in key outcomes between participants and households in the control group. A multivariate 'treatment' model estimated to isolate the impact of the CFA found that participation had a substantial positive impact on household cash revenue (ETB 3,658 per adult equivalent) and net cash income (ETB 3,411 per adult equivalent) earned from crop production. Local Average Treatment Effects (LATEs) computed for 'complier' households were also sizeable for these outcomes at ETB 2,879 and ETB 1,896 per adult equivalent respectively. Participants attributed increases in net income to improved seed, a stable product price, higher yields and a guaranteed market. Descriptive analysis of other perceived outcomes suggested that participants also benefitted from improved food security and better access to preferred markets, credit, new technology, information and technical advice. Levels of satisfaction with the terms and administration of the CFA were high.

Interventions that improve farming skills and mitigate risk are recommended to enhance inclusiveness. Efforts to strengthen producer organisations, cooperative unions and the legal infrastructure required to enforce contracts are also recommended.

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## Contents

<b>Acknowledgments</b> .....	<b>iv</b>
<b>Contents</b> .....	<b>vi</b>
<b>List of Figures</b> .....	<b>viii</b>
<b>List of Tables</b> .....	<b>ix</b>
<b>List of Appendices</b> .....	<b>x</b>
<b>1 Introduction</b> .....	<b>1</b>
1.1 Context of the study.....	1
1.2 Rationale for the study.....	3
1.3 Outline of the thesis .....	4
<b>2 Literature review</b> .....	<b>5</b>
2.1 Definition, features and motivation for CFAs .....	5
2.2 Benefits, risks and challenges of CFAs .....	6
2.3 Theories, perspectives and frameworks for the study of CFAs .....	9
2.4 Empirical studies of CFAs .....	13
2.5 Chapter summary.....	16
<b>3 Research objectives, hypotheses and research questions</b> .....	<b>17</b>
<b>4 The study area, sample design and research methods</b> .....	<b>19</b>
4.1 The study area.....	19

4.2	Sample design .....	21
4.3	Factors affecting participation in the CFA.....	22
4.4	Impact of CFA on income and other outcome variables .....	23
4.5	Ethical issues .....	27
4.6	Chapter summary.....	27
<b>5</b>	<b>Data collection and descriptive statistics .....</b>	<b>28</b>
5.1	Data and data collection .....	28
5.2	Descriptive statistics for the household sample .....	28
5.2.1	Household demographics .....	29
5.2.2	Household wealth and assets .....	30
5.2.3	Household farming enterprises .....	31
5.2.4	Participation in CFAs, membership in cooperatives and willingness to pay .....	32
5.3	Chapter summary.....	33
<b>6</b>	<b>Participation in and impact of ACOS Ethiopia’s CFA .....</b>	<b>34</b>
6.1	Participation in ACOS Ethiopia’s CFA and factors affecting participation .....	34
6.2	Household impacts of ACOS Ethiopia’s CFA.....	38
6.2.1	Impact of ACOS Ethiopia’s CFA on household income .....	38
6.2.2	Impact of ACOS Ethiopia’s CFA on other indicators of household wellbeing .....	42
6.3	Chapter summary.....	44



<b>7</b>	<b>Summary, conclusions and recommendations .....</b>	<b>45</b>
7.1	Summary .....	45
7.2	Conclusions and recommendations .....	47
7.3	Limitations and future research .....	49
<b>8</b>	<b>References.....</b>	<b>50</b>
<b>9</b>	<b>Appendices.....</b>	<b>56</b>

### **List of Figures**

Figure 2.1:	A summary of the benefits, risks and challenges of contract farming .....	9
Figure 2.2:	Stages of establishing CFAs, (summarised from Barrett et al., 2012) .....	12
Figure 2.3:	Determinants of formation and sucess of CFAs (Da Silva & Rankin, 2013, p. 26) .....	13
Figure 4.1:	Map of districts comprising the study area(Chamberlin et al., 2007).....	20
Figure 4.2:	Sampling design .....	22

## List of Tables

Table 4.1: Classification of the population based on predicted and observed participation status .....	25
Table 5.1: Household and farm characteristics in the study area, 2014 .....	29
Table 5.2: Household wealth and farm assets in the study area, 2014 .....	30
Table 5.3: Household farming enterprises in the study area, 2014 .....	31
Table 5.4: Membership, participation and willingness to invest in CFAs in the study area, 2014 .....	33
Table 6.1: Reasons for participating in ACOS Ethiopia's CFA .....	35
Table 6.2: Reasons for not participating in ACOS Ethiopia's CFA .....	35
Table 6.3: Logit analysis of factors affecting participation in ACOS Ethiopia's CFA (n=207) .....	37
Table 6.4: Comparison of income outcomes in the treatment and control groups.....	39
Table 6.5: Impact of ACOS Ethiopia's CFA on indicators of household income (n=128)....	40
Table 6.6: Classification of matched households with predicted and observed participation status (n=128).....	41
Table 6.7: LATEs and ATEs of participation in ACOS Ethiopia's CFA (n=128) .....	41
Table 6.8: Impacts of participation in ACOS Ethiopia's CFA on indicators of wellbeing (n=103).....	42
Table 6.9: Perceived sources of impact on household net income (n=103) .....	43
Table 6.10: Participants' attitudes on other terms of ACOS Ethiopia's CFA (n=103) .....	44

## List of Appendices

Appendix A Respondents consent form and questionnaire .....	56
Appendix B: Definition of variables .....	68
Appendix C: Household sample design.....	79
Appendix D: Regression estimating treatment effect on total crop expenditure per adult equivalent .....	80
Appendix E: Regression estimating treatment effect on total crop cash revenue per adult equivalent .....	81
Appendix F:Regression estimating treatment effect on net crop cash revenue per adult equivalent .....	81
Appendix G:Regression analysis on treatment effect on total crop revenue per adult equivalent .....	82
Appendix H: Estimated values of each outcome variable for classified groups.....	82
Appendix I: Data used to estimate the general treatment model .....	83

## Chapter 1

### 1 Introduction

This chapter introduces the context of the study by defining the concept and providing the background information on the case the study was conducted. It also presents the rationale for conducting the research and outline of the thesis.

#### 1.1 Context of the study

Inclusiveness, in the context of agribusiness value chains in developing countries, refers to the beneficial participation of smallholders (Da Silva & Baker, 2009, p. 6). Contract farming (CF) has considerable potential for integrating smallholders in to export and processing markets, and into the modern economy (Kirsten & Sartorius, 2010, p. 504; Wang, Wang, & Delgado, 2014, p. 2). CF is a form of vertical coordination whereby agribusiness firms contract farmers to produce for distant markets or to grow raw material for their processing facilities under various conditions (Prowse, 2012, p. 5). These conditions might include providing seed, other inputs, credit, and technical services to smallholders while guaranteeing supply to the agribusiness firm. It is a mechanism by which agribusinesses replace or supplement primary agricultural production with supply from smallholders (Glover & Kusterer, 1990).

CF was adopted from developed countries when agribusinesses started to source high value agricultural products from developing countries, initially in South America (Little & Watts, 1994, p. 66). One of the reasons for its popularity is the view held by many development agents that CF is a useful tool to promote economic development in free market economies (Glover, 1987, p. 442; Porter & Phillips-Howard, 1997, p. 228). Porter and Phillips-Howard (1997, p. 277) claim that CF is a product of market liberalisation in developing countries. Currently, this exchange relationship (institutional arrangement) is utilised in more than 110 developing and transitional economies by both multinational and local agribusiness firms (Oya, 2012, p. 1).

Many argue that it is beneficial for agribusinesses to engage in CF, particularly to mitigate risks and uncertainties (Glover & Kusterer, 1990). In doing so, agribusinesses achieve

economies of scale and labour efficiency with greater certainty of securing adequate supply of the required quality. At the same time, farmers benefit from a guaranteed market, stable prices, technological support, and access to credit and inputs. Productivity is expected to improve due to enhanced capacity utilisation beyond the farm gate and clear incentives for farmers to increase production in response to favourable or more predictable prices (Da Silva & Rankin, 2013, p. 4; Glover & Kusterer, 1990, p. 3; Goldsmith, 1985, p. 1126; Kirsten & Sartorius, 2010, p. 504).

Melese (2010, p. 29) considers CF to be a relatively new concept in Ethiopia. She contends that there were at least nine CFAs in various parts of Ethiopia for different products in 2009. One is led by the Agricultural Commodity Supply (ACOS), a partnership between local businessmen and Padon, an Italian family business group. The group is an industrial processor that supplies almost 80% of the baked bean market in the USA and Canada. It also has significant investments in Argentina, China and India (Ferris & Kaganzi, 2008, p. 5). In 2005, ACOS Ethiopia established a modern cleaning and processing facility in Adama town, 100 km East of Addis Ababa. Production at full capacity started a year later. Though the main product is the white pea bean, also known as the navy bean, it also processes red kidney beans, chickpeas and sesame (ACOS, 2012a).

Chickpeas are very important part of Ethiopia's pulse export sector, contributing 20% of both volume and value of pulse exports. Chickpeas are constituent of numerous Ethiopian cuisines and are consumed throughout the country. Production is associated with cereal cultivation in moist vertisol soils. Rotation with chickpea enhances soil fertility (Jones, Audi, Shiferaw, & Gwata, 2006, p. 2). Both the Kabuli and Desi varieties of chickpeas are grown in Ethiopia. The Kabuli type is produced in parts of the South West and East Shewa, while the Desi type is cultivated throughout the country (Shiferaw & Teklewold, 2009, p. 3). ACOS Ethiopia, aiming to enter the international market, introduced a number of new chickpea varieties including ACOS Dube, a Kabuli type variety. ACOS Dube has a larger seed size giving it potential to fetch premium prices in the European market (SNV, 2014a).

As the domestic crop is produced entirely by smallholders, ACOS Ethiopia negotiated contracts with farmer-owned cooperative unions to produce their Dube variety. Among

these unions is the Becho Weliso Farmers' Cooperative Union. SNV, a non-profit organisation facilitated the contract and it requires ACOS Ethiopia to provide seed, training and other technical assistance to participating members of the Union's cooperatives. Farmers repay the seed in kind and sell the balance of their crop to the company (SNV, 2014a, 2014b).

These farmers used to produce local varieties of the crop for sale to export and domestic markets through local traders and cooperatives. The supply contracts with ACOS Ethiopia have now provided them with access to high value international markets (ACOS, 2012b). Moreover, contract farmers are guaranteed a market for their product and benefit from price certainty. ACOS Ethiopia claims to have improved the lives of around 40,000 families through this and other contracts and development activities. The company also claims that productivity has increased due to the use of improved inputs, better farming practices, and modern marketing methods (ACOS, 2012a). The objective of this study is to test these claims by investigating the impact of ACOS Ethiopia's supply contract on smallholders at the household level. This study also investigates concerns that CFAs favour and benefit farmers who are better endowed with resources, but exclude the most resource poor households (Da Silva & Rankin, 2013, pp. 5, 9). If these claims are true, it is important to investigate factors that affect farmer participation in such schemes in order to recommend ways in which contracts and interventions should be designed to promote participation by the most disadvantaged farmers (Da Silva & Rankin, 2013, p. 9).

## **1.2 Rationale for the study**

The impact of CF on smallholders is a topic hotly debated in the development and agricultural supply chain literature (Prowse, 2012, p. 26). However, there are few conclusive empirical studies on the topic to support any one side of the debate. Furthermore, apart from a general assessment of CFAs by Melese (2010), there are no empirical studies measuring the impact and inclusiveness of CF on smallholders in Ethiopia. This study seeks to contribute to the literature by assessing the benefits accruing to small chickpea farmers contracted to ACOS Ethiopia via the Becho Weliso Farmers' Cooperative Union, and by identifying factors that constrain or encourage participation in this CFA. Governments, agribusiness firms and other development agents

in similar settings can benefit from these findings in their endeavours to promote pro-poor economic growth. In particular, this study may help governments make better decisions about promoting and supporting CF, and about the types of CFAs that warrant encouragement.

### **1.3 Outline of the thesis**

This thesis is organised in seven chapters including the Introduction. Chapter 2 reviews relevant literature on contract farming and develops theoretical and empirical frameworks for analysing the research objectives and questions posed in Chapter 3. Chapter 4 describes the study site, sampling design, research methods and techniques used to achieve each of the research aims. It also outlines ethical issues in this study and measures taken to mitigate risk. Chapter 5 describes the way data were collected in the field and presents descriptive statistics computed for the representative household sample. Results corresponding to each of the research objectives are discussed in Chapter 6, with conclusions and recommendations presented in Chapter 7. Limitations of this study and issues for further research are also considered in this final chapter.

## Chapter 2

### 2 Literature review

The chapter reviews the relevant literature on definitions, features and motivation of CF. It also draws the potential benefits and risks and practical challenges of CF from the literature. The chapter concludes by discussing theories, perspectives and frameworks used in the study of CF and by presenting results of similar empirical studies.

#### 2.1 Definition, features and motivation for CFAs

There are a number of ways to include farmers in modern food and agricultural value chains. Da Silva and Baker (2009, p. 195) describe these as business models, by which agribusiness firms organise their value propositions and assure their consumers of high standards for food quality and safety, affordable prices and reliability of supply. They contend that organising supply to deliver the benefits of logistics, economies of scale, traceability, and private sector quality standards are the biggest challenge for modern agribusinesses firms working with small-scale farmers. Despite these challenges, there is a strong business case for contracting small growers primarily based on the potential benefits such as secured supply, lower costs, flexibility, political capital and reduction of risk. Da Silva and Baker (2009, p. 195) group their business models into four categories: induced by producers themselves; initiated by the buyers; facilitated by intermediaries like government agencies and NGOs; and designed using alternate trade models based on third party certification schemes such as Fair Trade. In all cases, horizontal coordination of small farmers is seen as a prerequisite for contracting.

Contract farming is an institutional arrangement where downstream agribusiness firms delegate production of primary agricultural products to farmers under contracts (Bellemare, 2012, p. 1458). Starting with the nature of contracts, oral or written, there are a number of extensions to this basic definition. Many contracts include provisions for product price, quantity, quality and delivery. Some assign exclusive buying rights to the firm, while others keep it open. Many provide desired or required inputs, technical advice and machinery services (Huh, Athanassoglou, & Lall, 2012, p. 200; Melese, 2012, p. 279). In some CF models, the firm controls much of the production process, and farmers' roles



are reduced to the provision of land and labour. In many cases, the agribusiness firm has its own nucleus farm and in others it relies totally on contracted farmers. The farmers may even own these firms as marketing cooperatives. While this study focuses on small resource poor farmers in a developing economy, CF is an important market arrangement for a large proportion of agricultural produce supplied by larger farms in the developed world (Prowse, 2012, p. 13). Thus, as Melese (2012, p. 297) and Porter and Phillips-Howard (1997, p. 228) point out, CF is a diverse subject difficult to generalise and define.

Contractual arrangements between agribusiness firms and smallholders are strongly motivated by market and government failures that make it difficult for farmers to buy inputs and sell products (Barrett et al., 2012, p. 719; Oya, 2012, p. 23; Prowse, 2012, p. 19). Smallholders often have little choice outside of informal markets that do not generate the consistent supply of quality product required by agribusiness firms (Bhattarai, 2013).

While smallholders look for guaranteed markets for their produce with predictable prices and attainable quality requirements, they also look for these attributes in markets for inputs, credit, advice and technical support. In CF, agribusinesses absorb the risk of marketing the outputs and alleviate uncertainty for their raw material, while smallholders assume the risk of primary production in exchange for assured access to markets for both outputs and inputs (depending on the contract). Simmons (2002, p. 9) summarised possible reasons for engaging in CF from the smallholder perspective as: access to product markets with high transactions costs; access to relatively inexpensive credit where - for various reasons - they face high interest rates or credit is unavailable; access to services for managing on-farm risk; and access to information, inputs, logistics and marketing at relatively low cost. A large body of literature discusses the various advantage and disadvantages of CF. The following subsection summarises broader aspects of these arguments, as many of them are specific to particular contracts.

## **2.2 Benefits, risks and challenges of CFAs**

Generic advantages accruing to smallholders include: a guaranteed market for perishable products, access to larger, local or global markets; better farm advice and technical

support; access to farm inputs either in credit or cash; introduction to improved technologies which are otherwise expensive; opportunities to use hired agricultural machinery; and access to improved planting material or breeds. Contracts can also be used as collateral for loans. As a result, smallholders increase their productivity and production, and get higher and more regular cash incomes. Farmers can also derive other socioeconomic benefits like improved managerial skills and better access to information and social networks that, in turn, offer better employment prospects, coping strategies and greater financial and food security (Glover & Kusterer, 1990, p. 9; Masakure & Henson, 2005, p. 1731; Melese, 2012, p. 295; Prowse, 2012, p. 22; Sáenz-Segura, 2006, p. 34). Moreover, Masakure and Henson (2005) indicated that small-scale producers perceive participation in CF to be prestigious and a source of social esteem.

However, these benefits are challenged by authors like Watts (1992, p. 65) who argued that CF is a system induced externally where farmers exploit their family for a short-term increase in income while their equity is reduced due to the indebtedness from the provision of inputs and services on credit by the firms. Little and Watts (1994) also claim that large corporations manipulate CF, such that smallholders lose control over their production mix and have less flexibility to respond to shocks and opportunities. Watts (1992, p. 75) regards the idea of CF as “the process of something of a watershed in the process of peasant subordination to the international market”. Likewise, Mbilinyi (1988, p. 578) contends that “CF is a particular form of petty commodity production generated by the restructuring of capital labour relations in which peasants are increasingly subsumed in real and formal terms of capital”.

Practical challenges, particularly where CFAs involve smallholder farmers, include difficulties in coordinating farmers to achieve a consistent supply of quality product, inadequate managerial and technical capability within firms that contract smallholders, and a lack of transparency when assessing product quality, making payments to farmers and adjusting contracts to address exogenous shocks (Glover & Kusterer, 1990, p. 127; Melese, 2012, p. 295). The potential advantages, risks and challenges of CF to smallholders, firms and the local economy are summarised in Figure 2.1.

Viewed from the firm's perspective, potential benefits of contract farming include the ability to influence production processes, reduced need to invest in land and fixed assets, reduced need to manage large estates and a large workforce, access to local sources of credit through smallholder borrowing, greater flexibility in managing market fluctuations, and reduced risk of land and asset confiscation by host country governments (Glover & Kusterer, 1990, pp. 6-7; Melese, 2012, p. 295; Prowse, 2012, p. 22).

However, relative to vertical integration where the agribusiness firms owns and controls large estates, CF implies reduced control over production processes, less consistent quality and a less predictable supply of marketable product. On top of these, the costs of providing support services and of coordinating supplies from a large number of smallholders might be very high. Depending on the product and local circumstances, the practical challenges faced by these firms include side-selling of contracted products, misuse of contracted inputs, and difficulty in monitoring the adoption of preferred or required practices by contracted farmers (Glover & Kusterer, 1990, p. 127; Melese, 2012, p. 295).

Though not as common, some literature also considers the advantages and disadvantages of CF to the local economy. The most important advantage is correcting for institutional and government failures that prevent smallholders from accessing preferred markets. CF can also contribute to poverty reduction by increasing rural incomes, both for participating and non-participating households (Prowse, 2012, p. 23). An increase in household income is expected to generate further income and employment opportunities in the local economy through increased consumption of non-tradable goods and services. Empirical studies conducted in sub-Saharan African countries have estimated demand-side local growth multipliers ranging from 1.71 in Burkina Faso to 2.42 in Senegal (Hendriks & Lyne, 2003, pp. 433, 437). Furthermore, CF is expected to encourage investments that add value to local products (Section 1.3), while avoiding vertical integration a model that shifts production to large estates owned and controlled by foreign agribusiness firms (Eaton & Shepherd, 2001, pp. 19-20). Job opportunities are also created for youth both on farms and in agribusinesses (Glover & Kusterer, 1990, p. 9).

<b>Local Economy</b>									
<p><b>Benefits</b></p> <ul style="list-style-type: none"> <li>• Corrects market &amp; government failures</li> <li>• Increases farm incomes</li> <li>• Increases consumption of non-tradables</li> <li>• Increases rural incomes &amp; employment</li> <li>• Increases rural investment</li> <li>• Reduces rural poverty</li> </ul> <p><b>Risks</b></p> <ul style="list-style-type: none"> <li>• Favours rural elite</li> <li>• Aggravates income inequality</li> </ul>	<p><b>Smallholders</b></p> <table border="1"> <thead> <tr> <th><b>Benefits</b></th> <th><b>Risks</b></th> <th><b>Challenges</b></th> </tr> </thead> <tbody> <tr> <td> <ul style="list-style-type: none"> <li>• Market and price certainty</li> <li>• Access to preferred markets</li> <li>• Access to technical support</li> <li>• Access to farm inputs</li> <li>• Access to credit</li> <li>• Access to new technology</li> <li>• Access to social networks</li> <li>• Improved farm &amp; business skills</li> <li>• Improved yields</li> <li>• Higher &amp; more regular income</li> <li>• Improved food security</li> <li>• Social esteem</li> </ul> </td> <td> <ul style="list-style-type: none"> <li>• Exploitation</li> <li>• Inequity</li> <li>• Indebtedness</li> <li>• Loss of managerial control</li> <li>• Loss of flexibility</li> </ul> </td> <td> <ul style="list-style-type: none"> <li>• Coordination</li> <li>• Inexperience</li> <li>• Lack of transparency</li> <li>• Power imbalance</li> </ul> </td> </tr> </tbody> </table>			<b>Benefits</b>	<b>Risks</b>	<b>Challenges</b>	<ul style="list-style-type: none"> <li>• Market and price certainty</li> <li>• Access to preferred markets</li> <li>• Access to technical support</li> <li>• Access to farm inputs</li> <li>• Access to credit</li> <li>• Access to new technology</li> <li>• Access to social networks</li> <li>• Improved farm &amp; business skills</li> <li>• Improved yields</li> <li>• Higher &amp; more regular income</li> <li>• Improved food security</li> <li>• Social esteem</li> </ul>	<ul style="list-style-type: none"> <li>• Exploitation</li> <li>• Inequity</li> <li>• Indebtedness</li> <li>• Loss of managerial control</li> <li>• Loss of flexibility</li> </ul>	<ul style="list-style-type: none"> <li>• Coordination</li> <li>• Inexperience</li> <li>• Lack of transparency</li> <li>• Power imbalance</li> </ul>
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<p><b>Agribusiness firms</b></p> <table border="1"> <thead> <tr> <th><b>Benefits</b></th> <th><b>Risks</b></th> <th><b>Challenges</b></th> </tr> </thead> <tbody> <tr> <td> <ul style="list-style-type: none"> <li>• Influence production</li> <li>• Less investment in land &amp; assets</li> <li>• Less management of labour</li> <li>• Less risk of confiscation</li> <li>• More flexibility</li> </ul> </td> <td> <ul style="list-style-type: none"> <li>• Inconsistent supply</li> <li>• Inconsistent quality</li> <li>• High cost of coordination &amp; support</li> </ul> </td> <td> <ul style="list-style-type: none"> <li>• Side-selling</li> <li>• Misuse of resources</li> <li>• Non-adoption by farmers</li> </ul> </td> </tr> </tbody> </table>			<b>Benefits</b>	<b>Risks</b>	<b>Challenges</b>	<ul style="list-style-type: none"> <li>• Influence production</li> <li>• Less investment in land &amp; assets</li> <li>• Less management of labour</li> <li>• Less risk of confiscation</li> <li>• More flexibility</li> </ul>	<ul style="list-style-type: none"> <li>• Inconsistent supply</li> <li>• Inconsistent quality</li> <li>• High cost of coordination &amp; support</li> </ul>	<ul style="list-style-type: none"> <li>• Side-selling</li> <li>• Misuse of resources</li> <li>• Non-adoption by farmers</li> </ul>	
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Figure 2.1: A summary of the benefits, risks and challenges of contract farming

An important potential disadvantage of CF to the economy is its alleged support for the rural elite and exclusion of those who are resource poor. On the other hand, interventions to correct this may harm competitiveness of the industry by including ineffective farmers (Glover & Kusterer, 1990, p. 134; Goldsmith, 1985, p. 1135). These potential advantages, risks and challenges, summarised in Figure 2.1, have opened up many avenues for research using different theoretical frameworks. Some prominent theories are discussed in Section 2.3.

### 2.3 Theories, perspectives and frameworks for the study of CFAs

Transaction Cost Economics (TCE) assumes that market actors suffer from bounded rationality and are opportunistic (self-interested with guile); they can deceive, lie, cheat and steal (Prowse, 2012, p. 28; Williamson, 1985, p. 30). Consequently, participation in a market entails costs before the transaction is concluded that are incurred in finding the right partner, negotiating terms, and finding other information about the exchange. Costs

are also incurred after the transaction for monitoring of performance and covering losses; these costs are referred as *ex ante* and *ex post* transaction costs respectively (Williamson, 1979, p. 245).

Transaction costs are influenced by the characteristics of the transaction, product and environment within which transactions occur (Bhattarai, 2013, p. 32). Williamson (1979, p. 247) identified asset specificity, frequency and uncertainty as the three most important characteristics of transactions that alter the cost of engaging in an exchange.

An agribusiness firm incurs very high transaction costs when engaged in informal markets in developing countries where quantity, quality and regularity in delivery are unpredictable owing to high levels of environmental and behavioural risk (Da Silva & Rankin, 2013, p. 27). These uncertainties discourage investment in assets required to add value to products. The seasonality and perishability of agricultural products also increases the complexity of transacting, particularly when markets require specific quality standards and credence attributes in products. Complexity increases transaction costs by increasing the uncertainty of supply, by increasing information and monitoring costs, by increasing the need for assets that have little value in alternative uses, and by increasing the cost of renegotiating incomplete contracts *ex post* (Bhattarai, Lyne, & Martin, 2013).

At the same time, smallholders face high transaction costs when selling their products in thinly traded informal markets where reliable information is scarce and marketing costs are high due to poor physical and legal infrastructures. They also face high transaction costs in their efforts to procure inputs. The recent proliferation of mandatory food safety and quality standards to meet customer requirements in global markets has added to the high unit transaction, compliance and marketing costs confronting individual farmers who trade small quantities (Da Silva & Rankin, 2013, p. 27; Holleran, Bredahl, & Zaiet, 1999, p. 670; Pingali, Khwaja, & Meijer, 2005, p. 64). Under these conditions, firms and farmers have an incentive to engage in relational contracts to bulk up volumes traded and to reduce the uncertainty that increases transaction costs and diminishes investment in value-adding assets (Da Silva & Rankin, 2013, p. 27; Prowse, 2012, p. 29; Williamson, 1979, p. 238).

Agency theory, when used to explain CF, assumes that both the firm (principal) and smallholders (agents) are risk averse, self-interested and have bounded rationality. The firm, as a principal, seeks to avoid the costs and risks of in-house production and contracts farmers who charge margins to grow and deliver the product. Managing the contract with an agent is easier when the contract includes incentives that encourage the agent to work in the interest of the firm (Eisenhardt, 1989, p. 59; Key & Runsten, 1999, p. 389). These incentives can be public (legal reparation), private (terms of the contract), or a mixture of both (Prowse, 2012, p. 31). The parties continue to work together as long as there is sufficient incentive for both to carry on. Different types of contracts serve the purpose of sustaining relationships depending on the context, information system, outcome uncertainty, outcome measurability and task programmability of the relationship (Bajari & Tadelis, 2001, p. 404; Eisenhardt, 1989, p. 70). On the other hand, some political economists have analysed CF as an exploitative institutional arrangement imposed on peasant farmers by large agribusiness firms to reduce their exposure to production risk and to extract quasi rents from the farmers by granting them loans that they cannot repay (Glover, 1984; Little & Watts, 1994).

Over time, these theories have been combined with other approaches like the business lifecycle theory, supply chain governance theory, the core capability or competency theory, and strategic management theories to analyse contract farming (Prowse, 2012, p. 37). A framework developed by Barrett et al. (2012, p. 716) offers a concise way to understand the procurement decisions of firms and patterns of smallholder participation. It treats CF as a process involving four stages, as shown in Figure 2.2. The first stage is selection of the location by the firm considering agro-ecological and hydrological suitability, transaction costs, socio-economic factors like productivity of farmers, level of technology adoption and political stability and location of warehouse, processing and other facilities. In the second stage, the firm sets the terms of the contract and offers it to selected farmers. The firm could select farmers directly or through cooperatives and other intermediaries. While the firm utilises various observable characteristics in selecting smallholders, selection also involves unobserved variables that encourage farmers to accept or reject the offer.

At the third stage, farmers decide whether to accept the terms or not. Logically, smallholders will accept the firm's offer if they think it will improve their utility. However, contracts may be accepted (rejected) even when smallholders perceive negative (positive) impacts. These unanticipated outcomes could reflect asymmetries in power relations, social pressure, incomplete information or uncertain outcomes. Consequently, initial acceptance or rejection does not necessarily imply that the contract is perceived to be fair or unfair. The fourth and last stage is the decision by firms and smallholders to honour the contract in the face of opportunities and constraints created by power imbalances, time lags and relationship-specific investments.

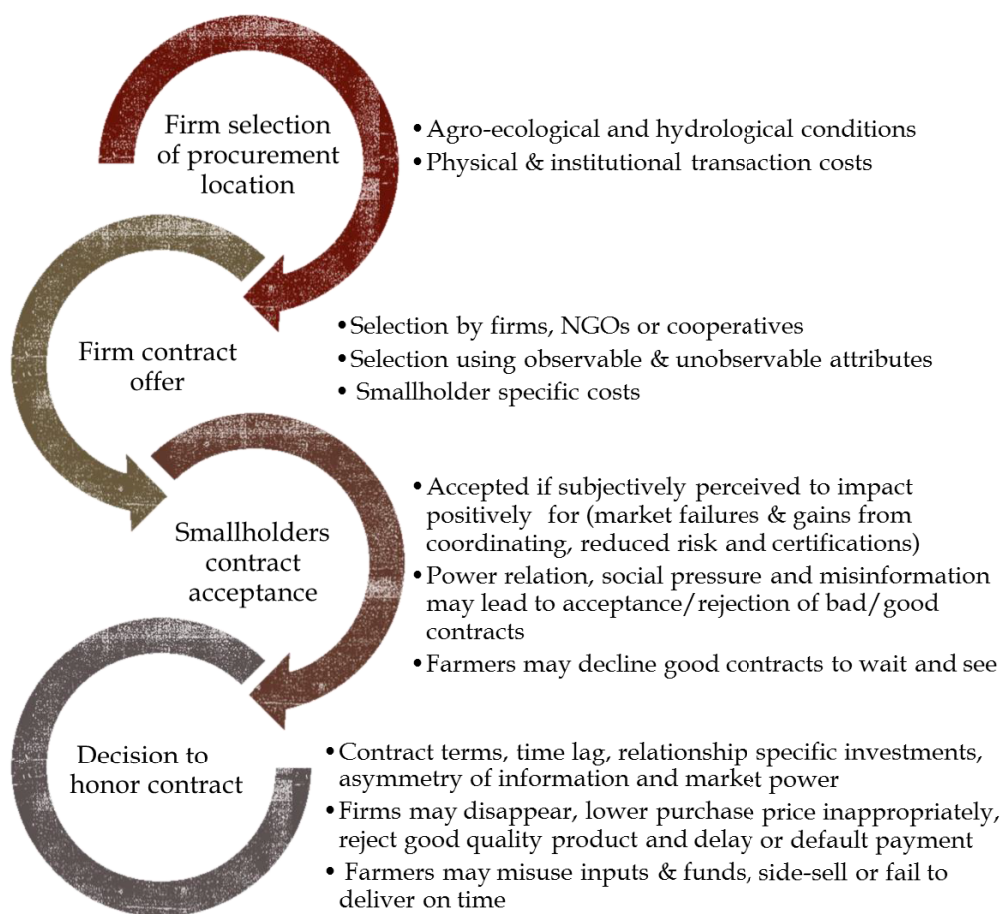


Figure 2.2: Stages of establishing CFAs, (summarised from Barrett et al., 2012)

Another, multidimensional framework that accounts for both formal and informal institutional rules and the existing stock of social capital was developed by Da Silva and

Rankin (2013, p. 26). They argue that their framework, illustrated in Figure 2.3, provides a more comprehensive explanation of CF, reflecting the fact that contractual arrangements do not only involve economic agents seeking an efficient and effective mode of exchange, but are also influenced by public agencies and NGOs with financial or social interests in CF schemes. The framework starts from a notion that CF, as a vertical coordination mechanism, can reduce transaction costs but does not eliminate opportunism and hold-up that weakens *ex-ante* investment incentives from both sides. It also recognises the fact that market instability and management problems could be sources of failure in CF schemes.

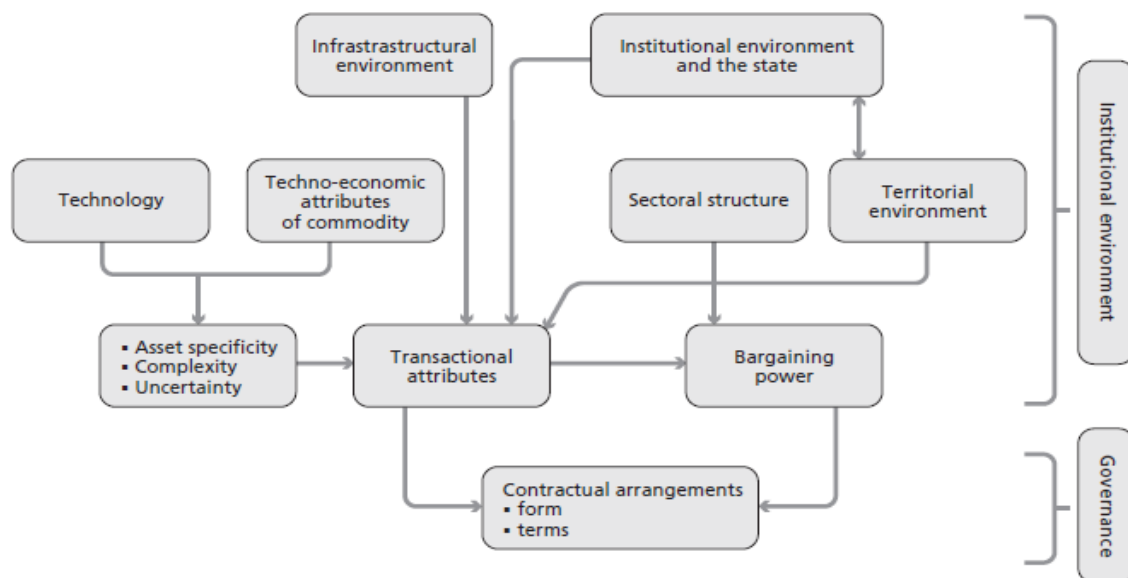


Figure 2.3: Determinants of formation and success of CFAs (Da Silva & Rankin, 2013, p. 26)

## 2.4 Empirical studies of CFAs

Early empirical research on contract farming was mostly qualitative, based on case studies informed by primary data taken from in-depth interviews with key informants and/or secondary data taken from reports and company documents (for example, Glover (1984, 1987, 1990); Glover and Kusterer (1990); and Goldsmith (1985)). These studies adopted a broad socio-economic approach in assessing the impact of CF and concluded that CFAs increased the incomes of smallholders, their access to credit and technical support, their production and productivity, helped to introduce new technologies and created jobs and



additional income in the local economy. CF also was credited with establishing farmers' associations, drawing women into the production economy, and providing households with opportunities to improve their nutritional and health status. Glover and Kusterer (1990) emphasised the transferability of improved technical, managerial and negotiation skills, and a better understanding of costs, quality and markets to other enterprises.

However, in almost all of the cases studied, it was reported that levels of indebtedness did increase as farmers had to finance the higher input and labour requirements of CF crops. Porter and Phillips-Howard (1997) argued that these concerns relating to poor management and power imbalances in CF would diminish with experience gained over time, with farmer control of land and irrigation water, and with efforts to promote gender equality.

Regarding the inclusiveness of CF, early case studies by Glover (1984, 1987, 1990), Glover and Kusterer (1990), Goldsmith (1985) and Simmons (2002) found no clear evidence of a bias against resource poorer farmers despite expectations that smaller farmers would be higher cost suppliers. Glover and Kusterer (1990, pp. 133-134) attributed this lack of bias to superior product quality on the part of smaller farmers, a tendency for larger farmers to find their own markets as they gained experience and wealth, and the social responsibility agenda that motivated agribusiness firms to engage in CFAs. Apart from informing the debate over the merits of CF, these early qualitative studies helped to refine the theoretical propositions and research questions subsequently addressed in numerous quantitative studies.

Among these quantitative studies, Bellemare (2012) study in Madagascar found that CF had a significant positive impact on total household income, net household income, income net of contract farming, income per adult equivalent and household income from livestock. Bolwig, Gibbon, and Jones (2009) also found that a CFA with certified organic coffee farmers in Uganda increased gross revenue and net profit from coffee. Narayanan (2014), compared the CF profits of four commodities with profits from alternative markets using cross-sectional survey data in India's Punjab state. She found variable impacts of CF not only across schemes (with different crops and firms) but also between farmers within a particular scheme. Miyata, Minot, and Hu (2009) argued that profit from

the contracted crop would tend to overstate the impact of CFA on household wellbeing as the CFA might draw labour and other resources from the household's other income generating enterprises. Instead, they used total household income per capita as their indicator of impact and found that CFAs with green onion and apple growers in China had positive impacts on per capita household income.

However, a study in India by Singh (2002) suggested that the positive early impact of CF on households and the local economy (through higher farm employment) could be short-lived due to unsustainable promotional prices and subsidies from firms, and the erosion of benefits when perceived power imbalances discouraged continued participation. Michelson, Reardon, and Perez (2012) studied CFAs between supermarkets and vegetable and fruit growers in Nicaragua using historical data spanning eight years and concluded that the CFAs did not benefit small farmers. They found that farmers contracted by domestic supermarkets were receiving the same mean prices paid by traditional markets. While international supermarkets provided insurance against volatile prices, farmers were paid disproportionately low mean prices. However, the same CFAs were credited with increasing annual household income and investment in productive assets compared to non-participants in the area (Michelson, 2013). No evidence of positive impact was found on investment in consumer durables or on the land holdings of participating farmers.

Masakure and Henson (2005) identified four groups of incentives or benefits of CFAs as perceived by contract farmers in Zimbabwe's high value vegetable export sector. The first group, labelled 'market certainty' included guaranteed markets, minimum prices and the provision of inputs and transport. The second group, labelled 'indirect benefits', included skills that could be applied to other crops and the use of CFAs as a stepping stone to other projects. The third group related to higher incomes, and the fourth to intangible benefits such as prestige.

Higher incomes and related benefits from participation in CFAs have been attributed to higher yields from greater use of specialised inputs and technical support, higher quality products and better access to premium markets (Bolwig et al., 2009; Miyata et al., 2009). Savings from low transaction costs arising from guaranteed input and output markets,

clearer quality criteria, and transparent measurements of volume and quality were also identified as a source of these benefits (Bolwig et al., 2009; Narayanan, 2014)

Most studies on the impact of CF on participant households provide complementary information on factors affecting participation. In western Kenya, it was found that the average size of farms contracted to supply a large sugar company had decreased over time (Casaburi, Kremer, & Mullainathan, 2014, p. 32). This suggests that farmers with relatively smaller farms were able to join and were not forced out of the CFA once its processes had been honed.

In China, Miyata et al. (2009) found that participation in a number of apple and onion CFAs was influenced by labour availability, distance from village heads and possession of agricultural equipment. Resource endowments and agriculture's share of household income were important determinants of participation in Uganda's SIPI certified organic coffee CFA (Bolwig et al., 2009). In India, participation in vegetable contracts was found to be biased in favour of larger farmers and farmers that achieved higher yields (Narayanan, 2014; Singh, 2002). Gender, age, agricultural experience, participation in cooperatives, land endowments, working capital, number of days that farmers do not work for cultural reasons, level of entrepreneurial and business skills, and attitude towards risk were significant determinants of participation in Madagascar CFAs (Bellemare, 2012). On the inclusiveness of CFAs, Barrett et al. (2012) commented that very few farmer, household or farm characteristics have been found to consistently affect participation in CFAs.

## **2.5 Chapter summary**

Relevant literature on definitions and features of CF were reviewed in this chapter, along with its potential benefits, risks and practical challenges. The chapter concluded by discussing theories, perspectives and frameworks used in this study of CF and by presenting results of similar empirical studies. The next chapter presents the goals, objectives and research questions that this study intends to address.

## Chapter 3

### 3 Research objectives, hypotheses and research questions

The empirical studies reported in Chapter 2, and other studies reported by Bijman (2008); Prowse (2012); Wang et al. (2014) and (Barrett et al., 2012), differ in their findings on the socio-economic impacts of participation in CFAs and factors affecting participation. Although most of these studies report positive welfare effects, variability was observed among farmers across countries and schemes, and across products within schemes. There is less consistency in factors identified as determinants of participation. While some of this variability can be attributed to differences in models and methods employed, it is clear that participation is influenced by a wide range of variables, and that some variables influence participation positively or negatively depending on prevailing institutional arrangements (Wang et al., 2014).

Knowledge of how CFAs impact participants and of the factors that influence participation is important to policy-makers seeking ways of promoting broad-based economic growth in rural areas (Narayanan, 2014). Interventions intended to shape CFAs in ways that promote and sustain broad-based growth should be based on information that is reliable and relevant. Empirical studies of CFA participation and impact have not been conducted in Ethiopia. Hence, the overarching goal of this study is to generate information about the impact of contract farming on smallholders in Ethiopia.

More specifically, this study has two related objectives. The first is to identify factors affecting the participation of smallholders in ACOS Ethiopia's CFA. The second objective is to assess the impact of participation in ACOS Ethiopia's CFA on smallholders in a well-defined study area. Information generated by this study should be useful to policy-makers, agribusiness firms, rural NGOs and farmers' organisations in Ethiopia and other developing countries with similar rural contexts.

The first objective requires identification of factors constraining and encouraging participation of smallholders in ACOS Ethiopia's CFA. These factors reflect the firm's criteria for selecting suitable locations, cooperatives and NGOs, and factors affecting household decisions to accept or reject the terms of the contract on offer. The latter may

include observable factors in both participating and non-participating households such as their land and labour endowments, dependency ratios, educational status, management skills, attitudes towards risk, and terms of the contract including price and quality specifications. The first null hypothesis is:

*H<sub>01</sub>: Participation in ACOS Ethiopia is not biased towards or against some households on any observable characteristics.*

The second objective investigates household impacts stemming from the second, third and fourth stages of the CF process illustrated in Figure 2.1. These impacts are influenced by the terms of the contract, which in turn are influenced by the institutional environment, farmer uptake and continued participation (Da Silva & Rankin, 2013). In part, this second objective requires measuring the impact of the CFA on farm income, expenditure and other indicators of household wellbeing after accounting for exogenous factors that may have affected these outcomes. Thus, the second null hypothesis is:

*H<sub>02</sub>: Participating in the CFA does not have a significant impact on household income or other observed indicators of household wellbeing.*

The research questions corresponding to these two objectives and hypotheses are:

1. What factors determine farmers' participation in ACOS Ethiopia's CFA in the study area?
2. What are the impacts of ACOS Ethiopia's CFA on household income and other indicators of household wellbeing in the study area?

The following chapter describes the study area and research methods. Chapters 5 and 6 present and analyse primary data collected for this study, and Chapter 7 summarises the findings in respect of the CFA's inclusiveness and its impact on participants.

## Chapter 4

### 4 The study area, sample design and research methods

This chapter describes the study area and details the sampling design used for this study. Statistical methods used to measure the impact and identify the factors preventing and encouraging farmers to join the CFA are also discussed in the chapter. It concludes with discussion on ethical issues of this study.

#### 4.1 The study area

The study area comprises of seven counties in three districts (Weredas) found in the South West Zone of the Oromia region of central Ethiopia. These counties constitute the catchment from which ACOS Ethiopia's contractual partner, the Becho Weliso Farmers' Cooperative Union, draws its membership.

The three districts, Becho, Illu and Tole (see Figure 4.1) are respectively 80, 55 and 40kms south of Addis Ababa, Ethiopia's capital city. These districts are predominantly rural, with at least 92% of the households dependent on small scale farming (Chamberlin, Tadesse, Benson, & Zakaria, 2007). Smallholders occupy more than 40% of the land in Becho and Illu Districts, and 30% in Tole. These estimates are respectively four and three times higher than the national average (10%). Households in these districts have, on average, 1.3 hectares of farmland. In the 1994 census year, fewer than 40% of farmers in all three districts had less than one hectare of land, compared to a national average of 63%. At the time of the census, more than 90% of the land occupied by smallholders in Becho and Illu districts was cropped. The corresponding estimate for Tole was 80%, which is equivalent to the national average.

The study area lies within the Becho-Addea teff and chickpea livelihood zone (HEA, 2008). This zone is characterised by mixed crop and livestock production. The zone is mostly a mid-altitude plain with fertile black vertisol soils. The main crops produced, consumed and sold in the zone are teff, wheat and chickpeas. In census year 1994, 25-30% of the land cultivated in the three districts was planted to chickpeas (Chamberlin et al., 2007). The total population of the three districts was estimated at 175,000 people, with a total

of 34,000 households (CSA, 2007). Female-headed households accounted for more than 19% of all households in Becho and Illu, and almost 15% of households in the Tole district (Chamberlin et al., 2007). The national average for female-headed households in that year (1994) was 17%. The average family size was 5.3–5.5 persons in Becho and Illu, and 5.7 persons in Tole. The average size of farm households in Ethiopia was 5.2 persons. Dependency ratios ranged from 0.98 in Illu district to 1.15 in Tole district, somewhat higher than the national average of 0.97 for farm households (Chamberlin et al., 2007).

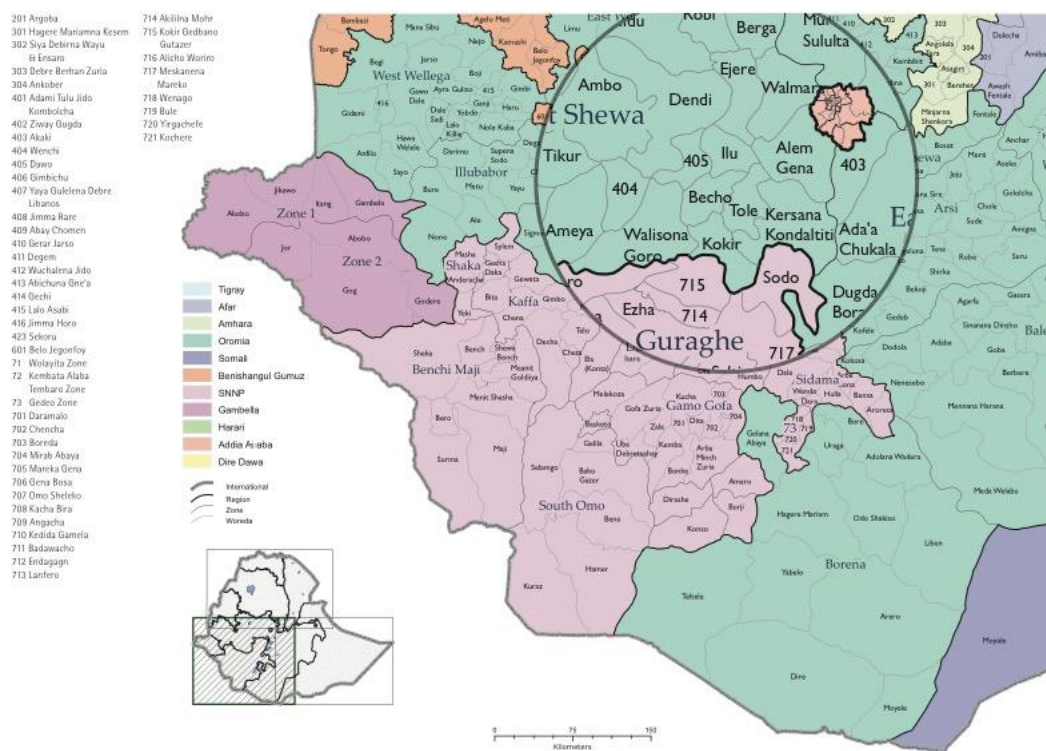


Figure 4.1: Map of districts comprising the study area (Chamberlin et al., 2007)

Three of the seven counties comprising the study area (Soyoma, Qobo and Awash Bune) are located in Becho district, three (Keta Asgori, Wasarbi Bessi and Butti Telgo) in Illu district, and one (Tulu Teji) in Tole district. ACOS Ethiopia contracts the Becho Weliso Cooperatives Union to supply chickpeas, and the Union - in turn - contracts five of its member cooperatives to deliver chickpeas grown by their members using (Dube) seed provided by ACOS Ethiopia. These contracts were implemented in 2014.

## 4.2 Sample design

This study adopted a quantitative research approach to estimate the impact of the CFA and to assess its inclusiveness. The primary data needed for both exercises were generated from two sample surveys conducted in the study area.

The first sample survey was designed to yield a representative sample of all farm households in the study area (the household sample). The study area was divided into primary sampling units (PSUs), each representing a Got (administrative sub-units within each county), and a small sample of PSUs was drawn with probability proportionate to an estimate of their size ( see Appendix C). Households were then randomly sampled at the same rate within each selected PSU. These samples were drawn from lists maintained in the county administrative offices. This process generated a representative sample as every household in the study area had the same probability of selection. As a result, unbiased descriptive statistics can be computed for the sample without weighting the data. The constant sampling fraction (10%) applied to households in each selected PSU was sufficiently large to generate a total sample size of 114 households.

The second sample survey was drawn randomly from a list of 305 households located in the study area that were participating in ACOS Ethiopia's CFA (the CF sample). This list was assembled from an appendix attached to the contract signed with the Becho Weliso Cooperatives Union. The CF sample comprised of 95 participating households. Figure 4.2 shows that the 'treatment' group comprises all sample households participating in the CFA, including participants identified in the household sample that were not selected into the CFA sample.



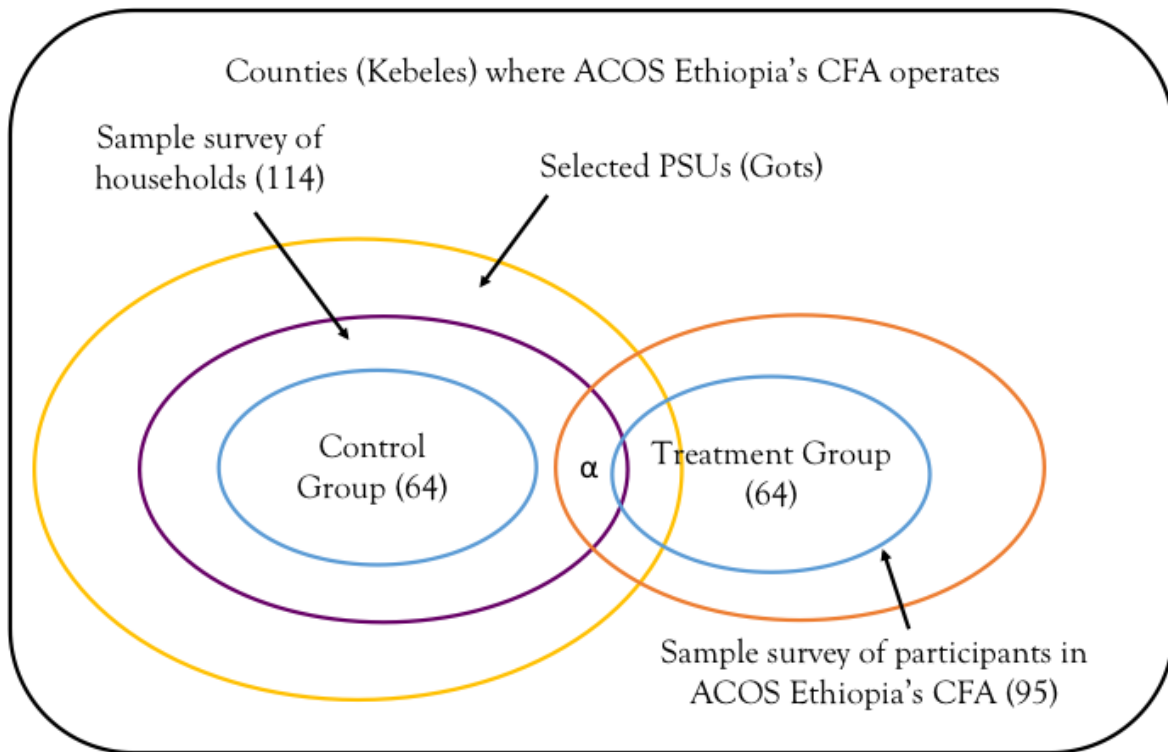


Figure 4.2: Sampling design

In Figure 4.2,  $\alpha$  represents the proportion of households in the representative household sample that participate in the CFA. This sample statistic provides useful information about the outreach of ACOS Ethiopia's operation in the study area.

### 4.3 Factors affecting participation in the CFA

Propensity Score Matching (PSM) was employed to identify a subset of the non-participants with household characteristics and resource endowments similar to those of participants. This subset constituted the control group and served as the counterfactual for comparisons with the treatment group. The PSM was based on a logit model of participants and non-participants, with observed time-invariant household and household head characteristics and resource endowments used to explain participation in CFA. Statistical significance of these explanatory variables provides information about the inclusiveness of the CFA.

#### 4.4 Impact of CFA on income and other outcome variables

Initially, this study used descriptive statistics to reveal differences between participants (treatment group) and the control group. In particular, differences between the mean values of key outcome variables ( $Y_i$ ) were assessed using univariate t-tests. Significant differences in these mean values signal likely impacts of the CFA. However, univariate tests may confound the impact of the CFA with other variables affecting the outcomes. A general treatment model was applied to control for the effects of observed and unobserved variables that affect outcomes but which are not related to participation. Khandker, Koolwal, and Samad (2010, p. 25) expressed the general treatment as follows:

$$Y_i = \beta_0 + \beta_1 T_i + \beta_2 X_i + \varepsilon_i \dots (1)$$

Where,  $Y_i$  is an outcome observed for the  $i^{\text{th}}$  household,  $T$  is a treatment dummy variable scoring one (1) for participants and zero (0) for non-participants, and  $X$  is a vector of observed household and farm characteristics affecting outcomes.

Estimating the model using ordinary least squares (OLS) poses a problem because households were not randomly selected for the CFA. The Cooperative Union was identified by ACOS Ethiopia and member participation was voluntary. Participation is therefore influenced by both observed and unobserved attributes resulting in endogeneity of the treatment variable. A popular way of addressing this selection bias is to estimate the treatment model using Instrument Variables (IV) in a Two-Stage Least Square (2SLS) regression model (Khandker et al., 2010, pp. 88-90).

Instrumental variables are observable household and farm characteristics fulfilling two criteria. First, they should be highly correlated with participation ( $T$ ), or with unobserved variables affecting participation. Second, they should not be correlated with unobservable variables affecting the outcomes or with the outcomes themselves. In this case,  $Y$  in Equation 1 should be affected by the IVs only through participation (Heckman, 1997, p. 447; Khandker et al., 2010, p. 88).

Several previous studies used instrumental variables to assess the impact of participation in CFAs. Narayanan (2014, p. 145) used risk scores, risk aversion to alternative prices,

mean return from contracting over the next best alternative, fixed irrigation costs, and the coefficient of variation in returns as IVs. Miyata et al. (2009, p. 1783) used distance from village leaders as an IV, Bellemare (2012, p. 1424) used producer group membership, the number of such memberships, number of female labourers, membership of women's organisations, and farmers' willingness to pay (WTP), while Bolwig et al. (2009, p. 1098) used the ratio of non-farm revenue to total revenue, and type of building materials as IVs. This study uses farmer's willingness to invest in a hypothetical CFA with different levels of initial investment as IVs. Tests were done to measure the strength of the instruments (Khandker et al., 2010, p. 91).

In the first stage of the 2SLS, the treatment dummy (T) is regressed on the instrumental variables (Z) and other independent variables (X) affecting treatment.

$$T_i = \lambda_0 + \lambda_1 Z_i + \lambda_2 X_i + \mu_i \quad \dots (2)$$

This stage of 2SLS regression could be estimated as a probit or logit model to accommodate the binary dependent variable T.  $\hat{T}$ , the predicted value of T in Equation 2, reflects that part of the treatment affected only by Z and X, and thus embodies only exogenous variation in participation, T (Khandker et al., 2010, p. 90). In the second stage, Y is regressed on  $\hat{T}$ , the predicted participation, and other explanatory variables (X) to identify statistically significant impacts of ACOS Ethiopia's CFA.

The Local Average Treatment Effect (LATE) was also calculated to estimate the impact of participation in the CFA. LATE is the average treatment effect on the outcome of those who decide to participate because of a change in the instruments(Z). In this study, outcomes investigated by the treatment model were measures of farm income, and the instruments were measures of willingness to invest in a CFA. LATEs can be expressed as:

$$LATE = E[Y/P(Z) = P(z)] - E[Y/P(Z) = P(z')] \quad \dots (3)$$

Where, P (z) and P (z') are the resulting probabilities of participation at different values of Z, z and z' (Bellemare, 2012, p. 1432; Khandker et al., 2010, p. 93).

Computing the LATE starts with identifying groups of households that would respond similarly to a change in the instruments. These households are referred to as ‘compliers’. The logit or probit model estimated in the first stage of the treatment model classifies matched households into four distinct groups as indicated in Table 4.1.

Table 4.1: Classification of the population based on predicted and observed participation status

Observed		Predicted	
		Does the household participate in the CFA?	
		No	Yes
Does the household participate in the CFA?	No	Non-participant compliers (NPC) and Never takers (NT1) )	Predicted never takers (NT2)
	Yes	Always takers (AT)	Participant compliers (PC)

Households in the first group, the top left cell, are predicted not to participate and who follow through and do not participate. This group consists of households that are compliers and households that are ‘never takers’ (NT1), i.e. households that will not participate no matter how the value of the instrument changes. Households in the second group, the top right cell, are predicted to participate in the CFA but were observed to be non-participants. This group comprises of ‘never takers’ (NT2) behaving the same way as their counterparts in the first group.

Households in the third group, the bottom left cell, are predicted to be non-participants but were observed to participate. These households, the ‘always takers’, will participate regardless of how the value of the instrument changes. However, households are not expected to behave as such and it is assumed that change in response to the instrumental variables will affect their decision to participate. Households in the fourth group, the bottom right cell, are predicted to participate in the CFA and who do follow through and participate. They are compliers who participated in the CFA, given the assumption of no ‘always takers’. It is also assumed that there are no defiant households that will always respond opposite to the prediction of the logit model; since instruments have a monotonic effect on participation, households are not expected to always participate

when predicted not to, or to always do the opposite when predicted to participate (Angrist, Imbens, & Rubin, 1996, p. 448; EHDi, 2015)

After identifying the four groups of households, LATE is calculated as the difference in the predicted outcome of participating compliers and the non-participant compliers:

$$LATE = Y_{PC} - Y_{NPC} \quad \dots (4)$$

However, the sub group ‘non-participant compliers’ (NPC) is classified together with the ‘never takers’ predicted not to take part in the first group. The predicted outcome of non-participant compliers is therefore computed using Equation 5 (Imbens & Wooldridge, 2007, p. 5).

$$Y_{NPC} = \left( Y_{(NPC+NT1)} - \left( Y_{NT2} \left( \frac{\#NT2}{\#NT2 + \#PC} \right) \right) \right) \left( \frac{\#PC + \#NT2}{\#PC} \right) \quad \dots (5)$$

In Equation 5, it is assumed that the predicted outcomes of the two ‘never taker’ groups would be similar and that the proportion of never takers and compliers would be the same in the groups that are predicted to participate and not to participate as households are sampled randomly (EHDi, 2015). Under these conditions, LATEs of participation for compliers that respond to changes in the instruments can be computed as:

$$LATE = Y_{TC} - \left( \left( Y_{(NPC+NT1)} - \left( Y_{NT2} \left( \frac{\#NT2}{\#NT2 + \#PC} \right) \right) \right) \left( \frac{\#PC + \#NT2}{\#PC} \right) \right) \dots (6)$$

CF respondents were also asked about perceived changes in non-pecuniary outcomes after joining the scheme. These outcomes included improvements in food security, health, status, and access to credit, advice, technical support, technology and social networks. Descriptive statistics and percentages were used to gauge the impact of the CFA on these measures of household wellbeing.

#### **4.5 Ethical issues**

The questions posed to respondents were of a non-personal nature and related to matters within the professional competence of the interviewees. For this reason, ethics approval was not sought, as provided for by the exemption specified in article 6.2.3, sub-article 2 of Lincoln University's policy on human ethics. The researcher and enumerators come from the study area and were aware of what respondents would perceive to be sensitive information. In the interests of best practice, respondents were informed that participation was voluntary, confidential and anonymous, that they did not have to answer all questions, that they could withdraw their information at any time, that their names would not be recorded on the questionnaires, and that the interviews would not be recorded. Respondents agreed to the interviews in writing by signing a consent form (Appendix A).

#### **4.6 Chapter summary**

This chapter described the study area, sampling design, and statistical methods proposed to measure the impact of the CFA and to identify factors influencing farmer participation. It concluded with a note on ethical issues relating to this study. The next chapter provides an overview of the data gathered and presents descriptive statistics computed for an average household in the study area.

## Chapter 5

### 5 Data collection and descriptive statistics

This chapter presents statistics computed for the household sample describing an average household in the study area. The chapter opens with a summary of the type of data collected and the methods used to gather and record these data.

#### 5.1 Data and data collection

A uniform structured questionnaire was used in both surveys to gather information on household, household head and farm characteristics, contract farming status, and farmers' perceptions of the CFA. This information included family size, family labour, farm size, farming enterprises, input purchases, hired labour, farm and household assets and their dates of purchase, income from the CFA and other farming activities in the 2014 crop season (June to October), and non-farm earnings. For CF respondents, it also included questions about changes in the use of agricultural training and extension services, improvements in non-pecuniary measures of wellbeing, strengths and weaknesses of the scheme, their future participation, and willingness to pay for a hypothetical CFA.

Appendix A presents the questionnaire used to gather information, and Appendix B defines each of the variables measured. Enumerators with relevant experience were hired in the study area and trained *in situ* to administer the questionnaire. The questions were addressed to the *de facto* head of the household. The data were gathered from April through mid June 2015. Data recorded in the household and CF sample surveys were captured on a common Microsoft Excel database.

#### 5.2 Descriptive statistics for the household sample

The descriptive statistics presented in this chapter were computed only from data collected in the household sample survey and therefore describe an average household in the study area. This representative sample covered 114 households, of which eight participated in ACOS Ethiopia's CFA (i.e.  $\alpha=8/114=7.0\%$ ).

### 5.2.1 Household demographics

Table 5.1 presents the mean value of variables measuring household demographics. On average, households in the study area have 5.5 members, of whom 1.74 are children under the age of 15. Almost all of the adult members work on the farm. The *de facto* household head is close to 45 years of age, and 14% of them are women. Education levels are very low. Household heads have just 3.2 years of formal schooling.

Table 5.1: Household and farm characteristics in the study area, 2014

Variables	Valid cases	Mean	Std. error
Total number of family members	114	5.51	0.20
Number of male family members	114	2.67	0.13
Number of female family members	114	2.83	0.12
Number of children in the family ( $\leq 15$ years)	114	1.74	0.13
Number of adult family members (16 - 65 years)	114	3.68	0.16
Number of elderly family members ( $\geq 66$ years)	114	0.10	0.03
Family members working on farm (No.)	114	3.44	0.16
Age of the <i>de facto</i> head of the household (years)	113	44.72	1.06
Households with a male <i>de facto</i> head (%)	113	86	3
Years of formal schooling of the <i>de facto</i> head (Years)	113	3.19	0.29
Farming experience of the <i>de facto</i> head (years)	113	25.42	1.03
Chickpeas growing experience of the <i>de facto</i> head (years)	113	20.98	1.13
Households with farming as the primary occupation of the head (%)	114	99	1
Estimated average monthly non-farm income (ETB)*	114	34.21	23.64
Households possessing a dwelling roofed with corrugated iron (%)	114	32	4
Households possessing at least a second dwelling (%)	114	58	5
Distance of residential house to the nearest paved road (Km)	114	1.76	0.15
Time taken to transport products to market (Hours)	48	0.90	0.08

\* 1 NZD = 14 Ethiopian Birr (ETB) in 2014

Household heads have more than two decades of farming and chickpeas growing experience, and virtually all of them regard farming as their primary occupation. Non-farm incomes are trivial. More than two-thirds of the households reside in dwellings roofed with thatch grass. Although most (58%) of the households have a second dwelling on their property, these buildings are usually partitioned into stables for livestock.



Farmers have to travel for about one hour to get to the nearest market town or village if they choose not to supply their cooperative. It takes about 20 minutes to walk to the nearest paved road, a distance of some 1.76kms.

## 5.2.2 Household wealth and assets

Table 5.2 presents information about the ownership and value of farm and household assets in the study area. Livestock, cattle in particular, dominate household assets. The estimated market value of livestock is more than double the combined value of other movable farm and household assets. Households usually keep a minimum of two oxen as a source of draft power, and a dairy cow to provide the family with fresh milk and other dairy products. Relatively little was invested in fixed improvements to farmland, and the inventory of non-livestock movable farm assets was also modest - comprising largely of animal-drawn ploughs. A single respondent who owned a truck valued at ETB 500,000 heavily skews the mean value of household movable assets reported in Table 5.2. Removing this outlier reduces the estimated value of these assets from ETB 5,288 to just ETB 900.

Table 5.2: Household wealth and farm assets in the study area, 2014

<b>Variables</b>	<b>Valid cases</b>	<b>Mean</b>	<b>Std. error</b>
Total livestock wealth (ETB)	114	22,939.91	1,634.68
Value of cattle owned (ETB)	114	16,614.04	1,209.98
Number of cattle owned excluding dairy cows	114	2.88	0.18
Number of dairy cows owned	114	0.87	0.08
Value of movable household assets (ETB)	114	5,288.11	4,427.00
Value of movable farm assets (ETB)	114	4,037.49	460.36
Value of fixed farm improvements (ETB)	114	1,922.65	283.30
Households that own an ox-plough (%)	114	91	3
Households that own a radio (%)	114	76	4
Households that own pack animals (%)	114	64	5
Households that own at least one mobile phone (%)	114	46	5
Households that own a knapsack sprayer (%)	114	5	2
Households that own a television (%)	114	2	1
Households with at least one bank account (%)	114	17	4

Battery powered radios are a widely used source of information and entertainment, and almost half of the households owned a mobile phone. TVs are rare as rural households seldom have access to electricity. Only one in six families had a bank account. Households may view cattle as a better store of wealth.

### 5.2.3 Household farming enterprises

Table 5.3 presents descriptive statistics for farming enterprises in 2014. On average, households are endowed a little over two hectares of farmland. This sample estimate is significantly higher than the 1994 census estimate of 1.3ha for the surrounding districts (Chamberlin et al., 2007), but nevertheless reflects very small land endowments.

Table 5.3: Household farming enterprises in the study area, 2014

<b>Variables</b>	<b>Valid cases</b>	<b>Mean</b>	<b>Std. error</b>
Total crop revenue	110	28,422	1,252.03
Total crop cash expenditure (ETB)	113	8,222	361.03
Total crop cash revenue (ETB)	114	8,117	873.72
Net crop cash revenue (ETB)	113	-51	819.94
Revenue from sale of teff (ETB)	114	6,420	699.81
Revenue from sale of chickpeas (ETB)	114	821	270.55
Revenue from the sale of wheat (ETB)	114	529	115.84
Revenue from sale of livestock and livestock products (ETB)	114	2,777	409.17
Area of land cultivated (ha)	114	2.29	0.09
Area of land owned by the household (ha)	114	2.08	0.11
Area of land rented from others (ha)	114	0.34	0.05
Area of land leased to others (ha)	114	0.13	0.03
Area of land irrigated (ha)	114	0.01	0.01
Area of land planted with teff (ha)	114	1.32	0.05
Area of land planted with wheat (ha)	114	0.39	0.03
Area of land planted with chickpeas (ha)	114	0.38	0.03
Households that planted teff (%)	114	100	0
Households that planted chickpeas (%)	114	87	3
Households that planted wheat (%)	114	79	4

The area of land cultivated by the average household exceeds the area 'owned' by 0.21ha, which is close to the net area rented in (0.34-0.13ha). The presence of leased land suggests that land tenure is sufficiently secure to support a land rental market. As anticipated, the vast majority of households in the study area cultivated teff (100%), chickpeas (87%) and wheat (79%). The area planted to teff (1.32ha) is some three times higher than that planted to either wheat (0.39ha) or chickpeas (0.38ha). Teff also generates more than three-quarters of total crop cash revenue. Chickpeas account for 10% of crop cash revenue, and wheat just six percent. The net cash income from crops produced in 2014 was ETB -50 indicating the subsistence nature of farming conducted by the average household in the study area. The value of crops consumed (ETB 20,305) was substantially higher than the revenue earned from crop sales (ETB 8,117). Despite the large investment in livestock, revenue earned from the sale of livestock and livestock products amounted to only one third of the revenue earned from crop sales.

#### **5.2.4 Participation in CFAs, membership in cooperatives and willingness to pay**

Table 5.4 presents information about household membership of farming cooperatives, CF participation and willingness to invest in CFAs. Two-thirds of the households are members of a cooperative operating in the study area. This highlights the important role that cooperatives play in providing access to services provided by the government, NGOs and private firms. On average, farmers live about three kilometres from the business premises of their cooperative. Seven per cent of households in the study area participated in the CFA with ACOS Ethiopia, and nine per cent had CFA experience with other firms. The contracts were mostly once-offs to multiply seed or to trial new varieties.

Data were collected on the willingness of farmers to invest in a hypothetical CFA with randomly assigned levels of initial investment promising a 10% increase in annual income. This exercise was intended to measure the respondent's confidence on their farming skills as well as their attitude to risk. More than 40% of the participants in the area rejected the offer at any of the initial investment levels.

Table 5.4: Membership, participation and willingness to invest in CFAs in the study area, 2014

Variables	Valid cases	Mean	Std. error
Households that are members of a cooperative (%)	114	67	4
Distance of residential house to the nearest cooperative office (Km)	114	2.92	0.14
Time taken to transport products to cooperative (Hrs)	66	0.38	0.02
Households with experience in other CFAs (%)	114	9	3
Households participating in ACOS Ethiopia's CFA (%)	114	7	2
Households willing to invest in a CFA with ≤ETB 750 initial investment (%)	114	44	5
Households willing to invest in a CFA with > ETB 750 initial investment (%)	114	14	3
Households not willing to invest in CF at any level of initial investment (%)	114	42	5

### 5.3 Chapter summary

This chapter provided an overview of the data and described how the data were collected. It presented descriptive statistics on household demographics, assets, farming enterprises, cooperative membership, participation in CFAs, and willingness to invest in CFAs for an average household in the study area.

## Chapter 6

### 6 Participation in and impact of ACOS Ethiopia's CFA

This chapter analyses factors affecting farmers' participation in the CFA and the impact of ACOS Ethiopia's CFA on household income as measured in the survey. It also considers other indicators of household well-being and examines farmers' views on various aspects of the CFA. The survey data used in these analyses are presented in Appendix I.

#### 6.1 Participation in ACOS Ethiopia's CFA and factors affecting participation

Participation in ACOS Ethiopia's CFA was restricted to a subset of farmers that were considered to be 'model farmers' by agricultural extension officers in the counties. These farmers were approached by their cooperatives and either accepted or rejected the offer to participate in the CFA. Although ACOS Ethiopia did not participate directly in selecting participants, it approved the selection process administered by the cooperatives and county extension officers. About 85% of participating households confirmed that they were recruited in this way. In general, there was a high level of interest in joining the CFA. This interest was generated by positive feedback from farmers in neighbouring districts who had already participated in the CFA as members of the Melka Awash Farmers' Cooperative Union. ACOS Ethiopia has been working with Melka Awash since 2011, starting with a demonstration plot to train and encourage farmers to supply chickpeas. As indicated in Table 5.4, an estimated seven per cent of households in the study area were participating in the CFA at the time of the survey.

Table 6.1 reports the reasons cited by the (95+8=103) participating respondents when asked what it was that motivated them to join the CFA. The most frequently cited reasons centred on better prices, seed quality and yield. Table 6.2, on the other hand, reports the reasons cited by non-participants for not participating in the CFA. The most frequent reason was simply that no offer had been received as the household either did not belong to a cooperative or was not selected by a cooperative. Assuming that non-participants who had received offers cited the other reasons, the primary reason for not participating

appears to be a concern that the quantity of seed supplied would be inadequate. This could indicate why some larger farmers preferred not to participate.

Table 6.1: Reasons for participating in ACOS Ethiopia’s CFA

<b>Participants' reasons for joining the CFA</b>	<b>% of participating respondents (n=103)</b>
Better price	61
Good quality seed	54
Better yield	43
Preferred variety for home consumption	29
Better quality product	21
Lower marketing costs	4
Others	3

Table 6.2: Reasons for not participating in ACOS Ethiopia’s CFA

<b>Non participants' reasons for not participating in the CFA</b>	<b>% of non-participating respondents (n=73)</b>
Not a member of/not selected by a cooperative	45
Shortage of seed provided by ACOS	38
Not having enough land	7
Lack of training	3
Other reasons	7

A logit model was estimated in order to identify the underlying factors that influenced household participation in the CFA (i.e. factors that could explain why households were selected and then elected to participate). The logit model predicted the probability ( $P_i$ ) that the  $i^{\text{th}}$  household would participate in the CFA using observed time-invariant, farmer, farm, and household characteristics, as explanatory variables.

Farmer attributes included the *de facto* head’s stated willingness to participate in a CFA, gender, age, and years of formal schooling. Three dummy variables were constructed to measure stated willingness to participate in hypothetical CFAs: the first scored one (1) if the respondent was willing to invest in a CFA with initial investment less than or equal to ETB 750, and zero (0) otherwise; the second scored one (1) if the respondent was willing to invest in a CFA with initial investment greater than ETB 750, and zero (0) otherwise;

and the third scored one (1) if the respondent was not willing to participate in a CFA that required investment, and zero (0) otherwise. These variables were intended to measure the household head's attitude to risk and confidence in their farming skills. It was anticipated that rates of participation would be highest for household heads who scored one (1) on the second dummy variable as they had more confidence in their skills and were more willing to accept risk. The third dummy variable was treated as the default category and therefore omitted from the logit model. Age was expected to impact positively on participation as older farmers have more farming experience than their younger counterparts. Likewise, formal schooling was expected to promote participation as education improves the farmer's ability to assemble and interpret technical and business information (Okello, Kirui, Njiraini, & Gitonga, 2012, p. 118).

The area of land owned per adult equivalent<sup>1</sup> and the household's stock of labour<sup>2</sup> were both expected to impact positively on CFA participation. It is easier for farmers with more land and labour to produce commercial crops beyond the household's subsistence needs. It is also easier for larger farmers to cover fixed information and transaction costs. Other time invariant farm characteristics like improvements made to the land were not considered as they were seldom observed in the study area – possibly a reflection of capital constraints and insecure property rights to land (Hagos & Holden, 2014). Wealthier households were also considered more likely to participate in the CFA. Wealth was measured by a dummy variable indicating the presence (1) or absence zero (0) of a dwelling roofed with corrugated iron (Eneyew & Bekele, 2013). Other measures of wealth, such as the value of cattle and farm equipment were excluded as they did not display much variation.

Table 6.3 presents the results of the logit model estimated using SPSS version 22 (Field, 2013). The estimated logit model was statistically significant at the one per cent level of probability with a Nagelkerke R<sup>2</sup> of 0.44 and correctly predicted the participation status

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<sup>1</sup>Adult equivalent = (number of adults + 0.5\*number of children)<sup>0.9</sup>. The power term 0.9 is included to capture size economies (Low, 1986).

<sup>2</sup>Labour endowment = number of adults ≤ 65 years of age + (0.5\*number of adults > 65 years of age).

of 75.8% of the sampled households. The results presented suggest that respondents who had confidence in their farming skills and who were more willing to accept risk were more likely to participate in ACOS Ethiopia's CFA. The odds of participating were estimated to be 19.3 times (95%) higher for respondents willing to invest more than ETB 750 in a hypothetical CFA, and 5.5 times (84%) higher for respondents willing to invest up to ETB 750 in a hypothetical CFA, when compared with respondents who were unwilling to invest.

Table 6.3: Logit analysis of factors affecting participation in ACOS Ethiopia's CFA (n=207)

<b>Explanatory variable</b>	<b>Estimated Coefficient</b>	<b>Wald statistic</b>	<b>Exp(B)</b>
Yes (=1) to CFAs with initial investment <= ETB 750	1.70	12.31 ***	5.49
Yes (=1) to CFAs with initial investment > ETB 750	2.96	28.19 ***	19.27
Gender of household head (1=male, 0=female)	0.58	1.13	1.78
Age of the household head (years)	0.04	4.56 **	1.04
Formal schooling (years)	0.05	0.69	1.05
Household labour endowment (#)	-0.02	0.02	0.98
Land owned per adult equivalent (ha)	0.45	0.50	1.56
Dwelling has corrugated iron roof (1=yes, 0=no)	1.37	14.90 ***	3.93
Constant	-5.17	20.39	0.01

\*\*\* and \*\* denote significance at the 1%, and 5% levels of probability, respectively

The results also support the view that increases in farming experience and wealth would increase the likelihood of participation in ACOS Ethiopia's CFA. It was estimated that a one year increase in the respondent's age would increase the odds of participation by a factor of 1.04 (4%), while possession of a dwelling roofed with corrugated iron would increase the odds of participation by a factor of 3.93 (80%). These results indicate that participation was biased against farmers who were relatively poor, risk averse and short of farming skills and experience. However, there was no evidence that participation was influenced by gender, formal schooling, farm size or household labour endowments. Compared to other studies on the factors impeding farmers from participation, this study reiterates some of the findings of at least two African studies done by Bolwig et al. (2009) and Bellemare (2012) that could probably be attributed to similar institutional and socio cultural contexts. However, age of the household head was found to influence participation negatively in these two studies, contrary to the findings of this study. This



might be due to the nature of the contracts in these two studies which were mostly for high value vegetables in Madagascar and certified organic coffee in Uganda. Higher levels of skill might have been required, contrary to the less technologically demanding crop of chickpeas

## **6.2 Household impacts of ACOS Ethiopia's CFA**

When assessing the impact of ACOS Ethiopia's CFA on household income and expenditure outcomes, it is important to compare similar households in the participant and non-participant groups, as participation in the CFA was not random. Propensity score matching (PSM) was used to identify a subset of participant and non-participant households, similar in respect to observed time-invariant, farmer, farm, and household characteristics. The PSM used the logit model estimated in Section 6.1 to predict the probability ( $P_i$ ) that the  $i^{\text{th}}$  household would participate in the CFA. Participants were then paired with non-participants who had similar  $P_i$  using a PSM matching procedure available in SPSS version 22 (Field, 2013). Unmatched cases were then excluded from the treatment and control groups, leaving 64 pairs of participants and non-participants.

### **6.2.1 Impact of ACOS Ethiopia's CFA on household income**

Households in the treatment and control groups were first compared for equality of mean outcomes using univariate t-tests. Table 6.4 summarises the results of these tests computed for continuous measures of household productivity, income and expenditure. ACOS Ethiopia participants had substantially higher levels of chickpea production, input expenditure, crop cash revenue, net crop cash revenue and total crop revenue. Per hectare yields of chickpeas (measured in quintals<sup>3</sup> per hectare) also appear to be higher for participants but the difference is not statistically significant at the five per cent level of probability. These findings suggest that increases in incomes are the result of better prices for chickpeas sold and inputs purchased.

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<sup>3</sup>A unit of weight equal to 100 kg commonly used in Ethiopia

Table 6.4: Comparison of income outcomes in the treatment and control groups

Group statistics	Treatment group (n=64)	Control group(n=64)	Std. error difference	t-test
Total chickpea productivity (QI /ha)	11.44	9.62	0.99	1.83 *
Total chickpea production (QI)	8.42	3.63	0.74	6.45 ***
Total cash revenue per hectare (ETB)	5,941.22	2,715.41	683.23	4.72 ***
Total farm expenditure per adult eq. (ETB)	3,202.74	2,369.55	263.45	3.16 ***
Total crop cash revenue/adult eq. without CFA	3,502.98	1,894.78	568.53	2.83 ***
Total crop cash revenue per adult eq. (ETB)	4,338.07	1,894.78	621.13	3.93 ***
Net cash crop revenue per adult eq. (ETB)	1,043.56	-451.54	536.54	2.79 ***
Total crop revenue per adult eq. (ETB)	9,520.00	7,775.49	688.46	2.53 **

\*\*\*, \*\*, and \* denote significance at the 1%, 5%, and 10% levels of probability, respectively

The general treatment model described in Section 4.4 was used to isolate the contribution of ACOS Ethiopia's CFA to these differences in income and expenditure. Equation 2 of the treatment model was estimated as a logit model identical to that described and presented in Section 6.1, except that the dummy variables measuring willingness to invest in a hypothetical CFA were treated as instruments (Z). These variables were strongly correlated with participation (see Table 6.3) but not with the income and expenditure outcomes (highest  $r^2= 0.26$ ).

Levels of participation predicted by Equation 2, ( $\hat{T}$ ), were included in Equation 1 to explain income and expenditure outcomes per adult equivalent ( $Y_i$ ), along with age, gender and educational level of the household head, land owned per adult equivalent, labour endowment, farm investment (value of farm assets and improvements to farm land) per adult equivalent, and number of crops cultivated in 2014. The latter variable was expected to impact negatively on cash returns as subsistence oriented farmers tend not to specialise in a cash crop. Table 6.5 presents estimates of the treatment model for each outcome. Full regression results are presented in Appendices D-G.

All of the estimated treatment models were statistically significant at the one per cent level of probability and the signs of statistically significant parameters matched *a priori* expectations. Multicollinearity was not apparent as all of the explanatory variables had Variance Inflation Factors (VIFs) close to unity - except for the linear and quadratic age terms which are interpreted jointly. The impact of participation in ACOS Ethiopia's CFA is

measured by  $B_1$ , the regression coefficient estimated for  $\hat{T}$ . A positive and statistically significant coefficient indicates that participation in the CFA had a positive impact on the outcomes. The standard errors of these coefficients were corrected for the two-stage process using the method described by Gujarati (2003, p. 791).

Table 6.5: Impact of ACOS Ethiopia's CFA on indicators of household income (n=128)

<b>Independent variables</b>	<b>Total crop expenditure /adult eq.</b>	<b>Total crop cash revenue /adult eq.</b>	<b>Net crop cash revenue /adult eq.</b>	<b>Total crop revenue /adult eq.</b>
Participation in the CFA ( $\hat{T}$ )	786.02	3,658.08 **	3,410.61 **	730.17
Age	201.96 **	64.11	264.60	-14.36
Age <sup>2</sup>	2.00 **	-0.81	-2.63	0.13
Gender of the household head	-231.34	63.26	281.95	-285.50
Years of formal schooling	-2.33	-181.03 **	-141.42 ^	151.10 *
Labour endowment	-72.47	210.50	201.41	-45.78
Land owned per adult eq.	2,799.14 ***	5,992.22 ***	2,782.97 ***	8,390.16 ***
Farm investment per adult eq.	0.14 **	0.12	-0.06	0.21 *
Number of crops cultivated in 2014	14.96	-843.19 ***	-851.00 ***	172.82
(Constant)	5,414.63 ***	-1,114.31	-6,569.88	1,553.11
F–statistic	22.25 ***	10.65	5.12 ***	20.57 ***
Adjusted R <sup>2</sup>	0.61	0.41	0.23	0.59

\*\*\*, \*\*, \* and ^ denote significance at the 1%, 5%, 10% and 15% levels of probability, respectively.

The results summarised in Table 6.5 show that participation in ACOS Ethiopia's CFA had a significant positive impact on both total crop cash revenue and net crop cash revenue. Participation added ETB 3658 per adult equivalent to total crop cash revenue, and ETB 3411 per adult equivalent to net crop cash revenue; other variables held constant. The results also show that farm size was the only variable that had a significant and positive impact on all outcome variables. As anticipated, specialisation does impact positively on cash returns.

Participation did not affect total crop expenditure as the new variety did not require any major changes in technology. The impact on total crop revenue was also not significant suggesting that even for farmers participating in the CFA, crops are produced mainly for subsistence purposes. Nevertheless, participation in ACOS Ethiopia's CFA substantially increased the crop cash revenue and net crop cash income earned by households.

The local average treatment effects (LATEs) of participation were computed for the instruments using the method described in Section 4.4. In this case, LATEs measure the impact of participation on outcomes in households that decide to participate following a change in their willingness to invest in a CFA. The estimated logit model classified the subset of matched households into four distinct groups as indicated in Table 6.6. Predicted values of the outcomes computed for each of the four groups are summarised in Appendix H.

Table 6.6: Classification of matched households with predicted and observed participation status (n=128)

Observed		Predicted	
		Does the household participate in the CFA?	
		No	Yes
Does the household participate in the CFA?	No	39 Non-participant compliers (NPC) Never takers (NT1) )	25 Predicted never takers (NT2)
	Yes	21 Always takers (AT)	43 Treated compliers (PC)

The LATEs computed for each outcome using Equations 3-6 (Section 4.4) are reported in Table 6.7, which also presents average treatment effects (ATEs). ATEs are the regression coefficients estimated in the second stage of the treatment model (Table 6.5) and refer to changes in outcomes caused by participation regardless of farmers' responses to changes in the instruments. Compliers that participated in the CFA were predicted to earn ETB 2879 more per adult equivalent in crop cash revenue, and ETB 1896 more per adult equivalent in net crop cash revenue than were compliers who did not participate.

Table 6.7: LATEs and ATEs of participation in ACOS Ethiopia's CFA (n=128)

Outcome variables	ATEs of participation (ETB)	LATEs of participation (ETB)
Total crop expenditure per adult equivalent	786.02	913.21
Crop cash revenue per adult equivalent	3658.08 **	2,879.11
Net crop cash revenue per adult equivalent	3410.61 **	1,896.24
Total crop revenue per adult equivalent	730.17	3,108.62

\*\*\*, \*\*, and \* denote significance at the 1%, 5%, 10% levels of probability, respectively

## 6.2.2 Impact of ACOS Ethiopia's CFA on other indicators of household wellbeing

As discussed in Chapter 2, CFAs could have impacts far beyond the income measures considered earlier in this chapter. Efforts were made to understand the impact of ACOS Ethiopia's CFA on non-pecuniary indicators of wellbeing. Participants (n=103) signalled their responses to questions about perceived changes on other indicators of wellbeing by selecting one option from a scale coded as; 1=decreased, 2=no change, 3=small increase (10%), and 4=large increase (>20%). Average values and percentages of responses are presented in Table 6.8. These responses include participants' perceptions of changes in household income, which can be compared with changes estimated by the treatment model.

Table 6.8: Impacts of participation in ACOS Ethiopia's CFA on indicators of wellbeing (n=103)

Variables	Mean	S.E. mean	% of responses			
			1	2	3	4
Household income	3.08	0.07	6	3	69	22
Farm expenditure	2.45	0.08	13	36	45	6
Net farm income	3.02	0.07	6	4	73	17
Hired farm labour	2.57	0.07	5	40	48	7
Access to other farm inputs	2.60	0.07	5	40	45	10
Access credit	2.78	0.07	7	16	69	8
Level of debt	2.53	0.08	9	37	46	8
Access to preferred market	3.17	0.06	1	10	61	28
Access to new technology and information	3.26	0.06	0	7	60	33
Level of technical advice	3.13	0.07	0	18	52	30
Access to social networks	2.93	0.07	0	31	45	24
Family food security	2.76	0.07	4	31	50	15
Family health	2.59	0.07	0	51	38	11
Better child education	2.66	0.06	0	43	48	9
Access to health care	2.57	0.07	3	44	46	7
Status in the community	2.87	0.06	0	24	64	12

The results indicate that the vast majority of participating households perceived increases in household income (91%) and net farm income (90%). Participants also perceived improvements in food security and access to preferred markets, credit, new technology, information and technical advice. They did not perceive increases in crop expenditure or

levels of debt. There was no evidence of longer-term improvements in family health and education, but this was not unexpected as the CFA had been running for just one season

Sources of the CFA’s perceived positive impact on net farm incomes were investigated, by asking participants if they attributed the change to any of the variables listed in Table 6.9. More than 93% of the participants perceived that their net income had increased and were able to respond to this question. The variables listed as potential sources of change in Table 6.9 were coded as dummy variables, scoring one (1) if the respondent did attribute change to the variable in question, and zero (0) otherwise. The mean value of each response and the one-sample t-test statistic comparing each mean with the neutral position (0.5) are presented in Table 6.9. Participants attributed perceived increases in net farm income to the superior quality of the Dube chickpeas variety introduced by ACOS Ethiopia, a stable product price, higher yields and a guaranteed market.

Table 6.9: Perceived sources of impact on household net income (n=103)

<b>Sources of increase in net income</b>	<b>Mean</b>	<b>S.E. mean</b>	<b>t-test against 0.5</b>
Improved quality of product	0.92	0.03	15.94 ***
Stable product price	0.83	0.04	8.65 ***
Higher yields	0.77	0.04	6.38 ***
Guaranteed market for chickpeas	0.68	0.05	3.89 ***
Better quality of inputs	0.56	0.05	1.29
Better price of inputs	0.46	0.05	-0.89
Lower marketing cost	0.44	0.05	-1.29

\*\*\*, \*\*, and \* denote significance at the 1%, 5%, and 10% levels of probability, respectively

Findings of this study confirm most of the existing theoretical and empirical understanding in terms of CF increasing the income of participant smallholders and mitigating market failure for output, input, credit, technology, information and technical advice. By doing so, it affirms that the institutional arrangement of contract farming could potentially be used as one of many tools to increase the income of smallholders, and to help bring development in rural economies in developing countries like Ethiopia.

For participants, this study also investigated levels of satisfaction with the terms and implementation of the contract. Participants were asked to rank their perceived levels of satisfaction on a Lickert-type scale ranging from 1=strongly disagree (or very dissatisfied

or highly unlikely), to 5=strongly agree (or very satisfied or highly likely), with a value of (3) representing neutrality. The mean responses and percentages reported in Table 6.10 indicate positive perceptions about all aspects of the CFA examined. Participants are satisfied with the price offered even if they do not fully understand the way price is calculated. There is some evidence that side-selling is perceived to be a problem (mean=3.40). This result is not unexpected as the product is very popular for home consumption. Almost 95% of the participants indicated that they were likely or highly likely to continue with the CFA in 2015. In addition, 83% of the non-participants indicated that they would like to join the scheme in 2015. Overall, these results indicate satisfaction with the terms and administration of the CFA, and suggest that farmers are benefitting from participation.

Table 6.10: Participants' attitudes on other terms of ACOS Ethiopia's CFA (n=103)

<b>Aspects of the CFA</b>	<b>Mean</b>	<b>S.E. Mean</b>	<b>% of responses</b>				
			<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
Satisfaction with the way price is determined	4.37	0.08	1	3	4	43	49
Quality specifications are clear	4.61	0.05	0	0	0	39	61
Required quality specifications are achievable	4.42	0.06	0	0	5	48	47
Seed was provided on time	4.45	0.07	0	1	7	39	53
Quality of seed provided was good	4.38	0.06	0	1	5	49	45
Level of advice provided was adequate	4.18	0.08	0	2	16	43	39
Training provided was adequate	4.35	0.05	0	1	1	60	38
Payment was made on time	4.69	0.05	0	0	0	31	69
Product collection (buying) was timely	4.57	0.05	0	0	0	43	57
Side selling is a problem	3.40	0.13	16	7	24	29	24
Likelihood of participation for next season	4.70	0.07	2	0	3	16	79

### 6.3 Chapter summary

This chapter applied multivariate techniques to identify factors influencing farmer participation in ACOS Ethiopia's CFA, and assessed the impact of the CFA on measures of household income. Other reasons for participation and other measures of household wellbeing impacted by the CFA were analysed using descriptive statistics.

## Chapter 7

### 7 Summary, conclusions and recommendations

#### 7.1 Summary

Contract farming (CF) is a form of vertical coordination that has considerable potential for integrating smallholders into export and processing markets, and into the modern economy. Viewed from development perspective, CF is an institutional arrangement by which agribusinesses replace or supplement primary agricultural production with supply from smallholders. Examples of these arrangements have been observed in more than 110 developing and transitional economies, and involve both multinational and local agribusiness firms. Many development agents view CF as a useful tool for promoting economic development in free-market economies.

Agribusinesses engage in CF to achieve economies of scale and labour efficiency with greater certainty of securing an adequate supply of quality product. Smallholders benefit from a guaranteed market, stable prices, technological support, and access to credit and inputs. Productivity is expected to improve due to the adoption of new technology by farmers, and better utilisation of processing capacity beyond the farm gate. The local economy benefits from additional employment on farms and in firms, and from stronger demand for locally produced goods as household incomes increase.

CF is a relatively new concept in Ethiopia. One of the better known cases was initiated by ACOS Ethiopia, a company that exports chickpeas. ACOS Ethiopia introduced new varieties, including ACOS Dube, and contracted farmer-owned cooperative unions (such as the Becho Weliso Farmers' Cooperative Union) to supply chickpeas. The contract requires the company to provide seed, training, and other technical assistance to smallholders that supply cooperatives within the Union. Participating smallholders repay the seed in kind and sell the balance of their crop to the company. ACOS Ethiopia claims to have improved the lives of many smallholders through this and other contracts.

This study tested these claims by providing empirical evidence of the impact of ACOS Ethiopia's contract farming arrangement (CFA) on smallholders and by identifying factors



affecting their participation. The impact of CF on smallholders and its ability to include the poorest of resource-poor farmers are hotly debated topics as there are few conclusive empirical studies. Moreover, no such empirical studies had been conducted in Ethiopia. This study was intended to contribute to the CF literature, particularly that relating Ethiopia. It was also intended to inform policy decisions about CF and CFAs that promote inclusiveness.

The study was conducted in an area comprising seven counties in three districts found in the South West Zone of the Oromia region of Ethiopia. This study adopted a quantitative research approach. Primary data were gathered in two sample surveys conducted in June 2015; a two-stage sample of 114 households representative of all households in the study area and a random sample of 95 contract farmers supplying local cooperatives with ACOS Dube chickpeas. A uniform structured questionnaire was used in both surveys to gather information on personal, household and farm characteristics, contract farming status, and farmers' perceptions of the CFA.

Seven per cent of households in the representative sample participated in the CFA with ACOS Ethiopia, and nine per cent had CFA experience with other firms. More than 40 per cent of the households rejected offers of a hypothetical CFA at any initial investment level. Propensity Score Matching (PSM), based on a logit model of participants and non-participants, was employed to identify a control group; i.e. a subset of non-participants with observed time-invariant attributes similar to those of participants. The model revealed that households led by experienced farmers who were confident in their farming skills, willing to invest in hypothetical CFAs, and relatively wealthy (possessed a dwelling roofed with corrugated iron), were more likely to participate in ACOS Ethiopia's CFA.

Differences between the mean values of key outcome variables ( $Y_i$ ), revealed significant differences in all measures of chickpea productivity, income and expenditure between the participant and control groups. A general treatment model was applied to isolate the CFA's contribution to these differences from the effects of other observed and unobserved variables affecting the outcomes.

The treatment model was estimated using Instrumental Variables (IV) in a 2SLS regression model to address selection bias. Results of this analysis showed that participation increased total crop cash revenue by ETB 3,658 per adult equivalent, and net crop cash income by ETB 3,411 per adult equivalent. Local Average Treatment Effects of participation were calculated and indicated that compliant participants earned ETB 2,879 more per adult equivalent in crop cash revenue, and ETB 1,896 more per adult equivalent in net crop cash income. Participating households also perceived improved access to preferred markets, to new technology and information, and to technical advice. Perceived increases in net farm income were attributed to the superior quality of the variety of chickpeas introduced by ACOS Ethiopia, a stable product price, higher yields, and a guaranteed market. Participant smallholders also had positive perceptions about the contractual terms of the CFA.

## **7.2 Conclusions and recommendations**

This study set out to answer two research questions: The first addressed the issue of inclusiveness, and the second the issue of impact on smallholder participants. This subsection concludes by addressing the research questions and discussing their implications for theory and policy.

### **What factors determined farmers' participation in ACOS Ethiopia's CFA in the study area?**

Two key factors affected participation in the CFA. Factor (1) reflects farming experience, confidence in farming skills, and attitude towards risk (measured in terms of the farmer's willingness to invest in a hypothetical CFA with different levels of initial investment). Farmers that had more experience, more confidence in their skills, and who were more willing to accept risk had a higher probability of being selected by, or accepting offers from, their cooperative to participate in the CFA. Factor (2) reflects the relative wealth of households, as measured by the possession of dwellings roofed with corrugated iron. In Ethiopia, households that can't afford corrugated iron resort to less permanent roofing materials such as thatch grass. These findings reject the null hypothesis that participation in ACOS Ethiopia is not biased towards or against some households. From a policy

perspective there is evidence that ACOS Ethiopia's CFA is biased against poorer households. Interventions that improve farming skills and which reduce household exposure to adverse outcomes may help to make CFAs more inclusive in Ethiopia.

**What are the impacts of ACOS Ethiopia's CFA on household income and other indicators of household wellbeing in the study area?**

Results of the treatment model estimated in this study indicate that participation in ACOS Ethiopia's CFA leads to meaningful increases in both revenue and net revenue earned from crop sales. Participation did not have a significant impact on crop expenditure, nor did it have a significant impact on total crop revenue as sales account for a relatively small share of household production. Apart from these income effects, households also perceived improved access to preferred markets, new technology and information, and the level of technical advice received. These findings reject the null hypothesis that participation in ACOS Ethiopia's CFA has no positive impact on income and other non-pecuniary indicators of household wellbeing. From a policy perspective there is evidence that ACOS Ethiopia's CFA increased income and improved the wellbeing of smallholders.

These findings support policies aimed at facilitating voluntary CFAs in Ethiopia. Promoting smallholder cooperatives and cooperative unions appears to be a particularly important policy instrument, as these producer organisations play a critical role in negotiating and managing supply contracts with agribusiness firms. Interventions aimed at growing the cooperative unions and developing the institutional, managerial and financial capabilities of cooperatives might not only broaden smallholder access to preferred markets but also improve their ability to negotiate terms that are more attractive to poorer farmers who perceive high levels of risk in CFAs. Complementary interventions aimed at strengthening the legal infrastructure required to uphold and defend contracts may also be required. Promoting CFAs is expected to enhance the adoption of new technology and the delivery of market information. Lead firms in CFAs, such as ACOS Ethiopia, often have the resources to generate or acquire and provide technology, information, and the intangible assets such as reputation, brands and supply contracts needed to access global food value chains.

### **7.3 Limitations and future research**

Ideally, a study aimed at assessing the impacts of CF in Ethiopia should cover all, or at least a representative sample of, such schemes throughout the country. Unfortunately, the resources and time available for this study restricted it to a single study area. Nevertheless, this CFA is broadly representative of schemes elsewhere in Ethiopia. ACOS Ethiopia's CFA has been running for only one season in the study area and as profits from farming might vary from season to season, matured CFAs with a longer time-span would have provided a clearer picture on impacts, and particularly on the non-peculiar impacts of CFAs. This study used a number of different enumerators to collect the data from different counties which might have increased variation due to differences in phrasing questions. However, as most of the questions were quantitative and training of the enumerators was conducted, these variations are not believed to affect results significantly. All costs and revenue streams in this study were based on recall by the heads of households as farmers in the area have very little experience in record-keeping. Though these might be less accurate than written records, overall results are not considered to be affected significantly.

With regard to future research areas and direction on CF, examining a greater number of CFAs in Ethiopia after a thorough inventory including their types, success/failure, and longevity, would reveal impacts in other contexts, particularly for products that require higher coordination and investment such as dairy, meat, fruit and vegetables. Such research would also inform governments of the necessity to seriously integrate CF to the current rural development policy. More research that investigates the types of terms of contracts that would increase the probability of positive impacts and help fine tune contracts, such as those done by Abebe, Bijman, Kemp, Omta, and Tsegaye (2013) and Saenger, Qaim, Torero, and Viceisza (2013), and institutional environment that guarantees support and required to uphold and defend contracts, would help make CFAs successful and bring positive impacts on income and other indicators of smallholders' wellbeing.

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## 9 Appendices

Appendix A: Respondents consent form and questionnaire

### **Household survey questionnaire for the study “impact of contract farming on smallholders in Ethiopia: The case of chickpea growers”**

**Faculty of Commerce - International Rural Development, Lincoln University,  
Canterbury, New Zealand**

#### **Informed Consent and Declaration**

This survey is part of a research project titled “Impact of contract farming on smallholders in Ethiopia: The case of chickpea growers”. A research student, Mr. Samuel Seba (SamuelTigistu.seba@lincolnuni.ac.nz), is conducting the work under the supervision of Associate Professor Michael Lyne (Michael.Lyne@lincoln.ac.nz) and Dr Kevin Old (Kevin.Old@lincoln.ac.nz) both from Lincoln University, Faculty of Agribusiness and Commerce. The purpose of the research is to evaluate the impact and inclusiveness of a Contract Farming Arrangement (CFA) between ACOS Ethiopia and smallholders in central Ethiopia. Participation in this survey is voluntary, and the respondent is free to withdraw at any time. Individual responses will be treated confidentially. In this regard, the identity of the interviewee or his/her household will be coded during the analyses to preserve anonymity. The survey interview is expected to take about 60 minutes.

The results of the research will be published without references to the name of the respondents or the organisations they work for. These organisations will be named in an unpublished thesis and will be available online if it meets the requirements of a Masters Degree at Lincoln University. Copyright to the thesis resides with the researcher and the university. Should you have any question regarding the nature of the survey, please contact the supervisors or the researcher at the e-mail addresses listed above or call the Researcher at +251 929 306 252. Please express your full consent to participate in this survey by writing your name and signing below.

I \_\_\_\_\_ (Full names of participant) hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to participating in the research project. I understand that I am at liberty to withdraw from the project at any time, should I so desire.

Signature: \_\_\_\_\_ Date: \_\_\_\_\_

Woreda: _____ Kebele: _____ Got: _____	Respondent is the head of household (Yes or No): _____  If not, what position does the respondent have in the household?	Duration of the interview Started ____:____ Finished ____:____
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Enumerator's

Name: \_\_\_\_\_ Signature: \_\_\_\_\_ Date: \_\_\_\_\_

1. Household characteristics

1.1. Size of household (family members or relatives who sleep here every day or at least on the weekends)

Total	Male	Female	≤ 15 years	16 – 65years	≥ 66years	Attending school	Working on farm	Working off-farm	Studying off-farm

1.2. Information on the household head or on the person responsible for farming activities in the household

	Age in years	Gender	Marital status <sup>1</sup>	Years of formal schooling	Years of farming experience	Years of chickpea farming experience
Household head						
Farmer*						

\* The person responsible for farm management if not the household head

1 Married, never married, widowed or divorced

1.3. Are any of the members in the household a member of a farmer association or cooperative? (Yes or No) \_\_\_\_\_

If Yes, go to question 1.4. If No Go to question 1.7

1.4. Names of the farmers' organisation(s) the household belongs to

\_\_\_\_\_

\_\_\_\_\_

1.5. Does any member of the household play a leadership role in this farmers' organisation(s)? (Yes or No) \_\_\_\_\_

1.6. If yes, what leadership role do they have? \_\_\_\_\_

1.7. Is at least one of the walls of the house made of bricks? (Yes or No) \_\_\_\_\_

1.8. Of what material is the roof of the residential house made? \_\_\_\_\_

1.9. Does the household own any other houses (Yes or No) \_\_\_\_\_

1.10. What is the distance from this residential house to the nearest paved road in kilometres? \_\_\_\_\_

1.11. What is the distance from this residential house to the office of the nearest cooperative responsible for ACOS Ethiopia's CFA in Kilometres? \_\_\_\_\_

1.12. What means of transportation do you use to transport your chickpea (contract or not) or equivalent grain produce to the nearest market town or cooperative collection centre? \_\_\_\_\_

1.13. How much time does it take to transport this produce to the nearest market town or cooperative collection depot (whichever is closer and applicable) using your usual means of transportation? \_\_\_\_\_Hours: \_\_\_\_\_Minutes

1.14. Is farming the primary occupation of the *de facto* head of household? (Y or N)\_\_\_\_

1.15. What was the estimated average monthly non-farm income for the year ended 31 December 2014 in ETB? \_\_\_\_\_

1.16. Please provide information on major moveable household assets

Household asset	Owned? (Y or N)	Current market value (ETB)	Time acquired	
			Year	Month
Vehicle				
Fridge/Freezer				
Television				
Satellite receiver				
Generator				
Radio				
Cell phone				
Solar charger				

## 2. Farm characteristics

### 2.1. Land holding of the household during the season ended December 2014

Description	Hectares
Total farm land operated	
land leased or lent to others (for the season)	
Land rented or borrowed in (for the season)	
Land (either owned or otherwise) flooded during the rainy season	
land (either owned or otherwise) that is irrigated	
Land (either owned or otherwise) planted with ACOS Ethiopia's chickpea for seed multiplication	
Land (either owned or otherwise) planted with chickpea for market	

2.2. Fixed improvements on land and farm

Improvements	Present(Yes or No)	Cost (ETB)	Time of improvement	
			Year	Month
Irrigation				
Fencing for crops				
Crop storage silo ('Gotera')				
Water tanks				
Chicken house				
Terraces				
Drainage canals				
Animal sheds				

2.3. Does the de facto household head or any member have a bank account or savings in a credit and saving association? (Yes or No) \_\_\_\_\_

2.4. If yes, which range in ETB best matches with the balance in the account having the highest amount of savings?

- 1) ETB 0 – 2,500 [     ]
- 2) ETB 2,500 – 6,500 [     ]
- 3) ETB 6,500 – 10,000 [     ]
- 4) ETB 10,000 or more [     ]

2.5 Crops and livestock produced (Including own consumption), inputs used and revenue generated in the 2014 season

Crops/livestock produced	Planted (Y or N)	Reason for planting(a)	Area (Ha)	Quantity produced	Revenue from sales (ETB)	Sold to (b)	Cost of inputs purchased or hired						
							Seed (ETB)	Fertiliser (ETB)	Chemicals(ETB)	Machine/ox(ETB)	Labour(E TB)	Transport(ETB)	Broker(E TB)
Chickpeas (ACOS)													
Chickpea													
Teff													
Wheat													
Barley													
Maize													
Haricot beans													
Total (office use)													

(a) 1= only for household consumption, 2 = mainly for household consumption, 3 = equally for household consumption and cash income, 4 = mainly for cash income, 5 = only for cash income.

(b) 1 = neighbours, 2 = traders collecting products in villages ('Sebesabi Negade'), 3 = roadside stalls, 4 = village markets, 5 = ACOS Ethiopia, 6= other companies with contract, 7 = marketing cooperatives and, 8=bigger city markets.



## 2.6. Livestock owned and sold in 2014 season

<b>Livestock and livestock products</b>	<b>No. of animals</b>	<b>Current value(ETB)</b>	<b>No. of animals sold</b>	<b>Revenue from sales (ETB)</b>
Cattle excluding dairy cows				
Dairy cows				
Sheep				
Goats				
Chickens				
Dairy products				
Eggs				
Total (office use)				

## 2.7. Movable assets

<b>Asset</b>	<b>Present (Yes or No)</b>	<b>Current market value (ETB)</b>	<b>Time acquired</b>	
			<b>Year</b>	<b>Month</b>
Tractor				
Harrow				
Trailer/cart				
Irrigation pump				
Ox-plough				
Knapsack sprayer				
Wheelbarrow				
Pack animals				

3. Contract Farming

3.1. Does the household have any experience with Contract Farming (CF)?(Y orNo) \_\_\_\_\_

3.2. If yes, which crop(s) or product(s) were grown under contract?

Crop	Year	Company

3.3. Is the household a participant of the CFA with ACOS Ethiopia (Yes or No)? \_\_\_\_\_

If yes, go to question 3.10. If No Go to question 3.4

3.4. Has the household heard about ACOS Ethiopia’s CFA? (Yes or No)\_\_\_\_\_

3.5. Has the household approached the firm/ cooperative to become a supplier for ACOS Ethiopia? (Yes or No) \_\_\_\_\_

3.6. If no, what were the reasons for not approaching?

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3.7. Has the household been approached by the firm/cooperative to become a supplier for ACOS Ethiopia? (Yes or No) \_\_\_\_\_

3.8. If yes, why did the household choose not to become a contract farmer for ACOS Ethiopia’s chickpea CFA?

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3.9. How likely is the household to become a contract farmer for ACOS Ethiopia’s CFA in the coming season if the opportunity exists?

Highly likely	Likely	Don’t know	Unlikely	Highly unlikely

3.10. Would the household be willing to participate in a CFA that increases income by 10% but requires an initial investment of (underline the investment drawn and write YES (NO) if willing (unwilling) to invest in the space next to the underlined level of investment)

- 3.10.1. ETB450 \_\_\_\_\_
- 3.10.2. ETB600 \_\_\_\_\_
- 3.10.3. ETB750 \_\_\_\_\_
- 3.10.4. ETB1100 \_\_\_\_\_
- 3.10.5. ETB2200 \_\_\_\_\_
- 3.10.6. ETB5400 \_\_\_\_\_

**NB Questions from 3.11 on are for participants of ACOS Ethiopia’s chickpea CFA only**

3.11. What were the initial primary reasons for participating in CFA?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

3.12. How did you come to participate in ACOS Ethiopia’s CFA? Circle (a) or (b)

- a) We opted to join
- b) The cooperative or company offered us an opportunity to join

3.13. Has the household experienced changes in any of the following as a result of participating in ACOS Ethiopia's CFA during the 2014 season?

<b>Impacts</b>	<b>Decreased</b>	<b>No change</b>	<b>Increased (&gt;10%)</b>	<b>Increased (&gt;20%)</b>
Farm income				
Farm expenditure				
Net farm income				
Hired farm labour				
Access to other farm inputs				
Access to credit				
Level of debt				
Access to a preferred market				
Access to new technology and information				
Level of technical advice				
Access to social networks				
Family food security				
Family health				
Access to better child education				
Access to health care				
Your status in the community				

3.14. If net farm income increased and/or risk decreased, which of the following are believed to be the source of this improvement?(Tick where appropriate)

Higher yields	
Better quality of product	
Stable price for chickpea	
Guaranteed market for chickpea	
Better quality of inputs	
Better price for inputs	
Lower marketing costs	

3.15. How is the price of the product calculated?

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3.16. Are you satisfied with the way the price is determined?

Highly satisfied	Satisfied	Neutral	Dissatisfied	Highly dissatisfied

3.17. Are there sanctions and rewards for quality performance? (Yes or No)\_\_\_\_\_

3.18. If yes, what are your perceptions of quality specifications of ACOS Ethiopia's CFA?

	Strongly agree	Agree	Somewhat	Disagree	Strongly disagree
Quality specifications for quality parameters are clear					
Specifications of the quality parameters are achievable					

3.19. How often does the household cultivate chickpea?

Every season	Most seasons	Every other season	Some seasons	Never

3.20. What is your view regarding the statements below on other terms of the contract?

Terms	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
Seed was provided on time					
Quality of the seed provided was good					
Level of advice provided was adequate					
Training provided was adequate					
Collection of the product after harvest was timely					
Payment was timely					
I delivered all products as agreed					
There was side selling by some farmers					

3.21. How likely is the household to continue producing for ACOS Ethiopia's CFA in the coming season if the opportunity exists?

Highly likely	Likely	Don't know	Unlikely	Highly unlikely

3.22. If unlikely, what are the reasons for leaving the scheme?

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## Appendix B: Definition of variables

<b>Variable name</b>	<b>Variable definition</b>
NOFAMILY	Number of total family members
NOMALES	Number of male family members
NOFEMALS	Number of female family members
NOCHILDN	Number of children in the family (<=15 years)
NOADULTS	Number of Adult family members
NOELDERS	Number of elderly family members (>=66 years)
ATDSCHOL	Family members attending school (No.)
WOONFARM	Family members working on farm (No.)
WOOFFARM	Family members working off farm (No.)
STOFFARM	Family Members studying off farm (No.)
AGEOFHHH	Age of the de facto head of the household (years)
GENDERHH	Gender of the de facto head of the household (0 Female, 1 Male)
MARRSTHH	Marital status of the de facto head of the household (1 Married, 2 Never married, 3 Widowed, 4 Divorced)
YSCHOLHH	Formal schooling attended by the de facto head of household (years)
YFARMEHH	Farming experience acquired by the de facto head of household (years)
YCHPEAGE	Chickpea growing experience acquired by the de facto head of household (years)
MEMBRSH	Membership of a cooperative (0 No, 1) Yes
NAMECOOP	Name of the cooperative
LDRSHROL	Whether members of household are playing a leadership role in the cooperative (0 No, 1 Yes)
NLDRSHRL	Name of the leadership role being played
BRICKWAL	Whether one of the walls of the residential house is built with bricks (0 No, 1 Yes)
ROFMATER	Roofing material of dwellings (0 Grass, 1 Corugated iron
OTHRHOUS	Possession of other dwellings (0 No, 1 Yes)
DISTROAD	Distance of residential house to the nearest paved road (Km)
DISTCOOP	Distance of residential house to the nearest cooperative office (Km)
TRNSMEAN	Means of transportation to take products to market (1 Pack animals, 2 Animal cart 3 Trucks )
TIMECOOP	Time taken to transport products to cooperative (Hr.)
TIMEMARK	Time taken to transport products to market (Hr.)
FARMPOCO	Is farming the primary occupation of the head of the household (0 No, 1 Yes)
NOFARMIN	Estimated average monthly non-farm income (ETB)
VEHICLE	Ownership of vehicles (0 No, 1 Yes)
MVEHICLE	Market value of vehicles (ETB)
AGVEHICL	Age of vehicles (Months)
FRIDGE	Ownership of fridge (0 No, 1 Yes)
MVFRIDGE	Market value of fridge (ETB)

<b>Variable name</b>	<b>Variable definition</b>
AGEFRIDG	Age of fridge (Months)
TELEVIS	Ownership of television (0 No, 1 Yes)
MVTELVIS	Market value of television (ETB)
AGETELVS	Age of television (Months)
SATRECIV	Ownership of satellite receiver (0 No, 1 Yes)
MVSATRCV	Market value of satellite receiver (ETB)
AGSATRCV	Age of satellite receiver (Months)
GENRTOR	Ownership of generator (0 No, 1 Yes)
MVGNRTOR	Market value of generator (ETB)
AGGNRTOR	Age of generator (Months)
ORADIO	Ownership of radio (0 No, 1 Yes)
MVRADIO	Market value of radio (ETB)
AGERADIO	Age of radio (Months)
CELLPHONE	Ownership of cell phones (0 No, 1 Yes)
MVCLPHON	Market value of cell phone (ETB)
AGCLPHON	Age of cell phone (Months)
SOLARCH	Ownership of solar charging system (0 No, 1 Yes)
MVSOLRCH	Market value of solar charging system (ETB)
AGSOLRCH	Age of solar charging system (Months)
WWHELL	Ownership of water well (0 No, 1 Yes)
COSTWHEL	Cost of water well (ETB)
AGEWWHEL	Age of water well (Months)
LANDOPRT	Total farm land operated (Ha)
LANDLESD	Land leased to others (Ha)
LANDRNTD	Land rented from others (Ha)
LANDOWND	Land owned (Ha)
LANDFLOD	Land flooded during the rainy season (Ha)
LANDIRGT	Land irrigated (Ha)
LANDACOS	Land planted with ACOS chickpea (Ha)
LANDOCHP	Land planted with ordinary chickpea (Ha)
IRIGATON	Irrigation work done on farm (0 No, 1 Yes)
COSTIRIG	Cost of Irrigation work done on farm (ETB)
AGEIRIG	Age of irrigation work done on farm (Months)
FENCING	Fencing work done on farm (0 No, 1 Yes)
COSTFENC	Cost of fencing work done on farm (ETB)
AGEFENC	Age of fencing work done on farm (Months)
CROPSTOR	Ownership of crop storage (0 No, 1 Yes)
MVCRPSTR	Market value of crop storage (ETB)
AGCRPSTR	Age of crop storage (Months)
WATRANK	Ownership of water tankers (0 No, 1 Yes)



<b>Variable name</b>	<b>Variable definition</b>
MVWATANK	Market Value of water tankers (ETB)
AGEWATNK	Age of water tankers (Months)
CHCKHOUS	Construction of chicken house (0 No, 1 Yes)
COSTCHHS	Cost of chicken house (ETB)
AGECHIH5	Age of chicken house (Months)
TERECE	Terence work done on farm (0 No, 1 Yes)
COSTTERC	Cost of terrace work done on farm (ETB)
AGETERRC	Age of terrace work done on farm (Months)
DRAINAGE	Drainage canal work done on farm (0 No, 1 Yes)
COSTDRAN	Cost of drainage canal work done on farm (ETB)
AGEDRANG	Age of the drainage work done on farm (Months)
ANIMSHED	Construction of animal shed (0 No, 1 Yes)
COSTSHED	Cost of animal shed (ETB)
AGESHED	Age of animals shed (Months)
BANKACCT	Has any member of the household has a bank account (0 No, 1 Yes)
BANKACCB	Bank account balance (ETB)1, ETB 0 - 2,500, 2 ETB 2,500-6,500, 3 ETB 6,500-10,000, 4 >ETB 10,000
ACOSCHPE	Was ACOS chick pea planted (0 No, 1 Yes)
RSACSCHP	Reason for planting ACOS hickpea (1 only for consumption, 2 mainly for consumption, 3 equally for consumption and cash income, 4 mainly for cash income, 5 only for cash income)
ARACSCHP	Area of ACOS chickpea planted (Ha)
YACOSCHP	Quantity produced from ACOS chickpea (Ql.)
RVACSCHP	Revenue from ACOS chickpea (ETB)
SLACSCHP	ACOS chickpea was sold to (1 Neighbours, 2 traders collecting products in villages ('Sebesabi Negade'), 3 roadside stalls, 4 village markets, 5 ACOS Ethiopia, 6 other companies with contract, 7 marketing cooperatives and, 8 bigger city markets)
SDACSCHP	Seed cost for ACOS chickpea (ETB)
FRACSCHP	Fertilizer cost for ACOS chickpea (ETB)
CMACSCHP	Chemical cost for ACOS chickpea (ETB)
OXACSCHP	Machine (oxen) cost for ACOS chickpea (ETB)
LBACSCHP	Labour cost for ACOS chickpea (ETB)
TRACSCHP	Transport cost for ACOS chickpea (ETB)
ORDCHPEA	Was ordinary chickpea planted (0 No, 1 Yes)
RSORDCHP	Reason for planting ordinary chickpea (1 Only for consumption ...)
ARORDCHP	Area of ordinary chickpea (Ha)
YORDCHP	Quantity produced from ordinary chickpea (Ql.)
RVORDCHP	Revenue from ordinary chickpea (ETB)
SALORCHP	Ordinary chickpea was sold to (1 Neighbours ...)

<b>Variable name</b>	<b>Variable definition</b>
TEFFPLTD	Was teff planted (0 No, 1 Yes)
RSTEFF	Reason for planting teff (1 Only for consumption ...)
AREATEFF	Area of teff planted (Ha)
YELTEFF	Quantity produced from planted teff (Ql.)
REVNTEFF	Revenue from teff (ETB)
SALETEFF	Teff was sold to (1 Neighbours ...)
WHEATP	Was wheat planted (0 No, 1 Yes)
RSWHEAT	Reason for planting wheat (1 Only for consumption ...)
AREWHEAT	Area of wheat planted (Ha)
YLDWHEAT	Quantity produced from wheat (Ql.)
RE VWHEAT	Revenue from wheat (ETB)
SALWHEAT	Wheat was sold to (1 Neighbours ...)
BARLYP	Was barley planted (0 No, 1 Yes)
RSBARLY	Reason for planting Barley (1 Only for consumption ...)
AREABARY	Area of barley planted (Ha)
YEDBARLY	Quantity produced from barley (Ql.)
REVBARLY	Revenue from barley planted (ETB)
SALBARLY	Barley was sold to (1 Neighbours ...)
MAIZEP	Was maize planted (0 No, 1 Yes)
R SMAIZE	Reason for planting maize (1 Only for consumption ...)
AREMAIZE	Area of maize planted (Ha)
YLDMAIZE	Quantity produced from maize (Ql.)
REVMAIZE	Revenue from sale of maize (ETB)
SALEMAIZE	Maize was sold to (1 Neighbours ...)
HBEANP	Was haricot bean planted (0 No, 1 Yes)
RSHBEAN	Reason for planting haricot bean (1 Only for consumption ...)
AREHBEAN	Area of haricot bean planted (Ha)
YLDHBEAN	Quantity produced from haricot bean (Ql.)
RE VHBEAN	Revenue from sale of haricot bean (ETB)
SALHBEAN	Haricot bean was sold to (1 Neighbours ...)
ORDPEA	Was ordinary pea planted (0 No, 1 Yes)
RSORDPEA	Reason for ordinary pea (1 Only for consumption ...)
ARORDPEA	Area of ordinary pea planted (Ha)
YORDPEA	Quantity produced from ordinary pea (Ql.)
RVORDPEA	Revenue from sale of ordinary pea (ETB)
SALORDPA	Ordinary pea was sold to (1 Neighbours ...)
LENTILP	Was lentil planted (0 No, 1 Yes)
RSLENTIL	Reason for planting lentil (1 Only for consumption ...)
ARELENTL	Area of lentil planted (Ha)
YDLENTIL	Quantity produced form lentil (Ql.)

<b>Variable name</b>	<b>Variable definition</b>
RVLENTL	Revenue from sale of lentil (ETB)
SALENTIL	Lentil was sold to (1 Neighbours ...)
VEGETABL	Planting of vegetables (0 No, 1 Yes)
RSVEGE	Reason for planting vegetable (1 Only for consumption ...)
ARAVEGE	Area of vegetables planted (Ha)
YLDVEGE	Quantity produced from vegetables (Ql.)
REVEGE	Revenue from sale of vegetables (ETB)
SALVEGLE	Vegetables were sold to (1 Neighbours ...)
SEEDCOST	Seed cost for all other crops except ACOS chickpea (ETB)
FERTCOST	Fertilizer cost for all other crops except ACOS chickpea (ETB)
CHEMCOST	Chemical cost for all other crops except ACOS chickpea (ETB)
OXENCOST	Machine (oxen) cost for all other crops except ACOS chickpea (ETB)
LABRCOST	Labour cost for all other crops except ACOS chickpea (ETB)
TRANCOST	Transport cost for all other crops except ACOS chickpea (ETB)
NOCATTLE	Number of cattle owned excluding dairy cows
CVCATTLE	Current value of cattle owned (ETB)
CATLSOLD	Number of cattle sold in 2014
REVCATLE	Revenue from cattle sold in 2014 (ETB)
NODCOW	Number of dairy cows owned
CVDCOWS	Current value of Dairy cows (ETB)
DCOWSOLD	Number of dairy cows sold in 2014
REVDCOWS	Revenue from sale of dairy cows (ETB)
NOSHEEP	Number of sheep owned
CVSHEEP	Current value of sheep owned (ETB)
SHEPSOLD	Number of sheep sold in 2014
REVSHEEP	Revenue from sheep sold in 2014 (ETB)
NOGOATS	Number of goats owned
CVGOATS	Current value of goats owned (ETB)
GOATSOLD	Number of goats sold in 2014
REVGOATS	Revenue from goats sold in 2014 (ETB)
NOCHICKN	Number of chicken owned
CVCHICKN	Current value of chicken owned (ETB)
CHIKSOLD	Number of chicken sold in 2014
REVCHIKN	Revenue from chicken sold in 2014 (ETB)
RVDAIRYP	Revenue from diary products (ETB)
REVEGGS	Revenue from sale of eggs (ETB)
ANIMCART	Ownership of a cart (0 No, 1 Yes)
MVCART	Market value of cart (ETB)
AGECART	Age of cart (Months)
IRIPUMP	Ownership of irrigation pump (0 No, 1 Yes)
MVIRPUMP	Market value of irrigation pump (ETB)

<b>Variable name</b>	<b>Variable definition</b>
AGIRPUMP	Age of irrigation pump (Months)
OXPLOGH	Ownership of ox-plough (0 No, 1 Yes)
MVOXPLGH	Market value of ox-plough (ETB)
AGOXPLGH	Age of ox-plough (Months)
NAPSPRAY	Ownership of knapsack sprayer (0 No, 1 Yes)
MVSPRYER	Market value of knapsack sprayer (ETB)
AGSPRYER	Age of knapsack spray (Months)
PACKANML	Ownership of pack animals (0 No, 1 Yes)
MVPAKANL	Market value of pack animals (ETB)
AGPACANL	Time since last animal was born or purchased
EXPWOCFA	Does the household have other (0 No, 1 Yes) experiences with contract farming
CRPOCFA1	Crop for another CFA1 (1 Teff, 2 wheat, 3 Chckpea)
YEROCFA1	Year for another CFA1
COMOCFA1	Company for another CFA1
CRPOCFA2	Crop for another CFA2 (1 Teff, 2 wheat, 3 Chckpea)
YEROCFA2	Year for another CFA2
COMOCFA2	Company for another CFA2
HHSAMPLS	Is the household respondent of the household sample survey (0 No, 1 Yes)
PARTACOS	Is the household a participant of ACOS CFA (0 No, 1 Yes)
HERDACOS	Did the household heard about ACOS CFA (0 No, 1 Yes)
HHAPACOS	Did the household approach the cooperative (0 No, 1 Yes)
COPAPPHH	Has the household been approached by the cooperative (0 No, 1 Yes)
LPRTACOS	Likelihood of joining ACOS CFA (1 Highly unlikely, 2 unlikely, 3 Don't know, 4 Likely, 5 highly likely )
YCFA450B	Yes to a CFA with 450 ETB initial investment (0 Yes to other investments and no to any of the other investments, 1 Yes )
YCFA600B	Yes to a CFA with 600 ETB initial investment (0 Yes to other investments and no to any of the other investments, 1 Yes )
YCFA750B	Yes to a CFA with 750 ETB initial investment (0 Yes to other investments and no to any of the other investments, 1 Yes )
YCFA1100	Yes to a CFA with 1100 ETB initial investment (0 Yes to other investments and no to any of the other investments, 1 Yes )
YCFA2200	Yes to a CFA with 2200 ETB initial investment (0 Yes to other investments and no to any of the other investments, 1 Yes )
YCFA5400	Yes to a CFA with 5400 ETB initial investment (0 Yes to other investments and no to any of the other investments, 1 Yes )
NOTOACFA	No to CFAs with all initial investments (0 Yes to any of the investments, 1 No)
WOPTACOS	Who initiated participation (1 Farmers opted to join, 2 recruited by cooperatives)
CHINCOME	How income changed due to participation in ACOS CFA (1 Decreased, 2 No change, 3 slight increase <10%, 4, large increase 20%)

<b>Variable name</b>	<b>Variable definition</b>
CHFEXPND	How farm expenditure changed due to participation in ACOS CFA (1 Decreased...)
CHNETFIN	How net farm income changed due to participation in ACOS CFA (1 Decreased...)
CHLABOUR	How hired farm labour changed due to participation in ACOS CFA (1 Decreased...)
CHAFINPT	How access to other farm inputs changed due to participation in ACOS CFA (1 Decreased...)
CHACREDIT	How access credit changed due to participation in ACOS CFA (1 Decreased...)
CHLEDEBT	How level of debt changed due to participation in ACOS CFA (1 Decreased...)
CHPRMRKT	How access to preferred market changed due to participation in ACOS CFA (1 Decreased...)
CHTCHINF	How access to new technology and info changed due to participation in ACOS CFA (1 Decreased...)
CHTCHADV	How level of technical advice changed due to participation in ACOS CFA (1 Decreased...)
CHSONETW	How access to social network changed due to participation in ACOS CFA (1 Decreased...)
CHFODSEC	How family food security changed due to participation in ACOS CFA (1 Decreased...)
CHHEALTH	How family health changed due to participation in ACOS CFA (1 Decreased...)
CHBCHEDU	How better child education changed due to participation in ACOS CFA (1 Decreased...)
CHHLCARE	How access to health care changed due to participation in ACOS CFA (1 Decreased...)
CHSTACOM	How status in the community changed due to participation in ACOS CFA (1 Decreased...)
INCCHYLD	Change in net income was due to higher yield (0 No, 1 Yes)
INCHPQUL	Change in net income was due to better quality of product (0 No, 1 Yes)
INCHPRIC	Change in net income was due to stable price of chickpea (0 No, 1 Yes)
INCHGMKT	Change in net income was due to guaranteed market for chickpea (0 No, 1 Yes)
INCHINQL	Change in net income was due to better quality of inputs (0 No, 1 Yes)
INCHINPR	Change in net income was due to better price of inputs (0 No, 1 Yes)
INCHMKCO	Change in net income was due to lower marketing cost (0 No, 1 Yes)
SATIPRIC	Satisfaction level with the way price was determined (1 Highly dissatisfied, 2 dissatisfied, 3 neutral, 4 satisfied, 5 highly satisfied)
SANCRWRD	Prevalence of sanctions and rewards (0 No, 1 Yes)
CLEARSPC	Quality specifications were clear (1 Strongly disagree, 2 disagree, 3 neutral, 4 agree, 5 strongly agree)
ACHIVSPC	Required quality specifications were achievable (1 Strongly disagree ...)

<b>Variable name</b>	<b>Variable definition</b>
FRQCHPEA	Frequency of chickpea production (1 Never, 2 some seasons, 3 every other season 4, most seasons, 5 every season)
TIMESEED	Seed was provided timely (1 Strongly disagree ...)
QUALSEED	Quality of seed provided was good (1 Strongly disagree ...)
LEVIADVC	Level of advice provided was adequate (1 Strongly disagree ...)
ADQTRAIN	Training provided was adequate (1 Strongly disagree ...)
TIMEPYMT	Payment was made on time (1 Strongly disagree ...)
DELIVERY	The household delivered all produce (1 Strongly disagree ...)
SIDSELG	Prevalence of side selling (1 Strongly disagree ...)
TIMEBUYG	Product collection (buying) was timely (1 Strongly disagree ...)
LPRACOS2	Likelihood of participation for next season (1 Highly unlikely, 2 unlikely, 3 Don't know, 4 Likely, 5 highly likely )
CROPCOST	Total crop expenditure in 2014 season (ETB)
CROPCREV	Total crop cash revenue in 2014 season (ETB)
CCREVNAC	Total crop cash revenue without the CFA (ETB)
NETCASHR	Net crop cash revenue in 2014 season (ETB)
CROPTREV	Total crop revenue in 2014 (ETB)
LIVWELTH	Total livestock wealth as of June 2014 (ETB)
LIVCREV	Total revenue from livestock and livestock products in 2014 (ETB)
MVHHASST	Monitory value of major household assets (ETB)
MVFARASST	Monitory value of major household assets (ETB)
MVFARIMP	Monitory value of farm investments (ETB)
MVFHHAASST	Monitory value of farm and household assets (ETB)
FRMINVST	monitory value of farm assets and improvments (ETB)
AGEOFHH2	Age of the household heads squared
CROPMIX	Number of crops cultivated in 2014 season
CASREVPH	Total crop cash revenue per hectare in 2014 season (ETB)
CHPEAPRO	Total chickpea production in 2014 season (Qnl.)
CHPEAPRY	Chickpea productivity in 2014 season (Qnl/ha)
TVEHICL	Value of vhecles purchased before the CFA (ETB)
TTELVS	Value of television sets purchased before the CFA (ETB)
TSATRCV	Value of satelight reciever purchased before the CFA (ETB)
TRADIO	Value of radio purchased before the CFA (ETB)
TCLPHON	Value of mobile telephones purchased before the CFA (ETB)
YCLPHON	Possession of mobile telephone before the CFA (0 No, 1 Yes)
TSOLRCH	Value of solar chargers perched before the CFA (ETB)
TWWHEL	Value of water whells dug before the CFA (ETB)
YWWHEL	Possession of water whells before the CFA (0 No, 1 Yes)
THHASST	Total value of household assets before the CFA (ETB)
TIRRIG	Value of irrigation work done before the CFA (ETB)

<b>Variable name</b>	<b>Variable definition</b>
TFENCE	Value of fencing work done before the CFA (ETB)
TCRPSTR	Value of crop storage built before the CFA (ETB)
TWATNK	Value of water tanks purchased before the CFA (ETB)
TCHICKHS	Value of chicken house built before the CFA (ETB)
TTERRCE	Value of terrecing work done before the CFA (ETB)
YTERRCE	Weather terrecing was done before the CFA (0 No, 1 Yes)
TDRANG	Value of drange work done before the CFA (ETB)
TSHED	Value of animal shed built before the CFA (ETB)
TFARMIMP	Total value of farm improvments done before the CFA (ETB)
TCART	Value of animal drawn carts purchased before the CFA (ETB)
TIRPUMP	Value of irrigation pumps purchased before the CFA (ETB)
TOXPLGH	Value of oxplough purchased before the CFA (ETB)
YOXPLGH	Weather the household had oxplough before the CFA (0 No, 1 Yes)
TSPRYER	Value of Napsack sprayer purchased before the CFA (ETB)
TPACANL	Value of pack animals purchased or born beofre the CFA (ETB)
TFARASST	Total value of farm assets purchased before the CFA (ETB)
YCFAL750	Yes to a CFA with intitial investment of less than or equal to 750 ETB (0 Yes to other investments and no to any of the other investments, 1 Yes)
YCFAG750	Yes to a CFA with initial investment of more than 750 ETB (0 Yes to other investments and no to any of the other investments, 1 Yes)
ADULEQUT	Adult equiavalents in households (No.)
LABENDNT	Labour endowments in the households (No.)
DEPENEQ	Number of dependents per asult equivalent (No.)
LANDAEQV	Land cultivated in 2014 season per adult equivalent (Ha)
LANDOEQV	Land woned by the household per adult equivalent (Ha)
HHASETEQ	Value of major household asset per adult equivalent before the CFA (ETB)
FARASTEQ	Value of major household asset per adult equivalet before the CFA (ETB)
HFASTEQ	value of major household and farm assets per adult equivalent before the CFA (ETB)
FARIMPEQ	Value of farm improvemnts per adult equivalent before the CFA (ETB)
VACATLEQ	Value of catele per adult equivalent (ETB)
FRMINVEQ	Value of major fam assets and farm mprovments per adult equivalent (ETB)
NOCATTEQ	Number of cattle per adult equivalent
LNFINV	Natural logarithem of value of farm assets and farm improvments (ETB)
CRPCSTEQ	Total crop expenditure per adult equivalent (ETB)
CRPCRVEQ	Total crop cash revenue per adult equivalent (ETB)
CRVNCFEQ	Totla crop cash revenue without the CFA per adult equivalent (ETB)
NTCSHREQ	Net crop cash revenue per adult equivaent (ETB)
CRPTRVEQ	Total crop revenue per adult equivalent (ETB)
LVWLTHEQ	Total livestock wealth per adult equivalent as of June 2014 (ETB)

<b>Variable name</b>	<b>Variable definition</b>
LVCREVEQ	Total livestock revenue per adult equivalent (ETB)
HHASSTEQ	Value of major househod assets per adult equivalent (ETB)
FRMASTEQ	Value of major farm assets per adult equivalent (ETB)
FRMIMPEQ	Value of farm improvments per adult equivalent (ETB)
FHHASTEQ	Value of major household and farm households per adult equivalent (ETB)
PRE_1	Predicted probablity of household participation by logit model 1
PROPSCOR	Participation propensity scores
PRE_2	Predicted probablity of household participation by logit model 1 on matched housholds
PCRPCSEQ	Predited value of total crop expenditure per adult equivalent for each case (ETB)
UCRPCSEQ	Residual value for each case for predicted total crop expenditure per adult equivalent (ETB)
PCRPCREQ	Predited value of total crop cash revenue per adult equivalent for each case (ETB)
UCRPCREQ	Residual value for each case for predicted total crop cash revenue per adult equivalent (ETB)
PNTCSREQ	Predited value of net cash revenue per adult equivalent for each case (ETB)
UNTCSEQ	Residual value for each case for predicted net net crop cash revenue per adult equivalent (ETB)
PCRPTREQ	Predited value of total crop revenue per adult equivalent for each case (ETB)
UCRPTREQ	Residual value for each case for predicted total crop revenue per adult equivalent (ETB)
PCRPCSQ1	Predited value of total crop expenditure per adult equivalent for each case of never takers and compliers predicted to not participate (ETB)
PCRPCRQ1	Predited value of total crop cash revenue per adult equivalent for each case of never takers and compliers predicted to not participate (ETB)
PNTCSRQ1	Predited value of net cash revenue per adult equivalent for each case of of never takers and compliers predicted to not participate (ETB)
PCRPTRQ1	Predited value of total crop revenue per adult equivalent for each case of never takers and compliers predicted to not participate (ETB)
PCRPCSQ2	Predited value of total crop expenditure per adult equivalent for each case of never takers predicted to participate (ETB)
PCRPCRQ2	Predited value of total crop cash revenue per adult equivalent for each case of never takers predicted to participate (ETB)
PNTCSRQ2	Predited value of net cash revenue per adult equivalent for each case of never takers predicted to participate (ETB)
PCRPTRQ2	Predited value of total crop revenue per adult equivalent for each case of never takers predicted to participate (ETB)
PCRPCSQ3	Predited value of total crop expenditure per adult equivalent for each case of always takers (ETB)



<b>Variable name</b>	<b>Variable definition</b>
PCRPCRQ3	Predicted value of total crop cash revenue per adult equivalent for each case of always takers (ETB)
PNTCSRQ3	Predicted value of net cash revenue per adult equivalent for each case of always takers (ETB)
PCRPTRQ3	Predicted value of total crop revenue per adult equivalent for each case of always takers (ETB)
PCRPCSQ4	Predicted value of total crop expenditure per adult equivalent for each case of participating compliers (ETB)
PCRPCRQ4	Predicted value of total crop cash revenue per adult equivalent for each case of participating compliers (ETB)
PNTCSRQ4	Predicted value of net cash revenue per adult equivalent for each case of participating compliers (ETB)
PCRPTRQ4	Predicted value of total crop revenue per adult equivalent for each case of participating compliers (ETB)

Appendix C: Household sample design

Wereda	Kebele	Got	Households	Range	Prob.	Selected PSU	Sampled non-participants
Becho	Soyoma		<b>600</b>				
		Batu soyoma	254	1 - 254	0.07	102	26.00
		Bonga	167	255- 421	0.05	312	16.00
		Dhame	179	422- 600	0.05		
	Qobo		<b>250</b>				
		Cherecha	90	601-690	0.02	645	9.00
		Qobo	58	691- 748	0.02		
		Negeda	80	749 - 828	0.02		
	Awash Bune		<b>1205</b>				
		Ture Geda	430	829 - 1258	0.12	929	43.00
		Awash bune	450	1259 - 1708	0.12		
	Tullu Guji	325	1709 - 2033	0.09			
Illu	Ketta Asgori		<b>427</b>				
		Tachigna Keta	191	2024 - 2224	0.05		
		Koticha Kello	136	2225 - 2360	0.04	2,282	12.00
		Jigo lugo	100	2361 - 2460	0.03		
	Wataarbi Bessai		<b>365</b>				
		Bessi	95	2461 - 2555	0.03		
		Weserbi	94	2556 - 2649	0.03		
		Repa delta	176	2650 - 2649	0.05		
	Buti Tergo		<b>306</b>				
		Buti	96	2826 - 2921	0.03	2,911	9.00
Telgo		134	2922 - 3055	0.04			
	Gudechana	117	3056 - 3172	0.03			
Tolle	Tulu Teji		<b>535</b>				
		Tejina Challegi	126	3173 - 3298	0.03		
		Boreyona monaye	167	3299 - 3465	0.05		
		Tuluna Shuke	142	3466 - 3607	0.04	3,560	14.00
<b>TOTAL</b>			<b>3607</b>				<b>129*</b>

\* 15 questionnaires were discarded as they did not satisfy quality control

Appendix D: Regression estimating treatment effect on total crop expenditure per adult equivalent

<b>CRPCSTEQ</b>						<b>Collinearity Statistics</b>	
<b>Variables</b>	<b>Coefficients</b>	<b>S.E</b>	<b>New S.E</b>	<b>t-value</b>	<b>P- values</b>	<b>Tolerance</b>	<b>VIF</b>
(Constant)	5,414.63	1,575.99	1,896.57	2.85	0.005	-	-
†	786.02	532.85	641.25	1.23	0.223	0.64	1.58
AGEOFHHH	-201.96	66.74	80.31	-2.51	0.013	0.01	77.23
AGEOFHH2	2.00	0.66	0.79	2.53	0.013	0.01	72.87
GENDERHH	-231.34	256.54	308.73	-0.75	0.455	0.79	1.26
YSCHOLHH	-2.33	30.70	36.95	-0.06	0.950	0.66	1.51
LABENDNT	-72.47	63.65	76.59	-0.95	0.346	0.55	1.83
LANDOEQV	2,799.14	302.88	364.50	7.68	0.000	0.63	1.59
FRMINVEQ	0.14	0.04	0.05	2.61	0.010	0.89	1.13
CROPMIX	14.96	67.78	81.57	0.18	0.85	0.76	1.31
F- statistics	22.25				-		
Adjusted R2	0.61						

Appendix E: Regression estimating treatment effect on total crop cash revenue per adult equivalent

<b>CRPCRVEQ</b>						<b>Collinearity Statistics</b>	
<b>Variables</b>	<b>Coefficients</b>	<b>S.E</b>	<b>New S.E</b>	<b>t-value</b>	<b>P- values</b>	<b>Tolerance</b>	<b>VIF</b>
(Constant)	-1,114.31	4,576.05	4,377.03	-0.25	0.799	-	-
†	3,658.08	1,628.57	1,557.74	2.35	0.020	0.64	1.58
AGEOFHHH	64.11	188.87	180.65	0.35	0.723	0.01	69.98
AGEOFHH2	-0.81	1.82	1.74	-0.46	0.644	0.02	65.59
GENDERHH	63.26	796.24	761.61	0.08	0.934	0.81	1.24
YSCHOLHH	-181.03	93.94	89.86	-2.01	0.046	0.66	1.52
LABENDNT	210.50	193.69	185.26	1.14	0.258	0.56	1.79
LANDOEQV	5,992.22	838.92	802.43	7.47	0.000	0.60	1.67
FRMINVEQ	0.12	0.13	0.13	0.90	0.371	0.83	1.21
CROPMIX	-843.19	209.13	200.03	-4.22	0.000	0.77	1.30
F- statistics	10.65				-		
Adusted R2	0.41						

Appendix F: Regression estimating treatment effect on net crop cash revenue per adult equivalent

<b>NETCSHREQ</b>						<b>Collinearity Statistics</b>	
<b>Variables</b>	<b>Coefficients</b>	<b>S.E</b>	<b>New S.E</b>	<b>t-value</b>	<b>P- values</b>	<b>Tolerance</b>	<b>VIF</b>
(Constant)	-6,569.88	4,371.03	4,800.90	-1.37	0.174	-	-
†	3,410.61	1,477.88	1,623.22	2.10	0.038	0.64	1.58
AGEOFHHH	264.60	185.09	203.29	1.30	0.196	0.01	77.23
AGEOFHH2	-2.63	1.82	2.00	-1.31	0.191	0.01	72.87
GENDERHH	281.95	711.52	781.50	0.36	0.719	0.79	1.26
YSCHOLHH	-141.42	85.16	93.53	-1.51	0.133	0.66	1.51
LABENDNT	201.41	176.53	193.89	1.04	0.301	0.55	1.83
LANDOEQV	2,782.97	840.05	922.67	3.02	0.003	0.63	1.59
FRMINVEQ	-0.06	0.12	0.13	-0.43	0.669	0.89	1.13
CROPMIX	-851.00	188.00	206.48	-4.12	0.000	0.76	1.31
F- statistics	5.12				-		
Adusted R2	0.23						

Appendix G:Regression analysis on treatment effect on total crop revenue per adult equivalent

<b>CRPTRVEQ</b>						<b>Collinearity Statistics</b>	
<b>Variables</b>	<b>Coefficients</b>	<b>S.E</b>	<b>New S.E</b>	<b>t-value</b>	<b>P- values</b>	<b>Tolerance</b>	<b>VIF</b>
(Constant)	1,553.11	4,038.10	4,066.14	0.38	0.703	-	-
†	730.17	1,459.01	1,469.15	0.50	0.620	0.63	1.58
AGEOFHHH	-14.36	166.66	167.82	-0.09	0.932	0.02	68.93
AGEOFHH2	0.13	1.60	1.62	0.08	0.935	0.02	64.50
GENDERHH	-285.50	718.58	723.57	-0.39	0.694	0.79	1.26
YSCHOLHH	151.10	82.84	83.41	1.81	0.073	0.66	1.52
LABENDNT	-45.78	172.39	173.58	-0.26	0.792	0.56	1.79
LANDOEQV	8,390.16	844.84	850.71	9.86	0.000	0.61	1.64
FRMINVEQ	0.21	0.12	0.12	1.77	0.079	0.87	1.15
CROPMIX	172.82	185.34	186.63	0.93	0.356	0.79	1.26
F- statistics	20.57					-	
Adusted R2	0.59						

Appendix H: Estimated values of each outcome variable for classified groups

<b>Group name</b>	<b>Outcomes</b>	<b>N</b>	<b>Average values predicted</b>
Participant compliers	Total crop expenditure	43	3,157.70
	Total crop cash revenue	43	4,039.18
	Net crop cash revenue	43	836.72
	Total crop revenue	43	9,983.42
Never takers predicted to particpate	Total crop expenditure	25	2,906.60
	Total crop cash revenue	25	3,868.05
	Net crop cash revenue	25	918.61
	Total crop revenue	25	8,894.25
Non-participant compliers and never takers	Total crop expenditure	39	2,487.91
	Total crop cash revenue	39	2,155.65
	Net crop cash revenue	39	-332.27
	Total crop revenue	39	7,617.24
Non-participant compliers	Total crop expenditure	25	2,244.49
	Total crop cash revenue	25	1,160.07
	Net crop cash revenue	25	-1,059.52
	Total crop revenue	25	6,874.80

Appendix I: Data used to estimate the general treatment model

CASENO	PARTACOS	PRE_2	AGEOFHHH	AGEOFHH2	GENDERHH	YSCHOLHH	LABENDNT
1	1	0.5016	52	2704	0	4	3
2	0	0.1726	38	1444	1	1	4
4	1	0.6701	72	5184	1	0	3.5
5	1	0.7199	60	3600	1	0	3
6	1	0.6127	54	2916	1	0	3
10	1	0.5044	34	1156	1	0	2
12	1	0.6251	60	3600	1	0	3
13	1	0.6071	37	1369	1	7	5
14	0	0.4010	33	1089	1	5	4
15	0	0.3273	43	1849	1	3	5
16	1	0.4604	38	1444	1	7	6
17	0	0.2277	42	1764	1	7	6
18	0	0.6658	45	2025	1	11	5
19	0	0.1969	49	2401	1	0	4
20	0	0.4525	39	1521	1	6	6
21	1	0.6942	52	2704	1	10	6
22	0	0.2786	29	841	1	8	1
23	1	0.6826	45	2025	1	13	5
24	0	0.1490	30	900	1	1	2
25	0	0.4862	43	1849	1	9	5
26	0	0.1901	36	1296	1	5	4
27	1	0.6211	53	2809	1	3	4
28	1	0.3626	35	1225	1	1	2
31	0	0.6479	52	2704	1	8	4
35	0	0.3396	45	2025	0	9	5
36	0	0.1710	55	3025	0	0	4
37	0	0.3188	68	4624	0	1	2.5
38	0	0.5417	56	3136	0	0	3
40	0	0.1808	42	1764	1	3	2

CASENO	PARTACOS	PRE_2	AGEOFHHH	AGEOFHH2	GENDERHH	YSCHOLHH	LABENDNT
41	0	0.3988	58	3364	0	1	5
42	0	0.2915	32	1024	1	4	3
43	0	0.4997	54	2916	1	4	8
44	0	0.1939	42	1764	1	2	4
45	1	0.5377	38	1444	1	6	4
46	0	0.4529	61	3721	1	7	9
47	1	0.3367	53	2809	1	0	5
48	0	0.4489	46	2116	1	3	5
49	0	0.4016	39	1521	1	2	3
50	0	0.1374	37	1369	0	2	4
51	0	0.6175	39	1521	1	7	5
52	0	0.5838	41	1681	1	4	5
53	0	0.1601	32	1024	1	3	1
55	1	0.4350	47	2209	1	1	2
57	0	0.4745	60	3600	1	1	4
59	0	0.4691	43	1849	1	7	5
61	1	0.1862	42	1764	1	3	2
62	1	0.7732	50	2500	1	9	8
63	1	0.5900	44	1936	1	9	3.5
64	0	0.5388	38	1444	1	0	3.5
65	0	0.5519	51	2601	0	4	5
67	0	0.7497	67	4489	1	1	5.5
68	0	0.7374	65	4225	1	2	2
69	1	0.5864	45	2025	1	2	5
71	1	0.6131	42	1764	0	3	4
72	0	0.3124	80	6400	1	2	5.5
73	0	0.2649	76	5776	1	2	2
74	1	0.5333	40	1600	1	2	2
75	1	0.4101	27	729	1	9	3
76	1	0.7151	43	1849	1	7	4

CASENO	PARTACOS	PRE_2	AGEOFHHH	AGEOFHH2	GENDERHH	YSCHOLHH	LABENDNT
79	0	0.3043	48	2304	1	1	3
80	0	0.2843	54	2916	0	1	3
81	1	0.3764	37	1369	1	2	3
82	1	0.5430	24	576	1	8	2
83	1	0.5303	40	1600	0	8	2
84	1	0.7319	50	2500	1	3	8
85	1	0.3842	55	3025	1	3	7
87	1	0.6671	57	3249	0	2	6
89	0	0.6656	67	4489	1	3	4.5
90	1	0.7405	51	2601	1	6	6
91	0	0.4884	36	1296	1	2	2
92	0	0.4918	38	1444	1	2	3
93	0	0.5218	36	1296	1	1	2
94	1	0.4754	36	1296	0	1	4
95	0	0.3894	36	1296	0	0	3
96	0	0.4830	39	1521	1	1	2
98	0	0.7077	42	1764	1	8	3
100	1	0.7648	45	2025	1	12	5.5
101	1	0.6536	42	1764	1	1	3
103	1	0.7671	50	2500	1	10	6
104	1	0.5051	67	4489	1	2	4
105	1	0.4441	47	2209	0	0	3.5
107	1	0.5639	42	1764	1	4	7
113	0	0.4141	67	4489	0	0	2.5
114	0	0.4311	41	1681	1	4	4
115	1	0.5202	43	1849	1	0	6
118	0	0.5685	36	1296	1	4	5
119	1	0.4684	44	1936	1	5	6
125	1	0.6731	57	3249	1	6	4
128	0	0.4107	59	3481	0	3	3



CASENO	PARTACOS	PRE_2	AGEOFHHH	AGEOFHH2	GENDERHH	YSCHOLHH	LABENDNT
129	1	0.3651	39	1521	1	9	5
131	0	0.5405	37	1369	1	6	4
132	1	0.3704	62	3844	1	0	5
134	1	0.6344	48	2304	1	7	5
137	0	0.4545	51	2601	1	2	4
139	0	0.5361	43	1849	1	0	2
151	1	0.6145	50	2500	1	3	5
152	1	0.6371	43	1849	1	12	2
153	1	0.7042	55	3025	1	0	5
157	1	0.6075	49	2401	1	4	2
158	1	0.4714	57	3249	1	0	5
163	0	0.6178	40	1600	1	7	5
165	0	0.5413	31	961	1	10	3
166	0	0.5975	45	2025	1	2	5
167	0	0.4664	33	1089	1	2	3
170	0	0.6932	46	2116	1	2	5
172	0	0.6039	60	3600	1	0	1
173	0	0.5753	30	900	1	10	2
174	0	0.4939	65	4225	1	0	2
177	0	0.5646	38	1444	1	5	2
180	1	0.4168	36	1296	1	2	3
181	1	0.6200	40	1600	1	9	4
182	1	0.1481	54	2916	0	0	2
183	1	0.4061	25	625	1	10	2
185	1	0.4715	66	4356	1	0	2.5
186	1	0.5575	43	1849	1	1	3
187	1	0.6578	65	4225	1	1	6
190	1	0.4300	41	1681	1	5	4
191	1	0.6625	65	4225	0	0	2
192	1	0.6361	66	4356	1	0	1.5

CASENO	PARTACOS	PRE_2	AGEOFHHH	AGEOFHH2	GENDERHH	YSCHOLHH	LABENDNT
193	1	0.2552	65	4225	1	2	6
194	1	0.4409	47	2209	1	2	6
198	0	0.5718	44	1936	1	1	4
200	1	0.5545	32	1024	1	6	2
202	1	0.6121	57	3249	1	1	2
203	1	0.7317	56	3136	1	1	8
204	1	0.7052	52	2704	1	1	6
206	0	0.6502	59	3481	1	1	8
208	0	0.6017	48	2304	1	1	6

CASENO	LANDOEQV	FRMINVEQ	CROPMIX	CRPCSTEQ	CRPCRVEQ	NTCSHREQ	CRPTRVEQ
1	1.21	3031.2	5	2893.24	1101.08	-1792.16	10832.65
2	0.29	28.19	4	1562.48	822.23	-740.24	4346.09
4	1.19	1201.05	4	5624.8	2479.59	-3145.21	15742.82
5	1.44	749.53	4	5052.84	10510.59	5457.75	15938.19
6	2.27	1470.26	4	8198.49	25842.92	17644.43	24482.77
10	1.53	1274.38	4	7554.66	3331.71	-4222.95	
12	1.29	1511	4	4556.51	10073.34	5516.83	17021.36
13	0.75	2813.74	5	2694.08	1282.89	-1411.18	13540.45
14	0.52	1269.3	3	2347.86	697.38	-1650.48	7051.34
15	0.49	2317.83	3	2102.22	1121.18	-981.04	7826.73
16	0.56	549.91	7	2130.63	1020.33	-1110.3	8125.54
17	0.56	1320.86	5	1972.02	834.82	-1137.2	8199.74
18	0.56	1354.26	4	2170.52	927.57	-1242.95	10453.74
19	0.57	2397.91	3	2139.45	0	-2139.45	5772.21
20	0.39	1848.25	3	1601.82	859.05	-742.77	6056.72
21	0.87	2689.95	7	2269.1	798.31	-1470.79	13566.87
22	0.8	214.35	4	3456.47	1768.43	-1688.04	15245.98
23	0.41	326.19	5	1957.16	1304.77	-652.39	5153.85

CASENO	LANDOEQV	FRMINVEQ	CROPMIX	CRPCSTEQ	CRPCRVEQ	NTCSHREQ	CRPTRVEQ
24	0.37	78.13	4	1800.68	1878.81	78.13	6101.47
25	0.6	927.08	4	2015.65	897.17	-1118.48	9759.25
26	0.29	109.06	4	1830.06	481.59	-1348.46	4534.03
27	0.59	1132.33	3	2453.07	6286.56	3833.49	6624.85
28	0.44	767.17	2	2201.56	5172.92	2971.36	5874.34
31	0.37	1040.74	3	1304.91	1521.22	216.31	2059.21
35	0.95	498.43	5	2236.35	1832.43	-403.93	7077.7
36	1.03	30.99	6	2687.51	1601.4	-1086.11	7412.94
37	1.12	2321.54	4	4913.55	5282.98	369.44	12947.03
38	1.3	5111.84	5	5886.43	6250.29	363.86	16220.99
40	0.24	0	2	760.07	0	-760.07	2687.92
41	0.47	2184.79	5	1759.58	693.03	-1066.55	6542.63
42	0.81	2587.53	4	2810.98	1845.92	-965.06	14637.85
43	0.26	364.44	3	1066.59	290.05	-776.54	3770.64
44	0.77	1282.21	5	2820.53	710.3	-2110.23	8833.54
45	0.71	2857.78	5	2415.02	1278.54	-1136.48	9982.93
46	0.55	2484.54	4	1640.21	429.09	-1211.13	8747.8
47	0.7	2581.81	5	2452.6	1104.14	-1348.46	11346.82
48	0.6	1987.74	6	1680.7	897.17	-783.53	8951.8
49	0.7	1625.67	5	1951.04	951.44	-999.6	9185.52
50	0.52	946.43	4	1335.36	955.68	-379.69	6496.01
51	0.59	2106.53	5	2128.09	884.01	-1244.08	7729.7
52	0.3	2392.46	4	1391.62	219.31	-1172.31	4376.21
53	1.5	4000	1	5172	0	-5172	10400
55	1.4	89.29	7	6021.86	1934.61	-4087.24	5067.2
57	0.32	0	3	1078.62	619.9	-458.72	3454.64
59	0.43	735.83	4	1688.59	1210.48	-478.12	5067.51
61	0.51	89.29	4	4478.63	1413.76	-3064.87	6287.49
62	0.59	1982.88	7	2195.54	474.63	-1720.91	8015.9
63	0.69	2950.26	7	2579.74	1579.26	-1000.49	6959.15

CASENO	LANDOEQV	FRMINVEQ	CROPMIX	CRPCSTEQ	CRPCRVEQ	NTCSHREQ	CRPTRVEQ
64	0.65	51.75	6	1997.43	1854.27	-143.17	5799.97
65	0.54	482.97	6	1462.28	1358.36	-103.93	
67	0.61	937.14	6	2372.71	815.66	-1557.04	3045.71
68	1.3	77.72	4	3508.55	3303.23	-205.32	
69	0.39	1582.73	4	1892.33	1041.27	-851.06	4104.34
71	1.06	11.75	4	3426.13	5922.43	2496.3	11393.8
72	0.86	482.97	6		431.22		5110.01
73	0.47	0	3	1784.31	1078.92	-705.39	4018.04
74	0.74	852.36	5	3688.39	1498.09	-2190.3	7438.77
75	0.93	7423.46	5	5968.35	2950.72	-3017.63	9749.58
76	0.56	128.01	5	2690.15	0	-2690.15	5528.33
79	0.26	61.99	4	1256.33	309.95	-946.38	2867.03
80	1.29	34.46	4	3666.65	1378.44	-2288.21	12492.09
81	0.77	3729.72	5	3557.18	929.85	-2627.33	12966.19
82	0.93	5089.63	5	6509.55	6509.99	0.44	18631.29
83	0.77	14098.41	5	6748.03	5085.25	-1662.79	13239.18
84	0.58	2668.45	6	2055.92	316.42	-1739.5	5299.99
85	0.57	2332.28	7	3095.9	1598.35	-1497.55	7902.03
87	0.7	1215.12	4	1754.78	2096.31	341.53	9220.07
89	0.59	886.17	3	1678.33	474.35	-1203.98	5638.26
90	0.49	1102.53	4	1488.09	1630.97	142.87	5675.76
91	0.81	1334.25	5	1873.13	955.35	-917.78	6808.87
92	0.43	1563.67	4	1322.15	1263.57	-58.58	5657.34
93	0.47	2228.53	3	1575.22	595.27	-979.96	5878.25
94	0.68	577.91	8	2690.46	4892.29	2201.82	8797.9
95	0.49	2302.55	3	1487.75	990.97	-496.78	5408.23
96	0.59	114.27	3	1360.51	1509.29	148.77	5142.35
98	0.94	1070.08	4	3069.98	2349.24	-720.75	9091.55
100	0.61	1317.21	5	1632.02	2394.92	762.9	8642.53
101	0.76	946.74	6	2889.09	3241.95	352.86	11558.25

CASENO	LANDOEQV	FRMINVEQ	CROPMIX	CRPCSTEQ	CRPCRVEQ	NTCSHREQ	CRPTRVEQ
103	0.73	532.47	5	2730.68	3393.34	662.66	14496.73
104	0.52	963.17	4	2576.1	1162.75	-1413.35	6525.29
105	0.71	1033.16	3	2682.09	2040.5	-641.59	7296.71
107	0.66	1384.35	6	2679.81	1457.21	-1222.6	5952.71
113	0.74	349.72	5	3065.62	985.91	-2079.71	9152.21
114	0.59	1808.91	5	2285.81	927.95	-1357.86	9056.31
115	0.56	679.77	6	2156.61	890.47	-1266.14	8821.22
118	0.37	1050.79	4	1634.38	677.13	-957.26	5287.16
119	0.7	1169.16	6	2499.13	897.17	-1601.95	9679.5
125	1.03	2793.21	5	3200.22	1291.45	-1908.77	17344.22
128	0.74	0	4	1979.26	483.65	-1495.61	9505.65
129	0.58	2356.03	6	2508.16	1103.81	-1404.35	10860.02
131	0.77	1669.65	6	2409.85	1110.65	-1299.2	10215.4
132	0.7	2528.77	6	2151.9	681.28	-1470.62	11481.9
134	0.4	1228.97	5	2170.16	817.42	-1352.74	7326.92
137	0.86	1906.01	3	3628.76	9756.46	6127.7	16278.73
139	0.57	7088.99	3	2341.41	2526	184.59	7140.81
151	0.72	1348.69	5	3263.2	5713.85	2450.65	9591.1
152	0.94	2882.51	4	4389.55	9256	4866.45	14518.29
153	1.11	640.03	4	1782.79	5750.95	3968.16	8459.46
157	1.49	4985.35	4	2754.96	3646	891.04	10286.94
158	0.98	187.56	4	1965.31	9883.65	7918.34	8905.07
163	0.65	949.85	6	2107.36	1256.04	-851.32	9938.69
165	0.65	150.33	3	2464.47	1295.38	-1169.08	9116.27
166	1	6221.58	3	3418.83	9961.48	6542.64	9579.68
167	0.5	1723.05	3	1677.1	2038.94	361.84	4824.53
170	0.65	5542.54	3	5544.53	2392.46	-3152.07	8951.8
172	1.5	320	2	4375	6200	1825	12700
173	0.67	4528.24	2	5881.36	0	-5881.36	7154.09
174	0.94	2679.43	2	2395.41	4019.15	1623.74	7020.12

CASENO	LANDOEQV	FRMINVEQ	CROPMIX	CRPCSTEQ	CRPCRVEQ	NTCSHREQ	CRPTRVEQ
177	1.1	9315.64	3	2288.36	8548.47	6260.11	14970.79
180	1.51	3141.31	3	5579.87	15463.65	9883.78	15674.15
181	0.32	431.22	4	1556.29	6446.81	4890.52	7632.68
182	0.37	1997.86	2	1916.76	5431.8	3515.04	5431.8
183	0.44	65.76	2	2165.61	3901.61	1736	3901.61
185	0.56	1264.94	3	3612.52	8184.9	4572.38	8259.31
186	0.52	69.74	3	2634.31	6483.1	3848.79	6948.02
187	0.5	3462.89	4	2775.06	5323.23	2548.17	6310.12
190	0.28	641.88	4	1536.06	3765.95	2229.88	4795.55
191	1.25	455.5	3	9166.88	16183.78	7016.9	18112.97
192	1.12	669.67	3		10119.52		11272.84
193	0.26	481.59	2	1281.8	3679.15	2397.35	3679.15
194	0.26	31.24	3	918.23	3358.09	2439.87	3644.44
198	0.59	3989.01	3	1924.5	4322.6	2398.1	7740.74
200	0.52	4396.11	3	3350.29	6302.29	2952	6767.22
202	0.93	6120.08	4	3673.91	7292	3618.1	8073.29
203	0.46	2694.05	3	2305.47	5392.41	3086.94	6569.69
204	0.43	2910.35	3	1973.21	5223.7	3250.5	6429.84
206	0.38	269.31	2	1806.24	4385.95	2579.71	6463.51
208	0.56	534.28	3	2326.35	5226.87	2900.52	8079.16