From subsistence to market production

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Thesis

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To Doris and Mark

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Chapter 1
Introduction

1.1 Background

Over the years, agriculture has remained the main source of livelihood in Africa. It is the most important productive sector for rural people in sub-Saharan countries. As demonstrated by the green revolution in Asia, if strategically planned, agriculture is a potentially powerful means of breaking the cycle of poverty and hunger. However, most African countries have not been able to realize a successful agricultural revolution, largely due to underinvestment in the sector and other relevant non-agricultural sectors such as technology development, physical infrastructure, institutions and health (Diao et al., 2007). In recent decades, agriculture in African countries has been subjected to a number of reforms that aim at transforming subsistence agriculture into market oriented production. The structural adjustment programs in the 1980s and 90s, which included agricultural trade liberalization and privatization, led governments across sub-Saharan Africa to withdraw from produce marketing as well as providing other services to farmers. This was meant to encourage entry by private traders and foster competition, which in turn would improve producer prices. This, in turn, was expected to attract more investments by farmers to produce for the market. However, liberalization policies have had diverse effects on market prices. For example, farm prices have become unstable and unpredictable, adversely affecting household income and food security (Barrett, 1997; Ellis & Freeman, 2004; Kherallah et al., 2002).

The agriculture sector in Africa relied heavily on traditional export crops such as coffee, tea, cotton and cocoa. While these traditional exports still have a high potential to drive rural economic growth if farmers and traders manage to improve quality and identify niche markets, they may not benefit all small holder farmers. Considering the increasing population and ongoing process of urbanization, the greatest market potential for most African farmers may lie in domestic and regional markets for food crops (Diao & Hazell, 2004). Increased market integration of traditional food crops has been part of a development strategy by most African governments towards reduction of poverty and food insecurity in rural areas. This is based on the presumption that agricultural growth in the food sector can offer the greatest poverty reduction across most of rural Africa (Diao et al., 2007). However, the agricultural sector is dominated by small scale farmers who face a number of challenges (including limited access to improved technologies, productive resources, credit and markets) which limit their potential productivity in both food and cash crops (Kherallah et al., 2002). Their

productivity growth will largely depend on government support, otherwise, rural households will remain trapped in the cycle of poverty and hunger (Jayne et al., 2010).

Despite various agricultural reforms and a large population engaged in agriculture, the food security situation in Africa has not changed significantly. Food insecurity remains a significant and persistent challenge in sub-Saharan Africa. About 25% of the population in Africa still suffers from hunger and under nourishment due to low food availability and limited access to nutritious foods (Fan, 2015; FAO, 2015). More than a third of Africa's children are stunted, a situation that exposes them to a range of physical and cognitive challenges (Benson, 2004). Under nutrition is the major risk factor causing over 2.9 million deaths (28% of all deaths) in Africa annually (Benson, 2004). This situation has been largely attributed to subsistence production characterized by low productivity and consequently low returns. The hunger problem is compounded by fragmented small land holdings, due to rapid population growth (Ellis & Freeman, 2004). For instance, in Uganda the average acreage per household has decreased from 2.0 hectares in 1992/93 to 0.9 hectares in 2005/06 (Uganda Bureau of Statistics, 2007). A large rural population, of which some are landless, wide spread poverty, and dependence on rain-fed agriculture, have contributed to hunger in Africa (Vermeulen et al., 2012). In addition, shocks such as climatic fluctuations, conflict, and poor health due to diseases such as HIV and AIDS have directly or indirectly affected food availability, access and utilization (Webb et al., 2006).

Byerlee et al., (2006) argue that development of market-oriented food systems could be the best option for sustainable agricultural productivity and food security. Market production involves increased use of purchased inputs which in turn produce marketable surpluses (Martey et al., 2012). Market-oriented production can impact food security through direct and indirect effects. Direct effects are gains from increased economic access to food as a result of increased income which can be used to purchase food, while indirect effects are gains derived from investing income from the cash crop into production of staple crops. Market production plays a significant role in reducing regional food insecurity. Local food shortages caused by imbalances in food distribution due to ecological differences in some rural areas can be addressed through market production (Maxwell, 1996). It further allows (productivity-enhancing) specialization in production and access to a variety of food, hence reducing the burden for households to produce all that they have to consume (Timmer, 1997). This is, however, only feasible when a well-functioning agricultural marketing system exists. The functioning of markets is critical for market-oriented households to sell their produce and

raise sufficient income for non-food consumption, as well as to acquire the food they do not produce themselves.

In situations of missing markets and market imperfections that characterize most rural areas in developing countries, market-oriented production, if not properly supported, can be a threat to food security, especially for the resource poor households. Poor infrastructure -especially poor roads in rural areas, pushes up transport costs and makes it difficult for farmers to access markets. This affects both sellers and buyers. Sellers will not get competitive prices due to limited competition of traders, and buyers will pay high prices which might affect the quantities purchased. In most rural areas, local farmers tend to produce similar crops, and for similar reasons of poor infrastructure, food outflows exceed inflows. Therefore, during the lean season there is less food in the local markets, and this puts market-oriented households at risk of food insecurity. Moreover, poor households who cannot produce sufficient quantities of high quality foodstuffs may not compete on the market. The implication is that they cannot raise enough income for food and non-food consumption.

Food price volatility equally impacts on food security of market-oriented households. Most farmers sell their produce at low prices soon after harvest and buy food at higher prices during the lean period (Stephens & Barrett, 2011). This is partly attributed to inadequate support services and weak institutions. Lack of agricultural insurance and limited access to financial institutions in the rural areas make farmers vulnerable to seasonal price variability. Limited access to and high cost of credit compel farmers to sell their produce at low prices as they cannot borrow to smooth consumption and deal with shocks. This negatively affects returns from market production thus affecting livelihoods and household food security.

Commercialization of agriculture sometimes diverts resources away from home production of food and exposes resource poor households to a greater risk of food insecurity. Reallocation and untimely allocation of critical inputs to staple food production may result into technical inefficiency and expose households to food insecurity. Some economists have argued that market production partly contributed to why the green revolution in Asia did not address the problem of food and nutrition security. Reallocation of crop land from subsistence to production of grain for income replaced pulses that provided food to the peasants for wheat, thus exposing poor households to a greater risk of food and nutrition insecurity (Frison et al., 2006; Graham et al., 2007). These issues form the basis for this thesis. Unlike many others

that focus on the effect of cash crops, this thesis focuses on the effects of commercializing food crops on household food security.

Unlike traditional cash crops, food crops can be sold for income but also consumed by the household in case of unfavourable markets, thus increasing food security. However, in a situation where food crops have been promoted as cash crops, the control over food crops by women may be reduced, thus threatening food security especially in resource-poor households where produce is the sole source of income. How market-oriented production impacts rural household food security may also depend on other household related factors. This includes gender relations in intra-household resource allocation, driven by preferences, bargaining and the control of household income. This thesis contributes some insights into these issues based on empirical evidence as well.

In view of the growing population, shrinking land holdings, and questions about the functioning of markets, the underlying motivation for this thesis is to explore whether market production can sustainably improve rural households' food security. The assumption that increased household income will improve food security needs to be supported by empirical evidence. This thesis provides empirical information on the effects of market-oriented crop production on household food security in a developing country. It reports on a detailed study on the changing farming environment in the context of agricultural production for income, food and nutrition security. This information is important as an input into the process of agricultural production reforms to guide policy decisions based on facts.

1.2 Key aspects of market production and food security

1.2.1. Food security in Uganda

Although the agricultural sector in Uganda is dominated by food crops accounting for 51.6 percent of the gross production value, food and nutrition security have remained a challenge (The Republic of Uganda, 2015). About 48% of the population (37 million) were food energy deficient between September 2009 and August 2010, and 5% of the rural population is considered to be chronically food insecure (UBOS & World Food Program, 2013). World Food Programme (2009) reported 6.3% of households as food insecure and 21.3% as moderately food insecure and at risk of becoming food insecure. The number of households taking one meal a day has increased in the rural areas from 6.0% in 2002/03 to 10.1% in 2009/10. Statistics further indicate that children below 5 years in 13.3 % of rural households do not take breakfast (Uganda Bureau of Statistics, 2010b).

Like in many developing countries food and nutrition insecurity in Uganda are a consequence of poverty. The major underlying causes and threats to food security are limited economic access to markets especially in western and parts of central Uganda, and reduced availability of food in the market (Mckinney, 2009). There are insufficiently effective institutions, systems and mechanisms to link farmers to domestic, regional and international markets. Imbalances in distribution and affordability result in both seasonal and chronic under-nutrition and food insecurity (Mukhebi *et al.,* 2010). Slow technological adoption, especially among women farmers who provide close to 50% of the labour force, limited access to land and agricultural finance, and women's lack of ownership and control over land, are some of the factors that contribute to food insecurity (Conceição, Levine, Lipton, & Warren-Rodríguez, 2016).

The main strategy to address food insecurity in Uganda has been to focus on increasing agricultural production and productivity by promoting market-oriented production through careful enterprise selection development and improved marketing linkages. This is in the hope that households can access more food through the market. The government set out various programs and interventions, of which the most prominent is the Plan for Modernization of Agriculture (PMA) implemented between 2000 and 2008. The first two objectives of the PMA were to increase income of poor subsistence farmers through increased productivity and share of marketed production, and to improve household food security through the market rather than emphasizing self-sufficiency (MAAIF & MFPED, 2000).

1.2.2 Market- oriented crop production in Uganda

Agriculture remains the dominant sector of the rural economy in Uganda. It employs over 66 percent of the population and contributes 22 percent of GDP (Uganda Bureau of Statistics, 2013). Most of Uganda's agricultural sector is dominated by small scale farming on small land holdings. Real growth in agricultural output has declined from 7.9 percent in 2000/01 to 2.6 percent in 2008/09, and this is below the population growth rate of 3.2 percent. This has major implications for household food security. Crop production is the main source of household income for about 80.8 % of rural households in Uganda (Uganda Bureau of Statistics, 2014b). The major traditional cash crops are coffee, tea and tobacco (Uganda Bureau of Statistics, 2012). However, food crops underpin the rural economy by contributing 14.6 percent to the national GDP and retain a central role in the livelihood systems of farm households (MAFAP, 2013). Most households that are excluded from traditional cash crops depend on production and sale of food crops. Uganda's main food crops include plantains,

cassava, maize, sweet potatoes, millet, sorghum, beans and ground nuts. Maize, beans, cassava and bananas are grown by over 70% of the households (Uganda Bureau of Statistics, 2010a). Rice and wheat, though not traditional crops, have gained prominence and are rapidly increasing. Most food crops are both consumed and sold, depending on the food and cash needs of the household. However, grains are the most highly traded, though the volume marketed fluctuates annually depending on annual yields and weather conditions. Table 1.1 presents the proportion of staple crops marketed based on the last agriculture census (Uganda Bureau of Statistics, 2010a). Rice and maize have the highest proportion of marketed output because they are internationally traded, and rice is mainly consumed by the urban population. The rest of the crops are domestically traded, and their prices are largely determined by domestic supply and demand.

Table 1. 1: Production and proportion marketed of staple crops in Uganda - 2008/2009

Crop	Annual Production (thousands of tons)	Percent production marketed
Banana (food)	4,000	34.6
Cassava	2900	22.2
Sweet potatoes	1,800	12.1
Maize	2,362	40.5
Sorghum	376	14.3
Finger millet	277	19.0
Rice	191	54.5
Beans	929	31.6
Groundnuts	245	31.7

Source: UBOS and MAAIF

From 1999, the trend of the proportion of food crop sales to output has been increasing; marketed agricultural output increased from 56 % in 2002/03 to 58% in 2005/06 (Uganda Bureau of Statistics, 2007). FAO statistics indicate that from 2004, food exports excluding fish increased by 340% in 2010. As agricultural land continues to shrink due to population pressure, there is less land available for plantations such as coffee and tea, so most food crops have become cash crops. Market-oriented production is further driven by increased food demand because of the growing and urbanizing population. With increased globalization there is growing pressure from policy makers on farm households to specialize and produce products that compete on the global market. The opening up of external markets provides an incentive for farmers to allocate their resources to those crops that easily trade in the regional market. Consequently, production of non-traditional crops such as rice has increased in most parts of Uganda.

While Uganda is a net food exporting country (Benson et al., 2008), households in rural areas continue to face persistent food shortages. The proportion of staples marketed is not necessarily surplus as many households do not even produce enough for home consumption. Small holder farmers and poor farm households often sell food to raise income to satisfy demand for other family needs (Martey et al., 2012; Rahut et al., 2010).

1.2.3 Market production, gender relations and food security

Gender relations are dynamic and men and women respond differently to new economic circumstances. The implications of commercializing food crops for gender relations and in turn food security are not well understood. How has market production affected intra-household gender relations? How does market production affect the patterns of labour, land and resource allocation including income between men and women? How has market production changed traditional and cultural attitudes regarding the dominance of women in production and men in marketing? And how has it affected women's perceived role of food provision? These questions are fundamental and this thesis attempts to contribute to literature by answering some of them.

Gender affects farmers' access to resources and may also affect farmers' preferences concerning outputs. Men and women in agriculture play different roles and quite often are engaged in different enterprises. The literature indicates that, in most areas, cash crops are "men's crops" while subsistence or staple crops are "women's crops" (Orr et, al., 2014). Therefore, women are responsible for providing food for the household and men for providing other consumption goods. In most African communities, social norms and cultural practices dictate that males dominate decision making, production and marketing of cash crops (World Bank, 2009). There is evidence that even traditional women crops may be taken over by men when they become commercially viable (Doss, 2001; Kasente et al., 2002).

Gender inequality is one of the most pervasive forms of inequality, especially in developing countries. In most African countries, gender inequality in production and marketing of cash crops has significant implications for the ability of women to participate in market-oriented agricultural production. Women farmers, like the majority of farmers in sub-Saharan Africa, operate on a small scale. Male-headed households operate on much larger land holdings on average than female-headed households (Croppenstedt et al., 2013). African women farmers are less likely than men to adopt improved crop varieties and management systems (Doss, 2001). There is evidence of gender differences in crop yields; studies have shown that yields

of female-headed households as well as women's crops are lower than for male-headed households (Horrell & Krishnan, 2007). This in turn bears consequences on household food security. The differences in yields have been largely attributed to limited access to productive resources and opportunities particularly land and labour (Hill & Vigneri, 2014). Resources are not pooled among household members and this causes inefficiency in food production (Udry et al., 1995).

Women are believed to perform the bulk of agricultural labour both in staple and cash crops (Agarwal, 2014; Doss, 2014) although a wide variation is recorded across countries in Africa, some reporting below 50 % (FAO, 2011). In Uganda, for example, women constitute about 56% of the labour force in agricultural production (Palacios-Lopez et al., 2017). Yet, they have less access than men to inputs, extension services and information. Women have limited access to credit which is vital for production, marketing and smoothing consumption– they often do not hold a land title so they have no collateral to facilitate their access to credit. Most financial institutions are biased towards providing credit to heads of households who are often men (Vigneri & Holmes, 2009). The perception of money lenders that women are unable to produce marketable surplus limits women's access to rural financial services (Fletschner & Kenney, 2014).

In the words of Patel (2012), it is hard to conceive a discussion about hunger without connecting the incidence and distribution of hunger to women's disempowerment. Assessing the implications of commercializing food crops on women's empowerment in terms of resource control and allocation is important not just because it affects women, but also because it affects food security and the general welfare.

1.2.4 Market orientation and food crop productivity

With increasing awareness about scarcity of critical inputs in production, coupled with high food demand, the main point of concern for the agricultural sector has shifted from output growth through increased land expansion to increased productivity through more efficient farm management. The goal for efficient management is the optimal utilization of inputs to produce outputs in such a manner that maximizes economic returns. Today, the importance of technical efficiency in a changing agricultural production environment is widely recognized. Increasing technical efficiency in an already constrained resource system is key towards increasing food security and poverty alleviation.

Over the last few years, production of cash crops has received considerable attention in terms of technologies and inputs, based on the expectation that households need to raise income to secure enough food. The success of market-oriented production to deliver food security rests on increased productivity of the key resources –specifically land and labour. It can be argued that market-oriented households have access to superior technical expertise, including new technologies and production methods from government and other non-governmental organizations focused on commercializing agriculture. If knowledge gains from trainings targeting cash crops are also applied in staple crop production this would lead to higher technical efficiency and output of staple crops. However, there is mixed evidence on the relationship between market-oriented production and technical efficiency. Rios et al., (2009) find a positive correlation between market-oriented production and technical efficiency, although not consistent across countries. Various factors can explain why the technical efficiency of market oriented households might be higher or lower than that of subsistence households. A positive impact on technical efficiency may result from an income effect: the income increase resulting from market production may help farmers to overcome financial constraints that impede efficiency, thus increasing technical efficiency by improving the households productive capacity through investment in advanced technologies (Govereh & Jayne, 2003). Market production however, may also reallocate farmers' effort away from staple food production, which might result in a reduction in technical efficiency. The presence of shortfalls in efficiency means that output can be increased using the same technologies and without requiring additional conventional inputs. Empirical measures of efficiency are therefore necessary in order to determine the magnitude of the gains that could be obtained by improving performance in production.

1.2.5 Seasonal food prices, credit institutions and Market production

Seasonality in agricultural production can have a significant impact on rural households that are dependent on agriculture especially in Africa. Seasonality in agricultural production is a concern as this causes seasonal price fluctuations which affect the income of rural households. Cash crop farmers and commercial grain producers are more vulnerable to such staple food price fluctuations, and this can be a disincentive for market oriented production (Benson et al., 2008). If so, public policies and innovations are needed to avert the seasonality of rural income, as this may affect investment decisions of farm household and agricultural productivity growth (Khandker et al., 2017). Stimulating market-oriented production in small holder agriculture does not only require improved technologies but also a variety of

interventions in market development. Successful transitions to market-oriented production will require appropriate institutional arrangements, in terms of access to critical factors and the development of other factor markets such as financial markets (Collier & Dercon, 2014) . The absence of well-functioning credit markets for example, has been cited as one of the major obstacles to rural poverty alleviation (Beck et al., 2004).

Credit has great potential in reducing seasonal deprivation arising from agricultural cycles (Shonchoy, 2014). Credit can be a determinant of households' decision on when to sell. Farmers whose incomes vary over the agricultural cycle need access to credit to enable them to smooth consumption without selling their produce at low prices immediately after harvest. Expanding credit access can help rural households to allocate resources efficiently over time and improve their economic opportunities in market-oriented production. In such cases, households may opt not to sell their produce at low prices but instead store their produce and sell later when prices are higher. If sufficient farmers choose to do this, prices (and farmers' income) will be stabilized.

Despite the benefits, the poor often find it difficult to obtain credit due to the conditions and requirements of financial institutions. The formal credit market seems not to be consistent with the farmers' situation in rural areas. Lack of collateral, the mismatch between loan repayment and seasonal income, and production uncertainties constrain borrowing by farmers. Resource-constrained households with no other source of income suffer the most and face difficulty in accessing credit for smoothing their consumption (Shonchoy, 2014). As a result, most poor farmers resort to informal credit (Mallick, 2012)

A well-functioning food market is equally important in promoting market oriented production (Dillon & Dambro, 2016). Effective incentive structures in production rely on farmers' access to markets and to the proceeds of their labour for reinvestment. Market-oriented farmers also buy most of their food with income from the cash crop sales. Therefore, the efficiency of the food marketing system constitutes a significant aspect of market-oriented production. Farmers' confidence in the market system is likely to stimulate investment in market-oriented food production and increase agricultural productivity growth. As farmers grow cash crops in large quantities they rely on finding traders for their crops after harvest and alternative food supplies from within their area. Traders therefore, have a strong influence on the structure and functioning of market oriented production systems (Sitko & Jayne, 2014).

Traders play a key role in the food value chain as they assemble, store and trade in large stocks of grain from the farm to the consumer. Sitko and Jayne (2014) argue that traders operations have improved farmers' market access conditions in remote areas. Nevertheless, claims of rent seeking behaviour by grain traders still persist among famers and policy makers. Lack of transparency among traders in the food market has been highlighted as one of the factors limiting the improved performance of food markets. Food market structures in rural Africa involve significant asymmetries between sellers, particularly small holder farmers and buyers (traders) who have superior access to information (Jayne et al., 2014). Dominant traders do not always appreciate the transparency that comes with commodity exchange as this reduces their profit potential (Jayne et al., 2014). This mainly affects small scale farmers who rely on food sales for a significant part of their income and yet have limited capacity for timing their sales. These marketing challenges can be addressed by supporting the development of competitive assembly markets (Sitko & Jayne, 2014). Competition among traders at various stages of the value chain can improve farmers' market access conditions. As new entrants enter the food markets they compete away the rents enjoyed earlier by dominant traders.

1.3 Theoretical framework

A large part of agriculture in developing countries is dominated by small scale farmers engaged in multi-crop production for both food and income generation. Agricultural households combine two fundamental units of microeconomic analysis: the household and the farm. The interdependence of the two units greatly influences the economic behaviour of the farm households. As both producers and consumers agricultural households make joint decisions over production and consumption that may be interdependent upon one another. The farm households make decisions on allocation of labour and other inputs to crop production, and as consumers the households make decisions on; consumption of own produced goods, and allocation of income from farm produce and labour sales to the consumption of commodities and services including leisure.

Agricultural household models provide a framework for analysing household behaviour which integrates household decisions over production, consumption and labour supply (to production and home time). While they were first introduced to resolve the puzzle of a sluggish marketed – surplus response to food price changes (Singh et al., 1986), the uses of agricultural household models have been applied to other topics such as technology adoption policy, income distribution and off farm labour supply (Taylor & Adelman, 2003).

Agricultural household models have been used extensively to analyse a wide range of policy issues related to agricultural production; to explain the economic behaviour of rural households engaged in different farming systems including small scale subsistence, and commercial farms in developing countries.

The traditional approach to modelling household behaviour viewed the household as though it were a single decision making unit. The unitary model aggregates individual preferences into some kind of social preference function. It assumes that in a household either both adults have the same preference or one of them takes all the decisions. This has been criticized due to its welfare economic deficiencies (Chiappori, 1993). An alternative to the unitary model is the collective model. Collective models take into account the fact that a household is a group of individuals with different preferences among whom decision making process takes place (Chiappori, 1992). Considering a household with two adults (say, husband and wife), it is assumed that production and consumption decisions are as a result of an intra-household bargaining process.

Household decisions can be modelled using two different assumptions; if all markets exist production and consumption decisions can be made sequentially and consumption decisions will depend on the outcome of production decisions (De Janvry et al., 1991). As long as perfect markets for all goods exist, the household is indifferent between consuming own produced and market purchased goods. By consuming all or part of its own output which could alternatively be sold at a given market price, the household implicitly purchases the goods from itself (Taylor & Adelman, 2003). In situations where one or more markets are missing, however, production and consumption decisions are non-separable (De Janvry et al., 1991). Market-oriented households produce cash crops for the market and purchase non-food commodities as well as food and some inputs from the market. Rural households experience market failure due to high transaction costs which arise from a number of factors including poor infrastructure and remote markets. High transport costs, and excessive marketing margins arising from traders' monopoly power frequently cause market failure.

In a farm household model the household budget is endogenous and depends on production decisions that contribute to income through farm profits. Given the household resource endowment (land, farm infrastructure and labour time), production and consumption decisions are driven by various factors including market access and prices of inputs and outputs, the wage rate, the production technology on the farm as well as other household demands. The

household makes comparisons between the returns to allocating more of the resources to produce a cash crop or staple crops for home consumption. Without changes in production technology or land available, increasing cash crop production means de-emphasizing staple crop production. This may have implications for food security. Figure 1.1 illustrates how market production links to the components of food security (availability, access, utilization and stability).

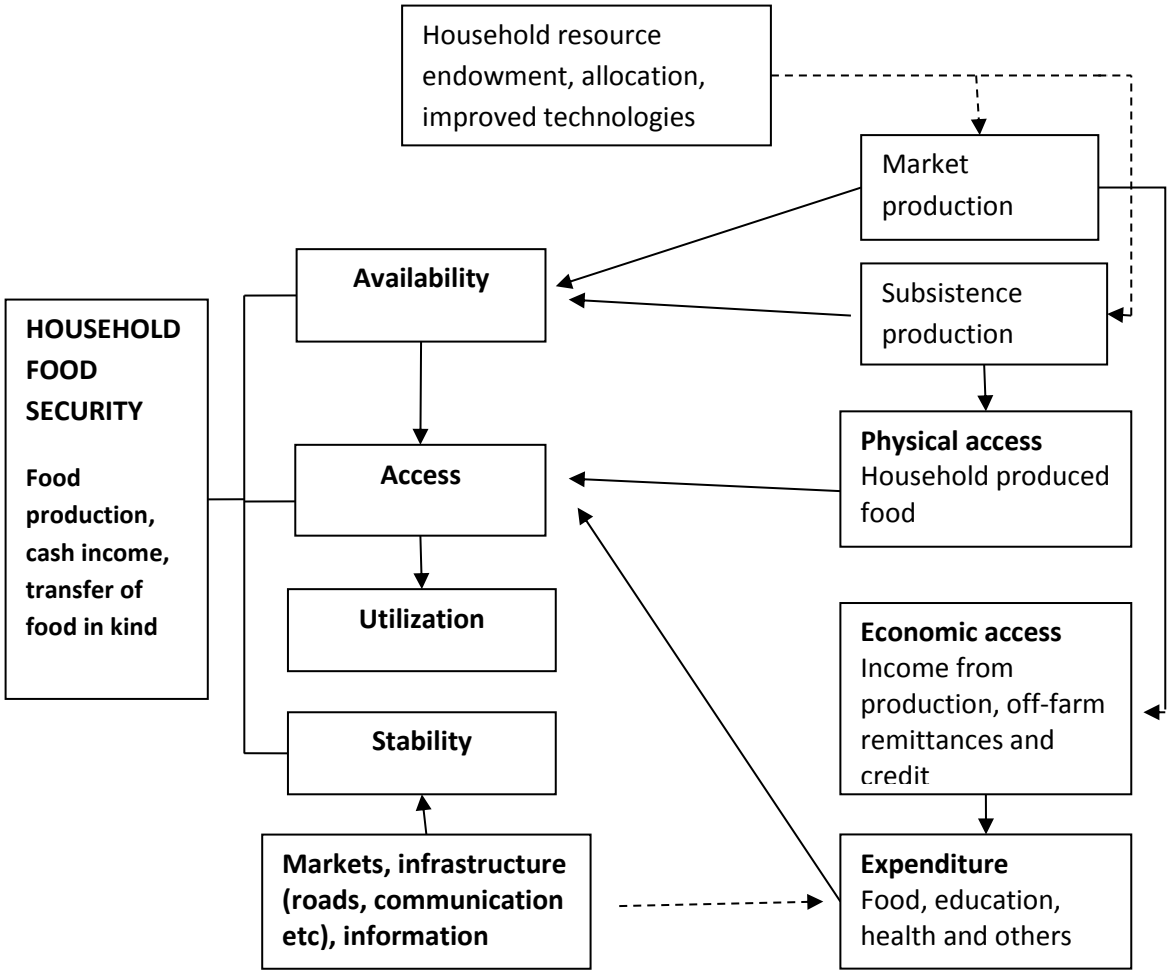

Figure 1.1: Conceptual framework for market production and rural household food security

A household is food secure when it has enough food in terms of quantities and quality that can be accessed by the members of the household and adequately utilized through consumption (Maxwell, 1996). Subsistence farm–households access physical food from their own output and may participate in the market with little surplus to sell or as buyers to supplement own production. Market-oriented farm households can access enough food from their own produce and sell surplus or may specialize and access food through the market.

Household economic access to food is influenced by endogenous and exogenous factors such as household characteristics, the organization of markets, infrastructure and transaction costs. The household maximizes utility of consumption goods (food and non-food) and leisure time under budget and time constraint. The household's optimal choice depends on consumer goods prices, wages and household characteristics. The household's level of income and its decisions on income expenditures determine its access to non-home produced food and consequently consumption. The proportion of income spent on food depends on other needs such as education and health as well as the preferences of the household member with a higher bargaining power.

1.4 Objectives and research questions

Food crops provide a major source of livelihood for the majority of rural households in sub-Saharan Africa. In Uganda, food crops such as rice, maize and cassava have been highly promoted for commercial production, and many households have responded by allocating part of their resources to production of these crops for markets. Whereas this has contributed to an increase in household income, limited research has been done to understand how such production changes have affected household food security. The overall aim of this thesis is to better understand the implications of agricultural transition, from subsistence to market-oriented food crop production on rural household food security. I specifically analyse market production effects on; household food consumption, women control and allocation of household income and productive resources, and technical efficiency of staple crops. Further, I investigate how the informal credit market shapes the food crop marketing behaviour of rural households and why the local food market is not competitive enough to eliminate price fluctuations.

This thesis addresses the following research questions in the subsequent chapters;

1. How does market production affect households' food consumption patterns? (Chapter 2)
2. How does market production affect women empowerment in intra-household resource allocation and control? And what are the consequences for household food security? (Chapter 3)
3. Does market production affect technical efficiency of staple crop production? (Chapter 4)

4. To what extent has the informal credit market shaped farmers' food marketing behaviour and why don't traders compete to eliminate persistent price variability in the food crop market? (Chapter 5)

1.5 Overview of research methods

Our study aims to investigate how market-oriented food crop production affects food security of rural households. We faced identification challenges arising from endogeneity of market-oriented production. This thesis attempts to overcome the identification problem by using a case of a well-supported market-oriented rice production program in western Uganda, where rice has been highly promoted as a priority cash crop. We find rice production in Kanungu district Southwestern Uganda a convincing case of market-oriented crop production as households specifically grow rice for the market. The details of this program are elaborated in subsequent chapters.

This research largely draws evidence from primary data collected from Southwestern Uganda. It utilizes four data sets assembled using different approaches. The main data set is from a cross- sectional household survey for a random sample of 1137 rural households. The survey asked about household production and marketing of food crops, food consumption, household income by source, expenditures, intra-household decision making and resource allocation, credit access and demographic characteristics. The household survey data were augmented with three other sets of data; first, data on women bargaining power collected from a simple lab-in-field experiment involving 245 couples. This was done to construct a women empowerment index as a proxy for women participation in control and allocation of household resources (chapter 3). The experiment was framed in the context of a real household environment where husband and wife allocate income to consumption preferences. The second data set focusses on informal credit, the various forms and how they operate. The third data set concerns grain trade in the study area (chapter 5).

The critical identification problem we face in the analysis of the aforementioned research questions is that households were not "randomly assigned" to participate in market production. This creates a self-selection problem typical of observational studies. Moreover, we cannot observe the outcome variables of market-oriented households if they had not participated in market oriented production. We therefore face a problem of missing data. To address this problem we use households from carefully selected neighbouring sub counties in which rice production was not promoted but that are otherwise similar as a comparison group.

This group is used to identify the counterfactual of what the food security of market oriented households would have been if they had not participated in market oriented production. This assumes that these households correctly reveal, at least on average, food security of subsistence households.

To further address the causal inference problem, different quantitative econometric methods that make necessary identification assumptions to create credible counterfactuals have been used. Literature provides various methods including randomized experiments, difference in difference estimators, regression discontinuity analysis, propensity score matching, and instrumental variables approaches (Blundell & Costa Dias, 2000). The choice of method depends on the nature of the question to be answered and the nature of the data available. While randomized experiments provide the most credible counterfactual (Blundell & Costa Dias, 2000), this study could not use that approach due to limited time and financial resources to support the experiments. The other drawback of this study is that we use data that were collected in a single cross-section survey, so that we do not have a panel. This becomes a limitation to using other methods such as difference in difference. We attempt to address the self-selection and missing data problems by using propensity score matching and instrumental variables (Blundell & Costa Dias, 2000; Ravallion, 2001). These approaches enable us to make statements on market production effects (chapters 2, 3 and 4), but we acknowledge that issues regarding identification remain.

1.6 Outline of the thesis

After this introductory chapter, each of the proceeding chapters addresses a specific objective. Chapter 2 provides the analysis of market production effects on rural household food consumption. We critically assess how market-oriented production impacts food access in terms of calorie and protein consumption as well as dietary diversity. Chapter 3 examines the effects of market-oriented production on women control over household resources. We focus on intra-household decision making in production and income expenditure and further link the outcome to household food security status. In chapter 4, we investigate how market-oriented production affects technical efficiency of staple crop production. The chapter presents technical efficiency levels of major food cash and staple crops, and factors that influence technical efficiency. Chapter 5 is concerned with the persistent behavior of households selling their produce at low prices soon after harvest. We explore the role of the informal credit market and traders in stabilizing seasonal grain price fluctuations. Chapter 6 summarizes empirical findings. I discuss the policy implications and the strategies for promoting market

production for poverty reduction as well as food security. At the end, I provide a brief summary of the thesis.

Chapter 2

Effects of market production on rural household food consumption: Evidence from Uganda

Abstract

Food access is an important element of food security that has since long been a major concern of rural households. A common intervention to improve food access has been increased promotion of market production in the hope that households will get increased income and enough access to food through the market rather than through self-sufficiency characteristic of subsistence production. We examine the effect of market production on household food consumption using a case of rice in western Uganda, where rice is largely a cash crop. Our analysis is based on propensity score matching and instrumental variable approach using survey data collected from 1137 rural households. We find evidence of negative significant effects on calorie consumption. Households engaged in rice production are more likely to consume less than the required calories per adult per day. On the contrary, we find positive significant effects on household dietary diversity. We do not find any significant effect on protein consumption. The overall analysis reveals that substitution effects outweigh income effects on food consumption. We suggest a mixed policy approach combining policies targeted at market production as well as production for own consumption, and nutrition sensitization.

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2.1 Introduction

Despite widespread economic and agricultural growth during the last decades, 13.5 percent of the population in developing regions remain chronically undernourished (FAO et al., 2014). Insufficient food consumption is a public health concern as it increases vulnerability to a range of physical, mental and social health problems (Nord, 2014). Children and youth who experience hunger, especially when this occurs repeatedly, are more likely to have poorer health (Kirkpatrick et al., 2010), reach lower levels of education, and have lower incomes at adulthood (Hoddinott et al., 2008).

Agriculture remains the focus of interventions as policy makers seek ways of reducing food insecurity in Africa, which is home to more than one out of four malnourished people (FAO et al., 2014). Africa's demand for food continues to increase rapidly as a result of urbanization, globalization and especially high population growth. Though impressive, agricultural growth has not been able to meet this rise (Collier & Dercon, 2014). In addition, agriculture remains the economic engine of many African countries, contributing an average of 30% of GDP. It is the main source of livelihood for rural households employing over 60 % of the work force in Sub-Saharan Africa (Thornton et al., 2011). As such, it is believed to have great potential to influence household food security (Godfray et al., 2010).

Market-oriented agricultural production is considered a viable option to ensure sustainable food security and welfare (Pingali, 1997). It has been promoted by policy makers with the expectation that it can raise household income and at the same time increase productivity of food crops due to increased input use. However, the market-production strategy in low income areas faces particular challenges; increased income and food productivity may not translate in increased food consumption. For instance a study by Aromolaran (2004) in Nigeria finds that calorie intake does not get a substantial share of marginal increases in income of low income households. Similarly, in parts of Eastern Uganda, one of Eastern Africa's major rice producing region, Whyte and Kyaddondo (2006) find that some rice cultivators starve because they sell all the food. Moreover, market production puts emphasis on specialization in what the producer has comparative advantage in. Considering the fact that food security is not only a problem of food supply but also access, improving productivity of a few selected food crops has limited potential for improving food security if food markets are not better integrated in rural areas.

Food access involves physical access to a place where food is available or owning the food that is home produced or economic access through having the purchasing power to buy it from the market. Whereas accessing food markets is of critical importance for households engaged in market production, rural areas still face the challenge of weak markets characterised by imperfections (Vermeulen et al., 2012). For a majority of people, access to food comes at least partially through the market when they have the income necessary to purchase supplementary or an adequate diet rather than produce it entirely. However, having sufficient income depends not only on the amount of money one earns but also on the price of food (Staatz et al., 2009). In low income countries such as Uganda where agriculture is dependent on rainfall, households that depend on the market for food face a challenge of food price volatility arising partially from seasonal variation and fluctuations in foreign exchange rate.

The transition from subsistence to market production has had effects specific to each household depending on its resources. The general experience is that, despite their participation in market production, resource-poor households have continued to experience food insecurity due to low supply and limited access (Misselhorn et al., 2012; Shively & Hao, 2012). Little has been done to understand how the transition influences food consumption patterns of households engaged in market production. In Rwanda reduced subsistence orientation was found to reduce household calorie consumption levels, although increased income from the cash crop significantly increased calorie consumption expenditure (Von Braun et al., 1991). Von Braun (1995) recommends that potential food crops should be promoted as cash crops to avoid negative effects of agricultural commercialization on food security. Yet, Kavishe and Mushi (1993) find higher levels of malnutrition in parts of Tanzania where maize, the food crop, is also a cash crop.

Within this context this chapter offers a contribution by exploring the relationship between market oriented agricultural production and food security. Unlike in most previous studies which focus on the effect of the traditional cash crops such as coffee (Kuma et al., 2016) and tobacco (Radchenko & Corral, 2017) which are mainly grown by large scale farmers (Carletto et al., 2016), we focus on market production effects of food cash crops which applies to a great majority of smallholders in rural Africa. Our analysis uses two different measures to proxy market oriented production; share of output marketed and a case of a food cash crop (rice) which has been highly promoted for market production, to illustrate the impact of market-oriented food crop production on rural household food security. This approach looks

beyond participation in the marketing of food crops to include the product choice based on the principal of profit maximization which is key to market oriented production. We examine the impact on quantity (caloric and protein intake) and quality (dietary diversity) of food consumed as well as access (food insecurity access scale) to enough quality food. We also provide empirical evidence on the impact of market oriented production on household health expenditure as one of the major welfare expenditure item closely associated with food security. This chapter makes the case that promoting market oriented production may not be effective in improving household food security particularly for small holders in the absence of other sources of income to support non-food consumption.

The chapter is structured as follows; Section 2.2 contains the theory linking market production and food security, Section 2.3 describes a case of a market-oriented agricultural program in western Uganda. Section 2.4 presents the methodology used to estimate the effect of market production on household food consumption. Section 2.5 outlines a description of the survey data. Section 2.6 presents results and discussion. The conclusion forms section 2.7.

2.2 Market production and food security

There are two divergent views on the effect of market production on household food consumption; the first view suggests that market production positively affects household food security as it generates income that empowers the household to purchase a variety of foods it does not produce (Timmer, 1997). As income increases, households are expected to adjust their food consumption pattern away from the cheap foods like cereals, tubers and pulses towards balancing their diet by including nutritionally rich foods, especially proteins of animal origin such as meat, fish, milk and other livestock products (Abdulai & Aubert, 2004). Moreover, in areas where markets are functional, income from market production stabilizes household food consumption against seasonality (Timmer, 1997).

In developing countries such as Uganda where agriculture is mainly rain fed, households experience seasonal variability in food supply, and this results in food price fluctuation. Most households therefore, suffer transitory food insecurity during the pre-harvest season, while they are relatively food secure during harvest and post-harvest periods. However, households engaged in market production are expected to have relatively better access to food during pre-harvest periods. As consumers they are affected by higher prices during the pre-harvest season, but as producers they benefit from high food prices that increase their profits from food production. If the positive profit effect outweighs the negative effect the households'

food consumption increases (Taylor & Adelman, 2003). Thus they are able to smooth their consumption through the market. Furthermore, Govereh and Jayne (2003) argue that income raised from market production can be used to purchase inputs for food crop production thus increasing productivity and consequently increase food availability.

The other view is that market production negatively affects household food consumption due to reduced food availability as a result of displacement of staples by cash crops or when a big portion of produce is sold (Braun & Kennedy, 1994). Food markets are located in far-away towns where food comes from different areas. Due to poor infrastructure, transport costs are high. Buyers, therefore, may not be able to access enough food as prices are high, and for sellers real income from produce decreases due to transaction costs (Goetz, 1992). Due to low output prices, farmers tend to sell large quantities, not necessarily because they have surpluses but to raise enough cash for taking care of household necessities (Fafchamps & Hill, 2005; Key, Sadoulet, & De Janvry, 2000; Rahut et al., 2010). Low prices thus reduce income and physical food available for the household, jointly causing food insecurity (Feleke et al., 2005; Sadoulet & De Janvry, 1995). Kostov and Lingard (2004) argue that under difficult conditions such as inefficient input, output, credit and labour markets, and the risks and uncertainties characteristic of most developing countries, subsistence agriculture may be the only way for rural people to survive. Households that engage in subsistence farming have access to comparatively cheaper food and to a variety of nutritious foods, especially vegetables and fruits that are rich in micronutrients (Zezza & Tasciotti, 2010).

Theoretical model

The structure of the model in which the household consumption is entrenched is critical in shaping the effects of market production on food security (Chiappori & Donni, 2009; Vermeulen 2002). We formalize the relation between market production and food consumption using a farm household model. First, we assume that the household can only produce for own consumption and next, we introduce a marketable crop. The differences between the two models illustrate the impact of the introduction of such a crop.

A simple household model without sale of produce

We assume the household maximizes the utility of the consumption of food (C_f), non-food products (C_{nf}) and home time (l_l). Following De Janvry et al. (1991), the utility function is concave, with the exact shape depending on household characteristics *z*:

$$Max_{l_f, l_l, C_{fm}} u(C_f, C_{nf}, l_l ; z) \quad (1)$$

The household produces staple food (Q) using land (A) and farm labour (l_f), where land is fixed in the short run but labour can be varied depending on its marginal productivity:

$$Q = q(l_f; A). \quad (2)$$

We begin with a simple model assuming that the household does not sell its produce. To finance market consumption of food (C_{fm}) and other products (C_{nf}), the household engages in off-farm employment (l_h) which is remunerated with a fixed wage rate (w) and has limited availability (M):

$$C_{nf} + p_{fm}C_{fm} = wl_h \quad , \quad (3a)$$

$$l_h \leq M \quad , \quad (3b)$$

where p_{fm} is the market price of food and the price of non-food consumption is the numeraire. Total food consumption (C_f) is the sum of own produce and food purchased in the market:

$$C_f = Q + C_{fm}, \quad (4)$$

The time endowment (T) of the household is limited:

$$T = l_f + l_h + l_l. \quad (5)$$

Utility is maximized under the following conditions (see appendix for derivations and full Kuhn-Tucker conditions):

$$\frac{\partial u}{\partial l_l} = \frac{\partial u}{\partial C_f}\frac{\partial q}{\partial l_f} = w\frac{\partial u}{\partial C_{nf}} - \lambda, \quad (6a)$$

$$\frac{\partial u}{\partial C_f}\Big/\frac{\partial u}{\partial C_{nf}} = p_{fm} - \mu\Big/\frac{\partial u}{\partial C_{nf}}, \quad (6b)$$

where $\lambda > 0$ if $l_h = M$; and $\mu > 0$ if C_{fm} = 0. Assuming an interior solution ($\lambda, \mu = 0$), this means that households will employ their labour in food production until the marginal utility of crop labour and the marginal utility of home time equal the marginal utility of the wage rate in non-food consumption. Consumption expenditures are allocated between food and non-food consumption according to their relative prices in the market. When the wage employment constraint is binding, the marginal utility of home time and crop labour will be lower than the marginal utility of the wage rate in market consumption. The household will now use more labour in crop production and consume more food than in the interior solution.

Introducing a marketable food crop

Increasingly, farmers do not just produce for own consumption but also for the market. Hence, we extend our model with the option to produce a new food crop that can be sold to

the market. In consumption, both crops are perfect substitutes. This gives the following adjusted food consumption constraint:

$$C_f = Q_1 + C_{f2} + C_{fm}, \tag{7a}$$

$$C_{f2} \leq Q_2 \tag{7b}$$

where Q_1 is the consumption of the traditional (non-marketable) food and C_{f2} is the consumption of the new crop, which is smaller than production.

The household can now allocate their land between the traditional crop (Q_1) and the new marketable crop (Q_2):

$$Q_1 = q_1(l_{f1}, A_{f1}) \tag{8a}$$

$$Q_2 = q_2(l_{f2}, A - A_{f1}) \tag{8b}$$

$$0 \leq A_{f1} \leq A \tag{8c}$$

Similarly, time can be allocated between the two crops, wage employment, and home time:

$$T = l_{f1} + l_{f2} + l_h + l_l \tag{9}$$

Due to transaction costs, the producer price for the marketable food crop (p_{f2}) is lower than the price of food in the consumer market (p_{fm}). The cash income constraint is as follows:

$$C_{nf} + p_{fm}C_{fm} = p_{f2}(Q_2 - C_{f2}) + wl_h \tag{10}$$

With $C_{fm}, l_{f1}, l_{f2} \geq 0$, this gives the following optimal utility conditions (see appendix for derivation and full Kuhn-Tucker conditions):

$$\frac{\partial u}{\partial C_f}\frac{\partial q_{f1}}{\partial A_{f1}} + \nu = p_{f2}\frac{\partial u}{\partial C_{nf}}\frac{\partial q_{f2}}{\partial A_{f1}} + \kappa \tag{11a}$$

$$\frac{\partial u}{\partial l_l} = \frac{\partial u}{\partial C_f}\frac{\partial q_{f1}}{\partial l_{f1}} + \xi = p_{f2}\frac{\partial u}{\partial C_{nf}}\frac{\partial q_{f2}}{\partial l_{f2}} + \varsigma = w\frac{\partial u}{\partial C_{nf}} - \lambda \tag{11b}$$

$$\frac{\partial u}{\partial C_f}\Big/\frac{\partial u}{\partial C_{nf}} = p_{f2} + \tau\Big/\frac{\partial u}{\partial C_{nf}} = p_{fm} - \mu\Big/\frac{\partial u}{\partial C_{nf}} \tag{11c}$$

The first condition (11a) describes the allocation of land: assuming an interior solution, both crops are cultivated and the marginal utility of productive land will be equal between crops. For a non-interior solution, the household specializes and the marginal utility of productive land is higher for the specialization crop.

The second and third condition (11b) and (11c) are similar to the optimal solution in the model without the marketable food crop. Assuming an interior solution, households will allocate their labour between the three activities –the staple crop, the marketable food crop and wage employment; until the value of the marginal productivity of labour in both crops and the value of the marginal utility of home time equals the marginal utility of the wage rate

in non-food consumption. In a non-interior solution, the household specialises in one or both crops, depending on the production technologies and the wage rate. Consumption will be divided between food and non-food consumption based on the reference price of food, which is bounded by the (normalized) prices of the cash crop and market food. Some households will purchase food: $C_{fm} > 0$, which implies that $\mu = 0$ and $\tau > 0$, *i.e.* no cash crop is sold. In this case, the relevant price is the price of market food. At the other extreme, households sell the part or all of their marketable crop produce: $Q_{f2} - C_{f2} > 0$, which implies that $\tau = 0$ and $\mu > 0$, *i.e.* no food is purchased. The relevant price is then the sales prices of the cash crop, which is lower than the price of market food. Hence, for households selling the marketable crop, food is cheaper than for households purchasing food in the market. Finally, some households will not engage in the food market at all. Their reference price will be an endogenous shadow in between the two market prices (See De Janvry et al., 1991).

The introduction of a marketable crop in the second model provides an additional opportunity for income generation to finance non-food consumption. Unless the marketable crop is inferior to the existing crop over the entire range of possibilities, the marginal productivity of land and labour will increase. Households will re-allocate part of their labour from leisure and staples to the cash crop, and –if relevant, they will decide to retreat partly or completely from the labour market. Consequently, the household will be better off than before in terms of income and utility. The increased income will have a positive effect on consumption of all goods, including food (positive income effect). However, additional income is not the only change. Also the reference price that people base their consumption decisions on may change. Remember that for the first model, the relevant price is the market price for food unless the household is constrained in the labour market. In the second model, the price is bound from below by the price of the cash crop and from above by the price of the market food. This implies that in the absence of labour market constraints, the introduction of a cash crop will result in a price that is lower than or equal to the pre-introduction reference price, which (*ceteris paribus)* will result in an increase or no change in food consumption (positive or zero substitution effect). Hence, in the absence of labour market constraints, the introduction of a marketable crop at the farm level induces a positive income effect and a non-negative substitution effect, so food consumption will unambiguously increase. Remains the situation with a binding labour market constraint in the absence of the marketable crop. In this case, the household can earn less cash than they would like and will produce and consume additional food instead so that its reference price is an endogenous shadow price lower than the market

price. If this price is lower than the price of the marketable crop, the substitution effect of the introduction of this crop will be negative, making the overall effect ambiguous.

This translates into the following two hypotheses:
Hypothesis 1. Participating in market production increases the reference price for food and depresses total food consumption at given income levels. This substitution effect outweighs the income effect associated with market production.
Hypothesis 2. Participating in market production increases household income through increased marginal value product of land and labour, which income is then used to purchase food that is not produced by the household thus increasing dietary diversity.

2.3 Market production in Uganda

In its strategy for poverty alleviation and improving food security, the Government of Uganda has promoted market production; first, through the Plan for modernization of Agriculture (PMA) between 2000 to 2008, followed by the National Agricultural Advisory Services (NAADS). The main objective is to increase income of poor subsistence farmers through increased productivity and share of marketed production thus improving household food security through the market rather than emphasizing self-sufficiency (MAAIF & MFPED, 2000). As the population increases, agricultural land per household continues to shrink. Consequently, there is less land available for cash crop plantations such as coffee or tea which traditionally generated cash for households' non-food consumption. Moreover, there is limited availability of off-farm income. As a result, most food crops have become cash crops. Additionally, non-traditional crops such as rice have been promoted as cash crops in most parts of Uganda. The advantage of food cash crops is that they can be consumed by the household when markets are unfavourable or in case of food shortage thus reducing market risks and food insecurity. For this study we follow up a case of rice production in Southwestern Uganda where rice has been highly promoted as a cash crop.

Commercial rice production in Kanungu district, Uganda

Rice was introduced in Kanungu district, Southwestern Uganda by IFAD in 2003, when trials of New Rice for Africa commonly known as NERICA series (CARD, 2014) were set up in Kihihi sub county under the Area-Based Agricultural Modernization Program (AAMP). The overall goal of the program was to contribute to poverty alleviation by increasing household income through increased agricultural productivity (IFAD, 2012). One specific objective of the program was commercialization of small holder agriculture to improve income and food

security of rural households. To achieve this objective various projects including rice production were started. In 2004 the promising NERICA varieties were promoted for production, targeting small holder farmers with less than five acres of land. In practice, however, participants were self-selected and it is not uncommon that households with more than five acres of land participated since there were no strict exclusion measures. The project started in two sub counties of Nyamirama and Kihihi that lie along the rift valley. These sub counties are considered to be relatively fertile. However, the area per se does not present a unique environment for rice production since the project has been extended to other sub counties. While many farmers participated, others did not due to various reasons such as limited land and labour.

The program promoted market production by offering farmers extension and training in modern farming technologies. The program did not only support production but marketing as well. It focused on strengthening capacity of farmers to access the market by training them in business development and market linkages, training marketing associations and providing support to value addition initiatives. By the end of the program in 2008, twelve rice hulling machines had been established in the study area, including one that does sorting and packaging. Such high-level support and promotion of market production has not been experienced in the neighbouring sub counties. The program was implemented for six years by the Ministry of Local Government in corroboration with district and sub county officials. After AAMP, the rice project was taken over by a government program called National Agricultural Advisory Services (NAADS). NAADS continued to support rice production and promoting it in other sub counties and a few other districts as a cash crop. It is now a priority cash crop in five out of twelve sub counties in the study area and one of priority commodities at national level (MAAIF, 2010). Rice production has significantly increased (CARD, 2014) from 150,000 tons on 80,000 hectares in 2004 to 280,000 tons on 140,000 hectares in 2012 (MAAIF, 2010; Reda et al., 2012).

2.4 Methodology

Participation in market production is a decision influenced by the characteristics of the household. While any household can decide to specialize in producing what they can easily market, raise income to buy food and be food secure, richer households may be in possession of more adequate resources such as land, labour and capital that give them a comparative advantage to produce for the market (Barrett, 2008). The decision of a household to produce for the market therefore, is based on self-selection rather than random assignment. The

implication is that characteristics of participants may differ from those of non-participants. Hence, a direct comparison of the outcome between the two groups produces biased estimates of the impact of market production (Blundell & Costa Dias, 2000). In this case estimating the causal effect of market production presents a case of endogeneity due to selection bias, and standard regression models using households with different levels of market participation will produce biased estimates unless there is some exogenous source of variation.

The study faced a challenge to identify households exposed to such variation. We chose to use a case of rice production in Kanungu district in western Uganda. Rice production is interesting as previous studies (Von Braun, 1995) have recommended food cash crops as a remedy to food insecurity attributed to cash crops. Upland rice in the study area is mainly grown for cash with very small proportions consumed by the household. We believe the rice project provides exogenous variation because commercial rice production was promoted to smallholder farmers in a limited number of sub counties, but not in comparable other sub counties. A potential threat for our identification could arise from the variation across sub-counties given that they were not randomly selected. To control for such variation we selected sub-counties that are from a similar agro ecological zone and same economic environment (in terms of infrastructure and institutions). Moreover, the treatment and comparison groups were given the same survey instruments.

We determine the effect of market production on household food consumption by estimating the differences in daily average calorie and protein consumption between households who have been exogenously exposed to commercial rice production –further called market oriented households, and the comparison group. To control for selection bias due to observable characteristics, we use propensity score matching to produce estimates of the counterfactual (Blundell and Costa Dias 2000). Propensity score matching has the advantage that it does not require baseline data, which is lacking in our study. Moreover, it does not require a parametric model linking outcome to the treatment, and it allows estimation of mean impacts without arbitrary assumption about functional forms and error distribution (Ravallion, 2007) thus improving the accuracy of the causal estimates (DiPrete & Gangl, 2004).

The propensity score p is the conditional probability (P(X)) of a household participating in rice production given observable characteristics (X) that are not affected by the intervention (Rosenbaum & Rubin, 1983); The propensity of observations to be assigned into the treated group are estimated by a Logit model;

$P(X) = prob(d = 1|X = E(d|X)$; d is the dependent variable; $d = 1$ for households growing rice and $d = 0$ for the comparison group. It is assumed that $0 < prob(d = 1|X) < 1$.

After estimating the propensity score, our parameter of interest is the average treatment effect on the treated (ATT) (Caliendo & Kopeinig, 2008). Given the right observations X, the observations of non-rice growing households are statistically what the observations of the rice growing households would be had they not participated. The market production effect is then decomposed as follows; (Rosenbaum & Rubin, 1983)

$$\begin{aligned} ATT &= E(Y^t - Y^c|X, d = 1) \\ &= E(Y^t|X, d = 1) - E(Y^c|X, d = 1]) \\ &= [E(Y^t|X, d = 1) - E(Y^c|X, d = 0)] \end{aligned}$$

To assess the robustness of the estimates, we use different matching methods (nearest neighbour matching, kernel matching and radius matching) (Caliendo & Kopeinig, 2008; Heckman et al., 1997). In addition, we carry out sensitivity analyses using Rosenbaum's bounds to establish the sensitivity of the estimated treatment effects to a potential unobserved covariate that is highly correlated with both treatment and potential outcomes.

Due to uncertainty that derives from unobserved confounding factors in estimation of causal effects by matching methods (Becker & Ichino, 2002), we augment our results by using the local instrumental variable approach as an alternative strategy for estimation of causal effects. IV regression gives the local average treatment effect (LATE), which is the average treatment effect for those induced into the treatment by assignment (Angrist & Imbens, 1995). In our case we use awareness of market-oriented rice production as the instrument. This instrument has been used in previous studies such as in Dontsop et al., (2011). We estimate the local average treatment effect for those households induced into market-oriented production through agricultural extension services. We believe that awareness of market oriented production affects food consumption only through production. Without the household utilizing the information and producing for the market, awareness alone cannot affect household food consumption. Awareness of market-oriented production therefore is a valid instrument. Although IV reduces the precision of the estimates and may produce biased estimates due to the un-testable nature of the assumption of the approach, results from the two approaches provide complementary information on causal effects since they rely on different information and different assumptions (Blundell & Costa Dias, 2000; DiPrete & Gangl, 2004).

2.5 Data

2.5.1 Data collection and sample selection

We use household survey data collected during the pre-harvest period in 2014 from Kanungu district, Western Uganda. We chose to collect data during the pre-harvest period as this is the period in which most households experience food shortages and hence the period interventions should target. One could argue that households engaged in market production have a relatively smooth consumption since they depend on the market for a bigger proportion of their food. However, this may not be true in rural areas where food in the market is locally supplied. Due to forces of demand and supply, in post-harvest period staples prices fall and households that purchase food are likely to consume more since acquiring calories is relatively cheap while the opposite is true during pre-harvest period. Thus, households that depend on the market for their food security are equally affected by the agricultural cycle (D'Souza & Jolliffe, 2014).

We employed a multi-stage sampling procedure to select respondents. The sample was drawn from seven sub counties; five representing rice-growing sub counties that have been exposed to rice production (treatment), and 2 representing the non-exposed and therefore non-rice growing areas (control). The sub counties were purposively selected considering those with similar socioeconomic and agro-ecological conditions so that participation in rice production is the only exogenous difference. From each of the sub counties that grow rice a list of villages was made and 4 villages were randomly selected. From each of the selected villages a list of households was made by the village councillor and the extension worker and 30 households were randomly selected. Similarly, lists of households from 6 randomly selected villages in each of the non- rice growing sub counties was made. From each control village, 50 households were randomly selected. For various reasons such as absence or refusal to respond, a total of 63 households were not interviewed, resulting in a sample of 1137 households of which 592 were from areas that have been exposed to promotion of commercial rice production and 545 from areas that have not received this promotion and consequently do not grow rice.

We observe negligible ‘contamination’/spill over effects in the sub counties used as control. While equally suitable for rice cultivation as the treatment areas, rice cultivation is virtually absent, and there are no alternative market crops not cultivated in the treatment sub counties. The absence of rice in the control areas is likely due to information gap. Information creates awareness and may shape attitude which are important factors in framing outlooks and

expectations of farmers towards technology choice (Doss, 2006). Unless farmers are given information with regard to a new technology, they are likely not to adopt it. Market information in particular plays a significant role in farmers' decision to participate in market production (Goetz, 1992; Omiti et al., 2009). Most farmers lack the capacity and enthusiasm to search for information by themselves. Moreover, in Uganda farmers have developed an attitude of relying on 'hand outs' such that they always wait for support from government or non-governmental organization to adopt a new technology. We therefore believe that if a similar program would have been introduced in the non-rice growing area, households would equally participate in market production.

2.5.2 Indicators

For each respondent household, we collected data on household demographic and socioeconomic characteristics, agricultural production and marketing, and food security. We measure market production as the share of total agricultural production sold. Considering the multidimensional nature of food access, we use three types of indicators of food consumption; daily calorie and proteins consumption per adult male equivalent (AME), household dietary diversity, and household food insecurity access scale (HFIAS). These indicators augment our results and limit the risks associated with measurement errors when a single measure is applied.

By using calorie and protein consumption per day per adult male equivalent (AME) rather than per capita, we control for variation that arise due to different food requirements by age and sex groups. This allows direct comparison of energy intake by households of different size and composition (Weisell & Dop, 2012). We use conversion factors (West et al., 1988) to compute the energy (calories) and protein intake per adult equivalent per day based on quantities and frequency a given food stuff was consumed by the household in a recall period of 7 days. The survey uses a 7 day recall period to control for daily consumption fluctuations. As households do not keep consumption records, we relied on the memory of female respondents for quantities and frequency of foods consumed since women are usually in charge of food preparations (Beegle et al., 2012).

Food wastage after it has been prepared and food eaten away from home present potential biases, but we expect these to be small. Since the survey is conducted during pre-harvest period we expect minimal wastage as food is rather scarce. Similarly, in rural areas it is not common that people eat away from home except on functions or when they travel to far

distances, and we do not expect many of such occasions. However, respondents may have difficulties remembering all the foods their household consumed over the recall period. Moreover it may also be difficult for respondents to accurately estimate quantities consumed of home produced foods such as tubers. These are harvested as piece meal, and there are various containers used during harvest such that we relied on the good estimation skills of the women who harvest and cook such foods. As such, there is potential of measurement error associated with recall and estimates of food consumption and this could cause biased estimates (Beegle et al., 2012). This is partly addressed by using alternative food security indicators that do not rely on reported quantities.

Dietary diversity is a qualitative measure of food consumption that reflects household access to a variety of foods, and it is a proxy for nutrient adequacy of the diet (Hoddinott & Yohannes, 2002; Kennedy et al., 2011). Dietary diversity captures the number of different types of food or food groups consumed in a specific period (Zezza & Tasciotti, 2010). The various foods are grouped into eleven categories; cereals, root and stem tubers, vegetables, fruits, meat, eggs, fish, milk and milk products, pulses, cooking oil, and sweeteners. If a household consumed any one of the foods in a given category in the period of 7 days before the interview, it scores 1 and 0 otherwise. The sum of all categories is the household dietary diversity score (HDDS).

The HFIAS score is conventionally used as a continuous measure of the degree of food insecurity in terms of access for a period of four weeks (Coates et al., 2007). In our study however, we extend the period to twelve months to control for seasonality in the agricultural cycle. HFIAS captures conditions related to anxiety, uncertainty, insufficient quality and food intake and prevalence of such conditions. We ask nine questions about frequency of occurrence of conditions above and we compute the score based on responses. The maximum score is 27 when a household responds 'often' to all the nine questions, and the minimum score is 0 when the household does not experience the occurrence in the past 12 months. The higher the score, the more food insecure in terms of access the household is.

2.5.3 Descriptive statistics on market production and food security

To validate the choice of our case study, we calculated the proportions of food crops marketed and the market production index for both treatment and control area (Table 2.1). Rice, which is only grown by 72.9% of sampled households in the treatment area, is by far the crop with the highest proportion marketed: 57 percent compared to 13-29 percent for other crops. The

marketed shares for other crops are also slightly higher in the treatment area, possibly due to spill over effect of project activities such as training in business development and market linkages. Overall, households in the treated area sell 53.4 percent of their produce, compared to 40.8 percent for households in the control area. Hence, while both groups of farmers engage in food markets, this engagement is substantially higher for farmers who have been exogenously exposed to market-oriented production. These proportions are much higher than the national average crop commercialization index of 26.3 (Carletto et al., 2016)

Table 2.1: Percentage share of food crops marketed

Crop	Pooled sample (N = 1137)		Treated (N=592)		Control (N= 545)	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Rice	57.1	24.3	57.1	24.3	-	-
Millet	28.7	25.9	35.0	28.0	21.5	21.5
Beans	29.1	25.6	32.0	27.8	26.8	23.4
Ground nuts	28.0	26.1	28.3	27.1	27.7	25.4
Maize	21.7	26.8	27.0	28.6	15.7	23.3
Banana	24.6	27.6	28.7	31.1	23.0	26.1
Sweet potatoes	15.7	25.0	19.8	28.5	13.0	22.0
Solanum potato	17.7	28.3	26.0	26.6	16.6	28.5
Cassava	22.3	31.2	22.7	30.5	22.0	31.7
Market production Index[1]	46.4	22.1	53.4	18.7	40.8	23..0

Source: household survey data. [1] Value of total household sales divided by total production value.

All production, including the share retained for home consumption, is valued at farm gate prices.

Food security of sampled households

Food insecurity is prevalent in the area. While on average survey households are food secure with a mean calorie consumption of 3580 kcal per adult male equivalent per day, caloric consumption for 26.5 percent is less than the minimum requirement of 2780kcal per adult male equivalent per day (FAO & WHO, 1985). This proportion is below what has been reported in a previous study, which indicates that 46% of the population in the western region was energy deficient in 2009-2010 (World Food Program & UBOS, 2013). Protein consumption seems less inadequate: we find about 11.0 percent of the households sampled with per adult equivalent daily protein consumption less than the recommended 56g per day (WHO, 2002). Surprisingly, a majority of households seem to meet the protein requirements, yet major sources of proteins are reported to be the most limiting by 51.2 percent of households sampled. Moreover, 36 percent of households asserted that they sometimes or often do not have enough to eat, and 33.3 percent of households reported eating less than

three meals per day. The reasons households give for not always having enough to eat include; harvesting too little (70%), selling most of what is harvested (14%), and lack of money (12%).

2.6 Results

2.6.1. Propensity score matching

Prior to estimation of market production effects, we use a logit model to predict the propensity score that are subsequently used for matching. Table 2.2 presents the logit regression results.

Table 2.2: Logistic regression estimates

Participation in rice market production	Coefficient	Std. Err.	P>z
Age of household head	-0.0274***	0.0073	-3.78
Education of household head	0.03288	0.0241	1.36
Education of spouse	-0.0318	0.0483	-0.66
Education of spouse x secondary occupation	-0.0407***	0.0145	-2.80
Number of persons in the household	0.0636**	0.0327	1.95
Land owned (Acres)	0.2765***	0.0414	6.68
Land owned squared	-0.0077***	0.0014	-5.57
Distance from home to the road (km)	0.0468	0.0339	0.167
Distance to the road squared	-0.0001	0.0001	-1.17
Access to extension services	0.0273	0.0493	0.55
Married=1;otherwise = 0	1.2799***	0.2488	5.14
Main occupation; agriculture =1; otherwise =0	1.3104***	0.3331	3.93
No secondary occupation =1; otherwise =0	-0.0309	0.2020	-0.15
Member in farmer group =1; otherwise =0	0.7365***	0.1796	4.10
Member of saving & credit group =1; otherwise =0	-0.7313***	0.1952	-3.75
Number of obs	933		
Prob > chi2	0.0000		
Pseudo R2	0.1504		

*Significant at 10%; **Significant at 5%; *** Significant at 1%

Market-oriented households are more likely to be married, with younger household heads, they own relatively more land, and agriculture is more likely to be their main occupation.

They are also more likely to be members of farmer groups and savings and credit associations. We impose the common support condition in the estimation of propensity scores by matching in the region of common support. This allows households with the same values of confounding factors to have a positive probability of being among rice growing households and the control group (Heckman et al., 1997). The distribution of propensity scores using Kernel and Radius matching are shown in Appendix A Figure 1.

Balancing tests show that before matching there are differences between the treated and the control group in the means of many covariates. Yet after matching these differences are very small and statistically not significantly different from zero. The chi2 test results show very low pseudo R2s for the matched sample, and these are statistically not significant ($p > 0.05$). The absolute standardized difference of the means of the linear index of the propensity score in the treated and matched control group (B) and the ratio of treated to matched control group variances of the propensity score index(R) conform to Rubins' recommendation (B is less than 25% and R is within the range 0.5-2) (Rubin, 2001). These results suggest that all covariates used to generate propensity scores are well balanced after matching. Details on propensity score estimates and balancing tests are presented in Appendix Table A1.1.

2.6.2 Does market production affect household food consumption?

Our results clearly indicate that market production reduces household caloric consumption. Compared to non-rice households, rice households consume on average 343–359 less calories per male adult equivalent per day depending on the matching method used (Table 2.3). This is substantial as it constitutes about 10% of the average consumption. These results are fairly robust to hidden selection bias: doubts on the statistical significance of estimated results occur only if confounding factors cause the odds ratio of participating in rice production to differ by a factor above 3.0 (DiPrete & Gangl, 2004).

Table 2.3: Average treatment effect and sensitivity analysis for food access

Outcome	Matching algorithm	Number of treated	Number of control	Mean outcome treated	ATT (SE)	Critical level of hidden bias (Γ)
Calorie consumption (per adult equivalent /day)	Nearest neighbour (NN = 4)	416	517	3358	-357.21*** (114.01)	Above 3
	Kernel matching (band width = 0.06)	416	517	3358	-359.47*** (101.57)	Above 3
	Radius matching (caliper =0.02)	402	517	3363	-342.31*** (101.5)	Above 3
Protein consumption (per adult equivalent /day)	Nearest neighbour (NN = 4)	416	517	113	8.11 (4.61)	
	Kernel matching (band width = 0.05)	416	517	113	10.80 (4.86)	
	Radius matching (caliper =0.02)	402	517	113	10.45 (5.37)	
Household Food Insecurity Access score	Nearest neighbour (NN =4)	416	517	4.89	0.68 (0.49)	
	Kernel matching (band width = 0.04)	416	517	4.89	0.58 (0.48)	
	Radius matching (caliper =0.03)	412	517	4.93	0.68 (0.42)	
Household Dietary Diversity Score	Nearest neighbour (NN = 5)	411	517	6.92	0.339** (0.16)	1.3 -1.4
	Kernel matching (band width = 0.05)	411	517	6.92	0.320** (0.13)	1.3 -1.4
	Radius matching (caliper =0.02)	397	514	6.92	0.330** (0.12)	1.3 -1.4

*Significant at 10%; **Significant at 5%; *** Significant at 1%

The negative effect of market production on calorie consumption confirms our hypothesis that the negative substitution effect outweighs the positive income effect. Consistent with previous studies, in rural Uganda food energy sufficiency is more closely associated with home production (World Food Program & UBOS, 2013). The increase in the marginal value product of land and labour resulting from the introduction of market-oriented rice production results in the withdrawal of resources from the production of staple food crops such as sweet potatoes and millet commonly consumed by the households themselves- (substitution effect). Households tend to allocate more of their labour and the most fertile land to the cash crop thus reducing labour availability for the staple crops. A substantial share of the rice harvested is

sold and since such income usually comes in lump sum, a large part is likely to be spent on non-food consumption that are one time purchases or seasonal payments such as health care and education fees. It is also important to note that in most rural households income accrued from market production is controlled by men though women have the primary responsibility of providing food for their households. Thus, food purchases largely depend on preferences of the husband and the bargaining power of the wife. We explore this issue further in our next chapter on gender and household resource allocation in market production. In a similar study, Carletto et al. (2016) find no association between crop commercialization and per capita calorie consumption although, they report a negative marginally significant relationship between commercialization and food expenditure in Uganda.

Considering health expenditure as an outcome variable, we attempt to support our argument that income from production is mainly spent on non-food consumption. We chose expenditure on health services because health is hypothesised to be an outcome of food and nutrition security (Alaimo et al., 2001). We find a positive statistically significant difference in health expenditure between rice and non-rice growing households (Table 2.4). Households participating in rice production spend 3.2 percent more of their income on health than household that do not participate in rice production. This finding is interesting in that, it could suggest that households engaged in market production, with insufficient food (evidence from calorie consumption analysis) spend a relatively bigger proportion of their income on health. This is not to argue that market production causes poor health but rather, as households reduce size or number of meals individuals are likely to suffer ill health due to increased vulnerability and consequently more likely to spend bigger proportions of their income on health services. Another possible explanation could be that individuals in households engaged in market production do not necessarily have poorer health than those in subsistence but rather have the economic power to respond to health shocks. This association thus requires further investigation.

Table 2.4: Average treatment effect on health and sensitivity analysis

Outcome	Matching algorithm	Number of treated	Number of control	ATT (SE)	Critical level of hidden bias (Γ)
Health expenditure (percentage of total expenditure)	Nearest neighbour (NN = 2)	426	539	3.17*** (0.793)	1.1 -1.2
	Kernel matching (band width = 0.02)	426	539	3.22*** (0.762)	1.2-1.2
	Radius matching (caliper =0.02)	426	539	3.18*** (0.757)	1.2-1.2

*Significant at 10%; **Significant at 5%; *** Significant at 1%

The effects on protein consumption and the household food insecurity access score are not statistically significant and thus do not provide further support for our hypothesis. Yet they neither support the commonly held belief that market production facilitates households to smoothen their consumption (Timmer, 1997). Households engaged in market production equally experience conditions related to anxiety, uncertainty, insufficient quality and food intake as the comparison households. This is confirmed by about 62.2 percent of households engaged in market production who asserted that they are often or sometimes worried that food would run out before they get money to buy more. Indeed 43.3 percent reported attending only two meals per day instead of 4 adopted by FAO (Weisell & Dop, 2012).

Unlike calorie consumption, results indicate a positive significant effect of market production on the dietary diversity score. Households engaged in market-oriented rice production on average have a dietary diversity score of 0.3 above that of non-rice households (Table 2.4). Again, these results are reasonably robust to hidden selection bias; only confounding factors that cause odds ratio of participating in rice production to differ by a factor above 1.4 cast doubts on the statistical significance of estimated results.

This result provides support for our second hypothesis: Market-oriented households are better able to purchase different types of foods and thus have a slightly more diverse diet. Overall, households derive a big proportion of their nutrition from cereals, tubers, and pulses which are consumed almost on a daily basis (Figure 2.1). Vegetables and fruits are commonly consumed in the wet season, when the survey was taken, but much less in the dry season due to limited availability. The rest of the food categories are consumed less frequently. Animal proteins are costly, not always available in sufficient quantities, and there is limited knowledge of their importance. The higher dietary diversity of market-oriented households results from a larger likelihood that these households purchase food hence they are exposed to

a variety of foods in addition to animal proteins including meat, eggs, fish, and cooking oil, which are typically bought in the market. Results, however, indicate that this increased consumption of animal products does not result in higher protein consumption levels. Presumably, the animal proteins are consumed in small quantities and maybe replace some of the home-grown proteins from pulses.

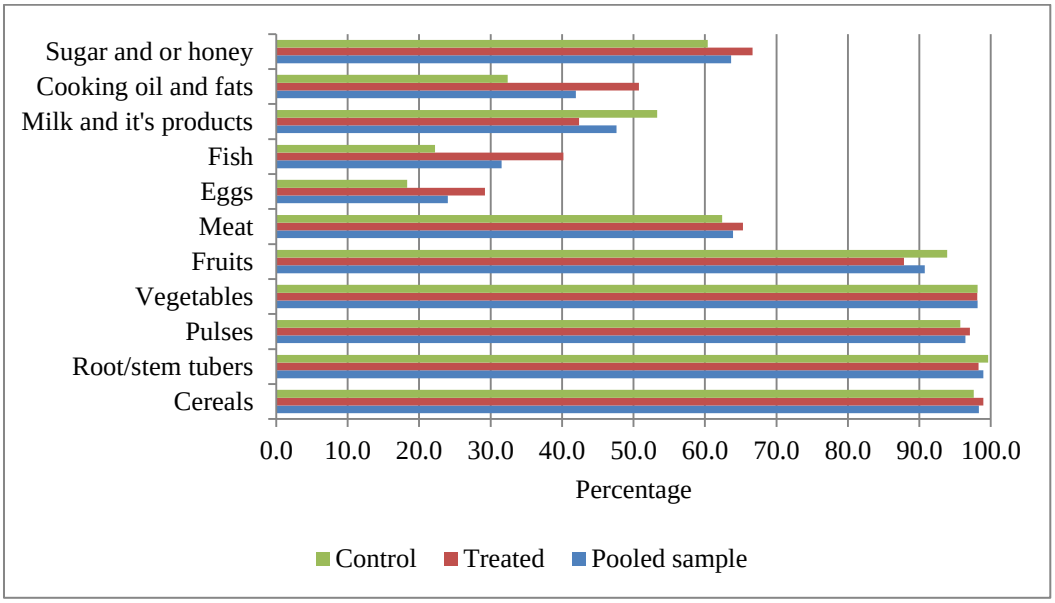

Figure 2.1: Proportion of households consuming food from different food groups in a 7 day recall period

2.6.3 Heterogeneous effects

Since land is a major resource for market production (Barrett, 2008) we analyse the market production effect on households disaggregated according to land holdings. We chose 3 acres of land as the boundary, because this divides the sample in half. We first test for covariate balancing using disaggregated data, and the results show that all covariates are well balanced (Appendix table A1.4). The pseudo R^2 after matching are very low and not statistically significant. The absolute standardized difference of the means of the linear index of the propensity score in the treated and matched control group (B) and the ratio of treated to matched control group variances of the propensity score index(R) conform to Rubins' recommendation (Rubin, 2001); B is less than 25% and R within the range 0.5- 2.

Table 2.5 shows that market-oriented rice production has a larger impact on food security for households with smaller farms. The associated decrease in calorie consumption is significant for both the lower and upper half of the sample households, yet the effect is largest for households with less than three acres. Based on the theoretical model, market production may affect consumption negatively for households that face constraints in supplying labour to the

market and these are most likely to be households with small farms. For such households, the positive income effect of the little produce they can sell is low, while the substitution effect is negative and can be substantial. The differences for dietary diversity are even more striking: market-oriented rice production significantly increases dietary diversity for households with small land holdings only. It is clearly more difficult to grow a variety of crops for a diversified diet on a very small farm, so purchased foods have more potential to increase dietary diversity for households with small land. Moreover, those with large farms are more likely to produce for the market as well as for home consumption.

Table 2.5: The effects of market production disaggregated by land holding

Outcome	Matching algorithm	Land owned< 3 acres			Land owned>= 3 acres		
		No. treated (control)	ATT (SE)	Critical level of hidden bias (Γ)	No. treated (control)	ATT (SE)	Critical level of hidden bias (Γ)
Calorie consumption (per adult equivalent /day)	Nearest neighbour (NN = 8)	136 (321)	-539.0*** (168.9)	1.8-1.9	279 (220)	-344.5*** (-124.9)	1.9-2.0
	Kernel matching (band width = 0.04)	136 (321)	-518.3*** (-122.7)	1.9-2	279 (220)	-322.9** (-110.4)	1.7-1.8
	Radius matching (caliper =0.03)	136 (321)	-520.7*** (-162.8)	1.9-2	271 (220)	-307.5** (-123.3)	1.7-1.8
Protein consumption (per adult equivalent /day)	Nearest neighbour (NN = 8)	136 (321)	11.32 (8.49)		279 (220)	9.52 (7.66)	
	Kernel matching (band width = 0.04)	136 (321)	11.85 (8.00)		279 (220)	9.64 (6.33)	
	Radius matching (caliper =0.03)	136 (321)	11.79 (8.18)		271 (220)	10.10 (7.58)	
Household Food Insecurity Access score	Nearest neighbour (NN = 10)	133 (318)	1.81* (0.76)		273 (219)	1.19 (0.73)	
	Kernel matching (band width = 0.05)	133 (318)	1.50 (0.98)		273 (219)	1.42 (0.93)	
	Radius matching (caliper =0.03)	133 (318)	1.72 (1.12)		262 (219)	1..3 (0.86)	
Dietary diversity score	Nearest neighbour (NN = 4)	133 (318)	0.72*** (3.49)	2.0-2.1	273 (219)	0.19 (0.42)	1.1
	Kernel matching (band width = 0.05)	133 (318)	0.67*** (2.68)	1.9-2.0	273 (219)	0.17 (0.86)	1.1
	Radius matching (caliper =0.02)	133 (318)	0.66*** (3.17)	1.8-1.9	262 (219)	0.24 (1.54)	1.2

*Significant at 10%; **Significant at 5%; *** Significant at 1%

2.6.4 Local average treatment effect

As an additional robustness test, we estimate LATE using awareness of market-oriented rice production through agricultural extension services as the instrument for the share of total produce marketed. The estimates therefore identify the average treatment effect among those

respondents who were induced to change their marketed share by extension information on rice production (Gangl, 2010). The results of the 2SLS Wald estimator are presented in Table 2.6. (For complete estimates, refer to appendix A 2.1-2.6). The F statistic test (23.6) for joint significance is significant at 5 % and exceeds 10 implying that the estimates are reliable (Stock et al., 2002). Moreover, the minimum eigenvalue statistic test for weak instrument is above the largest rejection rate at 10% (23.6 > 16.3) of a nominal 5% Wald test implying that awareness through extension is a strong instrument (Stock & Yogo, 2005).

Table 2.6: Local average treatment effect of market production on food consumption

Outcome variable	LATE	Standard error	F statistic
Calorie consumption	-157.56***	37.36	23.6
Protein consumption	0.186	0.518	
Household Food Insecurity Access score	0.1064*	0.053	
Dietary diversity score	0.030**	0.015	

*Significant at 10%; **Significant at 5%; *** Significant at 1%

Our results are consistent with ATT analysis; we find a negative significant effect of market production on household calorie consumption but not for protein consumption, and the effect on dietary diversity is significantly positive. Unlike ATT, we find a significant positive LATE on HFIAS, which is consistent with the negative effect on calorie consumption. The LATE of households induced into market production is significantly lower than the ATT. This can be explained by the different nature of the two estimators, while ATT gives an overall average effect, 2SLS gives a weighted average of unit causal effects and the weights are determined by how the compliers are distributed.

2.7 Conclusion

This chapter examines the effect of market production on rural household food consumption using the case of commercial rice production in western Uganda. We use primary data from rural households that were stratified randomly selected from areas where market-oriented rice production has been actively promoted and areas with similar conditions where this has not been done. We apply a propensity score matching approach to estimate the average treatment effect of market production and test for robustness of our results by estimating the local average treatment effects using instrumental variable approach. The results of both approaches are consistent and indicate that households engaged in market-oriented rice production are more likely to experience low caloric consumption. We argue that this is due to displacement of food crops for own consumption by the marketable crop and limited

allocation of the money earned from crop sales to food purchases. For farmers with very small farms, we observe a positive significant effect on the household food insecurity access score. We find no significant effect on protein consumption. On the contrary, we find evidence that market production increases dietary diversity. Smallholder households engaged in market production tend to purchase a bigger portion of their food, hence, they have access to different food stuffs. Finally, we find that market production effects on food consumption are more pronounced among households with small land holdings.

These findings suggest that market-oriented crop production is not sufficient for reducing hunger and under nutrition of smallholder households, even when the marketable crop is a food crop that can also be consumed at home. While reliance on markets for food consumption increases the diversity of the relatively monotonous diet, a substantial share of cash income is allocated to non-food consumption thus compromising energy consumption. This is a rational choice of the household, but it has negative effects on public health: malnourished children are less healthy, perform less well in school and adults earn less income.

What is needed is a mixed approach that combines policies targeted at market production, production for own consumption, and nutrition sensitization. We do not deny that households should produce for the market, if Uganda and Africa as a whole has to feed its fast growing population, but to ensure food security there must be a fair balance between increasing crop sales and own consumption. This can be achieved through policies that support both market-oriented and own-consumption oriented crops. There is need for technologies that support intensification of food production to enable smallholders raise enough food and surplus for sale. For example small scale irrigation technologies that can enable households to produce throughout the year will minimise the effect of seasonality on food security. Also improving the nutritive value of foods such as sweet potatoes, cassava and maize –which provide the highest proportion of calories for most households, could be key in improving household food security. Furthermore, there must be deliberate efforts to develop value addition technologies and infrastructure in rural areas to enable sellers and buyers easy access to food markets. In addition, nutrition sensitization can help improve the quality of the diet. Increased knowledge on the health effects of nutrition may change consumption preferences more towards food and increase the generally low dietary diversity.

Appendix

Appendix 1 Theoretical model

Model without sales

The Lagrangian for an interior solution to the problem can be written as follows:

$$L = u\big(q(l_f; A) + C_{fm}, wl_h - p_{fm}C_{fm}, T - l_f - l_h\big) + \lambda(M - l_h) + \mu C_{fm}. \quad \text{(A1)}$$

Differentiating with respect to market food consumption (C_{fm}), and farm labour (l_f), and wage labour (l_h) yields the following first order conditions:

$$\frac{\partial L}{\partial C_{fm}} = \frac{\partial u}{\partial C_f} - \frac{\partial u}{\partial C_{nf}} p_{fm} + \mu = 0, \quad \text{(A2a)}$$

$$\frac{\partial L}{\partial l_f} = \frac{\partial u}{\partial C_f}\frac{\partial q}{\partial l_f} - \frac{\partial u}{\partial l_l} = 0, \quad \text{(A2b)}$$

$$\frac{\partial L}{\partial l_h} = \frac{\partial u}{\partial C_{nf}} w - \frac{\partial u}{\partial l_l} - \lambda = 0 \quad \text{(A2c)}$$

Which can be summarized as follows:

$$\frac{\partial u}{\partial C_f} \Big/ \frac{\partial u}{\partial C_{nf}} = p_{fm} - \mu \Big/ \frac{\partial u}{\partial C_{nf}} \quad \text{(A3a)}$$

$$\frac{\partial u}{\partial l_l} = \frac{\partial u}{\partial C_f}\frac{\partial q}{\partial l_f} = w\frac{\partial u}{\partial C_{nf}} - \lambda \quad \text{(A3b)}$$

In addition:

$$\lambda, \mu, C_{fm} \geq 0, \quad \text{(A3c)}$$

$$l_h \leq M, \quad \text{(A3d)}$$

where $\lambda > 0$ if $l_h = M$; and $\mu > 0$ if C_{fm} = 0. (A3e)

Model with marketable crop

The Lagrangian for an interior solution to the problem is as follows:

$$L = u\big(q_{f1}\big(l_{f1}, A_{f1}\big) + C_{f2} + C_{fm}, p_{f2}\big(q_{f2}\big(l_{f2}, A - A_{f1}\big) - C_{f2}\big) + wl_h - p_{fm}C_{fm}, T - l_{f1} - l_{f2} - l_h\big) + \nu\big(A - A_{f1}\big) + \kappa A_{f1} + \lambda(M - l_h) + \tau\big(Q_2 - C_{f2}\big) + \mu C_{fm} + \xi l_{f1} + \varsigma\, l_{f2} \quad \text{(A4)}$$

This gives the following first order conditions:

Land allocation:

$$\frac{\partial L}{\partial A_{f1}} = \frac{\partial u}{\partial C_f}\frac{\partial q_{f1}}{\partial A_{f1}} - p_{f2}\frac{\partial u}{\partial C_{nf}}\frac{\partial q_{f2}}{\partial A_{f1}} - \nu + \kappa = 0 \quad \text{(A5)}$$

Labour allocation:

$$\frac{\partial L}{\partial l_{f1}} = \frac{\partial u}{\partial C_f}\frac{\partial q_{f1}}{\partial l_{f1}} - \frac{\partial u}{\partial l_l} + \xi = 0; \quad \text{(A6a)}$$

$$\frac{\partial L}{\partial l_{f2}} = p_{f2}\frac{\partial u}{\partial C_{nf}}\frac{\partial q_{f2}}{\partial l_{f2}} - \frac{\partial u}{\partial l_l} + \varsigma = 0; \quad \text{(A6b)}$$

$$\frac{\partial L}{\partial l_h} = \frac{\partial u}{\partial C_{nf}} w - \frac{\partial u}{\partial l_l} - \lambda = 0 \; ; \tag{A6c}$$

Cash consumption:

$$\frac{\partial L}{\partial C_{fm}} = \frac{\partial u}{\partial C_f} - p_{fm} \frac{\partial u}{\partial C_{nf}} + \mu = 0; \tag{A7a}$$

$$\frac{\partial L}{\partial C_{f2}} = \frac{\partial u}{\partial C_f} - p_{f2} \frac{\partial u}{\partial C_{nf}} - \tau = 0; \tag{A7b}$$

This results in the following optimal utility:

$$\frac{\partial u}{\partial C_f} \frac{\partial q_{f1}}{\partial A_{f1}} + \nu = p_{f2} \frac{\partial u}{\partial C_{nf}} \frac{\partial q_{f2}}{\partial A_{f1}} + \kappa \tag{A8a}$$

$$\frac{\partial u}{\partial l_l} = \frac{\partial u}{\partial C_f} \frac{\partial q_{f1}}{\partial l_{f1}} + \xi = p_{f2} \frac{\partial u}{\partial C_{nf}} \frac{\partial q_{f2}}{\partial l_{f2}} + \varsigma = w \frac{\partial u}{\partial C_{nf}} - \lambda \tag{A8b}$$

$$\frac{\partial u}{\partial C_f} \Big/ \frac{\partial u}{\partial C_{nf}} = p_{f2} + \tau \Big/ \frac{\partial u}{\partial C_{nf}} = p_{fm} - \mu \Big/ \frac{\partial u}{\partial C_{nf}} \tag{A8c}$$

$$\nu, \kappa, \xi, \varsigma, \lambda, \tau, \mu, C_{fm}, l_{f1}, l_{f2} \geq 0 \tag{A8d}$$

$$l_h \leq M, \tag{A8e}$$

$$0 \leq A_{f1} \leq A \tag{A8f}$$

$$C_{f2} \leq Q_2 \tag{A8g}$$

where $\nu > 0$ if $A_{f1} = A$; $\kappa > 0$ if $A_{f1} = 0$; $\xi, \varsigma > 0$ if $l_l = 0$; $\lambda > 0$ if $l_h = M$; $\tau > 0$ if $Q_2 - C_{f2} = 0$; and $\mu > 0$ if $C_{fm} = 0$.

Appendix 2 Propensity score matching

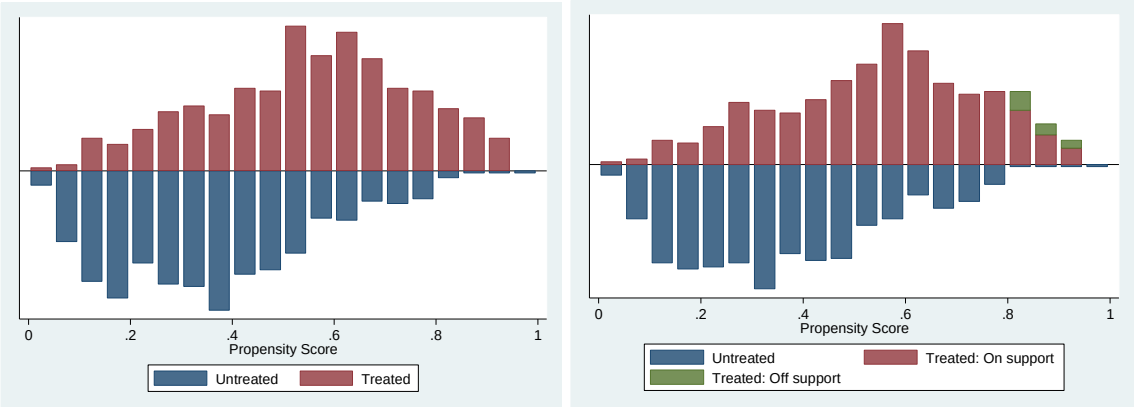

Figure 1: Distribution of propensity scores and the region of common support

Table A1.1: Propensity score matching and covariate balancing test

Variable	Sample	Mean		%reduction	t-test
		Treated	Control	(bias)	p>t
Age of household head	Unmatched	42.181	42.716		0.536
	Matched	42.181	43.176	-86.0	0.265
Education of household head	Unmatched	5.8353	5.3711		0.045
	Matched	5.8353	5.8175	96.2	0.939
Education of spouse	Unmatched	4.7819	4.9258		0.585
	Matched	4.7819	4.9637	-26.3	0.461
Education of spouse Squared	Unmatched	35.339	44.195		0.010
	matched	35.339	38.282	66.8	0.322
Number of persons in the household	Unmatched	6.6473	5.7421		0.000
	Matched	6.6473	6.3797	70.4	0.131
Land owned (Acres)	Unmatched	5.441	3.5855		0.000
	Matched	5.441	6.0145	69.1	0.157
Land owned squared	Unmatched	62.405	38.951		0.017
	Matched	62.405	73.819	51.3	0.284
Distance from home to the road (km)	Unmatched	2.4801	1.4003		0.106
	Matched	2.4801	2.1682	71.1	0.711
Distance to the road squared	Unmatched	216.71	25.13		0.309
	Matched	216.71	99.163	38.6	0.584
Access to extension services	Unmatched	2.0162	1.4991		0.000
	Matched	2.0162	2.2026	64.0	0.162
Married=1;otherwise = 0	Unmatched	.86311	.72542		0.000
	Matched	.86311	.83449	79.2	0.241
Main occupation; farming =1; otherwise =0	Unmatched	.94896	.89796		0.003
	Matched	.94896	.95437	89.4	0.711
No secondary occupation =1; otherwise =0	Unmatched	.49652	.55288		0.081
	Matched	.49652	.52359	52.0	0.427
Member in farmer group =1; otherwise =0	Unmatched	.65661	.43414		0.000
	Matched	.65661	.68987	85.1	0.298
Member of saving & credit group =1; otherwise =0	Unmatched	.78422	.83673		0.037
	Matched	.78422	.7966	76.4	0.656

Table A1.2: Chi-square test for significance of variable before and after matching

Outcome	Matching algorithm	Pseudo R2 Before (After) matching	$p>chi^2$ Before (After) matching
Calorie consumption	Nearest neighbour (NN = 4)	0.149 (0.010)	0.000 (0.687)
	Kernel matching (band width = 0.06)	0.149 (0.004)	0.000 (0.991)
	Radius matching (caliper =0.02)	0.149 (0.004)	0.000 (0.995)
Protein consumption	Nearest neighbour (NN = 3)	0.149 (0.010)	0.000 (0.688)
	Kernel matching (band width = 0.05)	0.149 (0.005)	0.000 (0.989)
	Radius matching (caliper =0.02)	0.149 (0.04)	0.000 (0.995)
Dietary diversity score	Nearest neighbour (NN = 3)	0.151 (0.010)	0.000 (0.692)
	Kernel matching (band width = 0.05)	0.151 (0.006)	0.000 (0.956)
	Radius matching (caliper =0.02)	0.151 (0.005)	0.000 (0.982)
Household Food	Nearest neighbour (NN = 3)	0.149 (0.010)	0.000 (0.688)
Insecurity Access score	Kernel matching (band width = 0.05)	0.149 (0.005)	0.000 (0.985)
	Radius matching (caliper =0.03)	0.149 (0.004)	0.000 (0.995)

Table A1.3: Sensitivity Analysis: Rosenbaum Bounds

Gamma	sig+	sig-	t-hat+	t-hat-	CI+	CI-
1	1.2e-06	1.2e-06	-376.44	-376.44	-517.35	-226.616
1.1	1.3e-08	.000057	-438.855	-312.895	-575.795	-158.906
1.2	9.3e-11	.00101	-493.491	-253.079	-628.817	-96.7301
1.3	5.5e-13	.008566	-543.83	-197.147	-677.867	-37.9797
1.4	2.7e-15	.041284	-588.088	-144.24	-722.018	20.8813
1.5	0	.128194	-629.625	-95.9149	-764.324	77.0881
1.6	0	.282981	-668.363	-49.2977	-803.401	130.27
1.7	0	.48101	-704.19	-4.0281	-838.623	180.895
1.8	0	.673149	-736.197	41.2362	-871.58	227.21
1.9	0	.820785	-769.557	82.8618	-901.617	276.157
2	0	.913813	-799.053	124.327	-930.764	319.927

gamma - log odds of differential assignment due to unobserved factors

sig+ - upper bound significance level

sig- - lower bound significance level

t-hat+ - upper bound Hodges-Lehmann point estimate

t-hat- - lower bound Hodges-Lehmann point estimate

CI+ - upper bound confidence interval (a= .95)

CI- - lower bound confidence interval (a= .95)

Table A1.4: Covariate balancing test for disaggregated data

		Land owned< 3		Land owned>= 3	
Outcome	**Matching algorithm**	Pseudo R2 Before (after) matching	$p>chi^2$ Before (after) matching	Pseudo R2 Before (After) matching	$p>chi^2$ Before (after) matching
Calorie consumption	Nearest neighbour	0.168	0.000	0.137	0.000
	(NN = 8)	(0.005)	(1.000)	(0.004)	(0.998)
	Kernel matching	0.168	0.000	0.137	0.000
	(band width = 0.04)	(0.004)	(1.000)	(0.005)	(0.989)
	Radius matching	0.168	0.000	0.137	0.000
	(caliper =0.02)	(0.005)	(1.000)	(0.004)	(0.997)
Protein consumption	Nearest neighbour	0.168	0.000	0.137	0.000
	(NN = 3)	(0.005)	(1.000)	(0.004)	(0.998)
	Kernel matching	0.168	0.000	0.137	0.000
	(band width = 0.05)	(0.004)	(1.000)	(0.005)	(0.989)
	Radius matching	0.168	0.000	0.137	0.000
	(caliper =0.02)	(0.005)	(1.000)	(0.004)	(0.997)
Dietary diversity score	Nearest neighbour	0.172	0.000	0.139	0.000
	(NN = 10)	(0.009)	(0.997)	(0.006)	(0.984)
	Kernel matching	0.172	0.000	0.139	0.000
	(band width = 0.05)	(0.005)	(1.000)	(0.004)	(0.9997)
	Radius matching	0.172	0.000	0.139	0.000
	(caliper =0.02)	(0.006)	(1.000)	(0.005)	(0.995)
Household Food Insecurity	Nearest neighbour	0.171	0.000	0.112	0.000
Access score	(NN = 4)	(0.011)	(1.000)	(0.007)	(0.999)
	Kernel matching	0.171	0.000	0.112	0.000
	(band width = 0.05)	(0.007)	(1.000)	(0.004)	(1.000)
	Radius matching	0.171	0.000	0.112	0.000
	(caliper =0.03)	(0.007)	(1.000)	(0.004)	(1.000)

Appendix 3 LATE

Table A2.1: Estimated Coefficient of the first stage 2sls regression

Market production Index	Coef.	Std. Err.	z
Access to rice information	7.68245***	1.580099	4.86
Education of husband	-.1749223	.2221204	-0.79
Education of wife	1.017373***	.2602783	3.91
Gender of household head	-4.84718	4.571034	-1.06
Married=1;otherwise = 0	19.92665***	6.482632	3.07

Household size	-.0558088	.4080594	-0.14
Dependency ratio	-.6931154	.6324333	-1.10
Wealth	7.48e-08*	4.41e-08	1.70
Size of land owned	.4288732**	.1683591	2.55
Household own livestock =1, 0 otherwise	2.605883*	1.44398	1.80
Distance to the market	.1677065	.257535	0.65
Depends on family labour =1; 0 = otherwise	-7.162626***	1.560961	-4.59
Main occupation; farming =1; otherwise =0	7.271373***	2.667086	2.73
No secondary occupation =1; otherwise =0	2.097032	1.472364	1.42
Member of farmer group =1; otherwise =0	1.222312	1.483673	0.82
Member of saving & credit group =1; otherwise =0	1.657622	1.862058	0.89
Member of marketing group =1; otherwise =0	3.946095	3.147769	1.25
Constant	14.4916**	7.506279	1.93
N = 897			
Prob > chi2 = 0.0003			
Adj R-squared = 0.1595			

Table A2.2: Estimated Coefficient of the local average response function for calorie consumption

Calorie consumption per adult equivalent	Coef.	Std. Err.	z
Market production Index	-157.5608***	36.45049	-4.32
Education of husband	-31.58104	40.29058	-0.78
Education of wife	149.7397**	57.86873	2.59
Gender of household head	-60.76985	833.3442	-0.07
Married=1;otherwise = 0	4054.641***	1304.231	3.11
Household size	-182.6151**	72.30085	-2.53
Dependency ratio	-152.5741	114.1156	-1.34
Wealth	2.13e-06	8.14e-06	0.26
Size of land owned	97.87317***	34.98307	2.80
Household own livestock =1, 0 otherwise	697.1903**	280.0948	2.49
Distance to the market	3.367714	48.26052	0.07
Depends on family labour =1; 0 = otherwise	-1735.366***	405.2877	-4.28
Main occupation; farming =1; otherwise =0	1363.313**	560.565	2.43
No secondary occupation =1; otherwise =0	328.2531	266.3926	1.23
Member of farmer group =1; otherwise =0	570.7794**	271.4545	2.10
Member of saving & credit group =1; otherwise =0	-61.03763	331.6799	-0.18
Member of marketing group =1; otherwise =0	586.8338	584.4817	1.00
Constant	149.7397**	57.86873	2.59
N = 897			
Prob > chi2 = 0.0003			

Table A2.3: Tests of endogeneity and Instruments

Ho: Variables are exogenous					
Durbin (score) chi2(1)		= 121.643 (p = 0.0000)			
Wu-Hausman F(1,878)		= 137.746 (p = 0.0000)			
First-stage regression summary statistics					
Variable	R- Sq.	Adjusted R- sq.	Partial R-sq	F(1,879)	Prob > F
MPI	0.1754	0.1595	0.0262	23.6391	0.0000
Minimum eigenvalue statistic = 23.6391					
Critical Values		number of endogenous regressors: 1			
Ho: Instruments are weak		number of excluded instruments: 1			
		10%	15%	20%	25%
2SLS Size of nominal 5% Wald test		16.38	8.96	6.66	5.53
LIML Size of nominal 5% Wald test		16.38	8.96	6.66	5.53

Table A2.4: Estimated Coefficient of the local average response function for Protein consumption

Protein consumption per adult equivalent	Coef.	Std. Err.	z
Market production Index	.1863621	.5183071	0.36
Education of husband	.0691842	.5747635	0.12
Education of wife	-.7341636	.8257357	-0.89
Gender of household head	3.941313	11.85635	0.33
Married=1;otherwise = 0	17.93539	18.58979	0.96
Household size	-7.804057***	1.028485	-7.59
Dependency ratio	-.1477808	1.810153	-0.08
Wealth	7.28e-08	1.16e-07	0.63
Size of land owned	1.054142**	.4986636	2.11
Household own livestock =1, 0 otherwise	-2.49612	3.996601	-0.62
Distance to the market	.9619399	.6891459	1.40
Depends on family labour =1; 0 = otherwise	-9.816545*	5.771993	-1.70
Main occupation; farming =1; otherwise =0	-.3001371	7.988874	-0.04
No secondary occupation =1; otherwise =0	328.2531	266.3926	1.23
Member of farmer group =1; otherwise =0	4.631779	3.875252	1.20
Member of saving & credit group =1; otherwise =0	-14.93218***	4.734261	-3.15
Member of marketing group =1; otherwise =0	-5.56572	8.359094	-0.67
Constant	124.7712***	21.1321	5.90
N = 897			
Prob > chi2 = 0.000			

Table A2.5: Estimated Coefficient of the local average response function for Household dietary diversity score

Household Dietary Diversity Score	Coef.	Std. Err.	z
Market production Index	.0304804**	.0155964	1.95
Education of husband	.0312325*	.0172472	1.81
Education of wife	.0580049**	.0244773	2.37
Gender of household head	.0219911	.356446	0.06
Married=1;otherwise = 0	.0987408	.5501953	0.18
Household size	-.0714728**	.0306793	-2.33
Dependency ratio	-.0034592	.0536184	-0.06
Wealth	1.37e-08***	3.45e-09	3.98
Size of land owned	-.0219401	.0149333	-1.47
Household own livestock =1, 0 otherwise	.0631537	.1189971	0.53
Distance to the market	-.0052599	.0204845	-0.26
Depends on family labour =1; 0 = otherwise	-.4825438***	.176539	-2.73
Main occupation; farming =1; otherwise =0	.0511938	.2530207	0.20
No secondary occupation =1; otherwise =0	-.7376765***	.1140387	-6.47
Member of farmer group =1; otherwise =0	.1474312	.1174353	1.26
Member of saving & credit group =1; otherwise =0	-.0117	.141576	-0.08
Member of marketing group =1; otherwise =0	-.1992775	.2482912	-0.80
Constant	5.325605***	.6544239	8.14
N = 888			
Prob > chi2 = 0.0000			

Table A2.6: Estimated Coefficient of the local average response function for Household food insecurity access score

HFIAS_score	Coef.	Std. Err.	z
Market production Index	.1000418*	.0537134	1.86
Education of husband	-.087747	.0686355	-1.28
Education of wife	-.3201816***	.0923193	-3.47
Gender of household head	.9252308	1.40235	0.66
Married=1;otherwise = 0	-1.336416	2.14871	-0.62
Household size	.1028982	.1223999	0.84
Dependency ratio	.7163163***	.2110866	3.39
Wealth	-3.16e-08**	1.38e-08	-2.29
Size of land owned	-.0962419*	.0582743	-1.65
Household own livestock =1, 0 otherwise	.6970592	.4637458	1.50
Depends on family labour =1; 0 = otherwise	2.287898***	.6539706	3.50
Main occupation; farming =1; otherwise =0	-2.74002***	.9234499	-2.97
No secondary occupation =1; otherwise =0	.1713491	.4514841	0.38
Member of farmer group =1; otherwise =0	-.367583	.4607165	-0.80
Member of saving & credit group =1; otherwise =0	-1.579066***	.5631965	-2.80
Constant	4.370352*	2.494946	1.75
N = 897			
Prob > chi2 = 0.0000			

Chapter 3

Market production, household resource allocation and food security: The gender dimension

Abstract

As many African countries promote market-oriented agricultural production, it is important to understand how market production influences gender equality in decision making and access to agricultural resources as this will affect attainment of the food security goal. We use a combination of a survey and lab-in-the-field experiment approach to address two major questions. First, does market production affect women's control over resources in rural households? Second, how does a change in women empowerment affect household food security? We use the instrumental variable censored regression model and propensity score matching to estimate market production and women empowerment effects. Our results show that market production negatively impacts on women empowerment in making production decisions and income allocation. Results also show that women empowerment has a positive effect on household food security. We conclude that market production may not be the appropriate means of empowering rural households to eradicate food insecurity unless rural women are empowered to participate in making decisions regarding resource allocation.

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3.1 Introduction

Market-oriented agricultural production has been promoted in many African countries as a strategy to improve food insecurity, which is often regarded as an issue of low household income and poverty (Clover, 2003; Gladwin et al., 2001). The extent to which market production succeeds in improving rural household food security depends on how the household allocates its productive resources as well as income that accrues from production. Shifting from subsistence to market production involves significant reallocation of household resources -especially land and labour, in order to support both food and non-food consumption (Govereh et al., 1999; Govereh & Jayne, 2003; Immink & Alarcon, 1993). In a household with different individuals, household resource allocation may be driven by one individual, the household head, or it may be a result of a negotiation process between different individuals notably a husband and wife, based on their preferences. Intra household resource allocation varies systematically with individual members bargaining power which is influenced by their access to household resources (Katz, 1997).

Intra-household gender relations are often not considered while implementing government development programs. Yet the reality is that, male-female power relations within households affect who gets access to means of production and who controls income from production (Patel, 2012). Whereas women play a key role in household food security, they are disproportionately disempowered through the current process and politics of food production, consumption and distribution (Patel, 2012). Women in Africa provide substantial labour in agricultural and food production (Hyder et al., 2007) but have no control over the output and income generated (Anderson & Eswaran, 2009). Control of most valuable resources is biased in favour of men leaving women disadvantaged in making decisions about resource management (Galiè et al., 2015). In ten countries in Sub-Saharan Africa decisions on large household and daily needs purchases, including woman's own health are most often made by husbands alone with proportions ranging between 37.6 to 60.4 percent (Kishor & Subaiya, 2008). Inequality in gender relations and women's relative lack of power limit women producers to respond with an economically appropriate supply response because they lack access to basic inputs of production (Due & Gladwin, 1991).

Implementation of agricultural projects often assumes a unitary household where income and resources are pooled and allocated according to a joint utility function. However, research has shown that this is not appropriate, based on a number of studies that have criticised the unitary household model (Donni & Chiappori, 2011; Vermeulen, 2002). Men and women are

individuals with preferences that may be different from each other and therefore household decisions should not be analysed using a single utility function for the entire household (Duflo & Udry, 2004). Programs that do not take into account the collective nature of household behaviour often result into marginalization of women and may not achieve potential outcomes (Kaaria & Ashby, 2000).

As households shift production patterns towards production of cash crops, it is important to understand gender associated challenges in regard to woman's control of resources and bargaining power and how these impact on household food security (Chung, 2012; Lim et al., 2007). Increased commercialization of food crops might lead to contrasting outcomes; it may increase women's income thus increasing their decision making power within the household (Anderson & Eswaran, 2009); the women can use the income to buy food and, or invest in food production thus improving food security (Govereh and Jayne 2003); on the other hand increased commercialization may lead to increased control of men over food crops thus increasing significance of marital bargaining in resource allocation (Sørensen 1996). The outcome is driven by various factors that might be country or community specific based on their socio-economic and cultural background.

This chapter seeks to explore how market production affects women's control over resources and the associated changes in food security in Uganda so as to guide formulation of policies to maximize the benefits of market oriented production, in terms of income as well as food and nutrition security. Whereas there is enormous literature on gender power relations and food/ nutrition security, most studies have focused on money transfer programs and child nutrition in especially Asia and Latin America. A review of the existing literature reveals that the linkage between market production, women empowerment and food security has not been widely explored empirically in Africa, and to the best of our knowledge no such study has been done in Uganda. Our study contributes to the existing literature by answering two major questions; Does market production affect women's control over resources in rural households? And if it does, how does a change in women's bargaining power affect household food security? We draw evidence from a case of rice production in Uganda as one highly promoted market oriented program. Our main finding is that market production has a significant negative effect on overall women empowerment in control over resources in production, and this effect is robust on separate indexes of women empowerment. We find evidence of a significant positive association between women empowerment in production and household calorie consumption.

The rest of the chapter is structured as follows; in section 3.2 we review previous studies, section 3.3 presents the theoretical framework, section 3.4 describes a case of market production programme while section 3.5 explains the data. We discuss the analytical methods used in section 3.6, in section 3.7 we present and discuss results and we conclude in section 3.8.

3.2 Market production, gender and resource allocation

3.2.1 Market production, women empowerment and productivity

Intra-household dynamics arising from gender differences strongly affect production and consumption decisions and consequently influence resource allocation and income expenditure (Abdullah & Duasa, 2010; Duflo & Udry, 2004). In many African households men have continued to dominate household decisions and control over resources. Agricultural production within many African households is carried out on multiple plots controlled by different members of the household. It is widely recognized that cash crops and income from production are predominantly controlled by men (Jaleta et al., 2009) while women partially control staple food crops and have the responsibility of providing food for the household (Udry 1996; Peterman, Quisumbing et al. 2011; Yiadom-Boakye et al. 2011). Even crops formerly known as women's crops, for instance cassava in Benin (Gray & Kevane, 1999), banana in Kenya (Fischer & Qaim, 2012) and rice in Gambia and Cote d'Ivoire (Kaaria & Ashby, 2000), have been claimed by men after they had been commercialized. Similarly, in Malawi and Uganda commodities that generate lower revenues are likely to be controlled by women while those that generate high revenues are more likely to be controlled by men (Njuki et al., 2011).

Gender inequalities in household decision making and control over resources have been found to have negative effects on agricultural productivity and food security (FAO, 2011). Limited access to inputs such as land, labour, agrochemicals and information has been reported to cause higher inefficiency levels among women farmers or women controlled plots (Peterman et al., 2014; Peterman et al., 2011; Udry, 1996; Yiadom-Boakye et al., 2011). Women are not able to pay hired labour, yet they offer their labour both on their plots and men's plots. Hence women may not be able to profitably participate in market production. For instance in Uganda and Malawi plots managed by women on average produce 13 percent and 25 percent less per acre respectively than plots managed by men or jointly with other members of the household (O'Sullivan et al., 2014). These gaps are attributed to the difference in the returns that men and women receive from factors of production, differences in level and quality of education

and differences in access to extension services. Orientation of extension services to focus on commercial crops managed by men seems to favour male farmers' demands in terms of crop choices while women crops are neglected (Joughin & Kjær, 2010).

Whereas land is the most important input in production, studies consistently show that rural women in Africa are less likely to control and own land than rural men[1]. Most women have limited or no access to productive land. They are given marginal land of poor quality and low potential (O'Sullivan et al., 2014; Rossi & Lambrou, 2008). In Cameroon for instance, while women undertake more than 75 % of agricultural work, they own less than 10% of the land (Rossi & Lambrou, 2008). It is not better in Ghana where female headed households gain access to farmland through senior male relatives who lend or rent them part of their land. Rent is often paid in form of produce immediately after harvest thus making the women more vulnerable to increased volatility of food prices and economic shocks when they buy the food in a later period (Carr, 2008). Lack of secure tenure to land limits women from accessing credit since land is often used as collateral. Access to credit is important in market production for various reasons including purchase of inputs and smoothing consumption during the pre-harvest season and in case of crop failure.

Whereas market production is expected to increase household income and improve general household welfare, some studies show that market production has negatively impacted women's rights and welfare in many African countries. For example in Malawi increased profitability of hybrid maize, a male cash crop, lead to increased acreage under maize while groundnuts, the women cash crop, reduced drastically in acreage (Due & Gladwin, 1991). Whereas this seems a smart economic decision, it affects women as well as household food security since women may not be able to buy inputs for staple food production. Similarly, a study by Behrman et al., (2012) in Maputo, indicates that expansion of the sugarcane production dominated by men lead to a general displacement of women dominated food crops such as banana. This trend is not unique to crop production but has also been observed in livestock production. In Ethiopia, Lenjiso et al., (2015) find that a shift towards market production of milk caused a reduction of milk processed and sold by women and hence the income under women's control, as men took over the marketing of milk. We complement this literature with evidence from Uganda showing the extent to which market production impacts

[1] In a conference on women land rights in Kampala, Uganda, Irene Cheptoek, a rural woman farmer narrates; " in Kapchorwa, the man owns the land, he decides what to plant on it and what to do with the harvest. The woman mainly provide the labour and are not even allowed to enjoy the fruit of the hard work they injected on the land" New vision 31/08/2015, Uganda's leading daily newspaper.

on women's empowerment to make decisions on the type of crop to grow, when to sell produce, how much to sell and how to spend the income from production.

3.2.2 Women's income, empowerment/ bargaining power and food security

There is consistent evidence of conflict between spouses concerning the control and expenditure of crop earnings in African countries (Haddad et al., 1997; Lim et al., 2007) and such conflict often contributes to food insecurity (Hidrobo et al., 2016). Conflicts in expenditure patterns can be resolved through bargaining depending on intra-household bargaining power levels between husband and wife as well as information sharing between the spouses. When information on income is asymmetric, individuals in the household are likely to make private decisions and may spend the money on private consumption (Ashraf, 2009).

A number of studies show that women's incomes are more strongly related to improvement in nutritional status than men's income (Quisumbing et al., 1995). Quisumbing et al. (1995) argue that if women had access to resources available to men they could make significant contributions to eradicating food insecurity. Angelucci and Attanasio (2013) observe that handing cash transfers to women in the poverty alleviation program in Mexico improved nutrition of poor urban households more than if the same amount would have been given to men. In Cote d'Ivoire, Duflo and Udry (2004) find that an increase in output of the crops predominantly produced by women resulted in increased expenditure towards food consumption, while a similar increase in output of cash crops predominantly produced by men had no effect on purchases of food. Compared to women, men tend to spend more of their earnings for personal spending such as drinking alcohol (Chant, 2002; Von Braun, 1995; Von Braun et al., 1991).

A few studies however, have rejected the common hypothesis that money controled by women positively affects household food consumption. A study by Braido et al., (2012) evaluating a social programme in Brazil using an unintentional experiment where money was transferred to women, finds that the programme leads to an increase in food expenditure. However, they do not find evidence to associate the effect to the woman being the benefit recipient. In Nigeria, Aromolaran (2004) observes a negative effect of women's income share on per capita calorie consumption in low income households. The author concludes that calorie intake is affected more by total disposable income than by the individual in control.

Besides income, household power relations in general and women bargaining power in particular, have been shown to be key elements in intra household resource allocation with significant impact on food security. The relationship and strength of the association between women's empowerment and household food and nutrition security vary across different domains of women empowerment and other contextual factors (Cunningham et al., 2015). A cross-country study in 63 countries in all developing regions reveals that women's status relative to men's is an important determinant of child malnutrition (Smith & Haddad, 2000). The study attributes over 50 percent of the reduction in child malnutrition between 1970 – 1995 to changes in women status and education. Case studies in different countries using different indicators of food security reveal a similar trend. Bhagowalia et al., (2012) find a greater degree of women's empowerment and maternal endowments to be associated with better long term child nutrition status in Bangladesh. They identify women participation in decision making to be an important influence on dietary diversity while attitude toward domestic violence has an effect on child stunting. In Uganda and Guatemala, Alkire et al. (2013) find that greater women empowerment is positively correlated with decreased hunger scores. They claim decision making and autonomy to be the key domains of empowerment determining the hunger score.

A study in Pakistan by Guha-Khasnobis and Hazarika (2006) finds a positive relationship between women's intra household status and child food security and they affirm bargaining power as a mechanism of intra household allocation. Lemke et al., (2003) find that in black South African households where men dominate decision making, there are more worries about food insufficiency than in households with partnership relations (with equal power) or those led by women. They find that households headed by male are more food insecure and have a higher incidence of experiencing hunger than households in partnership relations despite male headed households having a higher per capita income.

3.3 Theoretical framework

Our empirical specification is motivated by predictions of a collective choice model of household behaviour, with potentially diverging preferences of males and females. Before turning to this (cooperative) bargaining model, however, we first present a relatively simple unitary model of household decision-making as a benchmark.

Unitary model with market production

Assume a household maximizes utility of consumption of own produced food (Q_f), food purchased from the market (C_{mf}) and non-food items (C_{nf}). The household's (concave) utility function reads as follows;

$$Max_{Q_f,C_{mf},C_{nf}}\ u(Q_f, C_{mf}, C_{nf}) = \ \alpha lnQ_f + \beta lnC_{mf} + \gamma \ln C_{nf}, \quad (1)$$

The household maximises utility from consumption subject to a budget constraint and a land constraint. We assume the household has a fixed land base (A) that can be used to produce either a staple crop for home consumption (Q_f) or a cash crop (Q_c) for the market. For simplicity, we assume simple constant returns to scale production functions with land as the only input, or a linear relationship between the land area allocated to a crop and output;

$$A = Q_f + Q_c \quad (2)$$

Income earned from cash crop sales is used to pay for market-food and non-food consumption items as expressed below;

$$PC_{nf} = p_c Q_c - C_{mf} \quad (3)$$

Where; p_c and P denote the market price of the cash crop and non-food items, respectively, so that the price of market-food is the numeraire.

The Lagrangian associated with the constrained maximization problem is defined as;

$$L = \ \alpha\ ln(A - Q_c) + \beta\ \ln(p_c Q_c - PC_{nf}) + \gamma lnC_{nf} \quad (4)$$

Differentiating with respect to the two control variables; the area allocated to the cash crop (Q_c) and the amount spent on non-food consumption (C_{nf}), produces the following first order conditions;

$$\frac{\partial L}{\partial Q_c} = \frac{-\alpha}{A-Q_c} + \frac{\beta p_c}{p_c Q_c - PC_{nf}} = 0 \quad (5)$$

$$\frac{\partial L}{\partial C_{nf}} = \frac{-\beta P}{p_c Q_c - PC_{nf}} + \frac{\gamma}{C_{nf}} = 0 \quad (6)$$

Equation (5) states that, at the margin, the household should be indifferent between allocating land to the production of home food and allocating it to the production of the cash crop (to finance consumption of market-food). Equation (6) states that, at the margin, the household should be indifferent between spending income on the consumption of market-food items and non-food items. Rearranging equations (5) and (6) yields the standard outcome that the (price-weighted) marginal utilities of the three consumption items should be equalized for an optimal solution;

$$\frac{\beta}{p_c Q_c - PC_{nf}} = \frac{\gamma}{PC_{nf}} = \frac{\alpha}{p_c(A-Q_c)} \quad (7)$$

Bearing in mind that the choice of the crops is driven by prices, what happens if the price of the cash crop increases? This case is explored in the Appendix. Upon applying Cramer's rule, this yields the following predictions:

$$\frac{\partial Q_c}{\partial p_c} = 0, \quad \frac{\partial C_{mf}}{\partial p_c} > 0 \text{ and } \frac{\partial C_{nf}}{\partial p_c} > 0 \tag{8}$$

These outcomes are readily understood in terms of income and substitution effects. Raising the price for the cash crop implies a positive income effect, so the household will consume more market-food and non-food items (both are normal goods). The situation with respect to home-food is more complex, as this also involves a substitution effect. While the rise in income implies the household wishes to consume more of the home-produced food (increasing Q_f; another normal good), the shadow price of home-food increases as well. The price of home-food is defined by the opportunity costs, or the foregone returns to cash cropping. For an optimal solution, the income and substitution effect exactly cancel, so a unitary household does not adjust its land allocation after a cash crop price shock. Hence food security increases as a result of increased consumption of market food.

A bargaining model with market production

We now extend the unitary model to a more realistic collective household model where spouses bargain over the bundle of goods that is to be consumed. In what follows, the superscripts *h* and *w* indicate husband and wife, respectively. We consider cooperative bargaining between the spouses, and solve for a weighted average of the preferences of the two partners. Denote the bargaining power of the husband, or his weight in the collective utility function, by μ. The utility function for the collective model is defined as follows:

$$Max_{Q_f, C_{mf}\, C_{nf}}\, u^i\left(Q_f, C_{mf}, C_{nf}\right) = \mu(p_c)\, u^h\,(Q_f, C_{mf}, C_{nf}) + \left(1-\mu(p_c)\right)u^w(Q_f, C_{mf}, C_{nf})$$

$$=\mu(p_c)\ (\alpha lnQ_f + \beta lnC_{mf} + \gamma \ln C_{nf}) + \left(1-\mu(p_c)\right)(\alpha lnQ_f + \beta lnC_{mf} + \theta \ln C_{nf}) \tag{9}$$

Note that husband and wife have different preference parameters associated with the consumption of non-food goods: γ and θ. We make two critical assumptions: (i) the husband has stronger preferences for the consumption of non-food items than his wife ($\gamma > \theta$), and (ii) the husband's bargaining power is increasing in the price of the cash crop, reflecting that men are typically responsible for the sales of cash crops. That is, we assume $\mu(p_c)$ with $\mu'(p_c)>0$.

The Lagrangian reads as follows:

$$L=\mu(p_c)[\ \alpha\ ln(A-Q_c) + \beta\ \ln\left(p_cQ_c - PC_{nf}\right) + \gamma lnC_{nf}] + \left(1-\mu(p_c)\right)[\ \alpha\ ln(A-Q_c) +$$

$$\beta\ \ln\left(p_cQ_c - PC_{nf}\right) + \theta lnC_{nf}] \tag{10}$$

As before, we differentiate with respect to the cash crop (Q_c) and non-food consumption (C_{nf}), which now leads to the first order conditions;

$$\frac{\partial L}{\partial Q_c} = \frac{-\alpha}{A-Q_c} + \frac{\beta p_c}{p_c Q_c - PC_{nf}} = 0, \quad (11)$$

$$\frac{\partial \mathrm{L}}{\partial C_{nf}} = \mu(p_c)\left(\frac{-\beta P}{p_c Q_c - PC_{nf}} + \frac{\gamma}{C_{nf}}\right) + \left(1-\mu(p_c)\right)\left(\frac{-\beta P}{p_c Q_c - PC_{nf}} + \frac{\theta}{C_{nf}}\right) = 0. \quad (12)$$

These equations can be re-arranged to yield:

$$\frac{\mu(p_c)\,(\gamma-\theta)+\theta}{PC_{nf}} = \frac{\beta}{p_c Q_c - PC_{nf}} = \frac{\alpha}{p_c(A-Q_c)} \quad (13)$$

Observe that the optimal outcome of the collective model reduces to the outcome of the unitary model (in (7)) if both spouses have the same (relative) preference for the non-food goods: $\gamma = \theta$. In this case, the allocation decisions are identical to the ones discussed above, and a cash price shock will not affect the allocation of land (but will stimulate the consumption of market food and non-food items).

How does the optimal allocation for the collective model (13) compare to the optimal allocation for the unitary model (7) when men and women have different preferences? Comparing (7) to (13), it is evident that the collective model allocates a greater share of land to cash crop production. Specifically, because $\mu(p_c)(\gamma-\theta)+\theta>\theta$ (for $\gamma>\theta$), consumption of non-food items (c_{nf}) should increase relative to consumption of home-grown food. The denominator of the first term in (13) then becomes larger, and the denominator of the third term in (13) becomes smaller – restoring equilibrium.

The comparative statics with respect to a price shock are also different for the unitary and collective models. This follows from the assumption that a cash crop price shock will empower the husband – raising μ. All else equal, this implies that the new equilibrium will more closely resemble his preferences rather than hers. Since the husband has a greater taste for non-food items, the result of this power shift is that less land is allocated to home-food, and the consumption of non-food items increases more than before:

$$\frac{\partial Q_c}{\partial p_c} > 0 \quad , \quad \frac{\partial C_{nf}}{\partial p_c} > 0 \text{ and } \frac{\partial C_{mf}}{\partial p_c} > 0 \quad (14)$$

3.4 Market oriented program

In 2003, IFAD introduced the Area- Based Agricultural Modernization Program (AAMP) in Southwestern Uganda. The overall goal of the program was to contribute to poverty alleviation by increasing household income through increased agricultural productivity (IFAD, 2012). One specific objective of the program was commercialization of agriculture to

improve income and food security of small holder households with less than five acres of land. In practice, however, participants were self-selected and it is not uncommon that households with more than five acres of land participated since there were no strict exclusion measures. The program promoted market production by offering farmers extension and training in modern farming technologies. Promising NERICA (New Rice for Africa) varieties were promoted to stimulate commercial rice production. The program focused on strengthening the capacity of farmers to access the market by training them in business development and market linkages, training marketing associations and providing support to value addition initiatives. By 2008, twelve rice hulling machines had been established in the study area, including one that does sorting and packaging. Such high level support and promotion of market production has not been experienced in the neighbouring sub counties.

The project started in two sub counties of Nyamirama and Kihihi that lie along the rift valley. These sub counties are considered to be relatively fertile. However, the area per se does not present a unique environment for rice production as the project was later extended to other sub counties. The program was implemented for six years by the Ministry of local Government in collaboration with district and sub county officials. After AAMP, the rice project was taken over by a government program called National Agricultural Advisory Services (NAADS). NAADS continued to support rice production and promotion in the neighbouring sub counties and a few other districts as a cash crop. Rice is now a priority cash crop in five out of twelve sub counties in the study area and one of priority commodities at national level (MAAIF, 2010). Rice production has significantly increased (CARD, 2014) from 150,000 tons on 80,000 hectares in 2004 to 280,000 tons on 140,000 hectares in 2012 (MAAIF, 2010; Reda et al., 2012).Thus it presents a good case of market production

3.5 Data and descriptive statistics

To get an insight in household resource allocation and control under market production, we examine decision making and expenditure patterns of married men and women with particular interest in food provision. As it is not possible to observe women's control over resources and bargaining power directly, we use proxies. Different measures, such as asset share and income have been used in literature (Doss, 2013). Finding appropriate indicators should be guided by the need to find variables that are exogenous to bargaining within marriage, but most important these indicators should be culturally relevant (Quisumbing & Maluccio, 2000). We chose to use a combination of an expenditure game and survey-based empowerment

indicators to construct women empowerment indices that are used as proxies for bargaining power in household decision making and resource control (Wiig, 2011).

Survey data are extracted from a household survey of 1137 households on market production and food security in Kanungu district, Southwestern Uganda. The sample was drawn from seven sub counties; five representing rice growing sub counties that have been exposed to the AAMP (treatment), and 2 representing the non-exposed and therefore non-rice growing areas (control). The sub counties were purposively selected considering those with similar socioeconomic and agro-ecological conditions so that participation in AAMP is the only exogenous difference. We use data on demographic and socioeconomic characteristics, household food consumption and allocation of key resources (land, labour, agricultural produce and revenue). We use data on crop production and marketing to construct a market production index (MPI). Market production can be measured as a share of output sold in the total agricultural output per household or in terms of purchased inputs (Strasberg et al., 1999; Govereh and Jayne 2003). Since we are interested in the marketing of outputs, we measure market production as the share of total agricultural production sold. All production, including the share retained for home consumption, is valued at household-level sales prices. A value of 0 implies that a households' production is totally subsistence and 100 % means the households' production is exclusively market oriented. To investigate the relationship between women empowerment and food security, we use household calorie consumptions as an indicator of food security. We compute calorie intake per adult equivalent based on what the household consumed in a seven day recall period in a household survey. We also use the share of food expenditure to see whether women have an influence on the proportion of income that is spent on market food which they do not produce by themselves.

Expenditure experiment

We run a simple experiment using a 'charity game' to test for bargaining power on income expenditure among couples. Procedures were as follows; Individual participants were given 10 vouchers; each voucher has a value attached depending on where it is allocated. Participants were then asked to decide how to divide the 10 vouchers between two types of allocation (i) allocation to the household (ii) allocation to charity. Each voucher allocated to the household is worth Ug. Shs 800 while that allocated to charity is worth Ug. shs 1,000. This game was played twice; first confidential individual allocation, and second, a couple joint allocation. The Nash equilibrium is reached when everyone chooses all the coupons for themselves thus receiving Ug.Shs. 8000.

Implementation of the experiment

Participants were randomly picked from those who participated in the household survey. Using stratified random sampling, we selected 145 couples from the list of married couples in sub counties that are involved in commercial rice production and 100 couples from the control group (households in non-rice growing sub counties). We selected couples who are from parishes that are distant from each other to control for other participants getting prior information before the game. Save two sessions where we invited 10 couples for each, we invited 15 couples per day for each experimental session. We had only one meeting in each parish, and this enabled us to keep the experiment information a secret such that participants did not have any prior knowledge about the game. The meetings were held in different places such as churches, classrooms and outside depending on what was available and convenient. Two research assistants and the first author conducted the experiment and each was assigned five couples to observe.

Selected couples were invited by the extension officer and were urged to keep time as those who delayed would not be allowed to participate. In the invitation they were also informed that they would receive transport compensation equivalent to Ug. Shs 5000 ($2). Since this is slightly more than a daily wage for farm labour it motivated all those invited to show up. After all participants arrived at the meeting venue, they were briefed about the game and explained that after the games were played a lottery would decide which game determined their actual payoffs. Participants were also asked to agree on the charity they were willing to contribute to. While different options including orphans and the church were proposed, contribution to the elderly dominated the choices. Couples were then asked to separate such that husbands kept a distance from their wives as they played the individual game. After participants had made individual decisions couples were asked to sit together to make joint decisions. We did not reveal to the participants that they would play a joint game until they finished the individual game. They were urged to follow instructions and do the exercise under their 'normal behaviour'. After the games, individuals participated in a lottery to decide which game would determine their payoffs. Each individual received a payment equivalent to Ug. Shs 5000 transport money plus the allocation they made in the game won during the lottery. The maximum cash received by an individual was Ug. shs13,000 for someone who won a game in which they did not contribute to charity.

Measuring women bargaining power

We use a combination of methods to construct women bargaining power to enable us capture different dimensions of empowerment (production, economic, social) (Varghese, 2011)

From the charity game we construct a women empowerment index (WEI) as follows;

$$\text{Empowerment index} = \frac{\text{Joint decision} - \text{male decision}}{\text{Female decision} - \text{male decision}}$$

1= full bargaining power of woman

0= full bargaining power of man

From survey data we construct a women empowerment index in production based on women's participation in making decisions concerning production and marketing of eight common crops and income expenditure.[2] We compute the score based on responses (1 if the woman makes the decision and 0.5 for joint decision); the maximum score is 56 when the woman makes decision in all the questions and the minimum score is 0 when the husband makes all the decisions. The higher the score the higher the bargaining power the woman has. Moreover, we assess women social empowerment based on their participation in social activities and household decision making. We ask women eight questions – five on whether she asks for permission and three on whether she participates in household decisions[3] and compute the score based on the responses; The maximum score is 8 when an individual does not ask for permission for any of the activities and participates in making all household decisions mentioned. The minimum score is 0 when the woman seeks for permission in all the questions and does not participate in making household decisions. Again, the higher the score the more the woman is empowered to make decisions.

Descriptive statistics

Table 3.1 presents summary statistics of the variables used. The women empowerment mean scores are generally low, with a minimum of zero implying that in some households the men make all the decisions. A maximum of 55.5 also shows that in some households women make almost all production decisions. We observe a higher mean age for the husbands than that for the wives with a mean difference of 7 years between husband and wife. The husbands spent slightly more years in school than the wives with a difference of 1.4 years and their average

[2] We ask, who makes the decision on which crop to grow and where to grow it, labour allocation, type and quantity of seed to plant, quantity of harvest for home consumption, when to sell, quantity for sell and use of income generated

[3] We ask whether the woman asks the husbands for permission to; go to the market, visit hospital, visit friends and relatives, attend public functions and spend money. We also ask whether the woman participates in decisions regarding; her own health such as use of contraceptives, children education and household size

education suggest that a majority have only primary education (seven years). The husbands earn much more income than wives. A majority of households are smallholders with an average land size of 5.3 acres. Their main occupation is agriculture and about 50 percent have no secondary occupation. On average households market 48.6 percent of the food crops produced and some of the households in our sample did not sell any produce in the year of survey. More than 60 percent of the sampled households have membership in farmer groups and savings and credit associations.

Table 3.1: Descriptive statistics of variables used in the regressions

Variable	Mean	Std. dev.	Minimum	Maximum
WEI (Production decisions)	23.1	10.47	0	55.5
WEI (control over use of income)	0.4	0.45	0	1
WEI (socio-economic decisions)	4.1	1.55	0	8
Market production index	48.6	22.0	0	92.2
Age of husband	44.6	13.4	20	87
Age of wife	37.6	11.0	20	67
Age difference (male – female)	6.94	6.86	-7	37
Education of husband (years spent in school)	6.5	3.6	0	18
Education of wife (years spent in school)	5.1	3.1	0	17
Education difference (male – female)	1.44	3.49	-10	14
Number of persons in the household	6.7	2.8	2	19
Husband's annual income (million UGX)	2.5	2.3	0.006	11.0
Wife's annual income (million UGX)	0.8	0.87	0.004	4.4
Land owned (Acres)	5.3	5.9	0.25	35
Distance to the market (km)	6.72	5.92	0.48	72
Main occupation; agriculture =1; otherwise = 0	0.9	0.2	0	1
No secondary occupation =1; otherwise =0	0.5	0.5	0	1
Member in farmer group =1; otherwise =0	0.6	0.5	0	1
Member of saving & credit group =1; otherwise =0	0.9	0.3	0	1
Number of observation	231			

Participation of women in agricultural production decisions

Figure 3.1 presents the proportion of women by category that makes decisions in production and marketing of food crops. Less than 60 percent of women in rural households are involved in making decisions regarding production. The proportion is even lower for households involved in market production (treated) compared to those under subsistence (control). For a cash crop such as rice only 20 percent of women are involved in decision making. We observe a relatively higher proportion of women -slightly over 40 percent, participating in decision

making regarding staple food crops, specifically sweet potatoes and cassava -commonly referred to as 'women's crops'.

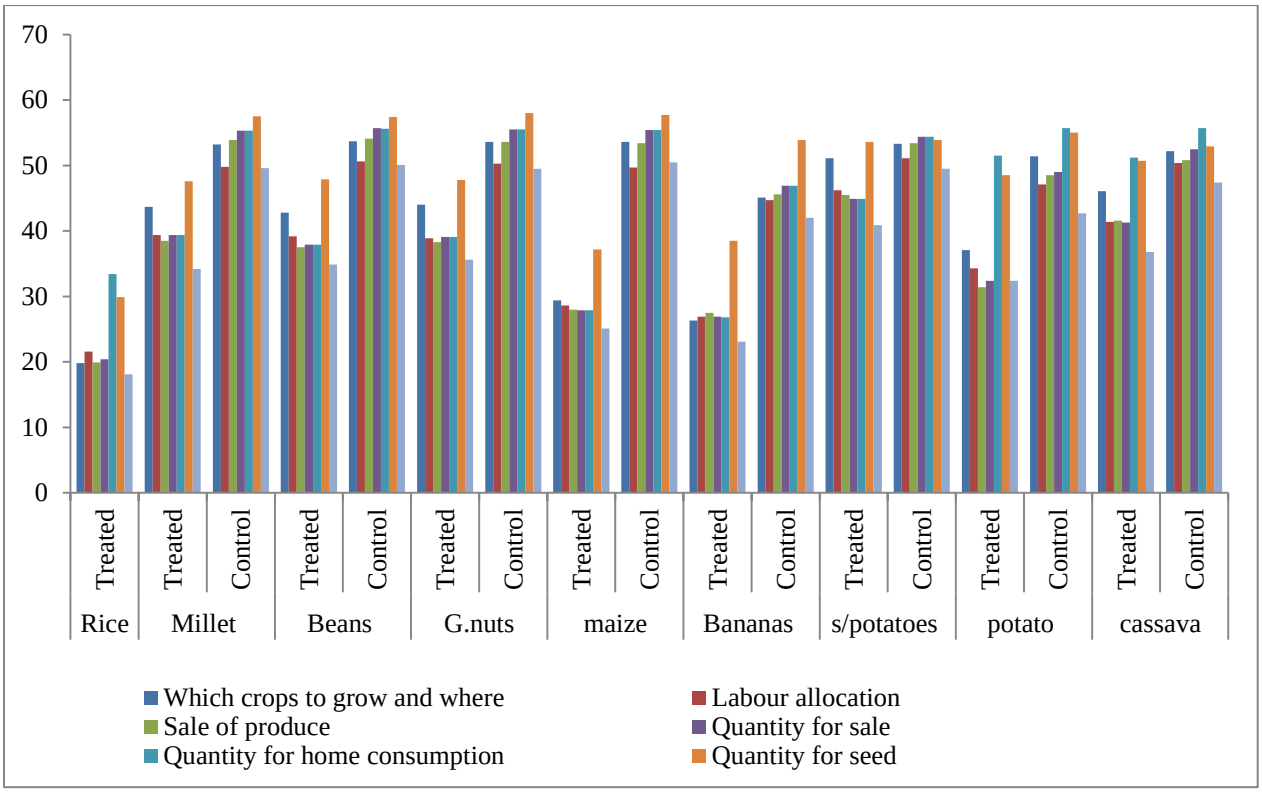

Figure 2.1: Proportion of women by category that makes decisions in production

3.6 Empirical specification

3.6.1 Market production and women empowerment

Estimating the average effect of market production on women control over resources presents some challenges. A methodological difficulty arises from the fact that participating in market production is not a random decision. It is a choice that individual households make and it is likely to be influenced by some unobservable confounding factors, such as entrepreneurial skills, which we cannot measure. We therefore face a problem of endogeneity arising from potential selection bias and omitted variables. This means that ordinary least squares estimation will lead to biased estimates since the market production index is likely to be correlated with the error term.

We attempt to reduce the effect of the potential sources of biases by using two approaches in our analysis; first, we use instrumental variable estimator to control for potential endogeneity (Angrist et al., 1996); next we check for robustness of our results using propensity score matching estimators, which we explain later in this section. The challenge with IV estimations is to find appropriate instruments. In our case we use a dummy for awareness / exposure to

information on rice production through agricultural extension services as the instrumental variable. This is based on the premise that information on rice production has influenced households more into market oriented production. In addition, we use land owned as an instrument for the regressions for women empowerment in control of income and social empowerment. We believe that land size highly influences market production but has no direct effect on empowerment in control of income and social empowerment. Land owned is not used to instrument MPI in the production decisions model because it directly affects production decisions. We estimate the local average treatment effect (LATE), which is the average effect of the treatment for the subsample of the population that is induced by a change in the value of the IV to select themselves into treatment (Angrist et al., 1996). In our case it is the average effect of participating in market production on women empowerment for the subsample of the population which is induced by information on production of rice for the market. Since our dependent variable women empowerment index (WEI) has a censored distribution bounded from below and above with a lower limit of 0, we estimate a maximum likelihood instrumental variable Tobit regression model to predict market production effects on women empowerment. The model is specified as follows;

In the first stage we estimate:

$$MPI_i = \alpha_0 + \alpha_1 z_i + \alpha_2 x_i + \varepsilon_i$$

In the second stage we estimate WEI as a function of the instrumented market production index (MPI'):

$$WEI_i = \beta_0 + \beta_1 MPI'_i + \beta_2 lnx_i + v_i \ ; \qquad i = 1, 2..... N$$

Where; β and α represent parameters to be estimated, i reflects the household, z represents the excluded instrument(s), x represents household socio-economic and demographic characteristics, v_i and ε_i are the error terms. Our main coefficient of interest is β_1, which reflects the response of women empowerment index to market production.

Factors that may influence the bargaining process include; age of wife, age difference, husband education, wife education, number of children, household size, husband income, wealth, distance to the market, livestock ownership, main occupation of the household, membership in farmer groups, savings and credit groups. Education is included because it tends to enhance a person's bargaining power and better understanding of their rights. Education offers women skills that are likely to increase their returns in the labour market and hence make them economically empowered (Malik & Courtney, 2011). Moreover, education brings about changes in cognitive ability which is essential to women's capacity to question,

reflect and act on and gain access to information and new ideas (Kabeer, 2005). The influence of age on women empowerment varies depending on the decision to make. In some studies the older women are found to be more independent and empowered than young women (Alkire et al., 2013) while in others it is the opposite (Kishor & Subaiya, 2008). The age difference between husband and wife is equally important as it is likely to influence experience and self-confidence of the marital partners (Mason & Smith, 2003). Similarly, wealth has been found to be positively associated with woman's resource control but negatively associated with overall decision making (Mahmud et al., 2012). Husbands' income may affect women empowerment -as men's income increases, they are likely to be engaged in off farm business thus allowing the wives to be more involved in decisions regarding food crop production. The number of children is expected to affect women's empowerment mainly through increased security in marriage associated with many children. The number of people in the household can help to empower women by contributing to labour and increasing their freedom of mobility. Distance to the market is expected to affect WEI because markets are usually a meeting point where women meet and can easily share information which may positively influence their empowerment. Livestock ownership may influence women empowerment as men tend to concentrate on livestock leaving women to make decisions on crop production. Membership in farmer groups, savings and credit groups may positively influence women's power to affect households decisions.

As a robustness check we use propensity score matching to control for selection bias. We compare women empowerment between women in households engaged in rice market production and their counterparts with similar observable covariates in households that are engaged in subsistence production (control group). The propensity score matching approach has several advantages; it does not require baseline data, comparison of the outcome variable is undertaken on households with similar characteristics (Imbens & Wooldridge, 2008) and when comparing subpopulations with similar characteristics, covariates are independent of the treatment variable and thus a causal interpretation of the results is reasonable (Caliendo & Kopeinig, 2008). Compared to IV approach, propensity score matching helps improve precision of estimates of treatment effects (DiPrete & Gangl, 2004). However, it only controls for selection on observables.

3.6.2 Women empowerment and household food security

Our second point of investigation is the link between women empowerment and household food security. It is difficult to demonstrate causal relations involving women empowerment

due to potential bias especially given the fact that unobserved factors such as family, cultural barriers and religious beliefs determine who within the household has access to a particular resource and for what purpose. Therefore, ordinary least squares estimates may be biased. Previous studies have used instrumental variable approach to control for endogeneity. For example Lépine and Strobl (2013) use ethnicity to instrument bargaining power in a study on the effect of bargaining power on child nutrition in Senegal. Others have used assets brought into marriage by the wife and age difference between husband and wife (Imai et al., 2014; Sraboni et al., 2014) as instruments for the women empowerment variable. In our study however, we have limited suitable instruments in our data. We attempt to use age difference and education difference between spouses and their interaction as potential instruments. This is based on the premise that relatively older and more educated husbands tend to have a higher bargaining power.

To test whether households with more empowered women are food secure, we estimate per capita household calorie consumption (C_f) as a function of women empowerment (WEI) and a set of control variables (x):

$$C_{fi} = \delta_0 + \delta_1 WEI_i + \delta_j x_{ij} + \omega_i$$

Where; δ represent parameters to be estimated and ω_i is the error term

Further, we estimate the effect of women empowerment on share of household food expenditure (C_{mf}) specified as follows;

$$C_{mfi} = \lambda_0 + \lambda_1 WEI_i + \lambda_j x_{ij} + u_i$$

Where; λ represent parameters to be estimated and u_i is the error term

The control variables include; household size, proportion of children below 5years, proportion of children above 5years, size of land owned, distance to the market, per capita household expenditure (proxy for income), dummy for main occupation, ownership of livestock, main source of labour, membership to farmer and credit/ savings groups, and distance to the market.

The variables selected have been shown to potentially influence household food consumption. Households with a high market production index are likely to have less food if their preference for non-food consumption is higher than that for food. Household size is relevant in that, given household expenditures, a large household is more likely not to have enough food compared to a small household. The household composition may affect calorie consumption as adults are expected to consume more calories than children. Households

whose members' occupation is mainly agriculture may require higher energy as they do a lot of manual labour. Livestock ownership have been found to have a positive impact on household food security (Ali & Khan, 2013). We also include the distance to the market as it influences access to the market and ultimately food access and expenditure.

3.7 Results

3.7.1 Does market production affect women's control over resources?

Since women empowerment indexes are censored we estimate instrumental variable tobit model to predict local average treatment effects (LATE). The ivtobit also gives us an opportunity to control for other variables other than participation in market production that may affect women empowerment. The results are summarized in Table 3.2 (full results are presented in appendix Table A2.1). The number of excluded instruments in models 1and 2 equals the number of exogenous variables in the equation and therefore the model is just identified so we do not test for over identification. In models 3-6, using a test of over identifying restrictions, we fail to reject the null hypothesis which suggests that the instruments are valid. We also perform the Anderson-Rubin test for weak instruments (Finlay & Magnusson, 2009); and the null hypothesis is rejected at 1% (models 1, 2 and 4) and 10% (models 3 and 5) levels of significance. Therefore, our instruments are adequate (Table 3.2). However, for model 6 we fail to reject the null hypothesis implying that the instrument is weak.

Table 3.2: Parameter estimates of Instrumental variable Tobit model for local average treatment effect of market production and determinants of women empowerment

	Overall WEI (production decisions)		Control over use of income (*charity game*)		WEI (social empowerment)	
	1	2	3	4	5	6
Market production index	-0.6718**	-0.4338**	-0.021**	-0.0323**	-0.012	-0.0001
	(0.3167)	(0.2134)	(0.0105)	(0.0140)	(0.0083)	(0.0045)
Constant	56.0565***	12.1299	1.1149**	2.0495*	2.1810	7.1720**
	(15.5093)	(16.1411)	(0.5125)	(1.2784)	(0.4086)	(3.0628)
Controls	no	yes	no	yes	no	yes
Observations	231	230	204	203	231	220
Amemiya-lee-Newey mini. chi2			0.353	0.863	3.035	0.295
p-value of Newey mini. chi2			0.5524	0.3528	0.08	0.587
Anderson Rubin chi2	13.15 ***	6.94***	5.15*	9.52***	3.18 *	0.30
p-value of A.R. chi2	0.0003	0.0084	0.0761	0.0086	0.0747	0.862

*Significant at 10%; **Significant at 5%; *** Significant at 1% Standard errors in parenthesis

Notes: Control variables include; wife age, age difference, years of husband education, years of wife education, household size, number of children, husband's annual income, size of land owned, wealth, distance to the market, dummies for; owning livestock, main occupation, secondary occupation, member of farmer group, member of saving & credit group (Appendix Table 1). For the WEI (social empowerment) regression, the variables are in natural logs. For the WEI in control over income and social empowerment regressions, MPI is instrumented by access to rice information and size of land owned. In the WEI in production decisions' regression, size of land owned is included as it directly affects decisions in production.

Our results show a negative and statistically significant impact of market production on women empowerment in making decisions regarding production and control over use of income. For every one percent increase in market production the women empowerment index in production and control over income reduces by 0.43 and 0.03 points respectively. The magnitude of the effects of market production on women empowerment in production (with a range of 0-55.5) are relatively larger than the effects on women empowerment in control over income (with a range of 0-1).

Propensity score matching estimates

As a robustness check we control for selection bias using propensity score matching. We try to create a sample of treated and control groups that are similar by estimating propensity scores. We use a logit model to predict the probability that a household participates in the rice production program. A common support condition is imposed and the balancing property is

satisfied. Results are reported in Table 3.3. The estimated model is statistically significant at 1 percent level. Results show a negative significant relationship between market oriented rice production and education of the wife, husband annual income, lack of secondary occupation and membership in savings and credit groups. Households with a large number of persons, large size of land owned, agriculture as main occupation and membership in farmer group are likely to participate in market production.

Table 3.3: Logistic regression model for participation in market oriented rice production program

Variable	Coefficient	Std. Err.
Age of husband	-0.0319	0.0227
Age of wife	-0.0214	0.0273
Education of husband	-0.0021	0.0480
Education of wife	-0.1328**	0.0591
Number of persons in the household	0.1848***	0.0660
Land owned (Acres)	0.0613**	0.0317
Main occupation; agriculture =1; otherwise = 0	2.1262***	0.8089
No secondary occupation =1; otherwise =0	-0.5181*	0.3171
Member in farmer group =1; otherwise =0	0.9938***	0.3296
Member of saving & credit group =1; otherwise =0	-1.6442***	0.5548
_cons	0.9830	1.1570
Number of obs	230	
Pseudo R2	0.162	
LR chi2(12)	49.87	
Prob > chi2	0.000	
Log likelihood	-129.012	

*Significant at 10%; **Significant at 5%; ***Significant at 1%

Prior to estimation of ATT, we tested for covariate balancing to assess the matching quality of PSM estimators, and the results are summarized in Table A2.3 (Appendix). After matching, the pseudo R- squared, the likelihood ratio chi-square and standardized bias are very low implying that there are no systematic differences in the distribution of covariates between participants and non-participants in market production. We use Kernel-based matching and radius matching methods to estimate the market production effect on women empowerment in resource control. Table 3.4 presents the average treatment effects on the treated considering different dimensions of women empowerment as the outcome.

Table 3.4: Average treatment effect estimates

Outcome	Matching algorithm	Number of treated	Number of control	ATT	Standard error	Mean empowerment index (control)
Control over use of income (*charity game*)	Kernel matching (band width = 0.08)	111	79	-0.012	0.086	0.40
	Radius matching (caliper =0.08)	111	79	-0.019	0.087	
WEI (social empowerment)	Kernel matching (band width = 0.09)	118	90	-0.224	0.243	4.36
	Radius matching (caliper =0.09)	118	90	-0.235	0.267	
Overall WEI (production decisions)	Kernel matching (band width = 0.05)	118	90	-5.709**	2.239	27.5
	Radius matching (caliper =0.02)	118	90	-5.263**	2.392	
Decision on type of crop to grow	Kernel matching (band width = 0.1)	118	90	-0.522*	0.275	3.84
	Radius matching (caliper =0.1)	118	90	-0.528**	0.236	
Decision on labour allocation	Kernel matching (band width = 0.08)	118	90	-0.443*	0.261	3.55
	Radius matching (caliper =0.08)	118	90	-0.449*	0.274	
Decision on sale of produce	Kernel matching (band width = 0.1)	118	90	-0.642**	0. 283	3.71
	Radius matching (caliper =0.1)	118	90	-0.636**	0.285	
Decision on quantity of produce to sell	Kernel matching (band width = 0.1)	118	90	-0.566*	0.304	3.84
	Radius matching (caliper =0.1)	118	90	-0.555*	0.304	
Decision on quantity for consumption	Kernel matching (band width = 0.11	118	90	-0.404	0.265	4.18
	Radius matching (caliper =0.09)	118	90	-0.396	0.310	
Decisions on use of inputs in production	Kernel matching (band width = 0.11)	118	90	-0.410*	0.245	4.06
	Radius matching (caliper =0.11)	118	90	0.413*	0.231	

Decision on income allocation	Kernel matching (band width = 0.02)	118	90	-0.542*	0.294	3.50
	Radius matching (caliper =0.08)	118	90	-0.549**	0.242	

*Significant at 10% ; **Significant at 5%; ***Significant at 1%

We observe a consistent negative significant effect of market production on overall women empowerment index in agricultural production. The empowerment index of women in households engaged in market production reduces by 5.7 points below the mean of 27.5 for women in households that are less engaged in market production. The results suggest that women in households engaged in market production are less likely to make production decisions. Further analysis of sub-indices used to compute the women empowerment index in production reveals significant negative effects ranging from 0.39 points (below the mean of 4.18) in quantity for consumption to 0.64 points (below the mean of 3.7) in making marketing decisions that is; when to sell. A test for sensitivity analysis using Rosenbaum bounds shows that our results are insensitive to hidden bias due to unobservable factors (Appendix Table A2.4). Given the consistent negative effects of market production using different approaches means that our results are robust.

A negative significant effect of market production on women empowerment could be attributed to the displacement of staple food crops such as sweet potatoes and millet also commonly referred to as 'women crops' by those crops that easily generate cash. Another possible explanation is that market production may lead to increased commercialization of staple crops controlled by women. The implication is that more women are likely to be disempowered since cash crops seem to be a domain for men. These results are consistent with Kaaria and Ashby (2000); Lenjiso et al., (2015); Njuki et al., (2011) who found out that as households' integration into the market increases, women lose control over what was traditionally regarded as their commodities and the income that accrues from them when they become commercialized.

Moreover, the negative effects can be attributed in large part to cultural beliefs and norms of a patriarchal society characteristic of African countries. In most rural agricultural households, culture provides men more right to control the revenue accrued from sales and set priorities about spending. Moreover, men are often seen to have the expertise in knowing what to spend on so they have more say on long term financial investments and planning for the money. Some cultures and religious beliefs have influenced women to be submissive to their

husbands to the extent that some have no bargaining power. Bargaining may be viewed as disrespectful and disobedience which sometimes may cause domestic violence and threats such as divorce (Bowman, 2002; Khan, 2000). This argument is in agreement with findings of Koenig et al. (2003) who claim that 14% of women in central Uganda admitted to being physically assaulted by their husbands because of arguments over money.

3.7.2 Does women empowerment influence household food security?

We estimate instrumental variable and OLS regressions with calorie intake per adult equivalent and share of food expenditure (survey data) as the dependent variables. We use two measures of women empowerment; the first is the measure of bargaining power constructed from the charity game and the second is the overall score from the seven domains of empowerment in agriculture. We focus on the two measures because they potentially directly affect calorie consumption from own produced food as well as market purchased food. Summarised results are presented in Table 3.5.

Table 3.5: OLS and 2SLS estimates of calorie intake and food expenditure shares as a function of women empowerment

Variables	Calorie intake per adult equivalent		Calorie intake per adult equivalent		Share of food expenditure	
	OLS	*OLS*	*OLS*	*OLS*	*OLS*	*OLS*
WEI (Production decisions)	-	-	17.7813*	20.0099**	-0.2739**	-0.255**
			(10.873)	(10.0261)	(0.1313)	(0.1199)
WEI (control over use of income)	64.4891	56.9315	-	-	-	-
	(269.961)	(255.2256)				
Constant	3279.986***	5107.607***	4114.379**	4231.0090	41.813***	-0.7924
	(318.343)	(1612.4570)	(453.226)	(1468.5200)	(3.3590)	(17.5645)
Controls	no	yes	no	yes	no	yes
Observations	204	204	231	231	231	231
Adj R-squared	0.006	0.1929	0.103	0.206	0.014	0.251
	2SLS	*2SLS*	*2SLS*	*2SLS*	*2SLS*	*2SLS*
WEI (Production decisions)	-	-	153.5968*	94.902*	-0.4596	-0.307
			(81.1578)	(55.895)	(0.7607)	(0.598)
WEI (control over use of income)	0.1125	1.130	-	-	-	-
	(1.7040)	(1.995)				
Constant	7.3298***	10.238***	-699.5052	1915.134	46.1360**	-3.1168
	(0.7078)	(1.950)	(1900.733)	(2327.997)	(17.8203)	(24.1722)

Controls	no	yes	no	yes	no	yes
Observations	204	204	231	230	230	230
Adj R-squared	0.002	0.15	0.103	0.0614	0.009	0.294
F- statistic	3.55	2.22	8.42	8.42	7.03	8.42

*Significant at 10%; **Significant at 5%; *** Significant at 1%. Standard errors in parenthesis

Notes: Women empowerment in control over income is instrumented with age difference. Women empowerment in production is instrumented with age and education difference among spouses and their interaction (age difference x education difference). Control variables include; household size, proportion of children below 5yrs, proportion of children above 5yrs, per capita expenditure, distance to the market, size of land owned, wealth, dummies for; main occupation, membership of saving & credit group, member of farmer group, ownership of livestock and family as main source of labour (Appendix Table 5 and 6)

We find a significant positive effect of women empowerment in production on household per capita calorie consumption. The effects are robust to controlling for other variables. The explanation is that households where women are empowered in making production decisions are more likely to produce more of staple foods and retain relatively sufficient quantities for home consumption. This is in agreement with Sraboni et al., (2014) who found similar results in Bangladesh. The result is consistent with a negative association between women empowerment in production and share of food expenditure which signifies that households with more empowered women might spend less of their income on food. Due to high purchase and low sales food price differences associated with transaction costs and seasonality characteristic of rural areas, women find it cheaper and convenient to produce their own food than buy. We find no evidence of a significant relationship between women empowerment in control over use of income and calorie intake. Consistent with other literature (Malapit & Quisumbing, 2015; Sraboni et al., 2014) on women empowerment, it means that not all dimensions of women empowerment affect calorie intake. The results however, should be interpreted with caution, since the Stock and Yogo (2005) weak instrument test indicate that the instrument is slightly weak.

Variation in calorie consumption is mainly explained by per capita expenditure, main occupation, distance to the market, source of labour and membership to farmer groups. Further, results reveal that food share of household's budget increases with large size households. This is consistent with a significant positive relationship between per capita expenditure and food share of the household budget.

3.8 Conclusion

This study examines the effect of market production on women control over resources in Uganda. We use a combination of a household survey and experiments to collect data from

married couples in Southwestern Uganda. We employ propensity score matching and the instrumental variable censored regression model to estimate the effects of market production on women empowerment. These methods allow us to control for both observables and unobservable factors associated with market production and women empowerment variables. Our findings indicate that market production negatively affects women empowerment in making decisions regarding production and control over income. We argue that market production deprives women of their rights and empowerment in decision making as men tend to repossess and take control over women commodities whenever they start to generate substantial income and also dominate income allocation decisions.

Moreover, we find a significant positive correlation between women empowerment in production and household per capita calorie consumption. We argue that women empowered in production tend to produce more of staple food for household consumption thus increasing calorie availability. Our findings suggest that market production is unlikely to increase the bargaining power of women hence they remain vulnerable to poverty and food insecurity. Despite the key role played by women in market production, most African rural women have been taught to believe that they are incapable of making decisions (Acharya et al., 2010) and should wait for their husbands to take the lead (Bowman, 2002). Consequently, they have taken a subordinate position and continue to be socially and economically dependent on their husbands. Social policies that empower rural women to participate in making decisions regarding what to produce, how much to sell and how to allocate income could improve food security for rural households. Given the persistent gender imbalance between men and women in accessing productive resources, market production may not be the appropriate means of empowering rural households to eradicate food insecurity. We, however, acknowledge limitations in our data, particularly the lack of social cultural and religious variables that could have provided more appropriate instruments for women empowerment. As such, further research that controls for social cultural and religious factors may provide stronger results.

Appendix

Appendix 1 Theoretical model

A household model with market production

The household's utility maximization problem is expressed as follows;

$$Max_{Q_f, C_{mf}, C_{nf}} \; u(Q_f, C_{mf}, C_{nf}) = \; (\alpha lnQ_f + \beta lnC_{mf} + \gamma \ln C_{nf}) \quad (1)$$

We assume that a household with a fixed productive land (A), produces a cash crop (Q_c) and a staple crop Q_f. The cash crop is sold at a market price(p_c), from which they earn income used for non food consumption at price (P) and market food consumption. Assuming the price of the market food is a numeraire, the household maximises utility from consumption subject to; income constraint; $PC_{nf} = p_c Q_c - C_{mf}$ (2)

And the land constraint; $A = Q_f + Q_c$ (3)

The Lagrange associated with the constrained maximization problem of the household is stated as follows;

$$\mathrm{L} = \; \alpha \; ln(A - Q_c) + \beta \; \ln(p_c Q_c - PC_{nf}) + \gamma lnC_{nf} \quad (4)$$

Differentiating with respect to the control variables (Q_c) and (C_{nf}) leads to the following;

$$\frac{\partial L}{\partial Q_c} = \frac{-\alpha}{A - Q_c} + \frac{\beta p_c}{p_c Q_c - PC_{nf}} = 0 \quad (5)$$

$$\frac{\partial \mathrm{L}}{\partial C_{nf}} = \frac{-\beta P}{p_c Q_c - PC_{nf}} + \frac{\gamma}{C_{nf}} = 0 \quad (6)$$

Let, $\frac{\partial L}{\partial Q_c} = G$; $G(Q_c, C_{nf}, p_c)$ and $\frac{\partial \mathrm{L}}{\partial C_{nf}} = F$; $F(Q_c, C_{nf}, p_c)$

It follows that ;

$$\frac{\partial G}{\partial Q_c} dQ_c + \frac{\partial G}{\partial C_{nf}} dC_{nf} + \frac{\partial G}{\partial p_c} dp_c = 0 \; ; \quad \frac{\partial G}{\partial Q_c} dQ_c + \frac{\partial G}{\partial C_{nf}} dC_{nf} = -\frac{\partial G}{\partial p_c} dp_c$$

$$\frac{\partial F}{\partial Q_c} dQ_c + \frac{\partial F}{\partial C_{nf}} dC_{nf} + \frac{\partial F}{\partial p_c} dp_c = 0 \; ; \quad \frac{\partial F}{\partial Q_c} dQ_c + \frac{\partial F}{\partial C_{nf}} dC_{nf} = -\frac{\partial F}{\partial p_c} dp_c$$

$$G = \frac{-\alpha}{A - Q_c} + \frac{\beta p_c}{p_c Q_c - PC_{nf}}$$

$$G = \; -\alpha (A - Q_c)^{-1} + \beta p_c (p_c Q_c - PC_{nf})^{-1}$$

$$G_{Q_c} = -\alpha (A - Q_c)^{-2} - \beta {p_c}^2 (p_c Q_c - PC_{nf})^{-2} \quad (< 0)$$

$$G_{C_{nf}} = \beta P p_c (p_c Q_c - PC_{nf})^{-2} \quad (> 0)$$

$$G_{p_c} = \; \beta (p_c Q_c - PC_{nf})^{-1} - \beta p_c Q_c (p_c Q_c - PC_{nf})^{-2} \quad (< 0)$$

$$F = \; \frac{-\beta P}{p_c Q_c - PC_{nf}} + \frac{\gamma}{C_{nf}}$$

$$F = \; \gamma {C_{nf}}^{-1} - \beta \; P (p_c Q_c - PC_{nf})^{-1}$$

$F_{Q_c} = \beta p_c P\ (p_c Q_c - PC_{nf})^{-2}$ (> 0)

$F_{C_{nf}} = -\gamma {C_{nf}}^{-2} - \beta P^2\ (p_c Q_c - PC_{nf})^{-2}$ (< 0)

$F_{p_c} = \beta P Q_c (p_c Q_c - PC_{nf})^{-2}$ (>0)

Applying Cramer's rule;

$$\begin{bmatrix} \frac{\partial G}{\partial Q_c} & \frac{\partial G}{\partial C_{nf}} \\ \frac{\partial F}{\partial Q_c} & \frac{\partial F}{\partial C_{nf}} \end{bmatrix} \begin{bmatrix} dQ_c \\ dC_{nf} \end{bmatrix} = \begin{bmatrix} -\frac{\partial G}{\partial p_c} \\ -\frac{\partial F}{\partial p_c} \end{bmatrix} dp_c$$

$$dQ_c = \frac{\begin{vmatrix} -\frac{\partial G}{\partial p_c} & \frac{\partial G}{\partial C_{nf}} \\ -\frac{\partial F}{\partial p_c} & \frac{\partial F}{\partial C_{nf}} \end{vmatrix}}{\begin{vmatrix} \frac{\partial G}{\partial Q_c} & \frac{\partial G}{\partial C_{nf}} \\ \frac{\partial F}{\partial Q_c} & \frac{\partial F}{\partial C_{nf}} \end{vmatrix}} = \frac{G_p F_{C_{nf}} - F_p G_{C_{nf}}}{G_{Q_c} F_{C_{nf}} - F_{Q_c} G_{C_{nf}}}$$

$G_p F_{C_{nf}} - F_p G_{C_{nf}}$

$$= \left(\frac{\beta p_c Q_c}{(p_c Q_c - PC_{nf})^2} - \frac{\beta}{(p_c Q_c - PC_{nf}} \right)\left(\frac{-\gamma}{{C_{nf}}^2} - \frac{\beta P^2}{(p_c Q_c - PC_{nf})^2} \right) - \left(\frac{-\beta P\ Q_c}{(p_c Q_c - PC_{nf})^2} \right)\left(\frac{\beta P p_c}{(p_c Q_c - PC_{nf})^2} \right)$$

$$= \frac{-\gamma \beta p_c Q_c}{{C_{nf}}^2 (p_c Q_c - PC_{nf})^2} - \frac{\beta^2 P^2 p_c Q_c}{(p_c Q_c - PC_{nf})^4} + \frac{\gamma \beta}{{C_{nf}}^2 (p_c Q_c - PC_{nf})} + \frac{\beta^2 P^2}{(p_c Q_c - PC_{nf})^3} + \frac{\beta^2 P^2 p_c Q_c}{(p_c Q_c - PC_{nf})^4}$$

$$= \frac{-\gamma p_c Q_c \beta}{{C_{nf}}^2 (p_c Q_c - PC_{nf})^2} + \frac{\gamma \beta}{{C_{nf}}^2 (p_c Q_c - PC_{nf})} + \frac{\beta^2 P^2}{(p_c Q_c - PC_{nf})^3}$$

$$= \frac{\gamma \beta (-p_c Q_c + p_c Q_c - PC_{nf})}{{C_{nf}}^2 (p_c Q_c - PC_{nf})^2} + \frac{\beta^2 P^2}{(p_c Q_c - PC_{nf})^3}$$

$$= \frac{-\gamma \beta \mathrm{P}}{C_{nf} (p_c Q_c - PC_{nf})^2} + \frac{\beta^2 P^2}{(p_c Q_c - PC_{nf})^3}$$

$$= \frac{\beta^2 P^2}{(p_c Q_c - PC_{nf})^3} - \frac{\gamma \beta \mathrm{P}}{C_{nf} (p_c Q_c - PC_{nf})^2}$$

$$= \frac{\beta \mathrm{P}}{(p_c Q_c - PC_{nf})^2} \left(\frac{\beta \mathrm{P}}{(p_c Q_c - PC_{nf})} - \frac{\gamma}{C_{nf}} \right)$$

From equation (6) $\frac{\beta}{p_c Q_c - PC_{nf}} = \frac{\gamma}{\mathrm{P} C_{nf}}$

Combining equation (5) and (6) shows that utility is maximized when;

$$\frac{\beta}{p_c Q_c - PC_{nf}} = \frac{\gamma}{\mathrm{P} C_{nf}} = \frac{\alpha}{p_c (A - Q_c)} \qquad (7)$$

This means that a household maximizes utility when the marginal utility of a shilling spent on food is equal to that spent on non-food and food purchased.

$G_{Q_c} F_{C_{nf}} - F_{Q_c} G_{C_{nf}}$

$$= \left(\frac{-\alpha}{(A - Q_c)^2} - \frac{\beta {p_c}^2}{(p_c Q_c - PC_{nf})^2} \right)\left(\frac{-\gamma}{{C_{nf}}^2} - \frac{\beta P^2}{(p_c Q_c - PC_{nf})^2} \right) - \left(\frac{\beta P p_c}{(p_c Q_c - PC_{nf})^2} \right)\left(\frac{\beta p_c \mathrm{P}}{(p_c Q_c - PC_{nf})^2} \right)$$

$$= \left(\frac{-\alpha}{(A-Q_c)^2}\left(\frac{-\gamma}{{C_{nf}}^2} - \frac{\beta P^2}{(p_cQ_c-PC_{nf})^2}\right) - \frac{-\gamma\beta{p_c}^2}{{C_{nf}}^2(p_cQ_c-PC_{nf})^2}\right) \quad (>0)$$

$$dQ_c = \frac{G_p F_{C_{nf}} - F_p G_{C_{nf}}}{G_{Q_c}F_{C_{nf}} - F_{Q_c}G_{C_{nf}}} = \frac{(+)(-)-(-)(+)}{(-)(-)-(+)(+)} = \frac{(0)}{(+)} = 0 \qquad (8)$$

$$dC_{nf} = \frac{\begin{vmatrix} \frac{\partial G}{\partial Q_c} & -\frac{\partial G}{\partial p_c} \\ \frac{\partial F}{\partial Q_c} & -\frac{\partial F}{\partial p_c} \end{vmatrix}}{\begin{vmatrix} \frac{\partial G}{\partial Q_c} & \frac{\partial G}{\partial C_{nf}} \\ \frac{\partial F}{\partial Q_c} & \frac{\partial F}{\partial C_{nf}} \end{vmatrix}} = \frac{G_{Q_c}F_{p_c} - F_{Q_c}G_{p_c}}{G_{Q_c}F_{C_{nf}} - F_{Q_c}G_{C_{nf}}}$$

$$G_{Q_c}F_{p_c} - F_{Q_c}G_{p_c}$$

$$= \left(\frac{-\alpha}{(A-Q_c)^2} - \frac{\beta{p_c}^2}{(p_cQ_c-PC_{nf})^2}\right)\left(\frac{-\beta PQ_c}{(p_cQ_c-PC_{nf})^2}\right) - \frac{\beta p_cP}{(p_cQ_c-PC_{nf})^2}\left(\frac{-\beta}{(p_cQ_c-PC_{nf})} + \frac{\beta p_cQ_c}{(p_cQ_c-PC_{nf})^2}\right)$$

$$= \frac{\alpha\beta PQ_c}{(A-Q_c)^2(p_cQ_c-PC_{nf})^2} + \frac{\beta^2{p_c}^2PQ_c}{(p_cQ_c-PC_{nf})^4} + \frac{\beta^2p_cP}{(p_cQ_c-PC_{nf})^3} - \frac{\beta^2{p_c}^2PQ_c}{(p_cQ_c-PC_{nf})^4}$$

$$= \frac{\alpha\beta PQ_c}{(A-Q_c)^2(p_cQ_c-PC_{nf})^2} + \frac{\beta^2p_cP}{(p_cQ_c-PC_{nf})^3} > 0$$

$$dC_{nf} = \frac{G_{Q_c}F_{p_c} - F_{Q_c}G_{p_c}}{G_{Q_c}F_{C_{nf}} - F_{Q_c}G_{C_{nf}}} = \frac{(-)(+)-(+)(+)}{(-)(-)-(+)(+)} = \frac{(+)}{(+)} > 0 \qquad (9)$$

If the price of the cash crop increases, households will get more income and consequently increase non-food consumption.

Appendix 2

Table A2.1: Parameter estimates of Instrumental variable Tobit model for local average treatment effect of market production and determinants of women empowerment

	Overall WEI (production decisions)	Control over use of income (*charity game*)	WEI (socio-economic decisions)
Market production index	-0.4338**	-0.0323**	-0.0001
	(0.2134)	(0.0140)	(0.0045)
Wife age	1.1295**	-0.0267	48.2190**
	(0.6203)	(0.0590)	(23.0328)
Wife age squared	-0.0100	0.0004	-49.4023**
	(0.0077)	(0.0007)	(23.6970)
Age difference	-0.0523	-0.0250**	0.0557*
	(0.1439)	(0.01210	(0.0336)
Years of husband	0.2408	0.0196	0.0260
education	(0.2730)	(0.02530	(0.0440)
Years of wife education	-0.0135	-0.0023	-0.0208
	(0.3373)	(0.0320)	(0.0381)
Household size	-0.4859	-0.0113	0.2750*

	(0.7146)	(0.0624)	(0.1541)
Number of children	0.2876	0.0496	-0.0618**
	(0.9163)	(0.0839)	(0.0285)
Husband's annual income	1.25e-06***	0.0092	-0.0156**
	(4.22e-07)	(0.0232)	(0.0079)
Size of land owned	-0.0437	-	-
	(0.2619)		
Wealth	2.03e-08	5.86e-09*	-0.0060
	(3.66e-08)	(3.42e-09)	(0.0119)
Household own livestock	0.4679	-0.2986*	-0.0246
=1, 0 otherwise	(1.7836)	(0.1636)	(0.0526)
Distance to the market	-0.3713*	-0.0006	-0.0122*
	(0.23070	(0.0195)	(0.0066)
Main occupation;		-0.3296	-0.0868
agriculture =1; otherwise	3.6553	(0.3463)	(0.1153)
=0	(3.9805)		
No secondary occupation	2.0949	-0.0095	0.1253**
=1; otherwise =0	(1.8203)	(0.1675)	(0.0552)
Member of farmer group	1.3717	0.4564**	-0.0284
=1; otherwise =0	(2.1165)	(0.1894)	(0.0559)
Member of saving & credit	-1.9015	-0.1567	0.1174
group =1; otherwise =0	(2.7556)	(0.2728)	(0.0760)
Constant	12.1299	2.0495*	7.1720**
	(16.1411)	(1.2784)	(3.0628)
Observations	230	203	220
Amemiya-lee-Newey mini.		0.863	0.295
Chi2			
p-value of Newey mini.			
Chi2		0.3528	0.587
Anderson Rubin chi2	6.94**	9.52***	0.30
p-value of A.R. chi2	0.0084	0.0086	0.862

*Significant at 10%; **Significant at 5%; *** Significant at 1%

Note: For the WEI (socio-economic decisions) regression, independent variables are in natural logs. For the WEI in control over income and socio-economic decisions regressions MPI is instrumented by access to rice information and size of land owned. In the WEI in production decisions' regression, size of land owned is included as it directly affects decisions in production

Table A2.2: Estimates of the first stage IV Tobit regression

Market production index	Coef.	Std. Err.	Z
Access to rice information	9.7341***	3.2545	2.99
Husband age	-0.2530	0.2051	-1.23
Wife age	0.4942**	0.2407	2.05
Husband education (years spent in school)	-0.1197	0.4303	-0.28
Wife education (years spent in school)	0.7259	0.5091	1.43
Number of children	-0.1937	0.6374	-0.30
Distance to the market	-0.5759	0.3886	-1.48
Size of land owned	0.6701**	0.3133	2.14
Husband's annual income	0.0000***	0.0000	4.41
Wife's annual income	0.0000	0.0000	0.66
Wealth	0.0000	0.0000	-0.25
Household own livestock =1, otherwise =0	0.3328	2.7996	0.12
Agriculture as main occupation=1; otherwise =0	0.9296	6.2239	0.15
No secondary occupation =1; otherwise =0	2.2888	2.8824	0.79
Member of saving & credit group =1; otherwise =0	-1.5276	4.1675	-0.37
Member of farmer group =1; otherwise =0	3.0581	2.9147	1.05
Constant	24.4362**	9.5761	2.55

Table A2.3: Covariate balancing test for the effect of market production on women bargaining power

Outcome	Matching algorithm	Pseudo R2 Before matching	Pseudo R2 after matching	$p>chi^2$ Before matching	$p>chi^2$ after matching
Control over use of income (*charity game*)	Kernel matching (band width = 0.08)	0.156	0.016	0.000	0.995
	Radius matching (caliper =0.08)	0.156	0.009	0.000	0.997
WEI (socio-economic decisions)	Kernel matching (band width = 0.09)	0.129	0.005	0.000	0.995
	Radius matching (caliper =0.09)	0.129	0.005	0.000	0.995
Overall WEI (production decisions)	Kernel matching (band width = 0.05)	0.162	0.011	0.000	0.967
	Radius matching (caliper =0.05)	0.162	0.010	0.000	0.979
Decision on type of crop to grow	Kernel matching (band width = 0.1)	0.162	0.030	0.000	0.509
	Radius matching (caliper =0.1	0.129	0.005	0.000	0.996

Decision on labour allocation	Kernel matching (band width = 0.08)	0.126	0.006	0.000	0.990
	Radius matching (caliper =0.08)	0.129	0.008	0.000	0.994
Decision on sale of produce	Kernel matching (band width = 0.1)	0.129	0.006	0.000	0.994
	Radius matching (caliper =0.1)	0.156	0.029	0.000	0.542
Decision on quantity of produce to sell	Kernel matching (band width = 0.1)	0.129	0.006	0.000	0.994
	Radius matching (caliper =0.1)	0.129	0.005	0.000	0.995
Decision on quantity for consumption	Kernel matching (band width = 0.11)	0.129	0.005	0.000	0.995
	Radius matching (caliper =0.09)	0.129	0.005	0.000	0.995
Decision on use of inputs in production	Kernel matching (band width = 0.11)	0.129	0.005	0.000	0.995
	Radius matching (caliper =0.11)	0.129	0.005	0.000	0.996
Decision on income allocation	Kernel matching (band width = 0.02)	0.152	0.016	0.000	0.811
	Radius matching (caliper =0.08)	0.129	0.006	0.000	0.994

Table A2.4: Robustness of ATT estimates to unobserved factors (rbounds test)

Gamma	sig+	sig-	t-hat+	t-hat-	CI+	CI-
1	0	0.00	-4.9242	-4.9242	-7.0566	-2.5751
1.1	0	0.00	-5.2459	-4.4967	-7.5211	-2.0512
1.2	0	0.00	-5.6037	-4.0931	-8.0303	-1.6032
1.3	0	0.00	-5.9565	-3.7622	-8.4505	-1.0819
1.4	0	0.01	-6.2336	-3.4527	-8.8843	-0.6327
1.5	0	0.02	-6.5845	-3.1034	-9.1817	-0.2976
1.6	0	0.03	-6.8578	-2.7773	-9.5084	0.0793
1.7	0	0.05	-7.1649	-2.4810	-9.7862	0.4014
1.8	0	0.07	-7.4342	-2.1862	-10.0901	0.7316
1.9	0	0.10	-7.6635	-1.8826	-10.3513	0.9097
2	0	0.13	-7.9221	-1.6837	-10.6433	1.2008
2.1	0	0.17	-8.1598	-1.3978	-10.8104	1.5083
2.2	0	0.22	-8.3873	-1.1392	-11.0540	1.7075

2.3	0	0.27	-8.6058	-0.8323	-11.3013	2.0203
2.4	0	0.32	-8.8685	-0.6427	-11.4562	2.2004
2.5	0	0.37	-9.0140	-0.4985	-11.6478	2.3459
2.6	0	0.42	-9.1681	-0.3079	-11.8726	2.6079
2.7	0	0.47	-9.3278	-0.0766	-12.0857	2.8241
2.8	0	0.52	-9.4988	0.0786	-12.2405	3.0580
2.9	0	0.57	-9.6421	0.1925	-12.4585	3.2314
3	0	0.62	-9.7780	0.3851	-12.6918	3.3857

gamma - log odds of differential assignment due to unobserved factors

sig+ - upper bound significance level

sig- - lower bound significance level

t-hat+ - upper bound Hodges-Lehmann point estimate

t-hat- - lower bound Hodges-Lehmann point estimate

CI+ - upper bound confidence interval (a= .95)

CI- - lower bound confidence interval (a= .95)

Table A2.5: OLS Estimates of calorie intake and food expenditure shares as a function of women empowerment

Variables	Calorie intake per adult equivalent		Calorie intake per adult equivalent		Share of food expenditure (survey data)	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
WEI (Production decisions)	-	-	20.0099**	10.0261	-0.2555**	0.1199
WEI (control over use of income)	56.9315	255.2256				
Household size	-153.7790*	84.7893	-129.1182*	74.3182	1.7142*	0.8889
Proportion of children <5yrs	-364.8301	965.5390	-179.4276	907.8650	24.4665**	10.8587
Proportion of children >5yrs	554.1416	918.1355	823.5159	857.9403	11.1377	10.2616
per capita expenditure	0.0061	0.0067	0.0080	0.0062	0.0003***	0.0001
Proportion of women income (%)	-150.5872*	88.1493	-187.2574**	82.0290	0.9658	0.9811
Distance to the market	-122.0794	29.3330	-117.8225***	27.7218	-0.0554	0.3316
Size of land owned	-9.0394	22.3265	8.6307	18.9191	-0.8354***	0.2263
Household own livestock =1, 0 otherwise	-153.1369	233.8248	-101.0967	208.7700	-6.0507**	2.4970

Main source of labour family =1; 0 otherwise	-423.3642*	243.4567	-341.8312	218.6214	2.1562	2.6149
Main occupation; agriculture =1; otherwise =0	-1255.987**	499.5310	-1095.5270**	456.2446	3.8289	5.4570
No secondary occupation =1; otherwise =0	236.2351	239.4996	227.9550	213.5916	1.1567	2.5547
Member of farmer group =1; otherwise =0	558.8598**	244.9117	562.6021**	219.1597	-6.9892***	2.6213
Member of saving & credit group =1; otherwise =0	136.3416	361.1755	-113.1052	308.0720	1.4374	3.6848
Constant	5107.607***	1612.4570	4231.0090***	1468.5200	-0.7924	17.5645
Observations	204		231		231	

*Significant at 10%; **Significant at 5%; *** Significant at 1%. Standard errors in parenthesis

Table A2.6: 2SLS Estimates of calorie intake and food expenditure shares as a function of women empowerment

Variables	Calorie intake per adult equivalent		Calorie intake per adult equivalent		Log Share of food expenditure (survey data)	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
WEI (Production decisions)	-	-	94.903*	55.895	-0.307	0.599
WEI (control over use of income)	1.130	1.995	-	-	-	-
Household size	-0.103	0.072	-87.800	86.622	1.685*	0.928
Proportion of children <5yrs	-1.892**	0.838	694.122	1127.081	23.881**	12.076
Proportion of children >5yrs	-1.127	0.791	1365.715	1009.606	10.763	10.817
per capita expenditure	0.000	0.000	0.013*	0.008	0.000***	0.000
Proportion of women income (%)	-0.119	0.093	-324.604**	131.033	1.060	1.404
Distance to the market	-0.135***	0.031	-105.401***	31.253	-0.064	0.335
Size of land owned	-0.006	0.032	9.006	20.490	-0.835***	0.220

Household own livestock =1, 0 otherwise	0.181	0.356	-116.508	226.946	-6.044**	2.432
Main source of labour family =1; 0 otherwise	-0.428*	0.231	-386.669*	241.453	2.190	2.587
Main occupation; agriculture =1; otherwise =0	-0.651	0.667	-1263.134**	507.021	3.943	5.432
No secondary occupation =1; otherwise =0	0.053	0.207	199.400	235.572	1.180	2.524
Member of farmer group =1; otherwise =0	0.326	0.340	623.457***	239.179	-7.027***	2.563
Member of saving & credit group =1; otherwise =0	-0.194	0.321	-127.756	334.111	0.7514	3.5743
Constant	10.238***	1.950	1915.134	2327.997	-3.1168	24.1723
Observations	204		231		230	
Adj R-squared	0.15		0.103		0.294	
F- statistic	2.25		8.42		8.42	

*Significant at 10%; **Significant at 5%; *** Significant at 1%. Standard errors in parenthesis

Chapter 4

Does market production affect technical efficiency? A food-cash crop in a subsistence farming system in western Uganda

Abstract

Low productivity arising from technical inefficiency negatively impacts on household income and food security by reducing food availability as well as economic access. It has been hypothesised that market-oriented production enhances productivity of staple crops through increased use of quality inputs and management technologies. We test this hypothesis using household survey data from western Uganda. Using a stochastic production frontier model we estimate technical efficiency of the major cash crop and staple crops. We use a propensity score matching approach to compare technical efficiency of market-oriented and subsistence households in production of selected staple crops. Results show higher technical inefficiency in staple crops compared to the cash crop among the market-oriented households. We also find a significant negative relationship between cash crop production and technical efficiency in staple crops production. We attribute the negative association to withdrawal of critical resources particularly labour from staple crops to cash crops during peak periods of labour demand.

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4.1 Introduction

Developing countries face the challenge of feeding their rapidly increasing population on limited productive land. To meet increasing food demand most countries cannot rely on expanding the crop area but will need to stimulate yield growth arising from increased factor productivity. This can be achieved in different ways; First, through increased access to and use of non-land inputs such as fertilizers and better technologies, for example high yielding varieties, to boost crop yields thus shifting to a higher production frontier (Mekonnen et al., 2015); Second, through more efficient utilization of inputs to produce maximum output given existing technologies. The latter approach is known as increasing technical efficiency. Technical efficiency is a prerequisite for economic efficiency, which in turn may be necessary for economic viability and sustainability of farms. Recent studies, however, show that technical efficiency is typically not achieved in African agriculture, as most households do not operate along the best practice frontier (Mugera & Ojede, 2014). Most farms produce at levels below potential for their biophysical environment, implying that more agricultural output can be produced using existing resources (Thiam et al., 2001).

Important to policy makers and farmers is that inefficiencies in agricultural production undermine poverty reduction and food security. Technical inefficiency directly decreases food availability by reducing supply. Indirectly it creates a demand problem by denying producers sufficient income to access what they do not produce themselves. Persistent technical inefficiency in sub-Saharan Africa is often attributed to limited access to information, extension services (Asante et al., 2014) and high quality inputs, especially clean seed (Poulton et al., 2010). A study by Mekonnen et al., (2015) reveals that developing countries have a sizable potential of improving agricultural production from the same level of inputs if they invest in efficiency enhancing technologies including knowledge and information transfer technologies (e.g. radios).

In recent years, most African countries have made an effort to invest in transforming agriculture from subsistence farming (often characterised by low productivity) to market-oriented farming in order to overcome poverty and food insecurity (Carletto et al., 2016). Farmers have received support from governments and non-governmental organizations in form of extension services, training and inputs such as high quality seeds to produce highly marketable crops such as rice. Prospects of getting high crop income induced farmers to invest in the production of marketable crops and adopt the recommended technologies.

This Chapter seeks to better understand the changes in technical efficiency in food crop production as farmers increasingly become more market-oriented. We investigate how market-oriented crop production affects technical efficiency in the production of staple crops. Promoting market production in a farming system dominated by subsistence production may positively or negatively affect technical efficiency of staple crops. Positive effects may arise through income generation that can facilitate households' timely access to quality inputs, information, extension services and improved technologies. For instance access to technologies such as radio programs and mobile phone subscriptions facilitates the transfer of knowledge and information expected to influence technical efficiency in agricultural production (Mekonnen, et al., 2015). Farmers may also easily access improved technologies and information by participating in market-oriented government-supported programs. For example in Uganda market-oriented households have benefited from government support through the commodity-based extension services approach aimed to transform low input subsistence agriculture into commercial market-oriented agriculture (Mwaura, 2014). In Zimbabwe, Govereh and Jayne (2003) found that cash crop production enhances food crop productivity as food crops benefit from extension services that households obtain through cash crop production programs. Similarly, semi-subsistence farms are found to have a higher technical efficiency in rice production than subsistence farmers in Thailand as a result of extension programs (Athipanyakul et al., 2014) .

Moreover, income from production may facilitate market-oriented households to carry out timely field operations which is key to achieving technical efficiency. For example they can supplement family labour with hired labour - reducing competition for labour between cash and staple crops during peak periods. Evidence from rice farmers in Nigeria shows that hired labour can have a positive impact on technical efficiency (Ogundele & Okoruwa, 2006). This positive path, however, requires households to invest income from the cash crop into efficiency enhancing technologies for the food crop.

In contrast, if poor households choose not to invest their knowledge and income in production of staple crops, introduction of a cash crop may have a negative impact on technical efficiency of staple crops. This may come as a result of seasonal competition for critical inputs -especially labour. Households that mainly depend on family labour are likely to prioritize the cash crop in terms of labour allocation and management such that activities in staple crops may be effected later in the cropping season hence affecting technical efficiency.

Further, for households with different plots of land there is likely to be competition for good quality plots between the cash crop and staples, which may result in low yields of staple crops on low quality plots (Binam et al., 2004).

We contribute to the existing literature by answering the questions whether market-oriented production enhances technical efficiency of staple crops, and whether market-oriented households are more technically efficient in cash crops than in staples. It is important that we understand how market production affects efficiency in staple crop production in order to inform policy interventions designed to enhance resource use to support market production as well as household food security. While a few studies have assessed the impact of cash cropping on food crop productivity (Govereh & Jayne, 2003; Strasberg et al., 1999), these studies focus on the effect of commercialization on food crop yields which may be due to technological change or technical efficiency. To the best of our knowledge none has explicitly studied the effect of market-oriented production on technical efficiency in staple crop production. Other related studies have assessed the effect of market interventions such as agricultural cooperatives (typically formed to aggregate small holders and link them to input and output markets) on technical efficiency in crop production. Using a stochastic frontier model and propensity score matching, Abate et al., (2014) for example find that farmers in cooperatives are more technically efficient than non-members in Ethiopia. They attribute this to increased access to productive inputs and extension linkages provided by agricultural cooperatives.

To answer the above questions, we analyse technical efficiency in production of a major food cash crop (food crop grown for sale) and staples among market-oriented and subsistence households. We use the case of rice market production in western Uganda, and compare resource use efficiency in production of staple crops among two groups of farmers -farmers benefitting from an intervention that aimed to promote market production and farmers from control areas that did not. We choose rice because it is a crop that has been extensively promoted for market production with the aim of increasing household income and food security. Overall, we find low technical efficiency in production of both the food cash crop and the staple crops. Technical inefficiency for market-oriented households is higher in staple crops compared to the food cash crop. In addition, we find evidence of significant higher technical inefficiency in staple crops production for market-oriented households compared to subsistence households. We conjecture that this result is associated with competition for critical resources in peak periods between the staple and cash crops.

The rest of the chapter is organised as follows; section 4.2 describes a case of a market-oriented agricultural program; section 4.3 provides an overview of data; section 4.4 presents the empirical approach; Section 4.5 explains results and we conclude in section 4.6.

4.2 Market-oriented food crop production in Southwestern Uganda

Market-based crop production in Uganda has increased remarkably in the past years. This is partly the result of the government's efforts to promote selected food crops as cash crops. Market production is motivated by market liberalization and urbanization which have resulted in increased demand for food both in the domestic and international market, especially in the neighbouring countries of Rwanda, Kenya and South Sudan. FAO statistics for example, indicate that cereal exports increased from 7.6 tonnes in 2000 to 299.4 tonnes in 2013, this is more than a ten-fold increase. Equally, pulses exports have increased by 988.5% from 3.5 tonnes in 2000 to 38.1 tonnes in 2013. For this study we consider the case of rice production in Southwestern Uganda, where rice has been highly promoted as a cash crop. Rice is interesting in that it is a marketable crop traded both domestically and internationally.

Through the commodity-based agricultural extension approach under the National Agricultural Advisory Services (NAADS) program, rice is one of the few food crops that has received a lot of support from the government and other agencies, such as the Japan International Cooperation Agency (JICA). Market-oriented rice production in Kanungu district, Southwestern Uganda, started with the introduction of upland rice varieties commonly known as NERICA by IFAD in 2003 (CARD, 2014). The aim of the project was to increase income and food security for small holder households (IFAD, 2012). The project started in two sub counties of Nyamirama and Kihihi, considered to be relatively fertile as they lie along the rift valley. Subsequently, with government support under the National Agricultural Advisory Services (NAADS) program, upland rice production has been extended to other sub counties. It is now a major food cash crop in five out of twelve sub counties in the study area, and one of the priority commodities at national level (MAAIF, 2010). Rice production has increased significantly from 150,000 tons on 80,000 hectares in 2004 to 280,000 tons on 140,000 hectares in 2012 (MAAIF, 2010; Reda et al., 2012). This reflects the results of training programs providing farmers with information on modern farming technologies and marketing. Farmers' capacity to access the market has been enhanced through training in business development, creating market linkages and providing support to value addition initiatives. Twelve rice hulling machines have been established in the study area, including one that does sorting and packaging.

4.3 Data

The data used are extracted from a household survey on market production and food security conducted in Kanungu district in 2014. The survey used a multi-stage sampling procedure to select households. A total of 1137 households were sampled; 592 were randomly selected from five sub counties exposed to promotion of commercial rice production and the associated extension services- (market-oriented households). Moreover, we surveyed 545 households randomly selected from two sub counties that did not receive this project (subsistence households). These households consequently do not grow rice. The sub counties were purposively selected considering factors that may drive selection of the area for implementing a market-oriented crop production program. In our case we considered sub counties with similar socio-economic and agro ecological conditions. We observe negligible 'contamination' /spillover effects in the sub counties used as control. This could reflect an information gap, because farmers in our control area lack the capacity or enthusiasm to search for information on rice production for commercial markets by themselves. We believe that if a similar program would be introduced in the non-rice growing area, households would equally participate in market production, as we will further discuss in section 4.4. This study uses data on household demographics and socioeconomic characteristics, inputs and outputs for production of key crops; rice as a cash crop; and beans and sweet potatoes as major staples.

We consider inputs and output for the food-cash crop (rice) and the staple crops (beans and sweet potatoes) during the main cropping season (August-February). We use three inputs; land, labour and seed. Land is the total area covered by the crop during the main season including own and rented land. Labour is the total number of person days, both from the family and hired, spent on all activities for a particular crop. Seed is the quantity of seed used (both retained from the previous harvest and purchased in the market). We consider only three inputs because fertilizers and pesticides are not used on the crops in this study, and the use of other inputs such as herbicides is negligible. We do not include capital items such as machinery and buildings in the production function as all households use hand hoes and store the produce in residential houses. Output for rice and beans is measured as threshed dry crop; output for sweet potato as quantity of fresh tubers.

Up front we mention the caveat that measurement error is an issue. Crops such as sweet potatoes are harvested in piece meal, which makes it difficult to estimate accurate output levels. We therefore, rely on estimates of participants regarding harvest levels as if the entire garden were harvested at once. The planting material for sweet potatoes is not tradable in the

study area and therefore it is difficult to estimate the quantity of seed used. Another limitation is that land is not adjusted for quality differences at plot level as such data is not available. In case a farmer knowingly allocates a better plot to either of the crops (cash or staple), this could bias our comparative analysis of technical efficiency in cash and staple crop production. One could argue that perhaps the farmer gets the potential optimal output from the low productive plot. However, it is important to note that 'poor' land quality may be partly as a result of poor soil management practices. For instance the output from such plots could be improved by applying fertilizer (Binam et al., 2004; Musa et al., 2015).

Descriptive analysis

Table 4.1 presents a summary of household and farm characteristics. Our sample reduced from 1,137 to 967 after we dropped households with missing observations on variables of interest. Not surprisingly, but important to note, is a significantly higher market production index for the market-oriented households. This indicates that these households are indeed more market-oriented , as they sell on average 54 percent of their output value compared to only 41 percent for the control households. A majority of household heads and their spouses have only primary level education. We observe a larger land size for market-oriented households. However, an average farm size of 2.4 hectares (with a standard deviation of 1.9) suggests that a majority of the households are still to be considered small holders.

Table 4.1 : Descriptive statistics for variables included in the study

Variable	Mean			t-test
	Pooled sample (N = 967)	Market-oriented households (N = 342)	Subsistence households (N= 625)	
Bean output (kg)	112.0	97.0	120.0	4.33***
Labour (man-days)	46.4	44.1	47.6	1.619*
Seed (Kgs)	16.8	16.1	17.3	1.748**
Area (acres)	0.21	0.19	0.22	1.328*
Sweet potato output (kg)	407.0	356.7	421.3	1.79**
Labour (man-days)	27.1	33.0	25.3	-3.462***
Seed (Kgs)	318.9	400.8	295	-4.872***
Area (acres)	0.2	0.2	0.2	0.844
Rice output (kg)		517.3		
Labour (man-days)		160.4		
Seed (Kgs)		55.8		
Area (acres)		0.43		
Age of household head	42.7	42.5	42.7	-0.27

Education of household head (years)	6.2	6.3	6.1	0.79
Education of heads spouse (years)	4.3	4.5	4.1	1.49
Household size	6.3	6.8	6.0	4.21**
Size of land owned (acres)	1.9	2.4	1.5	4.15**
Distance to main road (km)	2.4	1.8	1.3	3.64**
Distance to main market (km)	5.6	4.6	2.6	13.86***
Distance to sub county headquarters (km)	4.7	5.2	4.5	4.2**
Main occupation agriculture = 1	0.9	1.0	0.9	2.76**
No secondary occupation = 1	0.5	0.5	0 .6	-2.00**
Member of farmer group =1	0.5	0.7	0.4	6.71***
Member of savings and credit group =1	0.8	0.8	0.8	-1.61
Market Production Index (MPI)	46.3	54.1	41.0	8.72***

*Significant at 10%; **Significant at 5%; ***Significant at 1%

4.4 Empirical approach

4.4.1 Stochastic frontier model

Technical efficiency is a measure of the ability to obtain maximum output from a set of inputs given the best available technology. Different approaches are used to estimate technical efficiency. These include stochastic frontier models, parametric deterministic frontier models and non-parametric deterministic models (Bravo-Ureta et al., 2007) The choice for a specific model depends on the data and the context of the study. We use a stochastic production frontier model to estimate technical efficiency in rice production and two major staple crops; sweet potatoes and beans. The stochastic frontier model has an advantage over the deterministic model in that it incorporates a composed error structure with a two-sided symmetric error term that captures the random effects outside the control of the famer and a one-sided component reflecting inefficiency (Bravo-Ureta et al., 2007).

Following Wang and Schmidt (2002) we estimate a 'one-step' model that specifies the stochastic frontier for each crop j (rice, beans and sweet potatoes) on farm i and estimates how technical inefficiency depends on farm characteristics. We assume a Cobb-Douglas functional form. The model is specified as follows;

$lny_{ij} = \beta_0 + \beta_1 lnx_{ij} + v_{ij} - u_{ij}$, ...(1)

where; y is output and x_{ij} denotes a vector of inputs (seed, labour and land). β is the parameter vector associated with x variables for the stochastic frontier; v is a two-sided normally distributed random error; $v \sim N(0, \sigma_V^2)$ that captures the stochastic effects outside the farmer's control (e.g., weather, natural disasters), measurement errors, and other statistical

noise. The term u is a one-sided ($u \geq 0$) efficiency component that captures the technical inefficiency of the farmer. In other words, u measures the shortfall in output y from its maximum value given by the stochastic frontier $f(x_i;\beta)+v$. This one-sided term can follow such distributions as half-normal, exponential, and gamma (Greene, 2008). This study assumes that u follows a truncated normal distribution $[u \sim N(\mu, \sigma_u^2)]$ which allows the inefficiency distribution to have a non-zero mean μ. The two components *v* and *u* are assumed to be statistically independent of each other.

To analyze the effects of market-oriented production on farms' levels of technical efficiency, we defined the technical inefficiency model as follows;

$\mu_{ij} = \delta_0 + \delta_1(cashcrop_i) + \delta_m z_{mij} + \varepsilon_{ij}$ .....(2)

Where; μ_i is the mean of the inefficiency term assumed to follow a truncated normal distribution.

$cashcrop_i$ represents a dummy for market-oriented rice production (the key variable), and z_m represents a set of control variables accounting for inefficiency. These include; sex, age and education of household head, household size, size of land owned, access to extension services, type of seed, secondary occupation, source of labour (takes the value of 1 if the household mainly uses family labour, zero otherwise), distance to market and sub-county headquarters, membership to farmer groups and savings and credit associations. These factors are often reported to explain variation in technical inefficiency in agricultural production. Sex of household head is likely to affect technical efficiency as it influences access to productive resources such as land and inputs (Peterman et al., 2011). Age reflects experience, as most farmers have grown up in agricultural households. Education and access to extension services are likely to influence uptake of technologies which in turn affect technical efficiency (Kitila & Alemu, 2014). In Ethiopia, engagement in non-farm activities and, land holding are reported to influence technical efficiency of small holder maize farmers (Kitila & Alemu, 2014). There is mixed evidence on the relationship between farm size and productivity, while some studies report a positive relationship (Chirwa, 2007; Tan et al., 2010), others show an inverse relationship (Carletto et al., 2013). Membership of farmer associations and extension services facilitate timely access to inputs, information and technical assistance which are critical for technical efficiency (Chepng'etich et al., 2015). Access to credit facilitates timely usage of inputs including hired labour thus minimizing inefficiency.

4.4.2 Estimating market production effects on technical efficiency using propensity score matching

Comparing technical efficiency between the market-oriented and subsistence households presents some methodological challenges. First, market-oriented rice production is a government supported program and such programs are typically not offered at random. It is therefore important to consider the factors that are likely to drive the selection of the area (sub county) in which the programme is promoted. In this case for example, rice production may have been first promoted in sub counties that have more favourable weather and geographical conditions for the crop, or in sub counties with few other development programs. Regrettably sub-county specific data is lacking so we are unable to provide statistical information. The available information, however, indicates that sub counties are simply demarcated for administrative purposes and not geographical differences (Kanungu District Local Government, 2013). Arguably we may not completely rule out regional differences that may cause biased estimates. We therefore, include regional dummies in the inefficiency model to control for potential regional variation.

Second, participating in market production is not randomly assigned, but voluntary. Households self-select into market production. It is reasonable therefore, to expect that individual households who participate in market production are different from those that do not. While any household can engage in market production to increase its income, those with more resources such as capital and land are perhaps more likely to engage in it. In our case 24.6% of the sampled households from sub counties exposed to the rice programme are not engaged in market-oriented rice production. We therefore, face a common problem of selection bias. To overcome the problem of self-selection requires a counterfactual or control group that has the same characteristics as the treated group. Common approaches are; instrumental variables, difference in differences and matching methods (Blundell & Costa Dias, 2000). This study employs propensity score matching to construct an appropriate control group.

Matching tries to eliminate selection bias due to observable factors by comparing treated households with control households that have similar observable characteristics. The propensity score is the conditional probability of receiving treatment - in our case the conditional probability that a household participates in market-oriented rice production given its geographic location, demographic and household characteristics. Propensity score matching provides unbiased estimates in case self-selection can be explained by observables

and reduces the dimensionality of the matching problem (Becker & Ichino, 2002). Within subpopulations with the same value for the propensity score, covariates are independent of the treatment indicator and thus cannot lead to biases (Imbens & Wooldridge, 2008). The weakness of propensity score matching is its inability to deal with hidden bias due to unobserved heterogeneity between the treated and control groups which my lead to overestimation of market production effects. We address this problem by using Rosenbaum bounds approach to determine how strongly the unobservable must affect selection into treatment in order to undermine our conclusion on market production effects (DiPrete & Gangl, 2004).

In our analysis, the effect of market-oriented production on technical efficiency in staple crops production is determined by the difference in technical efficiency levels for the market-oriented (rice growing) households and the comparison group (non-rice growing).

We assume that participation in market-oriented rice production is a function of a range of observable characteristics at household and individual level. Formally it is expressed as follows;

$$d_i = \beta(w_i) + \tau_i$$

Where; $\mathrm{d} = 1$ for households growing rice and $\mathrm{d} = 0$ for the comparison group

w_i is a set of observed variables that influence the decision to participate in market-oriented production. Other unobserved household-specific factors are summarised by the random variable τ_i.

We use a logit regression model to estimate the propensity scores for the treated and control groups. In a counterfactual framework, our interest is to estimate the average treatment effect on the treated (ATT)[4] (Heckman et al., 1997; Smith & Todd, 2005), where the treatment is participation in market production (in this case rice production) and the outcome variable is technical efficiency. Propensity score matching balances distribution of observed covariates between treatment and control group based on similarity of their predicted probabilities of participating in market production. Thus, using different matching methods (kernel and

[4] Details on ATT estimation see Heckman, Ichimura et al. (1997), Becker, S. O. and A. Ichino (2002), Smith and Todd (2005)

radius) we are able to estimate the effect of market-oriented production on technical efficiency.

4.5 Results

4.5.1 Stochastic Frontier Analysis

We estimate the production frontier and technical inefficiency models for beans, sweet potatoes and rice using the maximum likelihood estimator. Results are presented in Table 4.2. In the models for beans and sweet potatoes, we assume that both market-oriented and subsistence households have the same production technology. We then predict technical efficiency levels which we use as our outcome variable in the propensity score matching analysis.

Table 4.2: Estimates of the stochastic production frontier function and determinants of technical inefficiency

Variable	Pooled sample		Market-oriented households
Lnoutput	Beans	Sweet potatoes	Rice
	Coefficients (Std. errors)	Coefficients (Std. errors)	Coefficients (Std. errors)
Production frontier			
Constant	3.056***	6.321***	4.293***
	(0.164)	(0.121)	(0.382)
Lnlabour (person days)	0.259***	0.036*	0.297***
	(0.034)	(0.020)	(0.071)
Lnseed (kg)	0.326***	0.014	0.169***
	(0.041)	(0.010)	(0.051)
Lnfieldsize (Acres)	0.544**	0.324**	1.216***
	(0.210)	(0.131)	(0.288)
Technical inefficiency model			
Constant	0.539	1.867***	-0.874
	(0.977)	(0.686)	(1.13)
Household grows rice =1, 0 otherwise	0.667**	0.679***	-
	(0.262)	(0.139)	
Sex of household head	0.177	-0.052	0.136
	(0.192)	(0.140)	(0.219)
Ln age of household head	-0.146	-0.295*	0.855***
	(0.234)	(0.173)	(0.282)
Ln education of household head (years)	0.005*	0.055	0.030
	(0.086)	(0.070)	(0.090)
Ln education of heads spouse (years)	-0.170	-0.007	0.012
	(0.096)	(0.065)	(0.085)
Ln size of land owned (Acres)	-0.612**	-0.323***	-0.246*
	(0.242)	(0.121)	(0.132)
Ln Distance to main market (km)	-0.181	0.153	-0.549***
	(0.199)	(0.135)	(0.193)
Ln Distance to sub county headquarters (km)	0.105	-0.138	0.036
	(0.199)	(0.145)	(0.163)

Seed type; improved seed =1; 0 otherwise	-	-	-0.094
			(0.133)
Access to extension services	0.084	0.019	0.134
	(0.153)	(0.116)	(0.155)
Source of labour; family =1: 0 otherwise	0.553**	-0.130	0.478***
	(0.220)	(0.106)	(0.143)
Household has no secondary occupation	-0.047	0.052	-0.035
	(0.124)	(0.092)	(0.1259)
Member of farmer group =1; otherwise =0	-0.020	-0.192	0.074
	(0.150)	(0.120)	(0.143)
Member of saving & credit group =1; otherwise =0	-0.073	-0.203*	-0.041
	(0.148)	(0.119)	(0.150)
Area dummy 1(Kihihi)	0.027	-0.501**	-0.167
	(0.167)	(0.177)	(0.142)
Area dummy 2(Nyamirama)	-0.487*	-0.547**	-0.523***
	(0.266)	(0.168)	(0.188)
Area dummy 3(Kambuga)	-0.454**	-0.240**	-
	(0.220)	(0.119)	
No. of observations	883	518	359
Diagnostic statistics			
$\sigma_s^2 = \sigma_v^2 + \sigma_u^2$	0.75	0.77	0.63
Gamma ($\gamma = \sigma_u^2/\sigma_s^2$)	0.86	0.99	0.77
Log-likelihood	-683.321	-269.64	-356.501
LR statistic	254.86***	7.33*	25.54***
Prob > chi2	0.000	0.000	0.000

*Significant at 10%; **Significant at 5%; ***Significant at 1% ;

Note: Ln denotes logarithm; pooled sample comprises all market-oriented and subsistence households that grow beans and sweet potatoes

As expected, parameter estimates of the stochastic frontier models indicate that inputs elasticities apart from sweet-potato seed are positive and statistically significant. This implies that households can achieve higher levels of output by increasing input use. The insignificant effect of sweet potato seed is not surprising since the seed is vegetative and the optimum plant density depends on the cultivar. Land input has the largest elasticities ranging from 0.32 for sweet potatoes to 1.2 for rice. This suggests land is the most critical input in crop production, which is logical given that agrochemicals and fertilizers are hardly used. Increasing cultivated land by one percent will increase beans and rice output by more than one percent. The sum of the coefficients on discretionary inputs in all models is greater than one, signifying increasing returns to scale. While output is highly responsive to changes in land size cultivated, further increasing farm size is presumably not sustainable in the short run given that 71.9% of arable land is under cultivation and arable land per person has declined from 0.45 in 1961 to 0.18 hectares per person in 2014 (data.wordbank.org/indicators). The likelihood-ratio test for all models indicates presence of significant technical inefficiency at the 1 percent level. The

value of gamma indicates that about 86% of variation in beans output; 99% variation in sweet potatoes output and 77% variation in rice output is due to technical inefficiency.

4.5.2 Does market production enhance technical efficiency of staple crops?

Generally there are high levels of technical inefficiency in food crop production for farmers in both market-oriented and subsistence production. Table 4.3 presents a summary of technical efficiency scores.

Table 4.3: A summary of technical efficiency scores for staple crops

Efficiency level	Market-oriented households		Subsistence households		Pooled sample		t-values	
	Beans	Sweet potatoes	Beans	Sweet potatoes	Beans	Sweet potatoes	Beans	Sweet potatoes
Mean	0.58	0.53	0.65	0.67	0.62	0.64	4.9667***	6.0206***
Minimum	0.11	0.11	0.13	0.05	0.07	0.05		
Maximum	0.87	0.90	0.91	0.94	0.91	0.94		
Proportion of households < mean	41.6	50.7	36.1	38.2	41.9	44.1		
Number of observations	322	138	561	390	883	626		

On average, subsistence households have relatively higher technical efficiency in staple crops than market-oriented households. Compared to subsistence households, a larger proportion of market-oriented households have a technical efficiency below the pooled sample's mean. The highest inefficiency is observed in sweet potato production with a mean technical efficiency of 53 percent. Considering the pooled sample, there is potential for households to increase their beans and sweet potato output by 37 and 36% respectively, through efficient use of the present technology. A similar message is presented in Figures 4.1 and 4.2, where we observe higher technical efficiency (in beans and sweet potato production), for the non-rice growing households. The mean comparison t-test of no difference in technical efficiency for both crops is rejected at 1 % significance level. The inefficiency regression results confirm these differences (Table 4.2). Estimates of the technical inefficiency models show a positive significant relationship between the dummy for rice production and technical inefficiency in staple crop production even after controlling for regional, social economic and farm characteristics. The coefficients for both the beans (0.66) and sweet potatoes (0.67) models are relatively high suggesting that market-oriented production has a strong efficiency

decreasing effect on staple crop production. High coefficients could also mean that inefficiency effects are overestimated due to endogeneity of participating in rice production. We check for robustness of these results using propensity score matching.

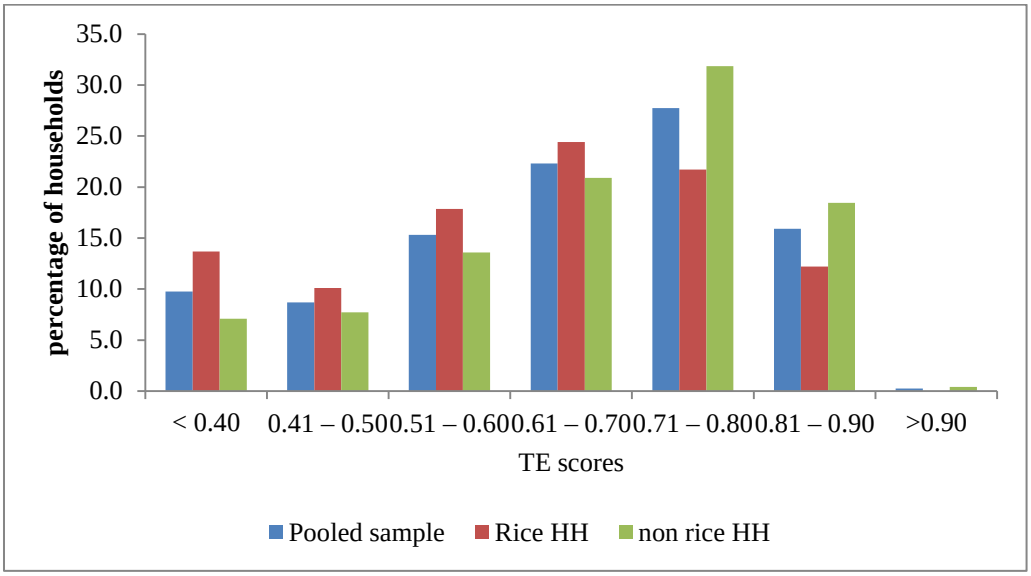

Figure 4.1: Distribution of technical efficiency scores in beans production

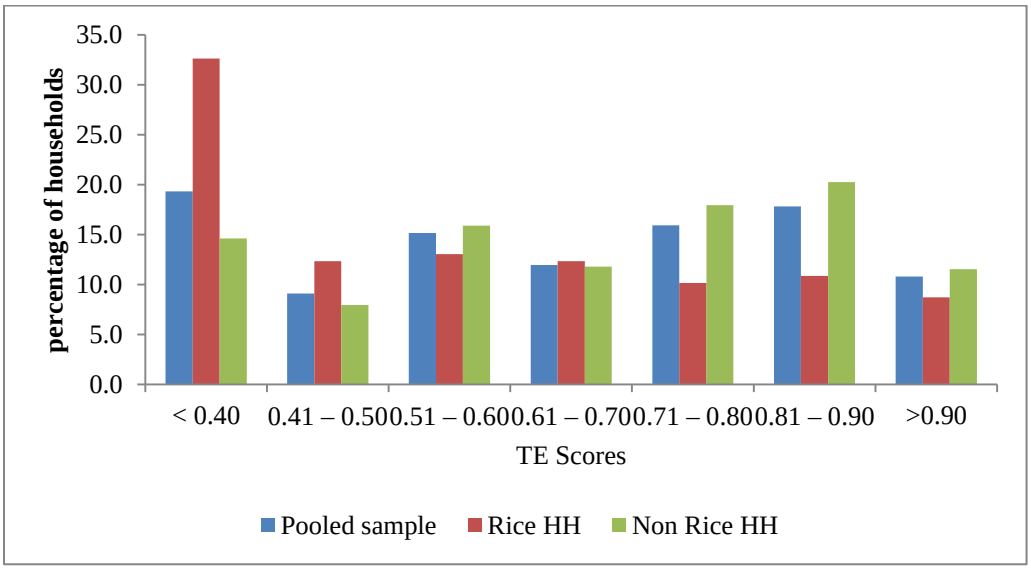

Figure 4.2: Distribution of technical efficiency scores for sweet potatoes

4.5.2.1 Propensity score matching analysis

Results of the logistic regression are presented in Table 4.4. Large households, with large size land, distant from the market and are members in farmer groups are more likely to participate in market-oriented production. This is logical in that a household requires a rather large farm to produce for the market and such land is likely to be distant from the market. Farmer groups are likely to be a source of information and inputs which are important for market production.

Table 4.4: Logistic regression for participating in rice market production

Variables	Coefficients	Std. Err.	z
Age of household head	0.0416	0.0422	0.98
Age of household head^2	-0.001*	0.0005	-1.76
Education of household head (years)	-0.0370	0.0258	-1.43
Education of heads spouse (years)	-0.0122	0.0302	-0.4
Household size (no. Persons)	0.0525*	0.0316	1.66
size of land owned (acres)	0.4814***	0.0827	5.82
Size of land owned^2 (acres)	-0.0195***	0.0042	-4.65
Distance to road (km)	-0.0356	0.0519	-0.68
Distance to main market (km)	0.6089***	0.0600	10.14
Agriculture as main occupation=1, otherwise =0	0.5514	0.3876	1.42
Household has no secondary occupation	-0.2878	0.1855	-1.55
Member of farmer group =1; otherwise =0	1.0181***	0.1890	5.39
Constant	-4.2335***	0.9649	-4.39
Number of observations	816		
Prob>chi^2	0.000		
Pseudo R^2	0.268		

*Significant at 10%; **Significant at 5%; ***Significant at 1%

We estimate market production effects on technical efficiency (ATT) using kernel and radius matching methods. We impose a common support condition and chi^2 test results show that all covariates are balanced (Table A1 appendix). The results are presented in Table 4.5. Consistent with descriptive statistics and the inefficiency coefficients we find that technical efficiency in staple crops is significantly lower for market-oriented households than for subsistence households. Results reveal that technical inefficiency in bean production is higher by 8.3% for market-oriented households compared to subsistence households. Similarly, in sweet potato production, technical inefficiency for market-oriented households is higher by 14.0 %. The results are consistent for both kernel and radius matching. Sensitivity analysis using Rosenbaum bounds shows that doubts on statistical significance of estimated results can occur if confounding factors cause the odds ratio of participating in market production to differ by a factor above 3.0 (DiPrete & Gangl, 2004). Thus our results are robust.

Table 4.5: Effects of market production on technical efficiency in production of staple crops

Outcome	Matching algorithm	Number of treated	Number of control	Mean TE treated	ATT (Std. error)	Critical level of hidden bias (Γ)
TE scores for beans	Kernel matching (band width = 0.05)	304	484	0.58	-0.083***	Above 3
					(0.0207)	
	Radius matching (caliper =0.05)	304	484	0.58	-0.082***	Above 3
					(0.0200)	
TE scores for sweet potatoes	Kernel matching (band width = 0.05)	135	461	0.55	-0.132***	Above 3
					(0.0352)	
	Radius matching (caliper =0.05)	135	461	0.55	-0.133***	Above 3
					(0.0303)	

*Significant at 10%; **Significant at 5%; ***Significant at 1%

The negative significant effects on technical efficiency may be attributed to withdrawal of critical labour inputs from staple foods when a household is producing a cash crop. A majority (61.2%) of households rely heavily on family labour for production of both staple and cash crop. This means that during peak periods of labour demand, family labour is constrained thus affecting timely field operations and consequently technical efficiency. This is affirmed by the significant positive relationship of family as the main source of labour with technical inefficiency. Given the seasonality of the food crops combined with constant changes in weather conditions (e.g. sudden rainfall), management decisions on resource allocation hinge on priorities and the risks effects of timing actions (land preparation, planting, weeding and harvesting) on output of a particular crop. In such situations market-oriented households are more likely to prioritize the cash crop. Moreover, market oriented households are likely to allocate the most productive land to the cash crop leaving marginal land for the staple crops hence affecting their technical efficiency. This argument is in line with the findings of Savadogo et al., (1998) in Burkina Faso. As pointed out by Neumann et al., (2010) inefficiency due to soil fertility constraints can be reduced by an effective land management. In situations where the farmer cannot improve the land quality through better soil management practices, allocating high quality land to the cash crop may seem to be a rational decision if the farmer gets higher utility from the cash crop. However, we are not able to establish whether market oriented households are economically efficient, as this study did not measure allocative efficiency.

4.5.3 Are market-oriented households more technically efficient in cash crops than staples?

Considering the subsample of market-oriented households, we predict technical efficiency of their major food cash crop and staples. Table 4.6 presents a summary of the frequency distribution of technical efficiency scores.

Table 4.6: A summary of technical efficiency scores for the cash and staple crops

Efficiency level	Market-oriented households		
	Rice	Beans	Sweet potatoes
Mean	0.60	0.58	0.53
Minimum	0.25	0.11	0.11
Maximum	0.87	0.87	0.90
Proportion of households < mean (%)	42.5	41.6	50.7
Number of observations	345	336	138

Results show that on average market oriented households could raise output of rice their main cash crop by 40% using the same inputs. However, it is possible that this would imply further delaying operations in staple crops and compromising technical efficiency in these crops. The estimated technical efficiency in rice production ranges from 0.25 to 0.87 and about 42.5% of the households have their technical efficiency score below the mean. Figure 4.3 show that in the short run, market-oriented households can increase their output in staple crops (beans and sweet potato) production by about 42% to 47% respectively by adopting existing technologies and the best farming practices. While the highest technical efficiency score is recorded in sweet potato production, over 30% of market-oriented households scored less than 40% technical efficiency for this crop. A comparison of mean technical efficiency of the cash crop (rice) and the staple crops using a t-test reveals that market-oriented households are more technically efficient (p-value = 0.001) in production of rice compared to the staple crops. The result is consistent with our conjecture that market-oriented households may concentrate their management on production of the cash crop. This result contrasts the findings by Binam et al. (2004) who found no significant differences in technical efficiency among maize and groundnut cropping system.

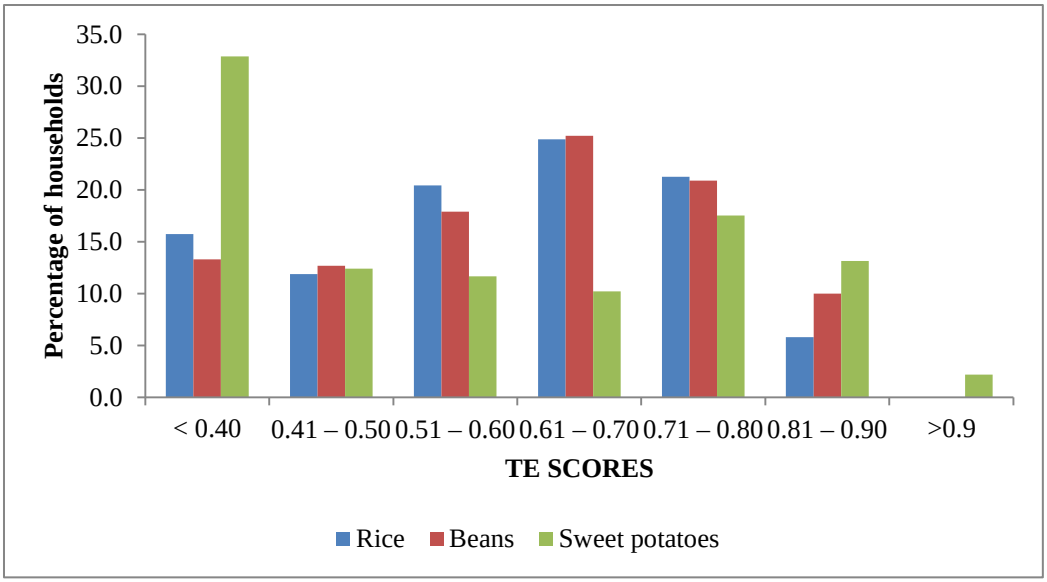

Figure 4.3: Distribution of technical efficiency scores for market-oriented households

4.5.4 Other factors influencing technical inefficiency

Other factors that influence technical inefficiency in food crops production include; age of household head, education of the spouse of household head, the size of land owned and source of labour. The age of household head has a mixed relationship with technical inefficiency. While it decreases technical inefficiency in sweet potatoes, it increases technical inefficiency in rice production. This might be explained by the fact that older household heads care more about the 'food security' staple crop (as sweet potato are commonly referred to) than the cash crop. It is likely that older household heads have bigger families to feed and therefore will tend to be efficient in staple crop production. A positive correlation between age and technical inefficiency in rice production seems to suggest that younger farmers are likely to be more technically efficient in production of a cash crop. This is perhaps due to physiological changes that affect managerial capability as well as strength and in turn labour productivity. Given that cash crops are usually managed by household heads and that the aged are relatively less active, they may not easily source for information and therefore, be more inefficient in management of the cash crop. The result is consistent with findings of Coelli and Fleming (2004) that age of household head increases technical inefficiency in the small holder mixed food and cash cropping system in Papua New Guinea due to increased difficulty in managing multiple tasks.

Technical inefficiency in beans production decreases with education of the household head's spouse. This result underscores the importance of formal education in agriculture (Reimers & Klasen, 2013). Farmers who are educated are more likely to access, process and use

information relevant to crop production including ease of access to inputs and adoption of best practices/ technologies that increase technical efficiency. Moreover, education helps farmers become better managers of limited resources by enhancing their decision making skills.

Contrary to what is commonly reported, that smaller farms tend to be more efficient, our results show a negative association between land size and technical inefficiency. This might be explained by the possibility that households with bigger farms could be practicing land management practices such as crop rotation and fallowing that improve land productivity. Similar findings have been reported in Bangladesh (Wadud & White, 2000). It is also probable that some of the plots used by households owning very small land are rented. Such plots may not be very productive as many households will not rent out their best plots. Households who use mainly family labour are less technically efficient, presumably because they have limited time to manage all activities of their different crops at the same time. A negative relationship between membership in a savings and credit group and technical inefficiency may be associated with easy access to credit that may enable households timely access to inputs particularly seed and labour. A negative coefficient of distance to the market in rice production implies that efficiency increases as market oriented farmers are further away from the market. This can be attributed to relatively easy access to labour and perhaps better plots as average land holdings tend to increase with distance from the market. Further, we observe significant effects on technical inefficiency associated with spatial dummy variables and this could be related to different soils.

4.6 Conclusions

We explore empirically the association between market production and technical efficiency in food crop production based on the hypothesis that market-oriented production increases technical efficiency in staple crop production. We estimate technical efficiency of one major food cash crop and two staple crops and attempt to isolate the effects of the cash crop on technical efficiency of the staple crops using propensity score matching approach. We find high technical inefficiency in the selected crops across the household categories. We also find that technical inefficiency in staple crops is significantly higher in market-oriented households compared to subsistence households. We argue that market-oriented households are more likely to withdraw resources from staples to cash crop production and seem not to invest their income in crop production. We offer two possible explanations. The first relates to the timing of operations and therefore the effectiveness of labour. Market-oriented households may give

precedence to their commercial crops, which –in combination with seasonality of operations, would delay operations in staple crops, thereby compromising staple output. The second explanation is that market-oriented households may allocate marginal land to staple crops, which would also lower output for staples. The implication is that they may be getting optimal output from such land and therefore the model overestimates market production effects. Including data on quality of plots allocated to the different crops in the frontier estimates would allow us to test for land quality effects. Regrettably we did not have these data. Our results should be interpreted with caution; we do not claim that market production causes inefficiency, but rather we show evidence that income from production may not be spent for efficiency enhancement in production of staple crops.

Despite the limitations, our findings show that there is significant potential for households to increase output in both cash and staple crops by increasing technical efficiency. However, for market-oriented households, increasing staple crop production may partly require withdrawing some inputs from the cash crop. This decision can be driven by the utility the household gains from production of either the food or the cash crop. Extending this study to establish the allocative and economic efficiency of market oriented households may be necessary. The results suggest that public policies aimed at enhancing market production should support innovations that increase technical efficiency. Supporting formal education for example in form of tailored adult literacy programs particularly for women who provide the bulk of agricultural labour might help farmers improve their management skills and hence improve technical efficiency of food crops. Labour saving technologies may be necessary to facilitate timely operations and subsequently improve technical efficiency in the long run. Given the increasing demand for critical inputs, the agricultural economy will rely on the growth of total factor productivity other than growth of inputs.

Appendix

Table A1: Chi-square test for significance of variable before and after matching

Outcome	Matching algorithm	Pseudo R2 Before matching	Pseudo R2 after matching	$p>chi^2$ Before matching	$p>chi^2$ after matching
TE scores for beans	Kernel matching (band width = 0.05)	0.262	0.010	0.000	0.719
	Radius matching (caliper =0.05)	0.269	0.010	0.000	0.724
TE scores for sweet potatoes	Kernel matching (band width = 0.05)	0.218	0.007	0.000	0.997
	Radius matching (caliper =0.05)	0.218	0.007	0.000	0.996

Table A2: Propensity score matching and covariate balancing test

Variable		Mean		t-test	p>t
		Treated	Control		
Age of household head	Unmatched	42.461	42.715	-0.27	0.789
	Matched	42.424	43.98	-1.51	0.130
Square of age of household head	Unmatched	1951.8	2022.1	-0.80	0.426
	Matched	1953	2100.7	-1.51	0.131
Education of household head (years)	Unmatched	6.2952	6.0702	0.79	0.430
	Matched	6.3257	6.5617	-0.74	0.459
Education of heads spouse (years)	Unmatched	4.494	4.124	1.49	0.136
	Matched	4.5099	4.4231	0.32	0.752
Household size	Unmatched	6.8464	5.9731	4.21	0.000
	Matched	6.8059	6.7717	0.14	0.888
Size of land owned (ha)	Unmatched	2.3769	1.5366	4.15	0.000
	Matched	2.2309	2.6948	-1.94	0.052
Square of land size owned (ha)	Unmatched	13.074	11.609	0.28	0.783
	Matched	12.092	17.013	-1.31	0.190
Household distance to main road	Unmatched	1.7937	1.2684	3.64	0.000
	Matched	1.668	1.685	-0.11	0.916
Household distance to main market	Unmatched	4.6233	2.5513	13.86	0.000
	Matched	4.0877	3.8922	1.30	0.193
Main occupation agriculture = 1	Unmatched	0.95482	0.90289	2.76	0.006
	Matched	0.95724	0 .96833	-0.72	0.471
No secondary occupation = 1	Unmatched	0.49096	0 .56198	-2.00	0.046
	Matched	0.49671	0.53107	-0.85	0.397
Member of farmer group =1	Unmatched	0.66867	0.43595	6.71	0.000
	Matched	0.66118	0.70169	-1.07	0.285

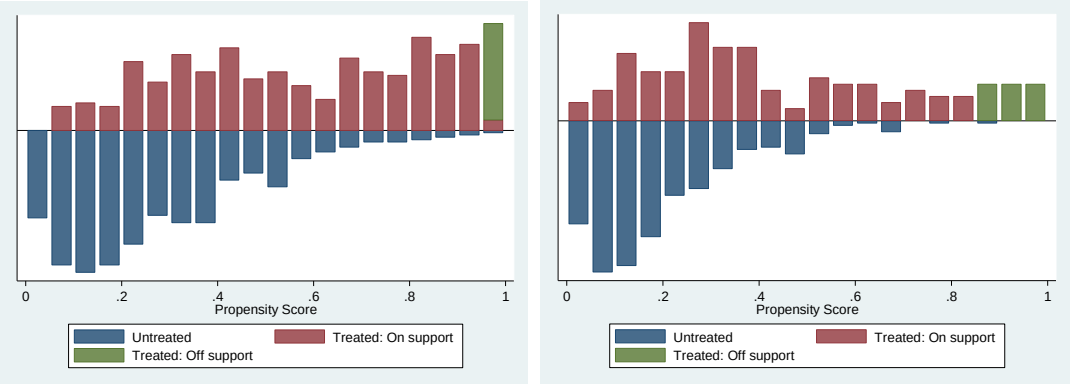

Figure 1: Distribution of propensity scores and the region of common support for beans and sweet potatoes (kernel matching)

Table A3: Sensitivity Analysis: Rosenbaum Bounds

Gamma	sig+	sig-	t-hat+	t-hat-	CI+	CI-
1	3.80E-11	3.80E-11	-0.0672	-0.0672	-0.08881	-0.04674
1.1	2.30E-13	3.40E-09	-0.07513	-0.05985	-0.09715	-0.03937
1.2	1.20E-15	1.30E-07	-0.08222	-0.05277	-0.10473	-0.03292
1.3	0	2.40E-06	-0.0889	-0.04661	-0.11201	-0.02707
1.4	0	0.000026	-0.09531	-0.04088	-0.11856	-0.02145
1.5	0	0.000187	-0.10119	-0.03585	-0.12482	-0.01649
1.6	0	0.000952	-0.10675	-0.03126	-0.13068	-0.01162
1.7	0	0.003658	-0.11207	-0.02704	-0.1365	-0.00751
1.8	0	0.01113	-0.11703	-0.02285	-0.1416	-0.00322
1.9	0	0.027883	-0.12161	-0.01897	-0.14651	0.00057
2	0	0.059352	-0.12606	-0.01545	-0.15127	0.004174
2.1	0	0.110141	-0.13039	-0.01195	-0.15581	0.007337
2.2	0	0.182054	-0.13442	-0.00878	-0.16016	0.010609
2.3	0	0.272935	-0.1383	-0.0059	-0.16471	0.013546
2.4	0	0.376928	-0.14201	-0.00293	-0.1686	0.016227
2.5	0	0.48598	-0.14553	-0.00032	-0.17229	0.01868
2.6	0	0.591856	-0.14894	0.002365	-0.17608	0.021614
2.7	0	0.687856	-0.15213	0.004793	-0.17992	0.024032
2.8	0	0.769755	-0.15528	0.00701	-0.18334	0.02653
2.9	0	0.835918	-0.15808	0.009207	-0.18688	0.028908
3	0	0.886813	-0.16134	0.011392	-0.19013	0.031171

gamma - log odds of differential assignment due to unobserved factors

sig+ - upper bound significance level

sig- - lower bound significance level

t-hat+ - upper bound Hodges-Lehmann point estimate

t-hat- - lower bound Hodges-Lehmann point estimate

CI+ - upper bound confidence interval (a= .95)

CI- - lower bound confidence interval (a= .95)

Chapter 5

Smallholder food marketing behaviour: Exploring the role of informal credit and traders in stabilization of food crop prices

Abstract

Many farmers in Africa sell their produce at low prices immediately after harvest because they need cash. They could solve temporary liquidity constraints by use of credit and store their produce to sell when prices are high. However, due to various reasons such as lack of collateral, high interest rates and transaction costs, many poor farmers have been excluded from formal financial services. In response, the informal financial market has expanded, but the question why informal credit has not facilitated storage to enable farmers benefit from intertemporal arbitrage opportunities remains largely unanswered. To answer this question, we investigate the role of informal credit markets and traders in stabilizing seasonal food crop prices. Our analysis is based on household survey data and interviews with key players in the informal credit market and grain traders in rural Southwestern Uganda. We find that community-based self-help savings and credit associations provide credit for the majority (62%) of farmers. Informal credit still excludes the very poor and is not sufficient to enable farmers to benefit from intertemporal arbitrage opportunities. Thus poor farmers continue to 'sell low and buy high'. The study also addresses a related fundamental aspect of food marketing: why is there no competition between traders bidding up prices after harvest and eliminating seasonal price fluctuations? We analyse traders' costs and profit structure in the study area, and shed some light on imperfections in the grain market and the barriers that limit competition between traders at the local level. We find that grain trade is not highly competitive. High transaction costs and limited access to credit are the main barriers limiting competition. Supporting community based self-help savings and credit associations to raise their portfolio can enable more farmers to borrow at the same time. Investing in infrastructure, organising and supporting small scale farmers to bulk their produce might lower transaction costs, promote competition and dampen price fluctuations.

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5.1 Introduction

Agricultural production in most African countries is dominated by small-scale farmers who depend on their produce for home consumption and income generation. As smallholder households increasingly engage in market production, their opportunity to increase household income and food security largely depends on the functioning of agricultural markets and other relevant markets such as the financial market. In the absence of well-functioning markets, prices of agricultural commodities in most sub-Saharan African countries typically fluctuate across space and time. Food crop prices are usually low at harvest but rise gradually until the next harvest. This seasonal price fluctuation is largely due to variation in domestic or even local supply and demand, as markets are imperfectly integrated. Most small holder farmers sell their produce at low prices immediately after harvest, and buy food later during the lean period at a higher price. This has been referred to as the 'selling low and buying high puzzle' (Burke, 2014; Stephens & Barrett, 2011).

Food crop price instability is of significant interest to development economists. Price variability of the type described above adversely affects household income. It hinders intensification of input use, adoption of technologies necessary for production efficiency and negatively affects productivity growth and food security (Gabre-Madhin et al., 2002). Seasonal variation in food prices affect household dietary intake and the nutritional outcome might be detrimental to health. Addressing the food crop price instability problem would help farmers to realize the potential economic and nutrition advantage of engaging in market production (Gilbert et al., 2017).

The persistence of non-stochastic food price variability is puzzling. One would expect that predictable price movements will affect decisions on when to sell or store produce by farmers and third parties. As opposed to perishable crops, grains can be stored in case of unfavourable markets conditions and sold later when prices are high. While seasonal price variations are predictable, a majority of farm households seems not to take advantage of this to benefit from inter-temporal arbitrage opportunities. Even more puzzling is; why is there no competition between traders, bidding up prices soon after the harvest, and dissipating rents from arbitrage? In theory, both storage by farmers and traders could help to attenuate price volatility.

To date only a few studies have assessed why farmers do not store but choose to sell at low prices. The existing literature offers various explanations, including lack of strong supporting

institutions and market-based risk management instruments such as warehouse receipts, forward price contracts and insurance (Byerlee et al., 2006; Coulter & Onumah, 2002). Lack of storage facilities or high storage costs and lack of liquidity might equally explain why households sell their produce at low prices immediately after harvest. Stephens and Barrett (2011) argue that poor households which are liquidity constrained may be compelled to sell their produce at a time when prices are low in order to take care of other needs. This is consistent with Fafchamps and Minten (2001) who mention that for most farmers the decision to sell or not to sell a staple (and how much to sell) is largely driven by the needs of the household rather than the price of the crop.

Temporary liquidity constraints can be solved by use of credit. Credit can improve farmers' income from production and food security through different pathways; (i) it can be used to smooth consumption and manage liquidity during seasonal income fluctuations (Matin et al., 2002; Yasuharu & LaStarria-CorNhieL, 2015); and related to this point, (ii) it may facilitate households to temporarily store their produce and sell when prices are high (Khandker, 2005; Matin et al., 2002). While the role of credit in agricultural production has been widely discussed (Conning & Udry, 2007), only a few studies have linked credit to agricultural commodity marketing (Burke, 2014; Stephens & Barrett, 2011). In these studies, the authors show that access to credit significantly influences small-holder sales and purchase behaviour of food grain. In Kenya for instance Burke (2014) finds that access to credit increases farm net revenues as it enables farmers to store their produce and sell when prices have gone up. Not only does storage affect household income, it also affects local price dynamics when markets are not integrated. Burke (2014) finds that local price fluctuations are dampened if sufficient farmers have access to credit. Expansion of credit access in rural areas may thus help reduce price dispersion.

However, due to various reasons such as lack of collateral, high interest rates and transaction costs, many farmers, especially the illiterate and the poor, typically have limited access to formal financial services (Ahmad, 2003). In recent years, the informal credit market has expanded and provides alternative sources of finance for households. Are farmers unwilling to borrow, or are they equally limited in accessing informal credit? Why don't informal financial institutions, such as private moneylenders and savings and credit cooperative associations/ societies (SACCOS), help to meet temporary borrowing needs of farm households?

Alternatively, traders could bid up prices and dissipate rents from arbitrage. Why does this not happen? Several explanations have been offered. One is that there are no excessive returns in grain trade, that the gap between low and high prices is due to high transaction and storage costs incurred by the traders (Ferris et al., 2014; Svensson & Yanagizawa, 2009). This means that traders only receive a fair compensation for their effort and the risk they run (e.g. theft or price drop). This argument is supported by the findings of Fafchamps, Gabre-Madhin, and Minten (2005) in Benin, Madagascar and Malawi that marketing costs are nearly proportional to transaction size with very little evidence of returns to scale in agricultural trade. Sitko and Jayne (2014) equally argue that food markets are highly competitive in terms of number of traders and marketing margins and that traders improve farmers' access to markets in remote areas in Sub-Saharan Africa and should be supported in order to further develop competitive rural markets.

Yet, others claim that traders are monopolists and earn non-competitive rents (Muto & Yamano, 2009; Svensson & Yanagizawa, 2009). These studies show that crop traders use information asymmetries to gain substantial surplus beyond normal profits. Some traders form networks that restrict farmers from selling directly to wholesale traders thus limiting competition. For instance in West Bengal, wholesale traders are unwilling to negotiate small trade volumes directly with farmers (due to high transaction costs and mistrust) but rather deal with small village traders (Mitra et al., 2016). As a result, village potato traders collude on the price to offer farmers and ultimately earn large margins due to limited competition. Using a field experiment, Bergquist (2016) also finds a high degree of collusion among maize traders in Kenya and this affects competition. While a number of studies have been done in sub-Saharan Africa, there is little evidence on whether food crop markets are competitive or not (Dillon & Dambro, 2016).

This chapter makes a contribution in addressing the above issues by focusing on the role of informal credit and traders in stabilizing food crop prices. We address two objectives; one, we analyse how semi-formal financial intermediaries (SACCOS) and informal credit sources influence the marketing behaviour and affect food security of rural households. Two, we attempt to better understand the food marketing dynamics focusing on grain trade in rural Uganda and the barriers that maintain excess margins (if they exist) in equilibrium in the rural food market. To address these objectives we conducted a set of surveys involving farmers (a household survey), managers of informal savings and credit associations, individual money lenders, and food grain traders.

This chapter adds to the literature an analysis of the contributions and limitations of the (informal) credit market in stabilizing seasonal food crop prices and ultimately smoothing income fluctuations. Further, we provide insights in the underlying causes of imperfect competition in the food markets in rural areas which may have maintained excess margins in the grain market. Our focus is on marketing of food crops, specifically grains (rice, maize, millet, beans and ground nuts) which are commonly traded in the area. We seek out strategic interventions for policy makers to leverage food crop prices for food security by improving the functioning of markets.

Our findings reveal that informal credit is not sufficient to enable farmers to store their produce and participate in intertemporal arbitrage. This is because the major sources of informal credit (ASCAs, ROSCAs and SACCOs) are financed by farmers' savings which are very small. We also find that the local grain market does not have sufficient competition between grain traders. The main barriers to competition include high cost of credit, poor infrastructure and marketing systems particularly individual marketing. Addressing these factors may significantly contribute to dampening seasonal food price fluctuations.

In the following section we explain how data were collected, section 5.3 gives an overview of food crop price trends in Uganda highlighting the market and price structure. In section 5.4 we discuss the role of the informal credit market. Section 5.5 presents the role of traders in stabilizing food crop prices, and we conclude in section 5.6.

5.2 Data

We collect all primary data from Kanungu district, western Uganda (Figure 5.1). The district borders Rukungiri district to the north and east, Kabale district to the south east, Kisoro district to the south west and the Democratic Republic of the Congo to the west. A majority of the population derives its livelihood from agriculture, especially crop production. This study combines primary and secondary data on food grains trade and informal financial institutions, to analyse rural food and financial market imperfections. Primary data were collected from farmers and local traders to understand the marketing systems at the local level. Grain traders were interviewed to gain insight in local trade activities. We collect qualitative data using semi-structured interviews with individual money lenders, managers of SACCOS and representatives of other informal financial institutions (ROSCAs and ASCAS) to better understand their lending technology.

Figure 5.1: Map of Uganda showing the study area and neighbouring districts (painted green) which provide market for food crops

Interviews with SACCO and ROSCA managers, money lenders and traders

We approached SACCO and ROSCA managers, money lenders and traders individually. For the first three groups, we used a semi-structured questionnaire to ask about their credit market experiences with farmers, with particular interest in borrowing and repayment, as well as transaction costs. In total 47 interviews were conducted; 15 with SACCO managers, 16 with chair persons of community-based credit and savings associations and 16 with money lenders/ traders who offer credit or buy crops at a fixed forward price. We faced a challenge of identifying money lenders as most of them are operating 'illegally' (i.e., they are not registered). Out of the 16 interviewed, only one is registered as a money lender. Those we interviewed were identified through their clients and colleagues. Whoever was interviewed was requested to provide names of other money lenders in the area. In order to better understand individual operations, some questions were respondent-specific. Five grain traders were also interviewed using a semi-structured questionnaire. We asked about the type of buyers and sellers they deal with, their transactions to better comprehend their cost structure, and the constraints and challenges they face in the grain trade.

Interviews with households / farmers

Household data were extracted from a household survey on market production and household food security. The survey was conducted in 2014 (March – June) and involved 1137 rural households. The sample was drawn from seven sub counties; five sub counties were purposively selected to represent market-oriented crop production and two represent subsistence crop production. Respondents were randomly selected from the list of households in randomly selected villages. We use data on household socio-economic and demographic characteristics, credit access and use, production and marketing of major food crops (rice, maize, beans and ground nuts).

Table 5.1 presents a summary of descriptive statistics of sample households. A majority of households are headed by males with an average age of 42.6 years. Their average education is 6 years of schooling, implying that the majority has only primary education. It is important to note that this has implications for one's capacity to operate a bank account as well as transactions in marketing agricultural produce. The average household size in our sample is 6.2 persons, which is above the national average of 4.7 persons per household (Uganda Bureau of Statistics, 2014a). The surveyed households are typically small holders with an average land size of 1.8 hectares. Their average annual household income –UGX 3.4 million is far above the mean national household income (UGX 2.0 million) in rural areas (Uganda Bureau of Statistics, 2014b). Crop sales contribute the bigger proportion (54.3%) of household income. This means that households mainly rely on seasonal income and therefore credit access is critical for households to manage liquidity constraints. The household survey reveals an average household annual expenditure of about UGX 2.7 million which translates into average monthly expenditures of approximately UGX 0.23 million. This is close to UBOS estimates of UGX 0.22 million for western Uganda and slightly above the national average household consumption expenditure of UGX 204,200 per month in rural areas (Uganda Bureau of Statistics, 2014b). The bigger proportion of income is spent on food (37.4%) and school fees (29.5%), expenditures that cannot be postponed. School fees for instance are paid three times in a year – the beginning of first and second term coincide with harvest period (end of January and May respectively) while the beginning of third term falls in the growing period (end of September). It is for such expenditures that households would need credit in order to store their produce awaiting for higher prices.

Table 5.1: Descriptive statistics of sample households

Variable name	Observations	Mean	Standard deviation	minimum	Maximum
Age of household head	1137	42.6	13.4	18	85
Gender of household head; male (percentage)	1137	82.9			
Education of household head (years)	1127	6.2	3.9	0	20
Education of household head's spouse (years)	1100	4.9	3.2	0	17
Household size	1135	6.2	2.6	1	24
Size of land owned (acres)		4.5	5.4	0	35
Average annual household income (million UGX)	1137	3.5	4.3	0.1	44.5
Average annual household crop income (million UGX)	1026	1.9	2.0	0.1	13.5
Average annual household expenditure (million UGX)	1132	2.7	3.1	0.1	32.3
Wealth (million UGX)	1137	19.3	20.5	0.1	72.1
Distance to the main road (km)	1137	2.56	3.68	0	48
Distance to the main market (km)	1137	6.08	4.48	0.048	72
Distance to input shop (km)	1114	4.64	3.68	0.016	27.2
Access to credit; Yes (percentage)	1125	83.7			
Proportion that used credit (percentage)	996	67.7			

Note: exchange rate; 1USD ≈ 2650 UGX

5.3 Trends in food crop prices in Uganda

Since the liberalization of markets in early 1990's food crop prices in Uganda are subject to forces of supply and demand. Price levels are driven by seasons, the overall national harvest, and whether the crop is traded in the international and or domestic market. Apart from rice and maize, which are internationally traded, the prices of other crops are largely determined by domestic supply and demand. Food crops are mainly traded on the spot market, where farmers sell their produce to neighbours, local traders and in various local markets. Figure 5.2 shows retail price trends of major marketed food crops in a regional market of Kabale (Figure 5.1) in Southwestern Uganda.

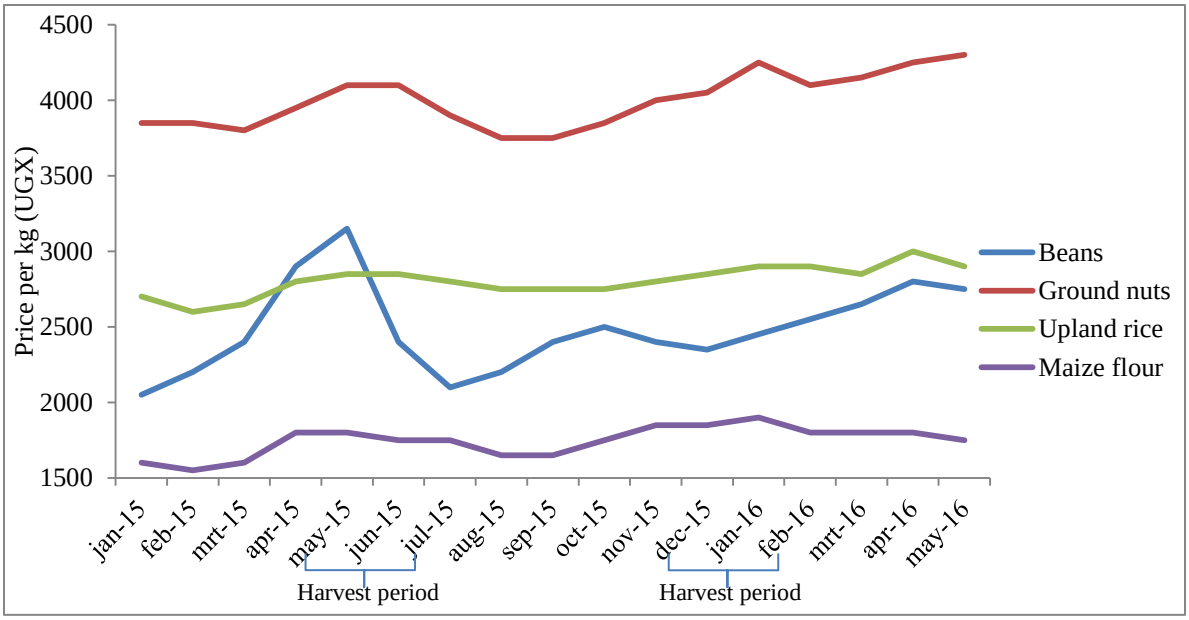

Figure 5.2: Retail price trends for selected crops in Kabale a regional market for Southwestern Uganda. Source: Agricultural market information system (AGMIS Uganda). Note; prices are expressed in nominal terms and in local currency

Due to the rain-fed nature of agriculture, food crop prices exhibit seasonal variations within a year. We observe low prices during the post-harvest periods in January-February and July – September, and rising prices during the growing season (reaching the peak around May and October-November). Price variation for Upland rice at regional level is relatively modest because its price is largely determined by international and regional markets with relatively high imports. About 42% of rice consumption is imported while 16.7% of total production is exported. The rice market is reasonably well integrated into the national market, and supermarkets compete with small shops retail prices (Kijima et al., 2015). The price for maize flour is mainly stabilised by the supply of fresh substitutes such as sweet potatoes, cooking banana and fresh cassava. Beans and ground nuts show a relatively high seasonal price variation because they are mainly traded in the domestic market and do not have close substitutes. This is consistent with findings by Minot (2014) on food price volatility in sub-Saharan Africa.

Figure 5.3 presents retail prices of major grains in local markets in Kanungu district. Intra-annual price variability is relatively higher in the local market compared to the regional market. This is because supply to the regional market is from various districts and the regional market is more integrated into the national market. Nevertheless, prices show a similar trend; they reach the lowest level soon after the harvest and increase during the lean season.

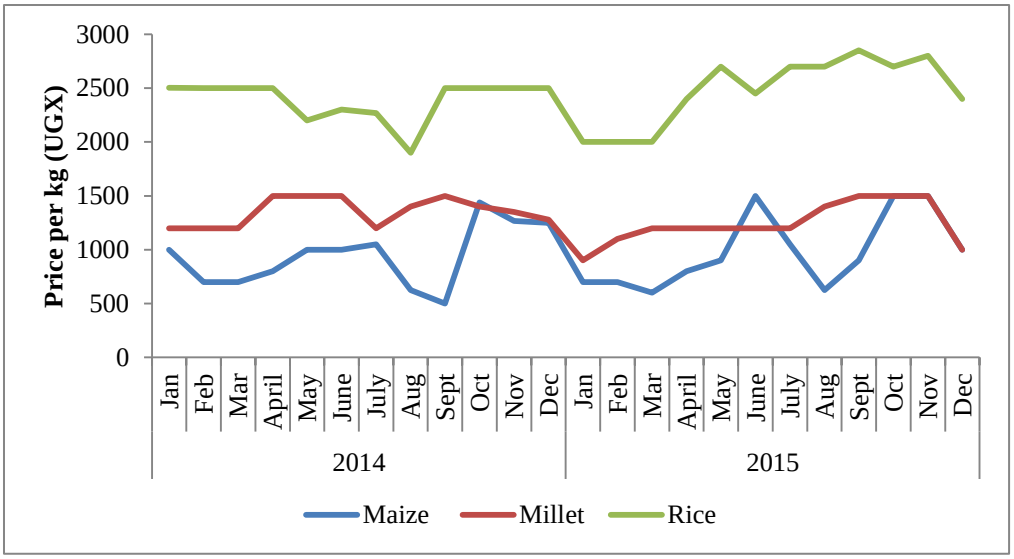

Figure 5.3: Average retail prices of grains in local markets in Kanungu district

Source: Uganda Bureau of Statistics (UBOS)

We compute relative price variability to understand the magnitude of seasonal price dynamics. Table 5.2 casts some light on the extent of price variability of the key crops. As mentioned before, rice prices do not show very strong variability as they seem to be linked to international rice prices. Millet price variability is relatively low because the demand for millet is rather low compared to other grains. Seasonal price variability is much higher for maize grain. This can be explained by a relatively very high supply of maize immediately after harvest and hence attracting very low prices. Yet, the demand for maize remains high as it is the main food for institutions such as schools and prisons. The world food programme equally demands significant quantities of maize for distribution as food aid. In addition there is significant cross boarder export of maize to Kenya, Rwanda and Sudan. Our findings are consistent with those in other African countries (Gilbert et al., 2017).

Table 5.2: Relative price variability of key grains in Kanungu district

Crop	Rice	Maize	Millet
Average price in the month before harvest (Ug. Shs)	2850	1500	1500
Average price in the month after harvest (Ug. Shs)	2000	500	1000
Price variation	850	1000	500
Relative price variability (%)	42.5	200	50.0

Note; price variability for rice, maize and millet is based on local market prices.

Exchange rate; 1USD ≈ 2650 UGX. Relative price variability = (price variation /av. price after harvest)100

Source: Uganda Bureau of Statistics 2015

Variation in average monthly retail prices could potentially reflect high storage costs as well as changes in market conditions specifically supply and demand fluctuations. In seasonal agriculture, food supply in isolated markets during the lean period comes from storage. Producers store food to smooth consumption between harvest and non- harvest periods and to take advantage of future high food prices. For traders, the main motivation for food storage is the speculation on future price increases. In a competitive market, storage plays a big role in ensuring that prices are dynamically consistent. However, storage-associated costs such as the cost of pesticides, rental costs, storage losses and the opportunity cost of capital may affect food grain prices.

Seasonal price variations would be reduced if farmers could limit supply after harvest, and store their produce to sell a few months later. This strategy would also earn them higher income. Using our household survey production and marketing data, and market prices we show that households can raise their revenue from crops specifically grains by 64.6 percent if they could store their produce and sell at least three months after harvest. Table 5.3 presents the average returns that sampled households could earn from different food crops at the lowest and peak prices in the season. Farmers who sell immediately after harvest, may lose 25% to 200% of the crop sold after harvest depending on the type of crop. Maize and beans display the highest loss (200 and 100 percent respectively). As mentioned above this is explained by the high demand for the maize and beans.

Table 5.3: Average estimated revenue by food crop at different prices in the marketing season

Crop	Quantity sold (kg)	Average price per kg immediately after harvest (UGX)	Revenue (UGX)	Average price per kg before harvest (UGX)	Revenue (UGX)	Percent change in revenue
Rice	541.8	2000	1,083,702	2850	1,544,275	42.5
Maize	309.6	500	154,842	1500	464,527	200.0
Millet	206.9	1000	206,910	1500	310,366	50.0
Beans	187.7	1000	187,749	2000	375,498	100
Ground nuts	102.4	2800	286756	3500	358,445	25
Average annual grain revenue			836,782		1,377,230	64.6

Source of data: survey conducted by the authors. The quantity sold are the averages of crops sold by the sampled households. The prices used are the lowest and highest prices in the marketing season (about 6 months)

For households that mainly depend on income from crops, they must have enough savings or access to credit to take care of household needs if they have to store their produce awaiting for peak prices. Whereas, it is known that savings are low due to low income, the question is; why don't they borrow to offset temporally liquidity constraints? For instance, assuming two equal cropping seasons in a year, and that a household spends all crop income before the next harvest and not able to cut expenses, the average household would require a loan worth UGX 418,391 (one season crop income (836,782/2) to defer grain sales for at least 3 months to the high price period just before the next harvest. In what follows, we assess the role of informal credit in the food crop market with evidence from western Uganda, but first, we present an overview of the rural credit market in Uganda.

5.4 Rural credit market in Uganda

5.4.1 Credit access in rural Uganda

There has been a general increase in demand for credit in Uganda. The national statistics indicate that the proportion of adults (aged 18 years and above) demanding loans increased from 17% in 2009/2010 to 22% in 2012/13 (UBOS statistics 2012/2013). Consistent with national statistics (UBOS statistics 2012/13), our survey reveals that the main purpose for which a majority (38%) of households borrow money is paying school fees. This is followed by working capital (17%) and consumption (16%) (Figure 5.4). Similar findings have been reported in other developing countries such as Nepal (Prina, 2015).

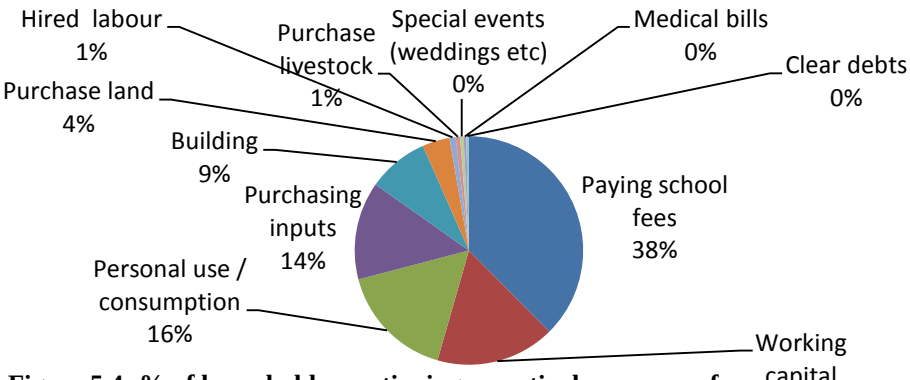

Figure 5.4: % of households mentioning a particular purpose for borrowing

Uganda's credit market consists of formal and informal sources of credit supply. Our findings indicate that a majority (84.2%) of sampled households has access to some form of credit. About 68.4 % of the households had obtained a loan in the past twelve months prior the survey and a majority (93%) obtained credit from informal financial services. Community-based saving methods, including accumulating savings and credit associations (ASCA) and

rotational savings and credit associations (ROSCA) categorised as 'self-help associations', seem to dominate (Figure 5.5).

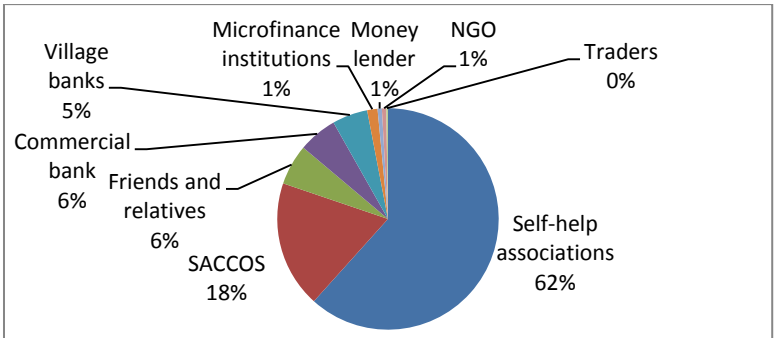

Figure 5.5: Source of credit

5.4.2 Formal credit market

The formal credit market includes commercial banks and microfinance institutions. Uganda's credit market is highly segmented and the proportion of the population accessing formal credit is still very low especially in rural areas. Financial exclusion of the rural population is attributed to lack of savings and reliable investment enterprises (Fletschner, 2008), high account transaction costs (Prina, 2015), documentation requirements and proximity to financial intermediaries (Allen et al., 2016). Individuals in civil service and non-agricultural business are more likely to apply for credit compared to those in the agricultural sector (Mpuga, 2010). National statistics indicate that only 0.36 million (9.1% of 3.95 million) agricultural households access credit (agricultural statistical abstract 2011). This is explained by various factors, such as high risk associated with rain-fed agriculture and lack of physical assets for collateral. While land is the most credible asset for collateral, a large part of the land is not titled due to high costs involved, but also due to the customary land tenure system where individuals have user rights but do not own the land. While those with land titles can access credit, in the absence of insurance markets they are unwilling to bear the risk of loss which may arise in case they are unable to payback (Boucher et al., 2008). For short term consumption credit, one would expect produce to be accepted as collateral. However, this is not viable due to poor marketing structures (individual marketing) and price fluctuations of agricultural commodities. High price of inputs / credit relative to output price and income volatility may significantly affect profits thus discouraging borrowers (Njeru et al., 2015). The small number of banks and delayed loan approval decisions equally discourage borrowers (Leon, 2015).

Moreover, there is a gender gap in use of formal financial services. Lending requirements of financial institutions limit rural women's access to financial resources (Fletschner & Kenney, 2014). Considering their employment status (perceived as house wives), women are less likely to use formal financial services due to their lower level of income and education (Aterido et al., 2013). In Uganda 48% of women are not empowered and lack access to or decision making ability over credit (Alkire et al., 2013). Women are more likely to be credit constrained to the extent that even those who apply get smaller amounts compared to men (Fletschner, 2009).

While the Government has introduced microfinance institutions to help farmers' access credit, only 1% of sampled households had borrowed from microfinance institutions in the previous year before this study. MFI have not helped poor farmers in rural areas as their requirements and procedure are not much different from those of commercial banks. This is further aggravated by insufficient infrastructure, low education levels and greater risks associated with agriculture production. Unless risks such as erratic weather conditions and income shocks are covered with micro insurance which is still lacking in Uganda financial markets microcredit will not benefit the rural poor farmers (Akotey & Adjasi, 2016). Consequently, most of the rural households have resorted to informal credit sources, which have relatively larger flexibility and where social capital may serve as collateral.

5.4.3 The role of informal credit market and its limitations in stabilizing food crop prices

Close to 100 million adults in sub-Saharan Africa use informal methods to save and borrow (Klapper & Singer, 2015). The informal credit market is not just a symptom of underdevelopment as viewed by many but complements the formal sector by supporting rural people who are excluded from the formal sector. Due to its flexibility, informal credit also provides another source in case of formal credit rationing (say when a borrower is offered less than requested for). Informal financial services are mainly community based and exist in various forms including; savings credit and cooperatives organization (SACCO), unregulated village banks, accumulating savings and credit associations (ASCA), rotational savings and credit associations (ROSCA), traders, private money lenders, friends and relatives (Anderson & Baland, 2002). The informal credit market plays an important role in supporting economic activities, including food crop production and marketing. Moreover informal financial markets enable households to smooth consumption and deal with shocks, such as ill health. Proximity and economies of scope enjoyed by informal lenders reduce transaction costs and risks and enable them to serve various types of clients excluded from the formal sector

(Guirkinger, 2008). The ability of the informal sector to utilise social networks to gather information on borrowers gives the informal market a comparative advantage over the formal sector in dealing with small holder rural households that lack collateral and documented income records.

5.4.3.1 Why don't farmers borrow money against their expected high future produce prices to stabilize their income and smooth consumption?

To gain insight into the borrowing behaviour of farmers, and how this shapes their commodity marketing behaviour, it is important to understand the different sources of informal credit, the terms and conditions of borrowing, and the challenges faced on the supply and demand side. The most common sources of credit in the study area include self-help associations (ASCA and ROSCAs), SACCOs and money lenders. We discuss each category in the subsequent section;

Community-based self-help associations (ASCA and ROSCA)

To minimise the effects of income fluctuations, households attempt to develop 'self-help' associations that enable them to smooth consumption. There are various community-based savings and credit associations in the study area, but their numbers could not be established because they are not registered. These are small village groups that operate almost a similar model of accumulating savings and provide loans to members with or without interest. About 62% of sampled households had received credit from the village associations in the past year prior to this study. The most widely used approach, especially by women, is a savings and credit association commonly known as 'Akabox' (a small box). The group derives the name from a metallic box that acts as a safe, it has 3 padlocks and the keys for each padlock are kept by 3 different people to ensure maximum safety of the money and books of account. Households select themselves and form small groups, each comprising about 30 people who are residents of the same village and known to each other. Each member of the group buys shares at Ug. 2,000 (0.6 USD) each and the maximum number of shares for one member is five (UGX 10,000). Every member is then required to save at least UGX 1000 – 5000 on a weekly basis and the money is borrowed by one or more members on application for a loan. The interest rate is determined by group members based on what they can afford. For most groups the interest rate varies between 3 and 5 percent per month. After a period of 12 months, all the loans must be paid. The fund and the accumulated profits are shared by the members and they start afresh.

ASCA and ROSCA have improved credit access for many resource-poor households especially women to deal with shocks like ill health, payment of education expenses, and purchase of inputs such as seed and labour. Members do not need collateral to apply for a loan, they rely on social collateral and the main deterrent to default is the threat of community sanctions and fear of losing access to credit in future. The groups only require one to have a known source of income (e.g., a cash crop garden, livestock) and guarantors with a credible credit history within the group. However, the groups have established mechanisms for assessing their members' capacity to pay back the loan. They have a loans committee that does regular monitoring and categorises the risk profile of their clients based on land size, cash crop acreage and number /type of livestock owned. For example in one of the groups (Rwentondo Tubebamwe) a member can access a loan of UGX 500,000 if s/he has at least one acre of rice. This suggests that there are still many households excluded from this category of informal credit market. What matters is not only access to credit but also how much credit one can access.

Although ASCA and ROSCA have helped to some extent in relaxing farmers' liquidity constraints, group loans are not sufficient to bail out farmers from selling produce during the peak season when prices are low. This is attributed to various limitations; The savings are generally very low and consequently the groups have limited capital. Credit rationing then becomes inevitable. A majority of the members are small holder farmers depending on seasonal agriculture characterised by low yields and low prices. Some members have to sell produce to fulfil the requirement of weekly savings. In fact some of the key respondents claim that 'akabox' contributes to food insecurity for poor households. We heard statements like; 'A woman will sell the only beans in the house to raise money for weekly contributions'. Others borrow from friends or relatives to raise weekly contributions, hence they remain in a cycle of debts that compel them to sell their produce at low prices. Moreover, most rural households are involved in similar activities (agriculture), as a result credit needs (e.g labour, school fees) of group members tend to be concentrated in the same period hence decreasing the utility of intra-village credit. If all group members cannot borrow at the same time, this means that those who are credit constrained will sell their produce even when the prices are low.

It was observed that the cycle of the majority of the groups end in November and the main aim is for households to prepare for the festive season in December. One might argue that if the money is shared at harvest time, assuming that each member received the maximum contribution/savings (5000x52 weeks = UGX 260,000), farmers would be able to postpone

sales until when prices are high. This can only enable the farmer to store for only one month or two for those with other sources of income, as it is just slightly above the average consumption expenditure of UGX 0.23 million for sampled household. This means that the loans or savings from self-help groups may not help the majority of farmers who depend on crop sales because they are very small to cover the inevitable expenses such as school fees, which are paid three times in a year and cannot be postponed.

Other risks include failure to pay back often times due to genuine reasons. Farmers borrow with the hope that they will generate sufficient crop revenue to repay the loan. However they face the risk of commodity market imperfections. In the absence of government price support mechanisms and insurance, farmers bear price risks and may fail to repay the loans.

Savings and Credit Cooperative Societies (SACCO)

Savings and Credit Cooperative Societies (SACCO) are another source of credit for rural households in Uganda. About 18% of the households in the study area had borrowed from a SACCO in the year prior the survey. SACCOs are community-based, member driven cooperatives managed by the board as representatives. Unlike ROSCAs and ASCAS, SACCOs are organized under one umbrella body; Uganda Cooperative Savings and Credit Union Limited (UCSCU) which is registered under Uganda Cooperative society. We can therefore, categorise them as semi-formal financial institutions. However, some SACCOs that do not meet minimum requirements are not registered. SACCOs are much bigger than community saving and credit associations and membership is open for anybody who can afford to buy shares.

To become a member, one must have shares and a savings account. One share is worth UGX 20,000 (7.5 USD). Members are required to deposit savings which finance members in form of loans. Credit access in SACCOs is restricted to members only. The interest rate ranges between 2% to 5% per month and is determined by members in the annual general meeting. Whereas the interest rate for SACCOS is often lower than that for community based associations, a majority of households prefers to join the associations. This is explained by various factors such as; high costs, bureaucracy, and lack of trust based on a history of poor management and corruption (Mugenyi, 2010). Similar findings have been reported in Kenya by Dupas, Green, Keats, and Robinson (2014). For instance it costs a total of UGX 34,000 to open an account in KICOD, one of the big SACCOs in the study area. This includes; an application fee, 3 passport photographs, shares, membership fee, savings ledger and a

passbook. As pointed out by managers we interviewed, many poor households cannot afford such a cost. When poor households are excluded from a credit source that has one of the lowest interest rates, the only option they have is to sell their produce at the prevailing price even when it is low. Moreover, farmers decry the bureaucracy involved in accessing a loan. From the time of application, it may take four weeks or more to access a loan in a SACCO and this discourages borrowers.

Credit rationing is high in SACCOs as demand exceeds savings. Often times, applicants do not access loans due to limited capital which is a result of little savings by members. Similar to ROSCAs and ASCAS, loan demands tend to accumulate in the same period. Even those with access, the contribution of rural SACCOs is insufficient to offset farmers cash needs given the small size of loans. While SACCOs can borrow from commercial banks and microfinance institutions, most of them lack collateral. Hence, they cannot access loans. Moreover, farmers are given a short grace period of one month before they start paying back the loan and the maximum term is twelve months. This is not favourable for a farmer who would want to store produce for at least two to three months. Like in the formal credit market, imperfect information/ information asymmetry is one major challenge that SACCOs face. The lender has less information than the borrower on ability and willingness to repay the loan. While some borrowers may have genuine reason for failure to pay back such as adverse weather conditions that may lead to crop failure, for others it is a moral hazard problem. Some borrowers acquire loans from various sources and there is no record to track them due to lack of coordination and limited credit information sharing among lenders (Ghosh & Ray, 2016).

Money lenders / traders

The number of individuals who have joined the credit market as money lenders has increased in the rural areas. They provide credit to about 1% of the households in our sample. Table 5.4 presents summary statistics on money lenders. Most money lenders are business people including traders who offer credit in form of cash or traders who offer goods on credit. The average money lender has primary education and has been in the money lending business for about 8 years. While money lenders are required by the government to register, only one out of sixteen interviewed lenders is actually registered. The rest operate illegally. They are therefore reluctant to provide information about their business. The money lenders we interviewed are willing to formalize their business but report to be constrained by a number of factors including; limited capital, rigorous procedures of forming a company, high registration fees and other charges as well as lack of information.

Table 5.4: Summary statistics on characteristics of Money lenders covered by the survey (N=16)

Variable	Mean	Std. Dev.	Min	Max
Age of respondent	38.5	10.3	27	65
Education of respondent (years)	8.0	4.0	0	16
Experience in the business (years)	7.6	5.7	1	23
Interest rate (per month)	15.9	6.3	10	50
Repayment period (months)	2.7	1.3	1	6
Highest amount of loan given (million UGX)	4.18	6.9	0.5	20.0
Credit worth (million UGX)	26.4	37.6	0.25	120.0
Average monthly costs incurred in the business (UGX)	164,166.7	156,026.2	5,000	400,000
Loan recovery rate	93.1	7.5	70	100

Note: exchange rate; 1USD ≈ 2650 UGX

Money lenders charge the highest variable interest rate ranging from 10 to 50 percent per month. This is above the profit margin obtained by grain traders (Table 5.5) implying that money lenders may not help farmers to store their produce. The interest rate depends on the client, and is determined by many factors including; the amount of loan required, loan period, credit history, credibility and status of the borrower, personal relationship and commercial bank interest rates. The maximum loan period recorded is six months. The lender offers a contract based on his or her assessment of the risk of default. This perhaps explains the high loan recovery rate ranging between 70% to 100% with a mean of 93.1%. The terms and conditions for borrowing include; collateral (land, commercial buildings, a car), a written agreement witnessed by a spouse, guarantor and a local government councillor. The registered money lender, in addition charges an application fee of UGX 50,000 and transport fee of UGX 100,000, which is used to verify the land, if used as collateral. Most of the land is not titled, however it can still be accepted as collateral by a money lender on the agreement that it has been sold to the lender. The contract /agreement involves the lender, borrower and witnesses who include a local council chair person, a spouse and parents or guardian if the borrower is not married. The agreement reads; "*I (the borrower) have sold my property (land, house etc (collateral)) to... (lender) at a cost of UGX. (market price)...*" Such an agreement is risky for the borrower as often the value of the collateral is much higher than the loan amount and some people have lost their property.

In addition to cash loans, some traders offer credit in the form of items such as seed (especially rice). What is striking is the interest attached on rice seed. Traders are not interested in cash but rather demand that at harvest, the borrower pays back twice as much of the seed quantity borrowed. For instance if a farmer borrows 100 kg of seed, they pay back

200 kg of rice. This translates into 100% interest for a period of 4 months, and may significantly reduce the farmer's returns by twice the value of the seed used. Given such conditions and terms of borrowing it is clear that a majority of households cannot borrow from money lenders. And those that do borrow cannot store their produce to engage in arbitrage since they have to pay back as soon as they harvest.

There is evidence of lenders reluctance to lend large sums of money to one individual. On average, the highest amount of loan offered is Ug. Shs 1.1 million. The amount of money given to one individual depends on what they can offer as collateral, the loan period and personal relationship. Land, vehicles and motorcycles are the most commonly accepted collateral for relatively large sums of money. This means that not many rural farmers can access credit from money lenders as they cannot afford such items as collateral. The key challenge faced by money lenders is information asymmetry. There is no full information about the borrower, their capacity and willingness to pay back the loan. Strict measures are therefore taken to minimize "bad type" borrowers. Credit rationing is one way of reducing risks associated with moral hazard. In case of default, there is little faith in the ability of courts of law to seize collateral to recover the loan. One of the high court Judges in Uganda Justice D. Batema is quoted by the national newspaper (The new vision 03/09/2015) warning money lenders to stop using courts as a way of recovering money from civil debtors: *"A debt is not a crime. When you are recovering a loan of 1m you do not sell a house of 36m"* The solution proposed by the judge is to renegotiate the payment schedule. Under such circumstances, money lenders charge high interest rates to cover the risk. Limited capital is another constraint to both money lenders and potential borrowers. All the money lenders interviewed acknowledge limited capacity to satisfy their potential clients. Even when money lenders may borrow from SACCOs and banks, they are constrained by high interest rates in commercial banks, since their borrowers may not pay in time to enable them to service their own loans.

5.4.3.2 Limitations to credit access

Our survey reveals that a portion (13.1%) of sampled households could not borrow from the informal credit market and have no access to credit due to various reasons **(**Figure 5.6**)**. Lack of collateral, high interest rate and unfavourable repayment terms are most dominant. This is not unique to Uganda, even in more developed countries like China some poor households are still excluded from the informal credit market (Yuan & Xu, 2015). If some households cannot borrow, and those who have access cannot borrow at the same time, or borrow enough to

offset their liquidity constraint they will be compelled to sell their produce even when prices are low.

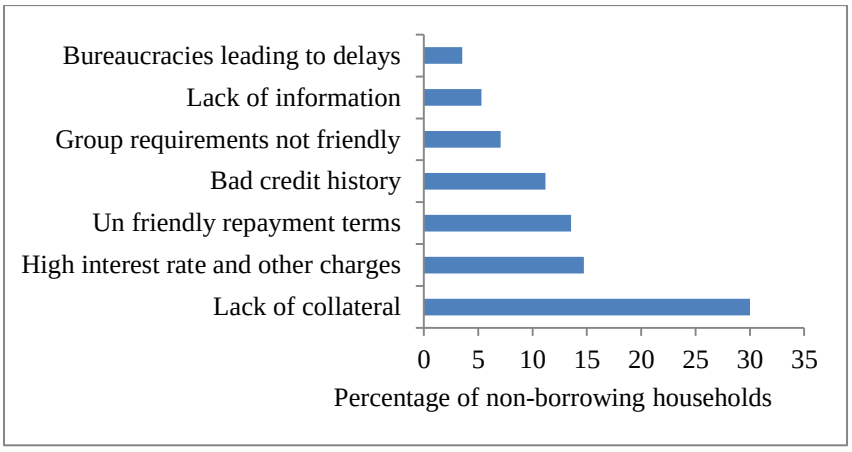

Figure 5.6: Reasons for not borrowing

5.5 The role of traders in stabilizing food crop prices

Economic theory predicts that, if a trader offers a lower price to the farmer than the equilibrium arbitrage price, another trader will offer a slightly higher price. The price will be bid up until the farmer achieves a full optimal arbitrage price for his produce. Why doesn't this happen in the food crop market? We attempt to answer this question in this section. But first it is important to understand the food crop marketing chain.

5.5.1 Marketing chain of food crops

Our interaction with farmers and traders revealed there is no organized marketing system for food crops. The food crop market is characterised by many small buyers engaged in primary marketing and assembly. Figure 5.7 depicts the marketing chain of grains (specifically rice) from the farm gate to the final consumer.

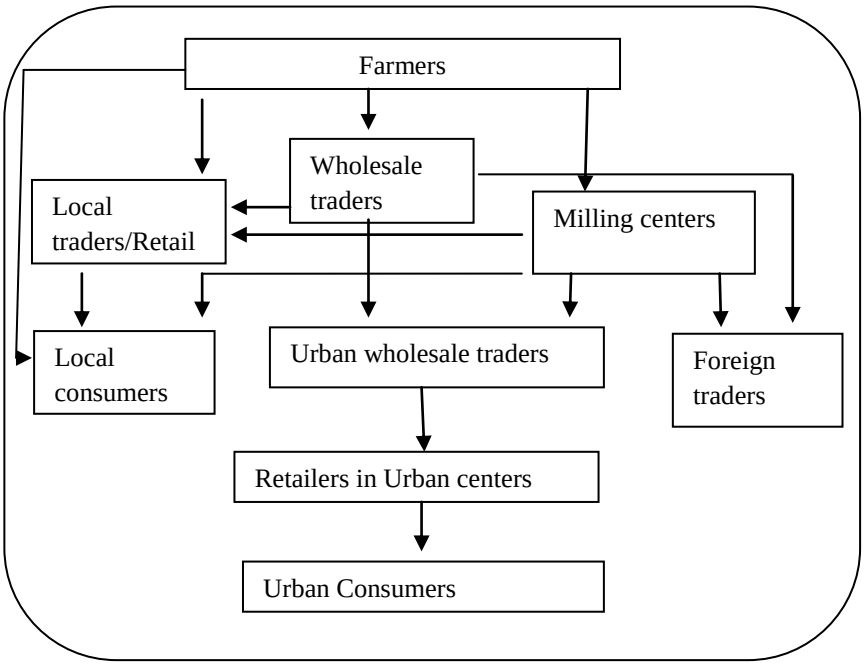

Figure 5.7: Flow of grains from the farm gate to the final consumer

Farmers sell their produce to three categories of buyers who include small local traders/ retailers, whole sale traders and millers. While some local traders go to the villages and buy from the farm, some farmers deliver their produce to traders in the nearest trading centre. In our study area, we find four categories of traders; 1) small local traders/ retailers who buy produce from farmers, millers and other traders and sell directly to consumers. 2) A few traders with stores who go to the villages, buy produce from farmers, assemble it and do whole sale to retailers and large traders (from outside the district). 3) Millers who buy directly from farmers and sell to large whole sale traders (from outside the district), retailers and consumers. 4) large whole sale traders from neighbouring urban centres especially Kabale and Kasese, as well as foreign traders from neighbouring countries, including Rwanda and the Democratic Republic of Congo, who buy from millers and local traders and sell to urban retailers.

5.5.2 Marketing margins and costs by type of grain traded

Middle men / traders operate at different stages of the market chain. While some deal directly with farmers, others only transact their business with fellow traders. In our case we assess average costs and profits of a local whole sale trader since they buy produce from a majority (73%) of the households. A total of five local traders were interviewed to gain insights in the grain trade dynamics at local level. The data were collected shortly after harvest in July 2016. Traders claim that this is their peak season confirming that most farmers sell shortly after

harvest. We obtained the details of the most recently completed transaction of one wholesale local trader. A summary of the average marketing costs and profits is presented in Table 5.5. We present costs and profits from one trader because unlike the others interviewed, he is only engaged in marketing food grains. We therefore believe that he presents relatively accurate information. The others we interviewed could not easily separate grain marketing costs from costs of marketing other commodities in their shops.

Table 5.5: Marketing margins, costs and farmers' share of wholesale/retail price by type of grain traded

Marketing margins and costs per ton			
Type of grain	Rice	Maize	Millet
Purchasing price	2,100,000	700,000	1,100,000
Selling price	2,300,000	800,000	1,300,000
Total distance traded (km)	22.5	25.7	22.5
Quantity purchased (tons)	3	2	4
Sales period (days)	14	21	56
Gross margin (UGX)	200,000	100,000	200,000
Marketing costs (UGX)	71,407.4	70,861.1	37,930.5
Total costs (purchase price + marketing costs)	2,171,407.4	770,861.1	1,137,930.5
Net profit (UGX)	128,592.6	29,138.8	162,069.4
Marketing cost as a percentage of gross margin	35.7	70.9	18.9
Net profit as a percentage of total cost	12.6	5.3	7.8
Purchase price as % of sales price	91.3	87.5	84.6
Marketing costs as % of sales	3.1	8.8	2.9
Profit margin (net profit as % of sales)	12.0	5.2	6.6

Note; Gross margin = selling price – purchase price; Profit =gross margin– marketing costs; and the time dimension for profit margin is one month (30 days)

Marketing costs are a comprehensive measure of all costs incurred in the marketing process from purchase to sale (assembly, transport, storage, processing, packaging, communication) and operating costs (rent of shop/storage facility, pest control, electricity, and market taxes, income tax on trading and wages). We find that local traders do incur relatively low costs (less than 10% of sales price) as they share some of these costs with farmers. For instance farmers provide the bags, load the produce when collected from the farm and sometimes deliver the produce to the traders. Marketing costs for rice and millet form a relatively small percentage of the gross margin implying that traders get relatively higher returns from these crops.

Grain marketing in the study area is a profitable venture. The profits vary with different types of grains. In absolute terms, millet displays the highest net profit followed by rice and maize. However, it is important to note that millet had a relatively longer sales period. In terms of profitability rice marketing is more profitable. The local trader interviewed obtains a larger profit margin as a percentage of the cost price in rice (12.6%) marketing followed by millet (7.8 %) and maize (5.3%).)This is expected in the local market where, compared to other crops rice has a higher demand from regional traders. Millet and maize are domestically traded and maize supply is much higher than the other grains as it is one crop grown by majority of households. The returns to money invested in grain trade is higher than the interest rate in SACCOs implying that a trader can make profit by borrowing money to engage in grain trade. The traders interviewed do not add value in terms of transformation, they essentially undertake both spatial and intertemporal arbitrage.

One might argue that the food grain market is highly competitive and the wide gap between high and low food crop prices is due to high storage costs and risks incurred by the traders. We do not find evidence in the study area to support this argument. When prices are low, local whole sale traders buy produce in large quantities which they later supply to retailers and other traders from within and outside the district. Some of the produce purchased is immediately re-sold. For example traders buy rice at UGX 2100 per kg and sell at UGX 2300/kg (Table 5.5) an increase of about 9.5%. Traders store part of the produce in expectation of higher prices in future. However, speculative returns may not be realized from inter-annual storage since most grains are produced for two seasons in a year. Storage costs therefore, are relatively low since grain stocks cannot be kept for a long time as they must be depleted before the next harvest. Considering all the traders interviewed, the storage period for grains reported ranges between 14 days to 84 days for a given consignment with an average of 45 days which is relatively short. It is also important to note that for most traders, the storage facility is multipurpose (acts as store, shop and residential for some). Thus storage costs are spread across the different grains and enterprises. During storage, traders incur various costs including direct costs such as the cost of pesticides, rental costs, storage losses and the opportunity cost of capital. Save the high opportunity cost of capital, other costs are relatively small. For example storage losses in case of rice were on average 0.44% of the grain stored in a period of about 38 days. These findings are consistent with reports from other studies (Delgado et al., 2017; Minten et al., 2016) in developing countries.

We acknowledge underestimation of costs due to lack of data on some unobserved trader costs such as opportunity cost of capital, time and risks such as quality deterioration in case the crop is not properly dried. Other risks such as theft and price shocks may be very small as they were not reported by the traders. Theft is not a big threat as most traders stay at the storage facilities and transportation risks for local traders are minimal considering a very short distance (25.7km) they move. Price shocks are not expected because traders store produce for short periods. We also note the difficulty in accessing true information from traders due to suspicion that they will be required to pay higher taxes. The other challenge is that most traders are involved in trade of different types of produce as well as selling other items, therefore it becomes difficult to isolate costs specific to food crop marketing from costs related to other activities. In the following section we discuss factors affecting competition in food crop trade in the study area.

5.5.3 Why is there no competition between traders, bidding up prices after the harvest, and dissipate rents from arbitrage?

Barriers to trade competition

Although the food market is free entry and exit there seem to be some barriers to competition at different levels in the market chain, which could explain why farmers continue to receive low prices for their produce. Other than trade barriers, insufficient competition could also arise out of collusion among traders such that marginal changes in market entry cannot induce significant changes in competition (Bergquist, 2016). From our interviews with local traders an inquiry on why traders from neighbouring urban centres do not buy produce direct from farmers reveals two major barriers; limited information and high transaction costs. The traders outside the villages cannot easily identify the farmers since they operate as individuals. The non-local traders buy from their fellow traders or engage them as agents for procurement. In addition, farmers rely on traders for market information and this tends to establish personal relationships. There is therefore, an element of mistrust between farmers and traders who are not known to each other. Most, farmers are not willing to engage in direct transactions with strangers because of fear that they may not get a fair price. As alluded to by Mitra et al. (2016) such a situation becomes a barrier to competition and farmers may be exploited by local traders.

High transaction costs are caused by various factors, but mainly poor infrastructure and individual marketing. The area is characterised by a poor road network which makes it

difficult and costly for traders to access the villages especially during the rainy season. Such conditions may discourage potential traders from outside the district. Poor roads not only increase transportation costs but also uncertainty about market prices and other transaction costs hence may significantly reduce producer shares (Cirera & Arndt, 2008). Some remote areas have poor access to telephone networks which limits communication such that traders can only access the villages physically and this increases search costs especially for the non-local traders. Furthermore, poor storage infrastructure and other associated costs equally constrain traders from taking temporal arbitrage opportunities. We observed that traders lack proper storage facilities. The traders interviewed store the produce in their small shops which contain other items. This limits the quantity they purchase at a given time.

In absence of collective marketing by farmers, the low production levels of small holders contribute to high transaction costs. Small quantities of output discourage potential traders to buy directly from farmers as it implies high search and transportation costs. While local traders make use of personal networks as well as get deliveries by the farmers, it becomes costly for non-local traders to acquire information about farmers' location, what and how much produce they sell. Consequently the number of actors in the market chain increase as small local traders take advantage of assembling the small volumes for the large traders from regional markets in big towns. These conditions thus create an environment where the price margin becomes wide.

Despite efforts by government and NGOs to revive cooperatives and support farmer groups under the hypothesis that farmers bulk their produce to increase their bargaining power (Bernard et al., 2008), we find that farmers continue to sell as individuals, a fact that may compromise their market selling prices. Consistent with Latynskiy and Berger (2016) our findings reveal that even farmers who belong to a marketing group prefer individual marketing through middle men and traders. They claim that traders can be easily accessed because they find them on the farm and that traders, in contrast to the farmer group, pay with cash on the spot (which enables farmers to manage liquidity constraints). While individual marketing may be convenient for farmers, in such circumstance farmers may be subjected to price discrimination as the trader negotiates the price with each farmer individually. Collective bargaining for example in farmer groups could reduce the number of middle men hence increase the farmers' share of the consumer price (Gruère et al., 2009). For instance in Kenya female farmers who participate in groups, bulk their harvest and sell directly to the large trader, obtain higher prices for millet (Handschuch & Wollni, 2015). Moreover, lack of

social capital and high level organization to strengthen internal and external relations with farmer groups and market chain actors equally influence individual marketing behaviour which in turn affect farmers' sales prices (Fafchamps & Minten, 2001; Kaganzi et al., 2009)

Limited credit availability is another barrier to grain trade competition. The traders interviewed assert that due to limited access to credit and high cost of capital, they operate with low capital such that they are not able to make large purchases in advance of sales. Lack of; start-up working capital required for financing grain trade (purchasing and transporting grain), storage facilities and risks equally present substantial trade barriers for most potential entrants in the rural areas. The higher the fixed costs, the fewer traders the market will support, and the more likely farmers will receive a low price for their produce. Moreover, we do find that some poor households tend to sell to specific traders who offer them credit either in form of inputs and or food. Such households sell their produce at a fixed forward price to some local traders who offer them loans. The traders say they keep monitoring their clients' rice gardens to recover the loan as soon as they harvest. We cannot rule out effects of personalized relationship between farmers and traders as well as 'indirect monopoly power' by some local traders. Similar findings have been observed in other countries such as India (Minten et al, 2011).

5.6 Conclusions

This study investigates the role of informal credit market and traders in stabilizing seasonal food crop prices. We discuss the imperfections in the rural Uganda credit market and how it shapes farmers' food crop marketing behaviour. Given the significance of traders in the market chain, we analyse traders' costs and profit structure in the study area, and we try to understand the imperfections in the grain market and the barriers that limit competition between traders at the local level.

While farmers do borrow from informal credit sources (specifically community-based self-help savings and credit associations), the credit that can be extended via these channels is insufficient to enable farmers to benefit from intertemporal arbitrage opportunities. It essentially supplements income from production rather than facilitate storage. In fact, loan repayment is one reason why farmers sell at low prices immediately after harvest. This is attributed to very small savings and reliance on agriculture as the only source of income. We also find that most of the (very) poor are unable to access informal credit to smooth their consumption. Thus poor farmers will continue to 'sell low and buy high'

Local traders provide a valuable marketing service to many small holder households by assembling and buying their small quantities of produce some from remote hard to reach villages. However, price volatility is consistent with limited competition in grain trade at the local level. We have provided several reasons why grain markets could be characterised by lack of competition. High transaction costs associated with poor infrastructure and individual marketing, and limited access to credit seem to be the main barriers to competition which in turn maintain excess margins in the grain market. Evidence from other sources suggest there may be collusion among traders, helping them to secure a greater share of the rents. For a colluding coalition it makes sense to maintain a condition where food can be purchased low and sold high. It remains to be researched how such a coalition can be maintained. We speculate that the many barriers to entry in the trader sector posed by information asymmetries, transaction costs, low trust between farmers and traders, and capital scarcity, help to maintain the current situation.

The policy implications of these findings in terms of market production and food security are several. There is need to reduce the cost of credit and increase access to credit. This can be done by encouraging and supporting community-based self-help savings and credit associations to raise their portfolio so as to enable more farmers to borrow at the same time. Low cost credit can stimulate investment in non-farm enterprises which may increase household income as well as savings. Other initiatives include the organisation of small scale farmers to form cooperatives, and the creation and support of farmer- managed warehouses to facilitate storage of agricultural commodities. The receipts then can serve as collateral for farmers to access credit. Existing farmers groups at village level can be supported to bulk and store their produce, enabling them to negotiate for a higher price. Moreover, bulking will reduce search costs and promote competition. Investing in infrastructure will lower transaction costs and promote competition. This will in return raise farm-gate food crop prices. The relative effectiveness of these various options should be analysed in the future.

Chapter 6
Synthesis

6.1 Introduction

Agricultural production in African countries has changed over time. While agricultural households relied heavily on export crops such as coffee, cotton, cocoa and tea for cash and food crops for own consumption, there has been increased market integration of food crops as a result of increased population pressure and urbanization. To date, the emphasis on poverty alleviation in African countries has led to increased monetization of the agrarian economy where food crops such as rice and maize have increasingly become cash crops. Cash crops (food and non-food) have been highly prioritized and promoted by governments and that of Uganda in particular. This is in the hope that small holder rural households will raise income which will increase their economic access to food so that they can be food secure through the market. Market-oriented production programs do not only benefit producer households, but are expected to increase food availability for the increasing urban population as well. This is not our focus though. We focus on the consequences for the producers as such programs directly impact on farmers who need to adjust their production and consumption decisions, develop management skills and competences to cope with the changing farming environment. This research sets out to better understand the implications of market oriented production, with special interest in commercializing food crops on rural household food security. The thesis focuses on four interrelated issues; to begin with we investigate how market production affects food consumption (chapter 2). Secondly, we assess market production effects on women control and allocation of resources (chapter 3). Third, we explore the effects of market production on technical efficiency of staple crops (chapter 4). And, finally, we assess the role of credit and traders in stabilizing food crops prices (chapter 5).

The overall analysis applies the theory of the household model which integrates production and consumption decisions. If markets exist, market oriented production is expected to provide a pathway for rural households out of poverty and food insecurity. This can be achieved through increased household income if the income is used to purchase food and or invested in production of staple food for home consumption. This pathway is expounded in Chapter 2. When part of income is reinvested back into production of staple crops for instance in high quality inputs and hiring labour for timely operations it can lead to higher technical efficiency levels and in turn increase output as discussed in chapter 4. How production income is spent, though, depends on the intra-household decision making process. This is

largely influenced by the preferences of the individual who controls the money or the one with a higher bargaining power. This partly forms the basis for our discussion in chapter 3 which focuses on gender issues in market production.

However, in most rural areas where markets do not function well, market production can become part of the problem of rural food insecurity. This may arise due to poor infrastructure and lack of supportive policies. Many rural areas are remote from roads and markets, making it difficult for producers and buyers to access markets. This means that if market-oriented households specialize in marketable crops they may not easily access what they do not produce. In addition, marketing margins are high and producers receive relatively low prices. Marketing margins are also inflated by the uncompetitive nature of most local markets. Chapters 2 and 5 explain this aspect and other barriers that limit competition in the food market. In the absence of supportive policies, for instance on rural financial services that enable farmers to gain access to credit and insurance services, market production may not benefit the poor. Chapter 5 explains farmers' marketing behaviour and how credit has helped or not helped them to take advantage of intertemporal arbitrage opportunities.

Increased market integration of smallholder rural households appears unavoidable if Uganda and Africa as a whole has to feed its rapidly growing population. However, the agriculture, food and nutrition security nexus is rather complex. It involves coordination of different sectors and requires good policies as well as supportive institutions to harness the full potential of market production to deliver more income, food and nutrition security. Unfortunately, the literature on market production lacks adequate empirical analysis on what works and what does not. How market production correlates with key factors of efficiency and gender relation which affect the outcomes is not well understood. In this thesis we have attempted to provide some important insights that can guide policy on how best to manage the transition from subsistence to sustainable market production for income, food and nutrition security as well as improve the general economic welfare.

6.1.1 Data

This thesis is based on three datasets; a rural household survey, interviews with informal credit managers and grain traders, and a field experiment. The household survey provides the main dataset which is utilized in all the chapters. Chapter three in addition employs data from a simple field experiment involving couples, to gain insight in intra-household resource allocation and decision making with particular interest in women bargaining power. Chapter

five uses data from interviews with informal credit managers and traders to understand farmers' participation in the credit market, and how this shapes their marketing behaviour and prices. Data from traders' interviews also provide insights on food marketing dynamics and specifically grains which are highly traded.

6.1.2 Methods

This thesis employs rather straight forward econometric approaches to provide analysis of interconnected issues in market-oriented agriculture. This study encounters methodological and econometric issues that frequently arise in attempting to establish causal relationships in observational studies. In such studies exposure to the 'treatment' is often influenced by subject characteristics. As a result, the baseline characteristics of the participants often differ systematically from those of non-participants. This creates a problem of self-selection and program placement bias. It is therefore, important to account for such differences between the participants and non-participants when estimating the effect of treatment on outcomes (Austin, 2011). In our context, participation in market oriented production is not randomly assigned. While every household has the opportunity to participate, there are other confounding factors such as entrepreneurial skills that cannot be observed, yet, are likely to influence participation in market production. This is a missing data problem.

This research endeavours to address self-selection and missing data problems using matching estimators (chapters 2, 3 and 4) and instrumental variables approach (chapters 2 and 3). Propensity score matching allows us to estimate the average treatment effects on the treated (ATT) (Imbens, 2004). Despite its weakness of failure to eliminate bias due to unobservable characteristics, propensity score matching is the most appropriate to deal with confounding factors in our setting. Chapter 4 estimates stochastic frontier models to predict technical efficiency levels in production of the main staple crops (sweet potatoes and beans). A comprehensive largely qualitative analysis is used in chapter 5 to gain a deeper understanding of the dynamics in food crop marketing, particularly grains. Qualitative analysis is essentially used in this chapter to allow a more flexible interaction with respondents and exhaustive discussion on the imperfections in the rural credit and grain markets.

In what follows, I discuss the main findings from chapters 2 through 5, the main conclusions, policy implications and suggestions for future research. This is followed by the general conclusion of the thesis.

6.2 General discussion of major findings and conclusions

6.2.1 Market production, food and nutrition security

Food insecurity in most African countries has been associated with high poverty levels in rural areas, which are attributed to low monetization of the rural economy (Ellis & Freeman, 2004). In the effort to reduce poverty and in turn food insecurity, many African countries have promoted market production with the view to boost household income which should increase access to and consumption of diverse and nutritious foods as well as nonfood goods that are not produced by the household. At the macro level, increased population, urbanization and cash demands have exerted pressure on rural households to produce marketable food crops.

Chapter 2 investigates how market-oriented crop production affects rural household food consumption. Using different indicators of food and nutrition security (calorie consumption, household dietary diversity score (HDDS) and household food insecurity access score (HFIAS)) as outcome variables, results show mixed effects. While market production has negative effects on calorie consumption, it has positive effects on household dietary diversity. The effects are stronger for households with smaller land holdings (less than 3 acres). Market-oriented households also have a higher food insecurity access score, implying they are more vulnerable to food insecurity. These results reflect possible displacement of food crops by the cash crop. Two main conclusions can be drawn; First, market-oriented production *per se* is not sufficient for reducing hunger of small holder households, even when the marketable crop is a food crop that can be consumed at home. Production of own food is still key to achieving food security for many rural households. Second, market production can improve nutrition security as households are able to access other foods they do not produce themselves.

It is evident that a bigger proportion of income from production is spent on non-food consumption. Whereas this would not be a problem, failure by the households to purchase adequate quantities to supply the required calories exposes them to food insecurity. In our context, households have exchanged food for expensive education of their children as revealed in chapter 5. In chapter 2 we show that health services equally take a reasonable proportion of production income. Preferences and intra-household bargaining may also influence expenditure of production income. While women may prefer to spend on food as well as in staple crop production men prefer to spend more on non-food items. Whereas farmers are said to be rational and will chose to spend where they derive the highest utility, it is important that they understand the consequences of inadequate food in terms of health and

learning capacity and in turn productivity of the human resource. Perhaps they could spend less on health if they spent more on food. This calls for policy makers to invest heavily in areas where most of the household income is spent especially in education and health thus enabling households to allocate more of their income to food.

6.2.2 Market production gender relations and food security

Women make fundamental contributions in developing countries' agriculture. Their roles vary across regions but, generally, they provide a significant proportion of the labour force in production of both staple and cash crops. While women in most rural African countries are responsible for ensuring food security for their households, they face gender-specific constraints that limit their productivity and contribution to food production. Women have limited access to productive resources and often they have little control over the income generated from the enterprises for which they provide labour. Frequently, this situation is worsened by development programs that fall short of supportive policies and other programs which ensure that women equally benefit. This thesis sheds some light on gender relations with regard to intra- household resource allocation and decision making in market production.

In chapter 3 we look at how market production affects women's control and allocation of household resources and the implications for household food security. Women must have some level of empowerment and bargaining power in order to influence household decisions. We use a number of indicators to construct women empowerment indices in the aspects of production, income allocation and social affairs. Results show that women in market-oriented households are less likely to participate in making production decisions and allocating income from production. Further analysis reveals that this has a negative impact on household food security. We argue that the negative effects are a result of displacement of women's crops, which are normally staple crops for home consumption by the cash crop. The results allude to gender and power relations in African society. The cultural behaviour and beliefs that men should control income generating activities and the revenues generated. In this context, household preferences or for that matter the preferences of the member of the household with most of the bargaining power matters. Our findings suggest that market production is unlikely to increase the bargaining power of women. Hence, they remain vulnerable to poverty, food and nutrition insecurity. Improving women access to and control of productive resources is key to improving household food security.

Turning to lessons for policy, since women are responsible for providing food for the household in most African culture specifically in the rural setting, there must be efforts to integrate gender issues in promoting market production. We believe that social policies which empower women to easily access productive resources (especially land) and participate in production decisions will improve food and nutrition security for rural households. Promoting women's education will enhance their capacity and skills to participate in market production specifically in improving adoption of better management technologies that will increase output of both staple and cash crops. Gender relations sensitivity must be emphasized in development programs today if we are to achieve sustainable development goals 1 and 2. An effective change in gender power relations will need a concerted effort of all stakeholders from the relevant sectors.

6.2.3 Productivity of staple crops

Low productivity in African agriculture is one major factor that contributes to poverty and food insecurity in the rural areas. The yield gap is largely attributed to technical and economic constraints that prevent farmers from increasing production to the maximum technically attainable. Substantially more food and income to purchase food could be produced with existing technologies if farmers had access to technical knowledge and skills required to increase productivity, the finances to invest in improved technologies and high quality inputs such as seed, land and other crop protection products (Godfray et al., 2010). Market-oriented production aims at increasing households' income which can be used to improve the productivity of agricultural enterprises and food security of rural farm households. Farm technical efficiency can contribute to both, it is therefore important to know whether market-oriented production improves technical efficiency. Chapter 3 investigates how market production has affected technical efficiency in staple crops. Our findings indicate that many households are producing at suboptimal levels due to technical inefficiency, and that market oriented production tends to have negative effects on technical efficiency in staple crops. Results show that market-oriented households are relatively more technically efficient in production of the cash crop compared to production of staple crops. This may be due to competition for critical inputs, particularly labour between the cash and staple crop during the peak labour demand period. Competition for high quality land/plots is another plausible cause, especially for households who rent part of their land.

Our results suggest that there is significant potential for households to increase output in both cash and staple crops by increasing technical efficiency. This will be achieved only when

farmers choose to invest part of their income in efficiency-enhancing technologies such as high quality seed and labour-saving technologies. As a matter of policy, there is need for action to accelerate the pace of adoption of better farming practices. Promoting education to enhance the farmers' capacity especially for women - to adopt advanced technologies and better crop management practices can increase technical efficiency and yields, and in turn, increase food availability (Rosegrant & Cline, 2003). Untimely activities in crop production can have significant impact on technical efficiency. Yet, most families use family labour for all their agricultural activities, and quite often, it is the woman in the household who is already constrained with other chores. Thus, supporting farmers to access labour saving technologies may be a pertinent move towards reducing inefficiency in staple crop production. Given the prevailing conditions as a result of climate change, sustainable soil and land management technologies that can conserve moisture will be critical in improving technical efficiency in crop production. This study raises new questions for further research; Does farmer specialization in production of one or two crops increase technical efficiency? What are the risks and benefits?

6.2.4 Informal credit market and farmers' marketing behaviour

Persistently, farmers have continued to sell their produce at a low price soon after harvest and yet they could store their produce and sell later during the lean season when prices are higher. Studies have shown that this behavior is perpetuated by the need for cash to facilitate consumption of food and non-food items, as well as to manage shocks. Chapter 5 attempts to shed some light on why farmers do not borrow to manage their temporary liquidity constraints as they store their produce awaiting for future high prices. The discussion is focused on the informal financial markets as most farmers in rural areas are excluded from the formal financial markets. Our findings reveal that farmers actually do borrow, but informal credit is not sufficient to enable farmers to participate in intertemporal arbitrage. Informal credit seems to fill the gap between their actual money demand and the limited income from crop sales rather than facilitating storage to allow sales at peak prices. This is explained by various factors; key among them is that the major sources of informal credit (ASCAs, ROSCAs and SACCOs) are financed by farmers' savings which are too small to provide credit to most of the members whose demands (school fees, seed and labour) tend to arise during the same period. Moreover, the members have the same source of income (agriculture) which is seasonal. Considering the high interest rates charged by individual money lenders farmers can only borrow from them to supplement their income but not to engage in arbitrage because the

returns do not compare. Besides, the very poor are excluded from the informal credit market so they remain with no other option but to sell their produce regardless of low prices. When the cost of borrowing is high, coupled with market imperfections and uncertainties, and in absence of insurance to offset the risks, some farmers may find selling their produce irrespective of the price the most rational decision. Based on our findings, we propose the following government interventions;

Government could consider establishing systems that accept not only land but also other assets such as livestock and income sources like produce as collateral. For example the warehouse receipt system can help many farmers to access credit (Coulter & Onumah, 2002). This must be backed by a well-functioning insurance system to hedge against the risks (e.g losses due to damage, theft or fire). In addition the system works only when there are reliable warehouses in place. Reducing the costs of acquiring a land title can also enable more farmers to register their land and be able to access credit. Policy makers could consider supporting community savings and credit associations with grants and long term low cost loans to enable more farmers access credit. Farmers need long term loans as their income is seasonal. However, this must be supported by efficient systems and regulations for determining beneficiaries to avoid such loans being captured by the wealthy. Policies that will reduce the cost of borrowing for example establishing a development bank that can provide long term low cost loans to the ordinary farmer are very essential to increase credit access. This approach has been used to correct for market failures or inefficiencies in other countries such as Bangladesh (Rahman, 2011), India (Meyer & Nagarajan, 2000) and the United States (Jensen, 2000). Low cost credit could stimulate the start of non-farm income generating activities to supplement seasonal production income (Adjognon et al., 2017). This will not only reduce pressure for selling produce soon after harvest but will also increase farmers' bargaining power for higher prices. In fact, our findings reveal that paying back loans and debts is one other reason farmers sell soon after harvest because if they store waiting for higher prices the loan will attract more interest so the farmers are trapped in that cycle. On a broader perspective, the government ought to improve the functioning of markets by investing in infrastructure particularly roads and markets in rural areas to cut down the cost of moving the food produced into markets. The last segment of chapter 5, illustrates that this does not only allow farmers to access better markets in terms of prices but also allows competition between traders hence bidding up prices at the farmers' level.

6.2.5 Seasonal grain price fluctuations; do traders have a hand?

Throughout the years, grain prices in most African countries consistently fluctuate within seasons. Notwithstanding seasonal harvests, grain price fluctuations can be minimized if there is sufficient competition between traders. The last part of chapter 5 explains why the grain market is not competitive enough to eliminate seasonal price fluctuations. Our findings reveal that the local grain market has not had sufficient competition between grain traders due to high cost of credit, poor infrastructure and marketing systems particularly individual marketing. We do not find any evidence of collusion among traders. It is clear that, unless these barriers are eliminated, farmers may continue to receive low prices for their produce. This has important policy implications; first, reducing the cost of credit may facilitate other potential traders to engage in grain trade thus creating competition which will raise prices. However, more empirical work should be done to investigate whether it is profitable to borrow money and invest in grain trade. How do returns compare with other uses of capital and labour? Second, as discussed in the above section, improving infrastructure especially the road network should reduce transport costs and increase competition in the grain market and in turn raise farm gate prices. Third, it will be important to organize and support farmers to form groups or cooperatives for collective marketing. This will increase farmers' bargaining power, reduce search costs and could attract more traders into the grain market thus, increasing competition and eventually prices.

6.3 General conclusion

The overall objective of this thesis is to better understand the implications of agricultural diversification, from subsistence to market-oriented food crop production, on rural household food security. The thesis is focused on key interconnected aspects in market-oriented production; associated effects on; food access and utilization, intra-household resource allocation and technical efficiency are clearly explained. The study also provides insights on marketing dynamics and the role of credit in marketing grains in rural Uganda. This research touches on the effects of market production on dietary diversity but does not look at nutrition security in terms of nutrient consumption. This provides an opportunity for further research. And beyond food security this research could be extended to look at market production effects on household welfare including health and education.

To a large extent, market production has high potential to contribute towards achieving the first three sustainable development goals; eliminating poverty and hunger, and ultimately attaining good health and wellbeing in Uganda and Africa in general. However, the potential

benefits of market production may not be achieved unless it is strategically planned and accompanied with other supportive programs and policies. At household level, strategic allocation of land and labour is crucial for rural households' to meet their food and non-food requirements. To ensure food security the agricultural policies must support both cash and staple food crops in a fairly balanced system. Issues of technical inefficiency must be addressed to increase output. As long as the expansion of food production does not match the population growth rate some people will remain hungry. Equally important, policies and programs for market production must be gender sensitive. Policies that protect and empower women and allow them access to and control of productive resources are inevitable. The change of culture to understand the significance and appreciate the benefits of gender equality and the contribution of women to agricultural development will not be easy but gradually some results will be registered. There is need to strengthen linkages between farmers and production support services including financial services, capacity development and marketing.

Finally, beyond the analysis covered in this thesis, there is yet, more that can be addressed to enhance market production for food security. There must be deliberate effort to develop infrastructure in rural areas specifically the road network and markets to improve the functioning of markets so that sellers and buyers have easy access to food markets. Moreover, there is need for necessary and sufficient resources especially land, for farm households to meaningfully produce for the market. Since productive land is not expected to expand but shrink due to high population growth, the proportion of the population depending on agriculture must reduce to allow profitable commercial agriculture. In order to advance sustainable market production, there must be effort by policy makers to support livelihood diversification by creating jobs that will attract some people off land. The important question is; should every small holder household produce for the market? It will be important to understand the heterogeneity among the small holders in order to address the need for integration of market oriented agriculture for income, food and nutrition security. What are the likely food security risks if the household choose to specialize and how will the households cope with relying on market purchased food? Sustainable market production will require a highly coordinated and integrated system of various actors across a range of sectors of production, marketing, financial sector and the community. The Governments ought to play a key role in providing appropriate policies.

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Summary

This thesis contributes to an advanced understanding of the implications of agricultural transition, from subsistence to market-oriented food crop production, on rural household food security. It is based on the analysis of food crop production in a range of social economic context: household food security, intra-household resource allocation, productivity and marketing. The study is underpinned by detailed research using mixed methods to answer some compelling and fundamental questions that arise from the main objective. The thesis in separate chapters, investigates how market production correlates with the four key interconnected aspects that drive the outcomes of market production. Specifically, I analyse market production effects on; household food consumption, women control and allocation of household income and productive resources, and technical efficiency of staple crops. Further, I investigate the role of the informal credit market and local traders in stabilizing seasonal grain prices.

Our empirical analysis is based on data collected from at least 1137 households, informal financial institutions and grain traders from rural western Uganda. Uganda provides a relevant context to address the above objectives because of its agricultural policy which aims to promote cash crops. The country has the second highest population growth rate (3.2%) in the world, of which 43 % depend on subsistence farming using an average farm size of 1.1 hectares per household. Chapter one provides the context of the thesis, highlighting the theoretical perspective of the research questions. The chapter presents the outline of the objectives and research questions which are discussed in the subsequent core chapters of the thesis.

Chapter 2 looks at how market oriented crop production impacts household food consumption. Using propensity score matching approach and instrumental variable estimators, we find contrasting effects on the different indicators of food insecurity. We find negative significant effects on calorie consumption, while there are positive significant effects on dietary diversity and household food insecurity access scale. Overall the chapter shows that the positive income effect on food consumption is outweighed by the negative substitution effect of food crops by the cash crop.

In Chapter 3 we analyse intra-household resource allocation and decision making of market oriented households with particular interest on how market production impacts women bargaining power on allocation of productive resources as well as income expenditure and

how the changes affect household food security. we use a simple experiment and household survey data on women empowerment indicators to construct women empowerment indices which are used as proxies for women bargaining power in household income expenditure and resource allocation in assessing market production effects. Results show that market oriented production has negative effects on women control and allocation of household resources. This could be due to male dominance in household decisions on economic matters such that women bargaining power decreases as the household engages more in cash crop production. We find that women empowerment in making production decisions does matter for household food security. This is because food provision is a responsibility of women and most households depend on own production for food security.

Chapter 4 examines how market production impacts productivity of staple crops in terms of technical efficiency. We estimate stochastic frontier models using a one-step approach to predict technical efficiency of major staples among the market oriented and subsistence households. Results show higher technical efficiency in production of staples among the subsistence households. we attribute this to a probable competition for resources especially labour between the cash and staples during critical periods.

Chapter 5 investigates the role of the informal credit market and traders in stabilizing seasonal grain price fluctuations. To what extent does informal credit market help farmers smooth consumption as they store their produce to take advantage of intertemporal arbitrage opportunities. We find that majority of the famers access credit through self-help saving and credit associations which are entirely capitalized by farmers' savings. However, we find no evidence that farmers use credit to temporarily store their produce awaiting for a higher price. This is attributed to a very low capital base due to very small savings, lack of collateral and other sources of income. Further, this chapter explores the question; why is there no competition between traders, to eliminate the seasons price fluctuations. The chapter provides answers to this question by explaining the imperfections in the grain market and the various barriers that limit competition and hence sustain wide marketing margins in rural areas.

The last chapter reviews and discusses the key findings, provides a summary of the main conclusions as well as direction for future research. It provides further insights on how market oriented crop production can benefit households by increasing income as well as food security

In sum, this research illustrates that while market production is a good strategy for increasing rural household income, production income has not been reflected in household calorie

consumption. However, there is evidence of improved dietary diversity which is a positive indicator for nutrition security. Still, we find that market oriented households are more vulnerable to food insecurity in terms of access. This reflects that households have a higher preference for non-food consumption. This research also shows that as households increasingly engage into market oriented production, women tend to be less involved in production decisions and this negatively impacts household food security. The analysis of productivity levels in terms of technical efficiency shows that a majority households operate below the potential for the biophysical environment for both the cash and staple crop implying that they can increase their output and ultimately improve their food security. This result shows that insufficient calorie consumption is not a result of displaced staples by the cash crop alone but also due to technical inefficiency which reduces output and consequently income from production.

The negative effects we observe in chapters two, three and four could be reversed if market oriented households increasingly involve women in production decisions and income allocation; and increase the share of production income on food purchases as well as on productivity enhancing technologies such as quality seed and labour saving technologies. To attain the goals of market production, there is need to strengthen linkages between farmers and production support services. Financial services in particularly are crucial to enable farmers smooth consumption and take advantage of intertemporal arbitrage opportunities. Investing in infrastructure especially the road network and rural markets, and organizing farmers into cooperatives/groups to bulk and store their produce will reduce transaction costs, promote competition between traders and improve the functioning of food markets.

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Biography

Proscovia R. Ntakyo was born in Kanungu district, western Uganda. She works with National Agricultural Research Organization (NARO) in Uganda as a research officer –Agricultural Economist, a position she assumed in 2009. She served as an assistant lecturer at Bishop Stuart University from 2004-2006. Prior to this, Proscovia worked with Ministry of Agriculture Animal Industry and Fisheries (MAAIF) as an animal husbandry officer at the livestock experimental station in Entebbe, from 1992-1999.

Proscovia started her PhD in Development Economics at Wageningen University in January 2013. Passionate about education, the move to start a PhD was a natural fit. She completed her master's degree in Agricultural Economics at Makerere University Kampala in 2008. In 2005, she graduated with a postgraduate diploma in project planning and management at Mbarara University of Science and Technology, in Uganda. In 2003 she attained a Bachelor of science degree in agriculture at Makerere University Kampala. Before joining MAAIF, she studied animal husbandry at Bukalasa Agricultural college in Uganda where she graduated with a diploma in 1995. Proscovia attended secondary school at Maryhill High School in Mbarara district, Western Uganda from 1982 to 1988. This was after Primary education at Namunye Primary school, in Kambuga, Kanungu district. Proscovia currently lives in Mbarara, western Uganda. She is based in Mbarara Zonal Agricultural Research and Development Institute, as a research scientist charged with evaluating and promoting agricultural research technologies in Southwestern Uganda.

Proscovia Renzaho Ntakyo

Completed Training and Supervision Plan
Wageningen School of Social Sciences (WASS)

Name of the learning activity	Department/Institute	Year	ECTS*
A) Project related competences			
AEP-60306 Advanced econometrics	WUR	2013	6
ECH-32306 Advanced micro economics	WUR	2013	6
ENR-30806 Advanced macro economics	WUR	2013	6
Production efficiency analysis summer school	WASS	2013	6
B) General research related competences			
Research Proposal	WUR	2013	4
Introduction course	WASS	2013	1
Systematic literature review	WASS	2013	2
Information literacy including endnote introduction	WGS	2013	0.6
Data Management	WGS	2013	0.4
Experiments in developing countries, methods and Applications	Groningen University	2015	2
C) Career related competences/personal development			
Techniques for writing and presenting a scientific paper	WGS	2013	1.2
Reviewing a scientific paper	WGS	2013	0.1
'Effect of market production on rural household food consumption: Evidence from Uganda'	CSAE - Oxford	2016	1
'Market production, household resource allocation and food security: The gender dimension'	3rd international conference on Global food security- Cape Town	2017	1
Economics cluster seminar series	Economics	2013, 2015 & 2016	1
Total			**38.3**

*One credit according to ECTS is on average equivalent to 28 hours of study load

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Propositions

1. Food security of rural African households lies not only in own gardens but also in the market.
   (this thesis)

2. Without empowering women to access productive resources and participate in household's resource allocation, commercializing agriculture will not reduce food insecurity in rural Africa.
   (this thesis)

3. Lack of innovation in the education system is the leading cause of high unemployment levels among the youth in Uganda.

4. Mandatory testing, and disclosure of HIV positive individuals can significantly reduce the spread of the AIDS epidemics.

5. Although social media makes communication more efficient, it has a negative impact on employee's efficiency in a workplace if its use is not regulated.

6. A PhD does not only test one's intelligence but also one's courage and resilience.

Propositions belonging to the thesis entitled: "From subsistence to market production: Implications for rural household food security in Uganda".

Proscovia Renzaho Ntakyo

Wageningen, 15 May 2018