Assessment of the Economic, Social, and Environmental Impacts of the Land Use Consolidation Component of the Crop Intensification Program in Rwanda

FINAL REPORT

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LIST OF ACRONYMS

AEZ	Agro-ecological zone
CIP	Crop Intensification Programme
FAO	Food and Agriculture Organization
FGD	Focus group discussion
GoR	Government of Rwanda
IR	Inverse relationship
LUC	Land Use Consolidation
MINAGRI	Ministry of Agriculture
MINITERE	Ministry of Lands, Human Resettlement and Environment
PRSP	Poverty Reduction Strategy
RAB	Rwanda Agricultural Board
RADA	Rwanda Agricultural Development Authority
RWF	Rwandan franc
USAID	United States Agency for International Development

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Background and Research Objectives

The Land Use Consolidation Act (LUC) was introduced in 2008 and is an important component of agricultural policy in Rwanda. As part of the Government of Rwanda's broader Crop Intensification Program (CIP), LUC entails participating farmers consolidating aspects of their operations with neighboring farmers, while retaining individual ownership of their parcels. LUC farmers also agree to grow a single priority crop that has been identified by the Ministry of Agriculture (MINAGRI) as best suited to local conditions and consistent with Rwanda's overall agricultural strategy. The rationale for LUC is that joining small plots together to farm as a single unit would deliver important economies of scale in agricultural production, resulting in improvements to efficiency and sustainability, which would in turn boost household well-being and promote greater equity.

LUC is a large-scale initiative, and by 2011 approximately 13% of the total land area under cultivation in Rwanda was under LUC, with approximately 40% of the farmers in the country participating (MINAGRI, 2012). LUC has been implemented to some extent in all districts of Rwanda, and continues to expand to additional areas.

Despite the importance of LUC, research related to the program has been limited, and there is a wide range of sometimes contradictory perspectives on its impacts. The present research project aims to fill this gap and reconcile these divergent views by providing a thorough and detailed analysis of the realities, perceptions, and impacts of LUC/CIP on socioeconomic and environmental outcomes. The research was carried out by a team at the National University of Rwanda with technical support from NORC at the University of Chicago as part of the LAND Project funded by USAID, and implemented by Chemonics International Inc. in Rwanda.

Literature Review and Research Methodology

The research builds on existing literatures on several topics relevant to LUC. These include theoretical and historical perspectives on land fragmentation and the process of land consolidation, LUC's role in the broader context of land reform in Rwanda, and a number of previous studies that have looked at various aspects of LUC.

The methodology for the research is a "mixed methods" approach that combines geographic, qualitative and quantitative methodologies. Using mixed methods allows each of the different research questions to be addressed using the most appropriate approach. The methodology for each of the three analytical approaches and associated data collection efforts is described as follows:

Geographic: A geographic analysis was used mainly to investigate the "what, where, and how" of LUC. The purpose of the analysis is to describe as accurately as possible where LUC is being implemented, what crops are prioritized in what areas, and how the

program has spread across the country. This portion of the analysis presents key statistics describing the scope and spread of LUC, and produces maps of Rwanda showing the distribution of LUC activities at district level.

Qualitative: A qualitative component was designed to obtain information about perspectives on a variety of aspects of LUC from participating farmers and other key actors. The qualitative data collection component consisted of carrying out 18 focus group discussions (FGDs), in which the research team convened groups of LUC farmers and other key stakeholders who were asked a structured set of questions designed to lead to more open-ended discussions. The 18 sites for the FGDs were carefully selected according to pre-set criteria to make the resulting analysis as informative as possible. The topics covered included general questions about implementation, concerns about initial participation and recruitment for the program, LUC in relation to other CIP components, and impacts of the program. Responses were compiled and analyzed to identify key trends and tendencies relevant to the research questions of interest.

Quantitative: Finally, quantitative data collection and analysis was an important component of the research. The quantitative component included a major data collection effort in which the research team designed and implemented a household survey of 742 households. These households were sampled from a variety of locations designed to capture the diversity of different geographies and crops included in LUC. The survey covered a range of topics including agricultural production, household income, consumption and food security, vulnerability to shocks, and opinions and experiences under LUC. Analysis of the data included both a descriptive presentation of the findings to illustrate the present situation facing LUC farmers, as well as econometric modeling and estimation to investigate causal impacts.

In the course of carrying out the research project, the research team prepared separate reports on the outcomes of applying each of these methodologies, along with an inception report and detailed literature review. This final report synthesizes and builds on the findings from the earlier reports.

Findings and Conclusions

The following key findings and conclusions emerge from the analysis:

- **Most but not all farmers are satisfied with LUC and believe it has brought them benefits, including increased yield.** Data from both the focus group discussions and the household survey suggest that satisfaction with LUC is quite high. Nearly two-thirds of farmers reported they were "very satisfied" with LUC, while most also believed their yield had increased as a result of LUC, and felt that LUC had a large and positive impact on their families. Farmers who participated in the focus group discussions likewise reported very high satisfaction with LUC. Nonetheless, a minority of farmers do report negative experiences, with just over 10% indicating that they are dissatisfied with LUC, and 18.5% claiming that their yields have been lower since joining LUC.

- **While both satisfaction and agricultural productivity of land are high, food insecurity, vulnerability to shocks, and poverty remain a serious problem for LUC farmers.** Farmers are generally positive about LUC and in addition, land productivity as measured in value of output per hectare is substantially higher among LUC farmers compared to farmers in other countries in the region. However, many problems at the household level persist. Food security remains pervasive, as two-thirds of the farmers reported their household did not have enough to eat in the past week. In addition, over half the respondents in the survey had experienced some kind of shock in previous three years that affected their household's ability to eat or changed their asset ownership, and farmers exhibit low levels of per capita expenditures consistent with high rates of poverty.

  These findings show that even with any improvements that may have resulted from LUC, many LUC households continue to struggle to meet basic needs. Moreover, further improvements to already high levels of land productivity may be difficult to achieve. As a result, more effective strategies for improving living standards for rural households may focus on improving access to non-farm income generating activities, as well as relieving population pressures on land by increasing the percentage of labor force in non-agricultural sectors.

- **Participation in LUC provides farmers with important access to inputs, such as improved seed and fertilizer, as well as frequent visits by extension agents and these aspects should be emphasized.** Eighty-three percent of the farmers included in the household survey reported using improved seed, while over three-fourths used fertilizer (either organic or chemical). Additionally, our regression analysis showed that access to subsidized fertilizer and more frequent visits from extension officers were associated with greater satisfaction and higher reported yields under the program. Thus, subsidized fertilizer and at least monthly visits from extension agents are highly valued by the farmers who receive them, suggesting that these aspects of LUC should be emphasized as the program expands.

- **Although LUC is voluntary by law, many farmers felt some degree of pressure to participate and initially exhibited resistance to the program. Working with farmers to understand and address these concerns when rolling out the program to new areas should receive greater emphasis.** Twenty-four percent of farmers in our survey indicated that their participation in LUC was not voluntary, and concerns about coercion in joining the program were also raised in almost all of the focus group discussions. Moreover, 45% of farmers in our survey felt there had been resistance to the program when it was introduced. While our data cannot confirm the extent to which these perceptions were accurate, these results do highlight the importance of farmer perception about participation in the program and understanding the underlying cause of the farmer concern.

- **Farmers lack access to storage and post-harvest processing for crops, which should be emphasized to maximize benefits from increases in productivity.** Both the household survey and focus group discussions suggest that farmers lack access to storage and post-harvest processing. In the household survey, only 22% of farmers had access to storage and only 12% processed crops post-harvest, which was corroborated by the focus groups. As such, just over 59% of total output was sold on average. Inadequate access to storage and processing may be a limiting factor for maximizing sale of output and food security throughout the year, thus affecting agricultural revenue and household well-being.

1. BACKGROUND AND RESEARCH OBJECTIVES

1.1. Background

Rwanda is a small, landlocked country located in central Africa. Despite rapid economic growth in recent years, Rwanda remains relatively poor, with a per capita GDP of USD 3,651 (World Bank, 2011) and 44 percent of the population living below the national poverty line of RwF 64,000, equivalent to USD 93 (GoR, 2012). With a population of 11.1 million in 2011 on a land surface area of 26,388 sq km, Rwanda is the most densely populated country in sub-Saharan Africa.

Rwanda is a predominantly agrarian economy, with agriculture contributing about 35 percent of GDP and employing more than 73 percent of the population (GoR, 2012). Though the climate in Rwanda tends to be favorable for a variety of crops, Rwandan agriculture is characterized by low levels of technology and productivity. Its hilly topography has earned it the name 'Land of a Thousand Hills,' and intense pressures on land as a result of high population density have led to widespread over-cultivation and consequent land degradation in the form of soil erosion. Farm sizes are typically small, with median farm holdings 0.33 ha per farming household (GoR, 2013).

Between 1990 and 1994 Rwanda was involved in a costly conflict that culminated in genocide, shattering the economy and plunging the population into deeper forms of poverty and vulnerability. Since this catastrophe, Rwanda has attempted a number of policy reforms and innovations designed to facilitate recovery and chart a transition from a poor to a middle income country. An important policy vehicle for reforms in the agricultural sector has been the Crop Intensification Program (CIP), which was introduced in 2007. The CIP includes a range of measures aimed at various aspects of Rwandan agriculture, including infrastructure, marketing, and extension, and is intended to increase the agricultural productivity of high potential food crops and to provide Rwanda with greater food security and self-sufficiency.

The Land Use Consolidation Act

An important component of the CIP is the Land Use Consolidation Act (LUC), which was introduced in 2008. LUC seeks to consolidate small individual land holdings into larger-scale farming enterprises. The rationale for LUC is that joining small plots together to farm as a single unit would deliver important economies of scale in the acquisition of inputs, processing and marketing, as well as efficiencies in access to extension services. The resulting improvements in efficiency and sustainability are expected to boost agricultural productivity, rural livelihoods, and food security, as well as promote more equitable distribution of land resources and protect small-holder rights.

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[1] Constant 2005 dollars

The concept of Land Use Consolidation was first introduced in the Land Policy of 2004 and the Organic Land Law No. 08/2005 of 14 July 2005. The Organic Land Law defines Land Consolidation as *"a procedure of putting together small plots of land in order to manage the land and use in an efficient manner so that the land may give more productivity."* (Official Gazette of the Republic of Rwanda, Year 44 no. 18, and 15 September 2005). Land Use Consolidation is also laid out in Article 30 under the new land law passed in 2013 (GoR, 2013).

The Government of Rwanda (GoR), through the agency of the Ministry of Agriculture (MINAGRI) and the Rwanda Agricultural Board (RAB) are responsible for implementing Land Use Consolidation. Farmers retain individual ownership of their parcels under LUC, but agree to consolidate aspects of their operations within the program (USAID, 2007). The LUC program dictates that the minimum size of a consolidated plot should be 5 ha (MINAGRI, 2012). LUC also entails shifts in patterns of cultivation for participating farmers. Traditionally, Rwandan farmers practice mixed crop farming; a single farmer can mix up to ten crops in less than one hectare of the farm plot (Takeuchi and Marara, 2009). Under LUC however, participating farmers agree to grow a single priority crop that has been identified by MINAGRI as best suited to local conditions and consistent with Rwanda's overall agricultural strategy. Priority crops include beans, maize, Irish potatoes, cassava, wheat, rice, soy, and banana.

Land Use Consolidation has been designed as a component of the Crop Intensification Programme and participation in the LUC allows farmers to access the other benefits from CIP. Other components of the CIP include a program for irrigation and mechanization in agriculture, improved fertilizer and input support, provision of proximate extension services, post-harvest handling and marketing services. These interface with LUC and shape how LUC is implemented. CIP provides farmers with improved seeds, fertilizer, extension advice and in some cases post-harvest services such as storage, processing and marketing. In exchange for these benefits the farmers agree to plant the crops as directed by the CIP program managers (see: www.minagri.gov.rw). Major activities of CIP, including LUC, are typically run through cooperatives although the law allows LUC to be carried out through farming contracts and associations (GoR, 2010; Konguka 2013). The law links LUC to settlement patterns and commercialization of agriculture (GoR, 2004).

LUC is a large-scale initiative, and by 2011 approximately 13% of the total land area under cultivation in Rwanda was under LUC, with approximately 40% of the farmers in the country participating (MINAGRI, 2012). LUC has been implemented to some extent in all districts of Rwanda, and continues to expand to additional areas.

1.2. Research Objectives

Despite the importance of LUC/CIP, research has been limited and there is a wide range of sometimes contradictory perspectives on the policy. Some researchers have claimed that the program has successfully improved outcomes (e.g. Kathiresan, 2012), while others raise concerns about possible coercion and other aspects of the program (e.g. Huggins, 2012). However, these studies are based on limited data, and a comprehensive

and systematic analysis of the impacts of LUC/CIP has been lacking. The present research project aims to fill this gap and reconcile these divergent views by providing a thorough and detailed analysis of the realities, perceptions, and impacts of LUC/CIP on socioeconomic and environmental outcomes.

The present research project was commissioned by USAID under Prime Contract No AID-696-12-00002 in March 2013 between Chemonics International Inc. and National University of Rwanda to provide comprehensive evidence on the impacts of LUC. This project was conceived from wide ranging consultations on land research in Rwanda. In September 2012 the LAND Project held a multi-stakeholder workshop to identify key, policy relevant research priorities on land. Drawing from submissions of 58 research themes by different stakeholders, three research priorities were selected for funding support, one of which was to examine the socioeconomic and environmental impacts of the Land Use Consolidation program in Rwanda. Following a competitive tendering process, the award was made to the UR team to a carry out this research in accordance with a Scope of Work (SOW) that laid out the research questions and described the timeline and deliverables.

In carrying out this research project, the UR team has used a mixed methods approach, which includes document review of LUC/CIP reports, an extensive literature review of existing research on land use consolidation, qualitative research, including focus group discussions and key informant interviews, and quantitative research, including the collection and analysis of household survey data. This final report consolidates the findings from previous deliverables including the inception report, a literature review, a mapping report, the report on qualitative research findings, household survey results and econometric analysis, as well as several stakeholder workshops, and presents an integrated set conclusions and recommendations.

The research uses qualitative and quantitative data collection and analysis to address several of the following research questions that were included in the Terms of Reference for the project:

- Describe where, when and how CIP/LUC is being implemented, including selection criteria for implementation, crops being promoted in different areas, extent to which LUC is delivered together with other components of the CIP, size of plots being grouped, implementation in hillsides versus lowlands, etc..
- Assess the degree to implementation of CIP-LUC is voluntary and farmers have an opportunity to participate in decision-making about its implementation.
- Evaluate the degree of adoption of LUC in places it has been introduced as well as factors influencing adoption. If farmers choose to opt out of CIP-LUC, what is the response of the program's implementers?
- Analyze farmer perspectives on LUC – benefits, challenges, and reasons for the indicated perceptions. The analysis should assess whether there are differences according to wealth, gender and agro ecological zones.

- Is there an entity to which farmers can take their claims if they are dissatisfied with the CIP-LUC or prefer not to participate? If so, are these avenues for recourse effective?
- Assess the impacts of land use consolidation in terms of:
    - Total Factor Productivity (TFP) and crop yields;
    - Access to and efficiencies in the delivery of extension services;
    - Access to roads, irrigation, and other farm infrastructure;
    - Capacity to reduce transaction costs;
    - Access to markets and credit;
    - Tenure security;
    - Agricultural income – average and seasonal/annual variance;
    - Intra-household distribution of agricultural income;
    - Food security and nutrition, disaggregated by age and gender;
    - Ability of farmers to withstand risks of: 1) market price fluctuations, 2) spoilage, post-harvest losses; 3)drought, flooding and other environmental risks; and 4) crop diseases and pest attacks;
    - Asset ownership (e.g. land, livestock, bicycle/motorcycle, radio, etc.), disaggregated by gender and age;
    - Social capital (e.g. cooperative membership, collective action, and relationships of mutual support and trust);
    - Erosion control and soil stability;
    - Soil fertility and health; and
    - Water quantity and quality
- Disaggregate impacts by wealth category of households, by Female Headed Households (FHHs) compared to Male Heads of Households (MHHs), and by agro-ecological zones (including regional agro-climatic zones; and plots situated on hillsides compared to those in lowlands.)
- Analyze potential impacts on farmer livelihoods and the environment of implementing resettlement policies to advance land use consolidation.
- Suggest policy recommendations for CIP-LUC to achieve improved livelihoods and environmental outcomes.

The remainder of the report is structured as follows. Section 2 provides a review of the literature on land consolidation, including an overview of both theory and practice, LUC in the context of land reform in Rwanda, and prior studies on the impact of the LUC/CIP. Section 3 presents the research methodology, followed by the findings in section 4. Section 5 presents conclusions and recommendations.

2. LITERATURE REVIEW

In this section, we provide a review of several areas of previous research that are relevant to the present analysis. These include the concepts and practice of land consolidation policies in general, as well as the debate over the economic justification of these policies. In addition, we situate LUC/CIP in the context of agricultural and land policy in Rwanda, and review the existing literature on various aspects of LUC/CIP.

1.1 Land consolidation in theory and practice

Land Consolidation is generally considered as putting together small plots with the aim of making them viable and more productive through economies of scale. Land consolidation is not a new concept, it has been implemented in a number of different countries, dating back to ancient China and the Roman Empire. Land Consolidation has been practiced in Europe since the Middle Ages and the current practices date back to the 19th and 20th centuries (Vitikainen, 2004). Practices of land consolidation are found today in Germany (Flurbereininigung) the Netherlands (ruilverkaveling) France (remembrement), Belgium, Luxembourg, Austria and Switzerland, as well as Finland (uusjako), Norway, and Sweden (fastighetsreglering). There has been considerable land consolidation in Eastern European countries following the collapse of Communism, which had initially resulted in fragmented property rights. By the early 1990s, land consolidation involved a quarter of all cultivated land in Western Europe, which is in excess of 38 million hectares of agricultural land (Vitikainen, 2004).

Land consolidation can follow different models in terms of the implementation process and the extent of voluntarism or coercion of the affected community. 'Comprehensive' land consolidation is the most coercive of the various models and involves the re-allocation of parcels together with a broad range of other measures to promote rural development (FAO, 2003). Examples of such activities include village renewal, support to community-based agro-processing, construction of rural roads, construction and rehabilitation of irrigation and drainage systems, erosion control measures, environmental protection and improvements including the designation of nature reserves, and the creation of social infrastructure including sports grounds and other public facilities.

Other forms of consolidation are voluntary or individual types (FAO, 2003). In voluntary consolidation schemes, unlike comprehensive schemes, all participants must agree fully with the proposed project. As a result, voluntary projects tend to be small and may be best suited to address localized problems. Voluntary projects usually have fewer than ten participants but in some cases this number may be higher (Musahara, 2006).

Individual consolidation involves the spontaneous consolidation of holdings, without the direct involvement of the state. However, the state may provide an enabling environment for consolidation by promoting instruments such as joint land use agreements and leasing and retirement schemes. Experience in a variety of countries has shown that entirely

voluntary consolidation tends to be a "slow and unsatisfactory" process (Zhou, 1999). This is due to the difficulties of community collective action, which suggests that progress would be particularly slow in communities where social bonds are weak or strained.

The implementation of land consolidation in Rwanda differs from this historical account in several ways. In Rwanda, land consolidation is defined by consolidation in use of land and not consolidation in ownership. Land is joined together but ownership of component smaller plots is retained by the original individual households. In many parts of the world, land consolidation has simply been a method of tapping economies of scale. While achieving economies of scale is an important component of LUC in Rwanda, as a land scarce society, LUC is also crucial for economic and optimal use of physical space. As part of the larger Crop Intensification Program (CIP), a chosen crop is grown on the consolidated plots with input supply (inorganic fertilizer and improved seeds), extension organized and mechanization support through cooperatives and government support. Additionally, in Rwanda the driving factor behind consolidation has been land fragmentation (Musahara, 2006; Musahara and Huggins, 2005; GoR, 2004; Ntirenganya, 2012).

Land fragmentation is a farm management issue and exists when a household operates a number of owned or rented noncontiguous plots at the same time (Austin et al., 2012). Households in Rwanda frequently own between 5 and 10 plots of land (Takeuchi and Marara, 2005). In general households actively try to access land in different eco-niches (e.g. valley bottoms and at higher altitudes) in order to benefit from differences in rainfall availability and soil retention characteristics (Balasubramanian and Egli, 1986). However, some scholars regard land fragmentation as a feature of less developed agricultural systems (Van Hung et al., 2007; Hristov, 2009) and a major obstacle to agricultural development because it hinders agricultural mechanization, causes inefficiencies in production, and involves large costs to alleviate its effects (Najafi, 2003; Thomas, 2006; Van Hung et al., 2007; Tan et al., 2008). According to Bizimana et al (2004), fragmentation also makes supervision and protection of the land difficult, results in loss of working hours due to distance to travel between plots, increases difficulty and cost of transporting agricultural implements and products, and results in small and uneconomic size of operational holdings. Such perceived adverse consequences of land fragmentation, have given rise to numerous land consolidation and land reform policies to reduce fragmentation in Europe and in African countries such as Kenya and Rwanda (Sabates-Wheeler, 2002; Sundqvist and Andersson, 2006).

While land fragmentation has been hypothesized to result in many negative consequences in Rwanda, others claim it confers benefits. For example, for household-level agriculture, fragmentation allows crop diversification and risk management across plots, allowing small-scale farmers to take advantage of the varying fertility, water retention, accessibility, altitude, and form of tenancy (Waller, 1993). Additionally, fragmentation allows landholders to better allocate labor throughout the year, according to the different labor demands of different crops planted in different microclimates and soils. Lastly, ownership of numerous small plots gives farmers greater liquidity, allowing them to sell

small plots during hard times without having the sacrifice their entire landholding. Given the many costs and benefits of land fragmentation, whether land consolidation is beneficial will be highly context dependent.

Land fragmentation is essential to the debate over land-use consolidation because of the relationship between plot size and productivity. The presence of an inverse relationship (IR) between farm size and productivity has been widely discussed in the literature. In a wide range of developing country contexts, smaller farms have been observed to be more efficient producers than larger ones (see Ali and Deininger 2014 for a discussion of the relevant literature). The empirical evidence supporting this inverse relationship is puzzling because this inverse productivity relationship runs counter to theories of economies of scale, which would suggest that larger farms should be able to exhibit higher rates of productivity.

Some have attributed the inverse relationship to inefficient markets, which push farm-households to make uneconomic resource allocation decisions. For example, without an effective labor market, farmers have no way to measure their opportunity costs and will continue to work their small plots long after the marginal value of their labor has become unprofitable (Sen, 1966). The lack of a land market, on the other hand, either for sales or leasing means that more productive farmers will not be able to acquire more land, thus preserving the inverse relationship status quo (Byiringiro & Reardon, 1996). Additionally, most small plot farmers are unable to diversify into cash crops in part because there are no effective markets or distribution channels for cash crops. Instead, farm-household production focuses on consumption preferences such that production decisions are based on household composition rather than commodity market factors of supply and demand (Ligon, 2011). Finally, the lack of access to capital markets or credit limits the farmer's ability to acquire additional inputs whether it is land, improved seeds and fertilizer or small-scale mechanization (Eswaran and Kotwal, 1986).

1.2 LUC/CIP in the context of land reform in Rwanda

In the 1980s and 1990s, policy attention in Rwanda became focused on the growing pressure exerted on agriculture due to population growth and limited productivity enhancing techniques. In the early 2000s the debate on land reform picked up and by 2003 draft on land policy and law started circulating (MINITERE, 2003). Increasingly land use, crop intensification, and villagisation were linked in policy discussions. In 2000, drafts of Vision 2020 had been produced and were published in 2002 (GoR, 2002a). The paper was about a strategy to transform Rwanda into a middle income country by 2020 with land use and agriculture poised as key tools and drivers.

The Poverty Reduction Strategy (PRSP) was enacted in 2002 and included specific references to land reform and consolidation (GoR, 2002b). These policies also ushered in new research debating the consolidation approach (Musahara and Huggins, 2005; Rwanda Initiative for Sustainable Development, 2000). For instance the PRSP stated that households will be 'encouraged' and the policy stated that, "one need to carry out the

regrouping of plots." MINITERE personnel suggested that land consolidation would be focused on encouraging increased production, through formation of adjacent plots with similar crops. According to policy-makers, this meant that, "nobody will lose their plot." Farmers were encouraged to adopt cash crops including tea, coffee, flower, and rice, on large mono-cropped areas, but each person had the ability to register his/her plot separately (GoR, 2004).

Despite this policy-level promotion of consolidation, skepticism on villagisation and land consolidation remained. For example, even before these land reform policies gained prominence, Blarel (1992) argued that land consolidation was unlikely to increase land productivity significantly. Additionally, consolidation was often implemented in conjunction with mono-cropping, which raised issues pertaining to safety nets, if mono-crops were to fail (Liversage, 2003). Moreover, in cases where land consolidation was implemented through cooperatives and associations, its success was heavily dependent upon the strength of the cooperatives to oversee the implementation. These questions highlight the need for evidence that describes what happened after LUC implementation that can shed light on whether these concerns were valid.

A comprehensive Land Reform Policy, which was the precursor for LUC, was ultimately passed in 2004 and was followed by enactment of the Organic Land Law in 2005. The policy aimed to address the serious problems facing Rwanda's agriculture sector, such as increasing pressure on limited land resources from the growing population, a customary land tenure system that favored land fragmentation and excluded women, inadequate agricultural practices to deal with pressure on land resources, numerous landless people that required resettlement, lack of a land registration system, inadequate land-use planning, and the use of farming methods with insufficient attention soil conservation. The law also aimed to address the far-reaching consequences of these land practices, such as the economic, food security, and farm management problems that resulted from land fragmentation, corruption and inefficient use of government funds due to the lack of a land registration system, and unplanned use of marshlands and soil degradation as a result of the inadequate land-use planning and farming methods.

LUC is thus integral to the goals of the Land Policy. Specifically land consolidation was designed to improve agricultural production and rural livelihoods, encourage voluntary participation in the program by farmers and private investors, support existing off farm employment opportunities to support laborers who may lose employment as a result of land consolidation, attract private investors and use of democratic principles through use of consultative methods (GoR, 2004). Land Use Consolidation has focused more on cooperative farming although the law also provides for Land Use Consolidation involving contract farming and farming associations.

1.3 Previous LUC studies

Since the beginning of its implementation in 2008, a number of research studies have considered various aspects of LUC from a range of different perspectives. Government sources document the implementation of the LUC program, including specific aspects

such as post-harvest handling and storage support services, proximity input provision, irrigation and mechanization, and marketing (GoR, 2009). In addition to government reports and data, a number of researchers have assessed the impact of LUC on various outcomes related to program goals.

Several investigations of LUC have been carried out using qualitative methods such as focus group discussions, key informant interviews, and direct observation. Ntirenganya (2012) examines the extent to which LUC has achieved its stated goals of reduced land fragmentation and improved livelihoods for farmers, with a particular emphasis on household food production. The author conducted in-depth interviews with 20 household farmers and 8 key informants from Gisenyi village in Bugesera District. The case study reports that farmers perceive increases in yield and attribute those increases directly to the program. However, given the small focus of the case study (one village), these results are not generalizable to the rest of the country's experience with LUC. Moreover, perceptions of a handful of farmers from a single village cannot compare to statistical evidence derived from a geographically broad, large-scale study employing rigorous scientific methods.

In a similar vein, Niyonzima (2011) studies the relationship between land reform policies and poverty reduction and specifically, using land consolidation as one of the indicators of land reform. He conducted focused interviews and observations across multiple districts, including Kirehe in the Eastern Province, Musanze to the north and Huye and Nyamagabe in the Southern Province. The author finds that LUC has been successfully adopted in the Eastern Province relative to the rest of the country and that consolidation in valleys with maize and rice has been more successful relative to other areas and crops. The author, however, suggests that significant challenges remain to achieving widespread success.

A few studies have attempted statistical analyses of LUC based on household survey data. In one such study, Birasa (2013) undertakes an econometric analysis of LUC on one site where farmers were organized as a producer cooperative growing rice. The author finds overall evidence of increasing yield and productivity per inputs applied but notes challenges in marketing outputs. Ekise et al. (2013) examine the impact of LUC on maize production in Nyabihu District. Using household survey data collected before and after the implementation of LUC in the district, the authors find maize yield increased by 347%. However, the very small sample size (40 households) and restriction to a single district limit the generalizability of these findings, while the lack of a statistical comparison group prevents the ability to attribute the increase in maize yield to the LUC. Bizimana et al. (2004) look at the relationship between land farm size, land fragmentation and economic efficiency in Southern Rwanda. The author's findings somewhat justify land consolidation in economic terms, however the analysis does not highlight differences across crops, and is also localized in one agro ecological zone of the Central plateau. Finally, Konguka (2013) provides more of a narrative account of LUC and related issues drawing On the whole, these studies have generated some useful findings,

but are constrained by data limitations and cannot claim to provide a comprehensive assessment of LUC.

Two recent works represent the formal government position on LUC. A formal assessment and report (Kathiresan, 2012) offers a positive account of the achievements of LUC on agricultural productivity. The report claims that the area under cultivation under LUC has increased by 18 times between 2008 and 2012 from 28,016 ha to 602,000 ha. Yield of maize has gone up 5 times, wheat and cassava 3 times Irish potatoes, soybeans and beans 2 times and rice by 30 per cent. The report published by the Rwanda Agriculture Board (Muhinda and Dusengemungu, 2013) frames LUC as a "homegrown" movement, consistent with the notion that LUC has a context particular to Rwanda. Both papers emphasize food security as a key goal of LUC and argue that that productivity dividends from LUC have supported other the land reform goals, such as the commercialization of agriculture. Both papers note challenges related to marketing and sustainability of the initiative.

Finally, some of the literature addresses other aspects of LUC. Konguka (2013) provides a thorough discussion of land consolidation, land administration and the position of LUC in the discourse on those issues. Meanwhile, Bizoza and Havugimana (2013) assess the factors that determine adoption of the LUC program. They find a positive association between the expectation of subsequent income increases to adopting land consolidation and a negative and significant relationship between female-headed households and adopting land use consolidation. Additional factors that impact adoption of LUC include gender, family size, trust, distance, and cropping/farming practices. However, their results are confined to Nyanza district, which raises questions as to whether the conclusions are applicable to other locations in Rwanda and across different crops under LUC.

Overall, the majority of these papers paint a positive view of LUC in Rwanda, however more critical perspectives exist. Huggins (2013) critiques land use consolidation in Rwanda as an attempt by the government to exert state control over agricultural land. The author documents the land reform process in Rwanda and from the start notes the concerted effort made by the government of Rwanda to transform the rural economy. He however argues that land use consolidation in Rwanda is an attempt to consolidate power in hands of a 'centralized authoritarian state' in order to make Rwandan peasants 'proletarians' (Huggins, 2013). The paper makes frequent references to coercion by government as a method of implementing LUC. Using case studies involving contract farming in Jatropha and Pyrethrum, the author criticizes the sustainability of both cases and finds little evidence of cooperative farming.

Although LUC has only been implemented for 6 years, a number of researchers have documented the implementation, impacts and perceptions of the program. However, a number of research gaps remain. In particular, none of these studies takes a national approach to evaluating the LUC/CIP program and each tends to be focused on a few regions or districts. Additionally, most of the research to date is focused on agricultural productivity and yield, as opposed to examining impacts on farmer livelihoods and

wellbeing. This study represents an attempt to fill this gap by carrying out rigorous empirical research on how LUC affects the program's broader goals of socioeconomic improvements, reduced food insecurity, and improved livelihoods.

3. RESEARCH METHODOLOGY

The research uses a mixed methods approach that incorporates geographic, qualitative, and quantitative methodologies. Using mixed methods allows each of the different research questions to be addressed using the most appropriate methodology, and can also allow for triangulation of findings by approaching research questions from more than one perspective. The geographic method incorporates official statistics and graphical mapping to illustrate the geographic scope of the program. The qualitative component collected and analyzed focus group data with groups of LUC participants throughout the country. Finally, the quantitative component consisted of a household survey of mostly LUC participants as well as a smaller sample of non-participants, and provides both descriptive and statistical analyses of the data. In the course of carrying out the research project, each of these methods was used to produce a separate report, with the findings synthesized in the final report. In this section, we describe in detail each of the three methodologies that were employed.

3.1 Geographic

The geographic analysis was used mainly to investigate the "what, where, and how" of LUC. The purpose of the analysis is to describe as accurately as possible where LUC is being implemented, what crops are prioritized in what areas, and how the program has spread across the country.

One source of data for this part of the analysis is official statistics maintained by the Rwanda Agricultural Board (RAB), which is the government agency charged with implementing the LUC program. These data are collected by CIP "focal points" in each district of Rwanda. The focal point, who is essentially an agricultural officer, works with the district officials and local leaders in discussing the priority crop and targets and ideally uses his expertise in identifying a crop to be grown by communities in consultations with local leaders. These focal points have data that is consolidated by RAB on sites, crops, acreage and the provision of other CIP services. It is these data sets that show where and what crops LUC is engaged in.

It is important to note that there are some important gaps in these official statistics. In some cases, data on participating farmers had not yet been collected by site managers and incorporated into the database. In addition, data on LUC specifically is limited in detail and for some areas data is missing. It would appear that data on the LUC program is not being collected in any consistent format and there does not seem to be a focus on quality reporting. It is also not possible to verify how accurate the data is. These shortcomings will make it difficult for program managers to assess progress or compare implementation experiences.

The geographic analysis also made use of a number of secondary data sources and reports. These include existing maps depicting agroecological conditions, as well as datasets produced from the National Agricultural Survey. General information on LUC has also been provided in the most recent statistical survey (the EICV 3) that was

completed in 2012. Finally, an Assessment of LUC and CIP (Kathiresan, 2012) commissioned by the Ministry of Agriculture towards the end of 2012 provided useful knowledge on the extent and geographical distribution of the program.

Using the sources described above, this portion of the analysis presented key statistics describing the scope and spread of LUC, and produced maps of Rwanda showing the distribution of LUC activities at district level, as well as the location of sites chosen as sample to this study.

3.2 Qualitative

The qualitative component consisted of carrying out 18 focus group discussions (FGDs), in which groups of LUC farmers were convened and asked a structured set of questions in order to elicit views about various aspects of the program. Responses were compiled and analyzed for key trends and tendencies, with a scoring system used for certain responses where appropriate to obtain measurable indicators.

The 18 sites were carefully selected on the basis of pre-set criteria chosen to make the resultant analysis as informative as possible. These criteria included ensuring a representative set of sites in terms of Rwanda's various agro-ecological zones and topographies, different CIP priority crops, and administrative provinces. The selection criteria also prioritized sites where LUC had been implemented for a longer period of time, and was designed to allow for comparisons of the same crop in different zones. Finally, where appropriate given the other criteria sites were chosen in proximity to one another to improve the efficiency of fieldwork. The location of the qualitative research sites and some basic information about each are summarized in Map 1 and Table 1 respectively.

Individual participants for the FGD were selected to provide a mix of farmers and various other relevant actors. FGDs were limited to a maximum of 10 participants, with each FGD designed to include 6 farmers (3 of whom were female headed households), with the remaining participants consisting of some combination of the following: crop managers, agricultural promoters, Integrated Development Program officers, site managers, agronomists, service providers, government officials with responsibilities related to environmental issues, *Umudugudu* (village) leaders, local social leaders, and land/site committee members. The final composition of the groups varied somewhat due to no-shows on the part of invited participants, but overall the FGD composition reflected the intended mix of mostly farmers along with other key players.

FGD questions revolved around issues articulated in the study terms of reference presented in the introduction. The organization of the instrument and topics included were as follows:

1. General implementation:

- How respondents learned about LUC, when they joined, overall experience
- Information about implementation of LUC in the area
2. Concerns about LUC participation:
    - Extent to which participation in LUC was voluntary
    - Extent to which participants had been concerned about losing land rights, switching to new crops, mistrust between farmers, losing control over production decisions
    - Gender imbalances
3. LUC in relation to other CIP components
    - Details of assistance received under the program
    - Marketing and prices of CIP priority crops
4. Impacts
    - Food security
    - Changes in environmental outcomes since LUC: water quality, soil fertility, tree planting, use of soil conservation (as perceived by farmers)
5. Other
    - Farmer membership in cooperatives or other groups
    - Access to finance related to LUC/CIP

Map 1. Geographical distribution of selected sites for qualitative study
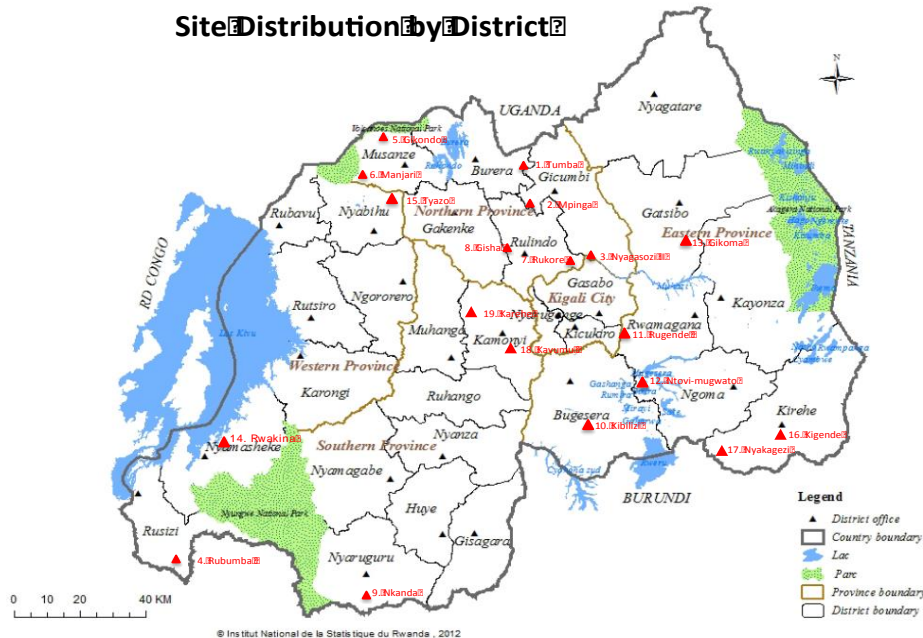
Table 1. Sites visited for qualitative study

AEZ	Province	District	Sector	Select site	Area under LUC in ha
Buberuka Highlands	North	Burera	Bungwe	Tumba	84
	North	Gicumbi	Miyove	Mpinga	184
	North	Gicumbi	Rwamiko	Nyagasozi	17
Volcanic Highlands	North	Musanze	Kinigi	Gikondo	159
	North	Musanze	Gataraga	Manjari	213
Central Plateau	North	Rulindo	Mbogo	Gisha	360
	North	Gakenke	Kivuruga	Rumarangabo	38
	South	Ruhango	Kinazi	Mirambi	160
	South	Nyaruguru	Busanze	Uwinkumba	18
Bugesera	East	Bugesera	Mayange	Kibilizi	300
Eastern Ridges and Plateau	East	Rwamagana	Muyumbu	Rugende	350
	East	Ngoma	Rukumberi	Ntovi-Mugwato	589
Eastern Savannah	East	Gatsibo	Rugarama	Gikoma	150
	East	Kirehe	Kigarama	Kigende	621
	East	Kirehe	Gahara	Nyakagezi	564
Kivu Lake side	West	Nyamasheke	Kanjongo	Ryankana	
Congo Nile	West	Nyabihu	Rugera	Murama	100
	West	Nyabihu	Bigogwe	Rukore	

3.3 Quantitative

For the quantitative portion of the study, the research team designed and implemented a household survey of 742 households. The survey covered a range of topics including agricultural production, household income, consumption and food security, vulnerability to shocks, and opinions and experiences under LUC. Analysis of the data included two components: a descriptive analysis intended to illustrate the situation on the ground for LUC farmers, and a statistical and econometric analysis to investigate the causal impact of LUC on outcomes.

The sample for the survey was selected by first identifying sites that would be included in the study, and then selecting individual farmers to be interviewed from those sites. A sampling frame from which sites were chosen was designed to achieve representativeness and variation according to the same criteria that were used for the qualitative data site

selection described above. Using information and reports provided by the Rwanda Agricultural Board (RAB), it was possible to identify sites representing combinations of the different attributes and for all the priority crops, namely maize, wheat, rice, beans, Irish potatoes, soybeans and cassava. Twenty sites were selected from different locations in the country. Map 2 and Table 2 show the sampled sites. Overall, the sites included 10 agro-ecological zones out of an official 12 zones, and 17 districts out of 30 administrative districts. Together, the selected sites covered all the priority crops as well as sites in the valley, hillside and marshlands.

Map 2. Geographical distribution of selected sites for household survey
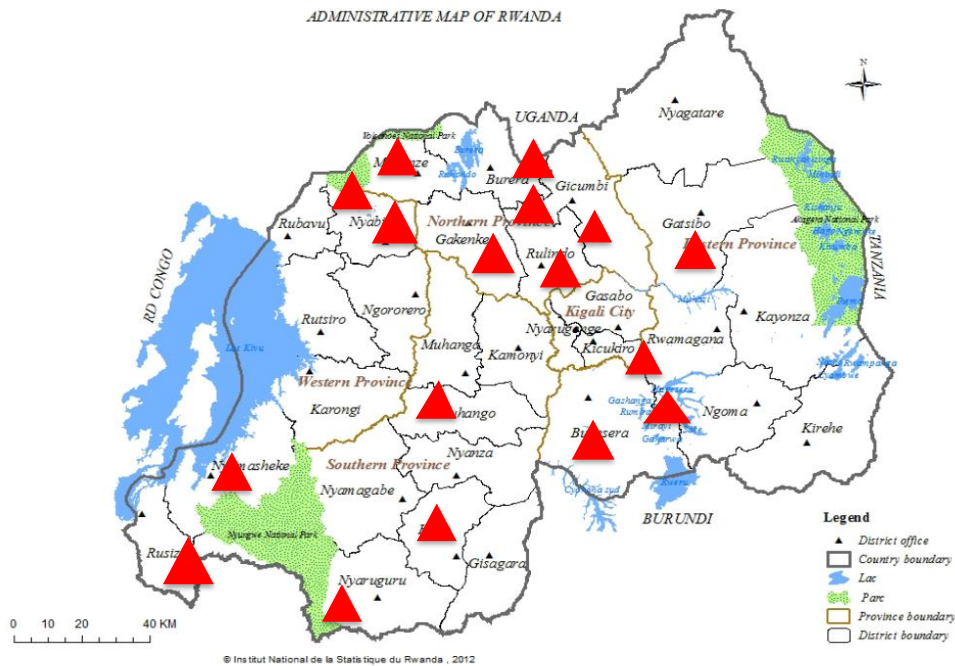
Table 2. Sites selected for household survey

AEZ	Province	District	Sector	Select site	Area /LUC in ha
Buberuka Highlands	North	Burera	Bungwe	Tumba	84
	North	Gicumbi	Miyove	Mpinga	184
	North	Gicumbi	Rwamiko	Nyagahinga	17
Volcanic Highlands	North	Musanze	Kinigi	Gikondo	159
	North	Musanze	Gataraga	Manjari	213
Central Plateau	North	Rulindo	Mbogo	Gisha	360
	North	Gakenke	Kivuruga	Rumarangabo	38
	South	Ruhango	Kinazi	Mirambi	160
	South	Nyaruguru	Busanze	Uwankumba	18
	South	Huye		Rwamjinga	
Eastern Ridges and Plateau	East	Rwamagana	Muyumbu/ Ruvomo	Rugende	350
	East	Ngoma	Rukumberi	Ntovi-Mugwato	589
Eastern Savannah	East	Gatsibo	Rugarama	Gikoma	150
	East	Kirehe	Kigarama	Kigende	621
	East	Kirehe	Gahara	Nyakagezi	564
	East	Kirehe	Gahara	Nyakagezi	
Kivu Lake side	West	Rusizi	Kanjongo	Ryankana	
		Nyamasheke	Bushenge	Karisimbi	
Congo Nile	West	Nyabihu	Rugera	Murama	100
	West	Nyabihu	Bigogwe	Rukore	

Research supervisors visited each of the 20 sites on a day when all heads of households would be present either for a LUC activity meeting or farming activities and selected at random 30 LUC-participating households for participation in the survey. On the day the survey was administered, enumerators or research assistants also moved around the village (or umudugudu) to select, where possible, another 6 households that were not under the LUC program. With 36 households for each site, the result was projected to be 720 households. Additional questionnaires were administered by the supervisors as a safeguard to ensure the target number of households was surveyed and a robust data set collected. By the time the data was cleaned, 22 additional households over the 720 household targets had full data fit to be included in the final count. Thus the final number

of complete questionnaires added up to 742, with 658 LUC participants and 84 non-participants[2].

A comprehensive questionnaire was used to collect data and information on social economic, nutrition, food security, and environmental attributes both in Land Use Consolidation sites and control areas. The total number of items in the questionnaire was 1,214. There were more than 150 root questions with 9 on identification, 7 on demographics and 7 on coping mechanisms and shocks. There were 23 root questions on plots and seeds, 18 on labour and pesticides, 22 on sources of seeds and fertilizers, 2 on labor details, 18 on harvest sales, 5 on wealth measures including health assets with the view of providing a picture on incomes and poverty distribution and characteristics, 1 on farm animals, 7 on cash and resources, and 18 on perceptions on LUC, 10 on environment, 2 on household expenditure in the last 30 days, and 3 on details about consumption.

Following data collection, the surveys were digitized using an SPSS template. The initial dataset was spot-checked for errors by the LAND Project Senior Research Advisor, and due an initial high rate of error the team undertook an extensive verification process of entered data. Entered data was cleaned by removing illogical outliers, correcting units and verifying consistency between data in questionnaires and in the database. A second spot-checking process following this cleaning and verification process revealed a much lower error rate, consistent with typical household surveys.

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[2] The intention of interviewing households that were not part of LUC was to form a control group that could be used in the empirical analysis. However, due to subsequent concerns about the size and representativeness of this control group, they were not used in the analysis of the data. Thus, the findings presented in later sections of the report reflect on the LUC households that were surveyed.

4. RESEARCH FINDINGS

In this section, we present the findings of the analyses described in the previous section. We begin by describing the implementation of LUC in terms of geographic coverage, patterns of priority crops, and how implementation has unfolded over time. In the second sub-section, we consider how LUC was perceived by the farmers who participated in it, and present findings on participants' views on a variety of topics. The third sub-section provides descriptive results from our quantitative survey in order to illustrate the current conditions facing LUC farmers in terms of various aspects of agricultural production and related outcomes, and household well-being. Finally, in the fourth sub-section we employ rigorous statistical analysis to investigate how LUC impacted outcomes for those who participated.

4.1 Implementation: Where, When and How

In this sub-section, we describe where, when, and how LUC has been implemented over time. As discussed in the Research Methodology section, the LUC program does not include a systematic and consistent reporting process to generate accurate and detailed official data related to the program. This presents a challenge for providing a thorough and detailed discussion of various aspects of LUC program implementation. Thus, in this section we piece together a broad overview of LUC implementation by drawing on information from a variety of sources that have been compiled related to various aspects of the program.

Since the LUC program's initiation in 2008, implementation has proceeded rapidly throughout the country. By 2011, MINAGRI estimated that LUC encompassed 13% of arable land in Rwanda and 40% of the nation's farmers, corresponding to nearly 1 million households (MINAGRI, 2012). Within the last five years LUC has been introduced in all districts of Rwanda, and the GoR aims to expand LUC to engage 70% of Rwandan farmers by 2017. The rapid pace of expansion of LUC in terms of both land area and households is illustrated in Map 3.

Table 3. Expansion of LUC

	2008	**2009**	**2010**
Number of ha. Under LUC	28000	66,000	254,448
No of households participating in the CIP	85000	200,000	750000

Source: RGB 2012

Map 3 shows the geographic spread of the program as of 2011 in terms of the total area in hectares under the program by district. As the figure shows, LUC has reached all districts of the country, but implementation has been more extensive in some areas than others. In particular, LUC covers substantially more area in the districts in the eastern part of Rwanda as compared to other parts of the country.

Map 3. LUC coverage by districts
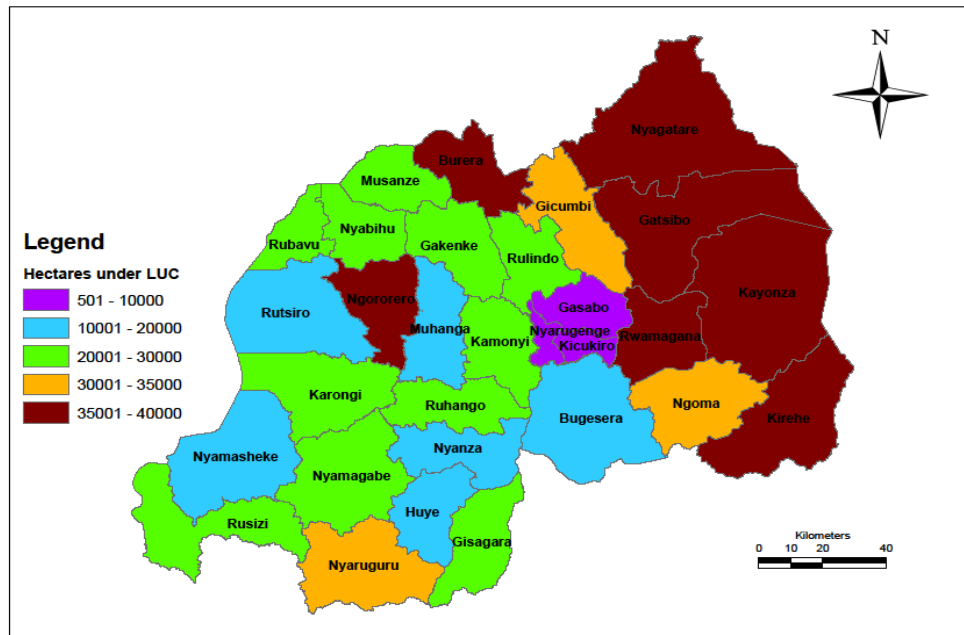
Source: Project Team

As described above, a total of eight priority crops are included in LUC. Figure 1 shows the total area under each of these crops[3] in season A of each year, as well as how coverage for each crop has evolved over time. Initially, LUC was focused on primarily on maize, which accounted for 65% of the total hectares under the program in 2008, with cassava also an important focus, comprising a further 32% of the LUC area. Rice, soya beans, and beans were only introduced in more recent years, but by 2011 beans had become the most widespread LUC crop, covering over 250,000 ha. Maize and cassava continue to comprise a substantial proportion of the area under LUC, followed by Irish potatoes Areas devoted to rice, wheat and soya beans are more limited.

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[3] Excluding bananas, which were incorporated into LUC at a later time

Figure 1. Hectares of farmland under LUC by crop and year
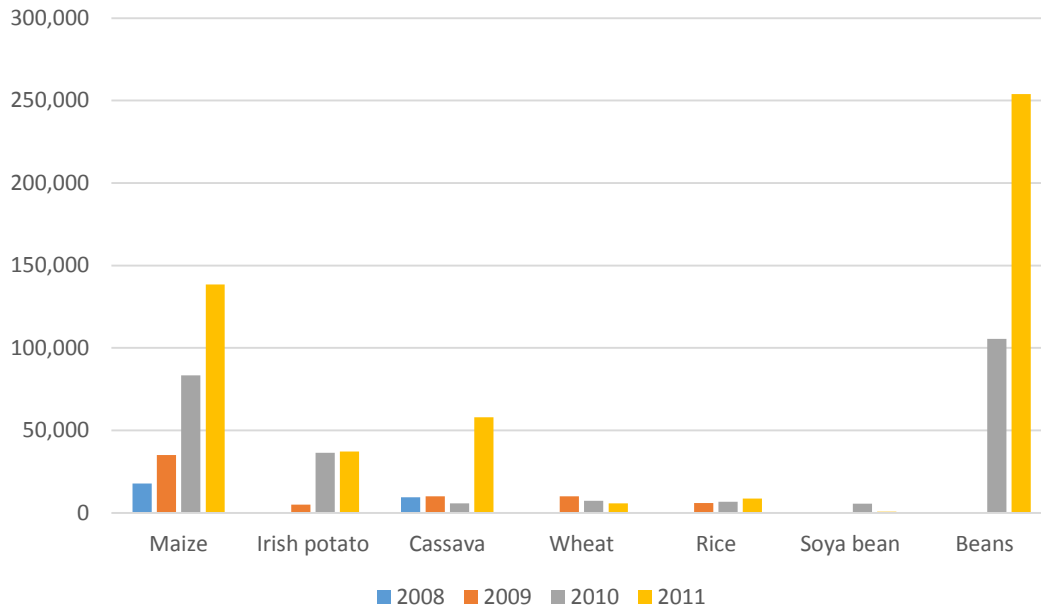
Source: Kathiresan (2012)

4.2 Farmer Perceptions and Experiences

In assessing the outcomes of LUC, an important consideration is how the program has been perceived by the farmers who participate in it. The research collected both quantitative and qualitative data that investigate a variety of aspects of how the program is perceived. These include overall views of the program and its benefits, perceptions related to whether or not the program was voluntary, and views on how LUC has impacted the environment.

General perceptions

Overall, perceptions of LUC tended to be positive, though with some exceptions. Figure 2 illustrates our quantitative results related to satisfaction. In terms of overall satisfaction, 65.7% report being "very satisfied" with LUC, with only 10.4% claiming to be unsatisfied, and the remaining 23.9% expressing a neutral view. Farmers were also asked about their view of the impact of LUC on their families, and 69.1% indicated the program had made a substantial and positive change. Most farmers also reported perceiving an increase in yield since joining, although 18.5% indicated they experience lower yields. Our focus group participants tended to express overall satisfaction with the program as well, with satisfaction particularly high among maize farmers.

Figure 2. Respondent perceptions of the LUC program impact
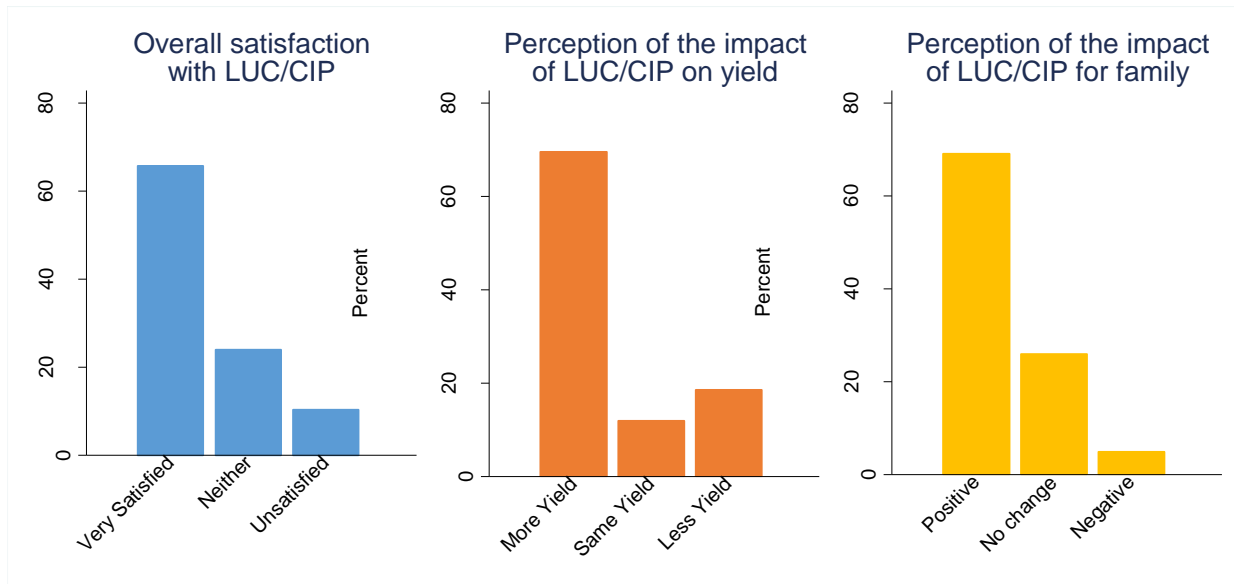
However, focus group participants also identified a number of challenges related to the program. These varied by area and crop, but commonly cited concerns included a lack of access to storage and post-harvest facilities, as well as markets for crops. In addition, some farmers raised concerns over access to fertilizers and other inputs, with several expressing the view that fertilizers had been allocated to maize farmers at the expense of other crops.

Farmers were asked about their views on a number of specific aspects of the program, shown in Figure 3. When asked whether the LUC priority crop was the most appropriate crop that could have been chosen, 88.6% responded affirmatively. In addition, 69.2% reported that seed and fertilizer delivery under LUC had been timely. We also considered farmer's views about the shift that LUC induces from intercropping of several crops a on a single parcel to mono-cropping of the LUC priority crop in many cases. The majority were not concerned about the switch to mono-cropping, but just under one-third of respondents indicated that they would prefer to intercrop. Investigating the circumstances under which intercropping is seen as particularly preferable is a subject for further research.

Figure 3. Respondent perception on aspects of the LUC program
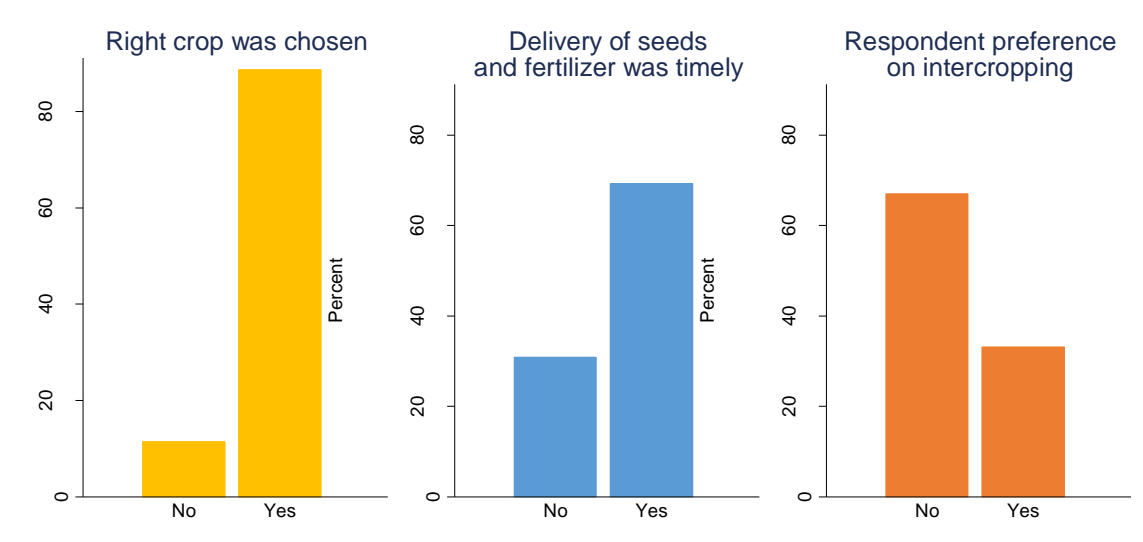
Voluntariness of participation

Another issue that our research considers is the extent to which farmers perceive their participation in the program as voluntary. According to the law, LUC is a voluntary program, and in areas where the program has been implemented farmers may freely choose whether or not to participate. However, there have been anecdotal reports suggesting that this is not always the case (Huggins, 2013).

Our data show that while some farmers perceive their participation as voluntary, others felt they were coerced to participate in the program and could not freely opt to decline participation. Our quantitative survey included two questions on this issue. When asked about their own participation in the program, 76% of our respondents responded that they had joined voluntarily, but 24% indicated that their participation was not voluntary. Respondents were also asked more generally whether there had been resistance to LUC when it was introduced, with 45% expressing the view that this had been the case.

Figure 4. Farmer perceptions on degree of coercion in the LUC program
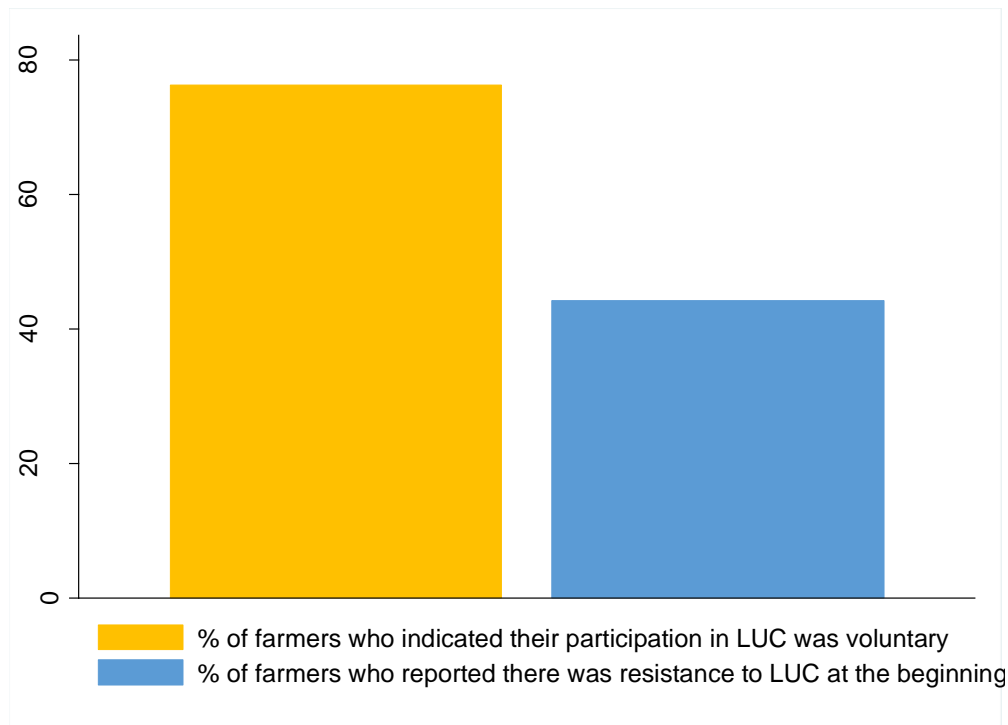
Concerns about coercion in joining the program were also raised in 16 of the 18 focus groups that were conducted as part of the qualitative data collection exercise. Focus group participants gave a number of reasons for their reluctance to participate, including concerns about switching to the LUC-prescribed crop, price fluctuations, and tensions between farmers who were not accustomed to working together on consolidated plots.

Environment

Finally, our data include a range of questions to consider how farmers perceived different aspects of the environment as having improved or deteriorated since the introduction of LUC. Figures 5 and 6 show that farmers tend to perceive positive trends in environmental outcomes overall. The majority of respondents report improvements in soil fertility, the quality of erosion ditches and prevalence of soil erosion, fodder availability, livestock integration, and the prevalence of tree plantations. Views were less positive about downstream water quality and firewood availability, but even in these cases only a small minority viewed the situation as having gotten worse following LUC, with the most common response for both being that conditions had remained the same. The only negative trend was related to the quantity of downstream water, with a slight majority reporting a decrease. It is important to bear in mind that these perceived environmental trends are not necessarily attributable to the impacts of LUC itself, but rather reflect how the situation has changed since LUC was introduced.

Figure 5. Respondent perceptions on changes in environmental factors
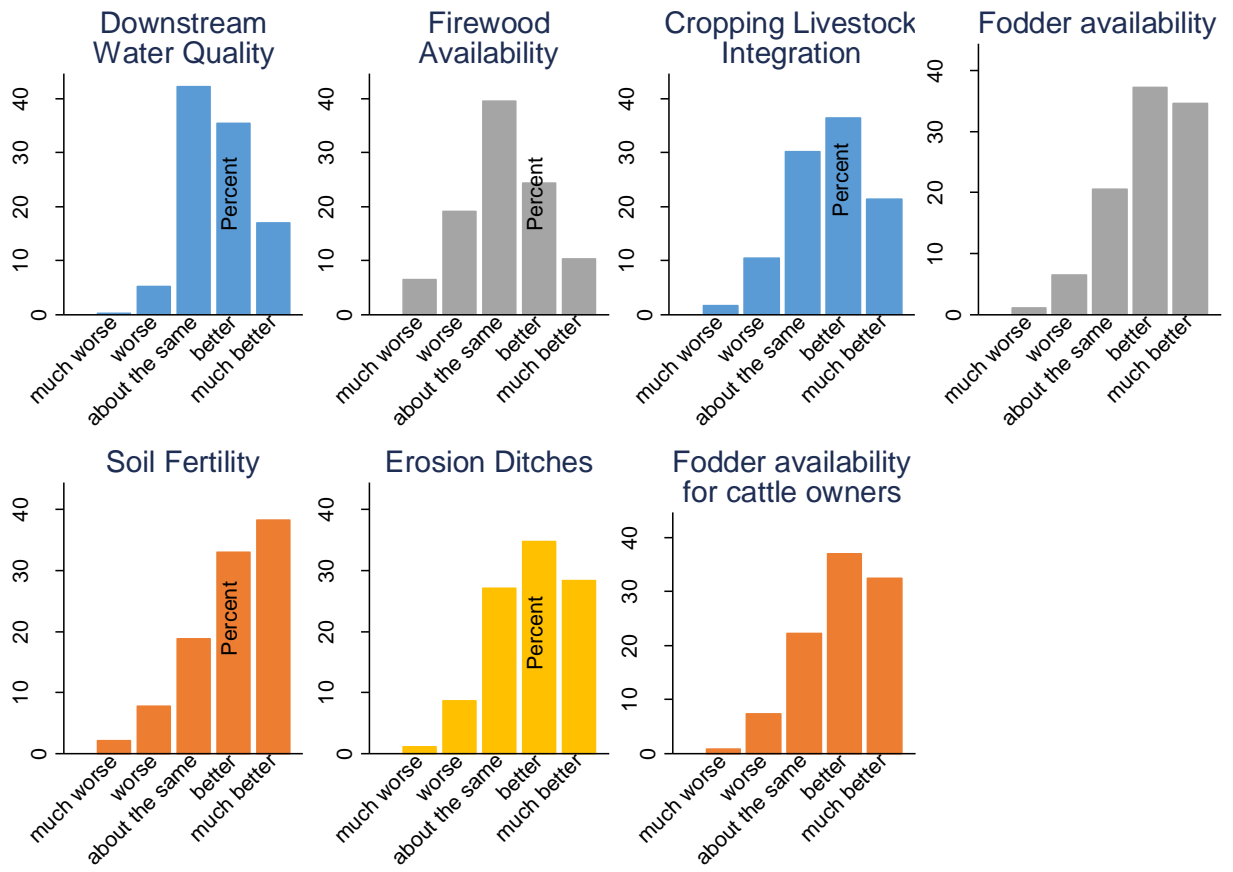
Figure 6. Respondent perceptions on environmental degradation
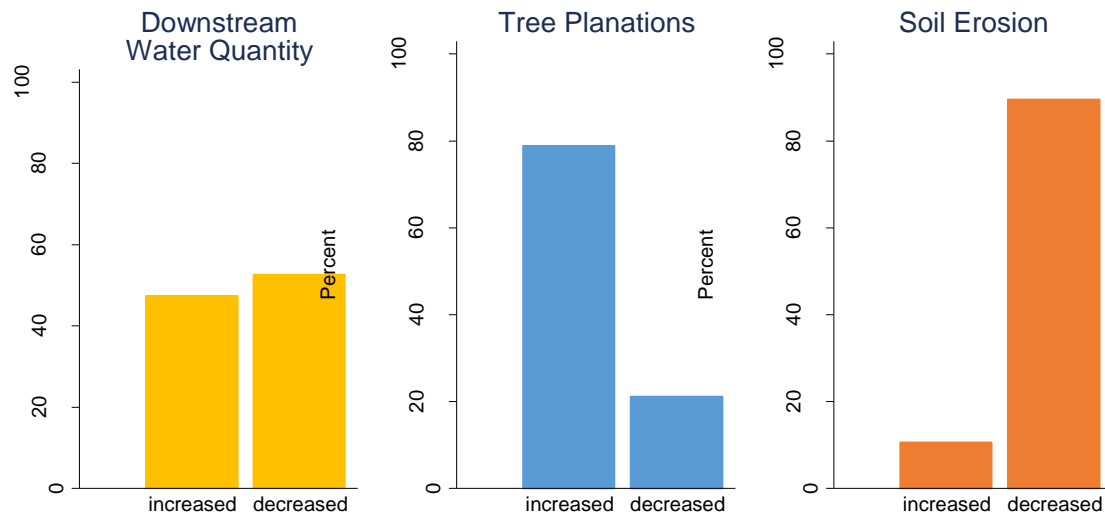
4.3 Quantitative Outcomes: Descriptive Analysis

In this section, we present our descriptive quantitative findings on a range of farmer-level outcomes. These outcomes include those related to agriculture, such as production levels, marketing and sales, and use of inputs and extension services, as well as measures of household well-being such as consumption, vulnerability to shocks, and food security. As described in the Methodology section, these findings are derived from a household survey of 658 LUC participants that was designed and implemented by the research team in 2013. It is important to note that the analysis in this section is descriptive, and is thus intended to provide an illustration of the current situation facing LUC farmers with respect to these outcomes rather than to make claims about how LUC affected these outcomes. The issue of how LUC impacted outcomes is taken up in the next section.

Demographic characteristics

Table 4 presents the basic demographic characteristics of our survey respondents. The average age of the household head was 45, with just under one-fifth of households headed by women. Only a minority of household heads had finished primary school, but 73% could read and write, a figure consistent with literacy rates reported elsewhere (GoR 2012). As shown in Table 5, households in the sample were drawn from nine different agricultural zones in Rwanda. Buberuka Highlands and Eastern Ridges and Plateaus were the most common agroecological zones, together accounting for just under half of all respondents.

Table 4. Demographic characteristics of survey respondents

	Mean	SD
Age of head of household	45.6	13.4
Household size	5.3	2.0
Female-headed households	18%	
Head of household finished primary school	39%	
Head of household finished additional schooling	11%	
Head of household is literate	31%	

Table 5. Breakdown of survey respondents by agro-ecological zone

Agro-ecological zone	No. of Households	% of Households
Buberuka Highlands	152	23.1
Bugarama Plain	33	5
Volcanic Summits & High Plains	76	11.6
Central Plateau	91	13.8
Bugesera	15	2.3
Eastern Ridges and Plateaus	172	26.1
Eastern Savana	36	5.5
Kivu Lake Sides	33	5
Congo-Nile	50	7.6
Total	658	100

Agricultural production and outcomes

The survey collected data on various aspects of agricultural production and outcomes. The farmers in the survey grow a wide range of crops, with the primary crop by household illustrated in Figure 7. The most common was maize, which was the primary crop for 24% of farmers. Irish potatoes, beans, wheat, cassava and rice were also the primary crop for at least 5% of the farmers. A substantial proportion of farmers generated most of their agricultural production value from other crops, mainly vegetables, with no single other crop amounting to more than 5% of the total.

Figure 7. Primary crops[4] grown by farmers

Note: All other crops includes Beans - Oridinary Dry, Soybeans, Avocado, Sweet Potato, Bananas, Fresh Beans, Beetroot, Cassava Leaves, Fodder, Fresh Peas, Imbwija, Inyabutongo, Papaya, Peas, Pepper, Pyrethum, Squash, Taro and Yams
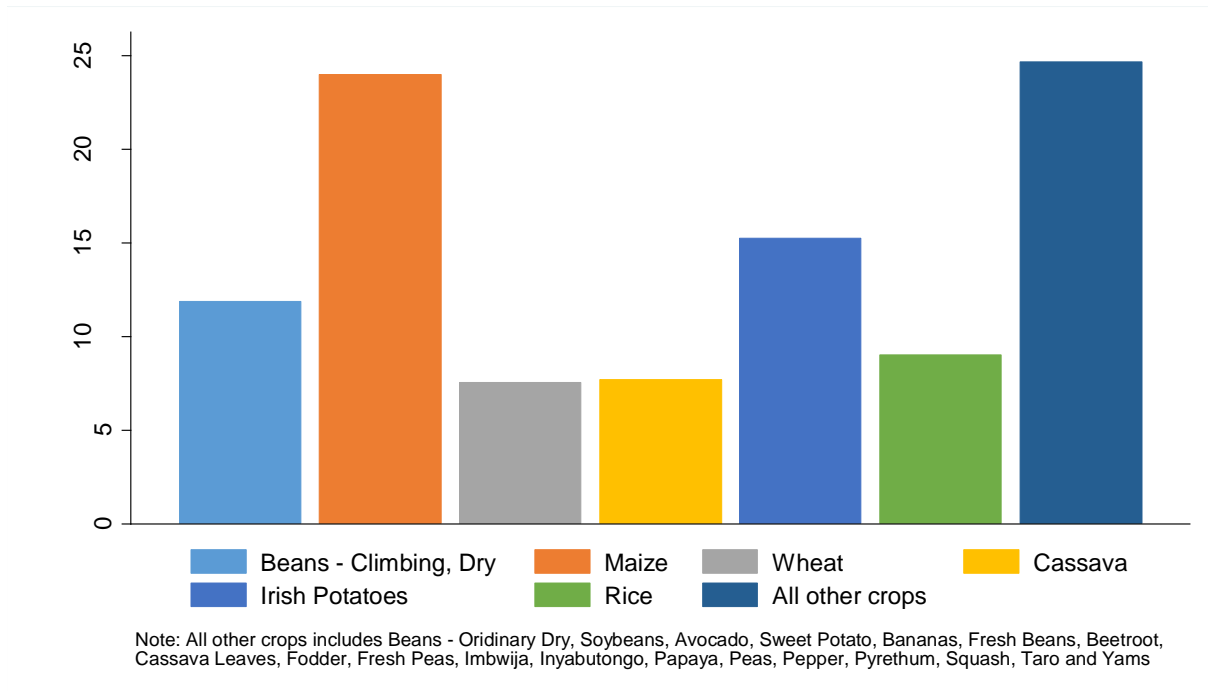
As would be expected given the context, land holdings tend to be small, as shown in Figure 8. For nearly half the sample, the total area of land farmed by the household is less than 0.25 hectares. The farmers in the sample tend to exhibit low levels of agricultural output as shown in Figures 9. The average value of output over the past year including output that was consumed by the household was RWF 332,966, with only 13% producing more than RWF 750,000 worth of agricultural output.

Agricultural productivity measured by value of output per hectare of land averaged RWF 989,440 across the sample. This compares favorably to other countries in the region. Based on figures from a recent study (Davis, 2011), value of output per hectare in our sample was 76% higher compared to a sample of Kenyan farmers, and 3.8 and 2.7 times greater than samples from Tanzania and Uganda respectively.[5] Figure 10 illustrates considerable variation in productivity. While yields per hectare for nearly 30% of the sample were at least RWF 1,000,000, 19% produced less than RWF 125,000.

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[4] Primary crops for farmers were determined by calculating the total value of agricultural production from all crops and identifying which crop contributed the most to that value

[5] Figures in the Davis (2011) study were adjusted for inflation and converted to RWF/ha. for comparability

Figure 8. Distribution of total size of land-holdings (in hectares)
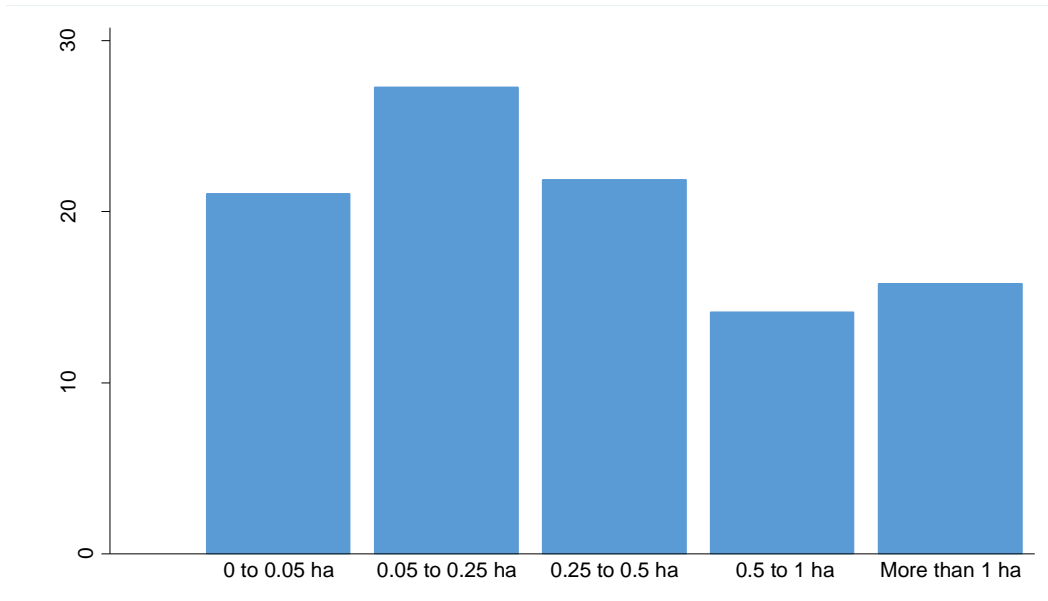
Figure 9. Distribution of total value of agricultural output
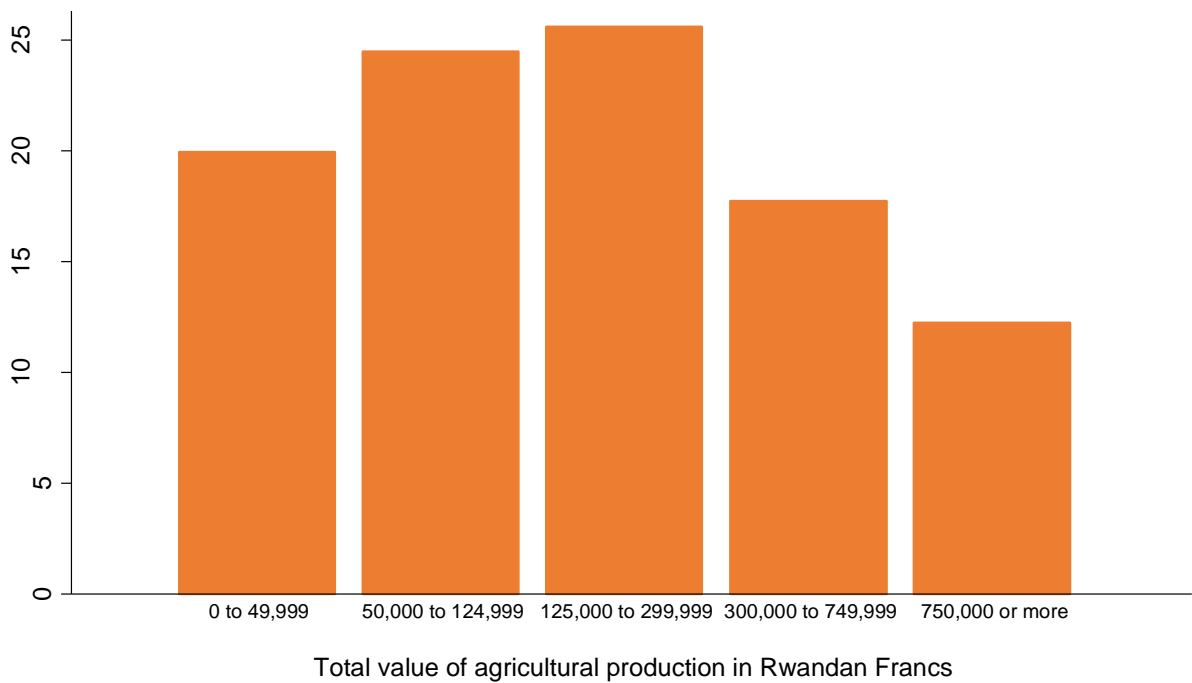
Figure 10. Distribution of agricultural value of output per hectare

Total value of agricultural production per hectare in Rwandan Francs
Note: 125 farmers are excluded due to missing data or extreme values
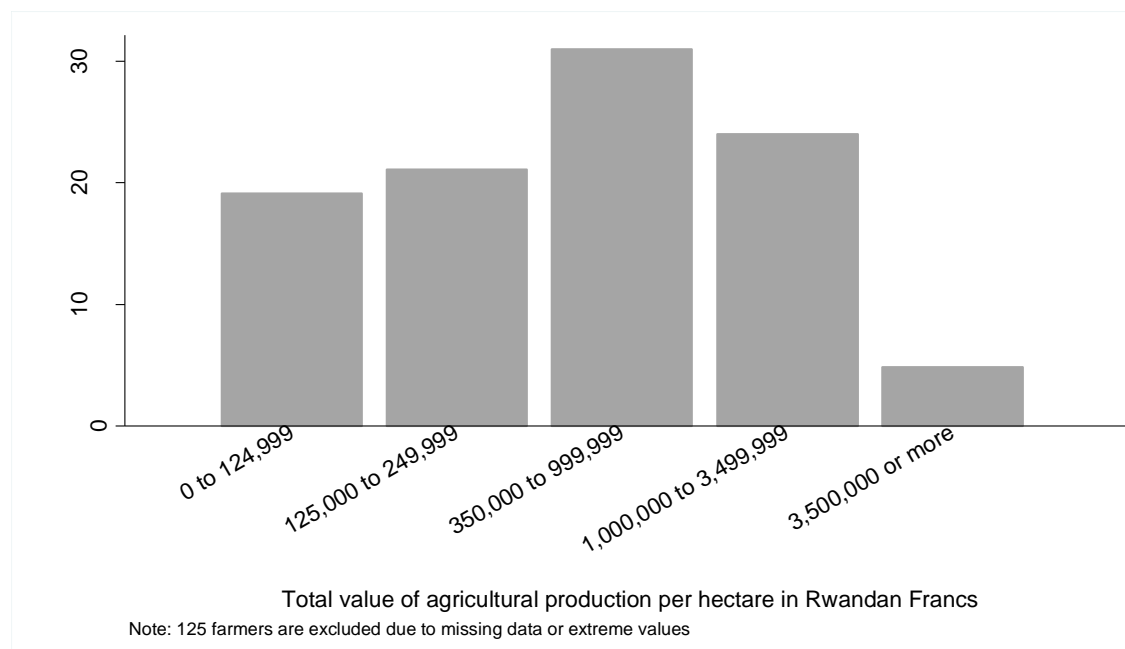
Table 6 shows inputs and services available to LUC farmers. Overall, LUC farmers tend to have good access to inputs. All of the LUC farmers in the sample reported having access to improved seed, with over three-quarters using both chemical and organic fertilizers. Pesticide use is somewhat less common, but may reflect less of a need for pesticides rather than access. Seventy-two percent of the sample regularly engage with extension agents as well. The data show that access to storage and processing facilities is more limited – only 22% have access to storage and 12% utilized post-harvest processing facilities, which is corroborated by concerns farmers raised during our focus groups.

Table 6. Use of inputs and access to services

	Frequency
Use improved seed (% of farmers)	83%
Use organic fertilizer (% of farmers)	43%
Use chemical fertilizer (% of farmers)	31%
Use both chemical and organic fertilizer (% of farmers)	56%
Use any pesticide (% of farmers)	42%
Receive seasonal visits from extension officers (% of farmers)	32%
Receive monthly visits from extension officers (% of farmers)	50%
Have access to storage facilities (% of farmers)	22%
Processed any crop post-harvest (% of farmers)	12%
Percent of total output sold	59%

Household well-being

The well-being of households that participated in LUC is measured in the survey in several ways. Figure 11 shows household consumption measured by the amount households spent per person on various items over the previous year. On average, household expenditure was RWF 17,133 per person. As would be expected, the highest amount was spent on food, with an average of RWF 4,503 per person corresponding to 26% of overall spending. The second highest expenditure category is non-food household expenditures, which includes alcohol and tobacco, soap and hygiene products, transportation, energy costs for lighting and cooking, waste disposal, rent (both land and housing), milling, and communications expenses. On average, households spend a total of RWF 1,738 per person or 10% of total per capita expenditures on non-food household expenditures.

Figure 11. Distribution of average per capita household expenditures, by expense category

Note: Other expenditures includes Personal Belongings, Household furnishings, Livestock expenditures, and Taxes and Fines.
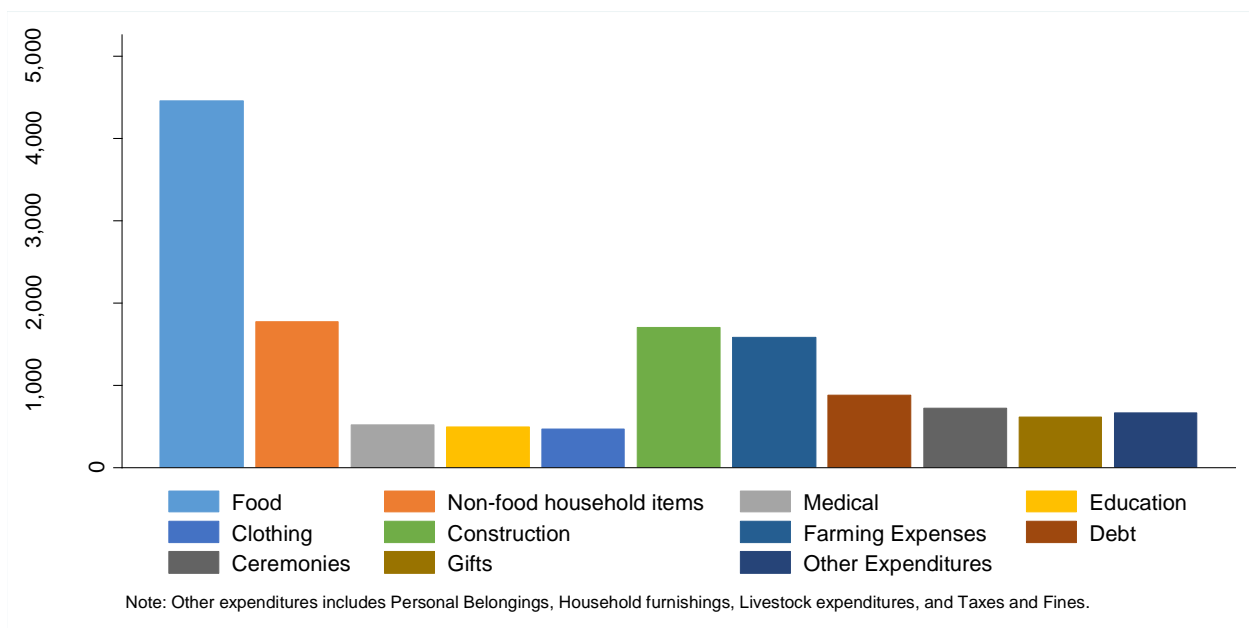
Our data show that LUC households remain highly vulnerable to unexpected shocks. The survey asked respondents whether they had experienced a variety of adverse events in the past 3 years, with responses shown in Figure 12. On the whole, 54% had experienced at least one such occurrence and 20% of those indicated that their household had not yet been able to fully recover from the shock. The most common shock was drought or bad rainfall, which affected 42% of respondents. High food prices and input costs were also common, with over 10% citing each.

Figure 12. Distribution of main types of shocks experienced by farmers

Note: Less than 5% of repsondents indicated they had experienced Floods, Landslides and Mudslides, Livestock Diseases, Human Disease/Epidemic,Job Loss, Fires, Death of Household Head, Insecurity/Violence, Death of a working household member, Death a non-working household member, Theft, Hailstones, Earthquake, Volcanic Activity, and Very low crop prices.
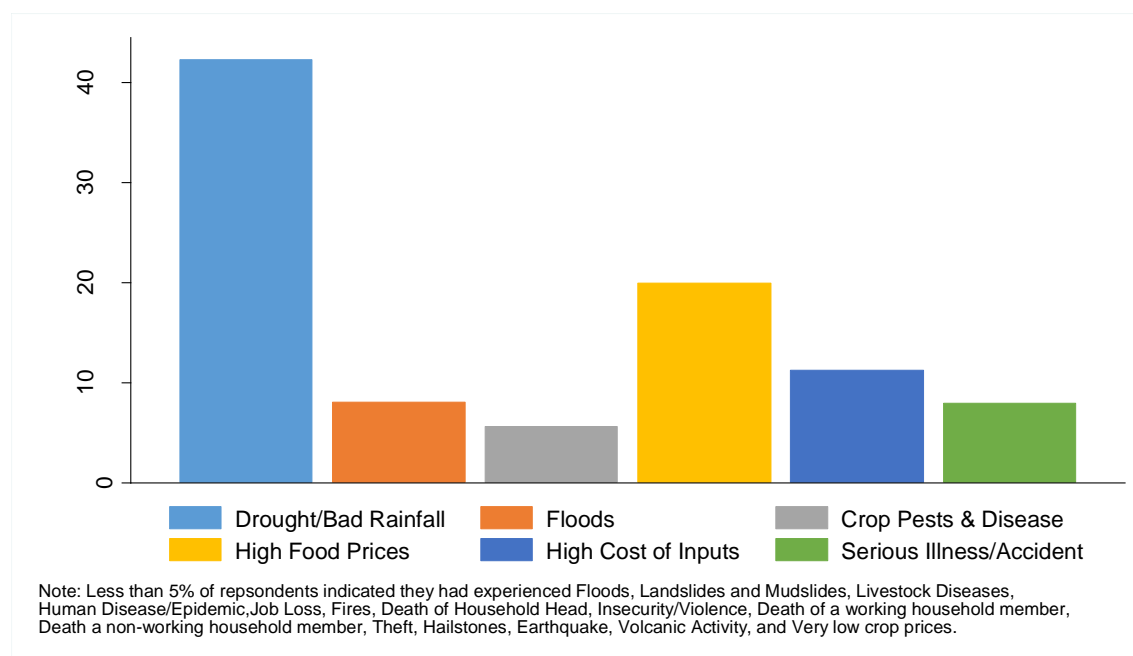
The vulnerability of LUC households is also reflected in responses to questions about food security shown in Table 7. When asked whether their households had not had enough to eat at any point in the past week, over two-thirds answered affirmatively. Substantial proportions also indicated that they had experienced other dimensions of food insecurity in previous week. It is important to note that the survey was administered during the hungry season in Rwanda, and the prevalence of food insecurity is liable to be lower at other times of the year. However, our results show that food insecurity remains a serious problem for LUC farmers for at least part of the year.

Table 7. Food security within respondent households

	Frequency
Household did not have enough food in the past week (% of respondents)	67%
Relied on less preferred and less expensive food (% of respondents)	50%
Borrowed food or relied on help (% of respondents)	16%
Limited portion size at mealtimes (% of respondents)	47%
Reduced consumption by adults (% of respondents)	29%
Reduced number of meals eaten in a day (% of respondents)	44%

4.4 Quantitative Outcomes: Impacts of LUC

While the previous section has provided a useful illustration of the current conditions facing LUC farmers, such an analysis is not able to shed light on causal relationships related to the program. For example, while we note that farmers are vulnerable to food insecurity, we are not able to say whether the situation is better or worse as a result of LUC. In this section, we undertake some more rigorous econometric analyses in order to investigate various causal relationships in the data. First, we use a series of probit regressions to explore why some farmers perceived the program more positively than others. We then attempt to measure how LUC impacted a variety of outcomes for farmers using a continuous treatment model.

Determinants of Perceptions About LUC

One area where it is useful to undertake a more rigorous empirical analysis is in investigating the factors that are associated with different perceptions on the part of farmers concerning the program. There are three questions in particular in the survey that are relevant here:

- How satisfied are you with the program? (1=very satisfied, 2=neither satisfied or unsatisfied, 3=unsatisfied)
- Generally are you making: (1=more yield, 2=the same yield, 3=less yield)
- What is your overall feeling about the impact of LUC/CIP for your family? (1= big positive change, 2=no real change, 3=negative change)

Using these questions, our analysis seeks to identify why some farmers perceive the program more positively than others. To do so, we estimate three probit regression models, one for each of the three perceptions questions above. Each model estimates how different farmer and plot characteristics are associated with more positive responses. For the first model, the dependent variable is the probability that a farmer reports being "very satisfied" with LUC, the second is the probability that a farmer claims to have experienced higher yields following the program, and the third is the probability that a farmer believes that LUC has brought about a large and positive change for his or her family.

The results are presented in Tables 8-10. The first set of results suggests that more frequent visits from extension agents and greater value of their agricultural output are associated with greater satisfaction with the LUC program. For the question on whether yields have increased in Table 9, frequency of extension visits and value of agricultural output remain significant and positive, and in addition more educated farmers are less likely to report increased yields. This may indicate that LUC benefits less educated farmers by teaching them techniques that they would not otherwise be aware of, whereas more educated farmers may already be using good farming practices. In addition,

farmers with access to fertilizer subsidies through the program are more likely to report increased yields, which suggest that increased access to fertilizer is an important aspect of the LUC program. Table 10 shows similar results for the likelihood of perceiving a large and positive change; although here older household heads are less likely to respond positively, while those who have been in the program for longer are more likely to give a positive response. Interestingly, the number of years in the LUC program was not significantly associated with any of the outcomes, except for a weak relationship with likelihood of perceiving a large and positive change. It is notable that none of the regressions identify significant relationships with other factors such as gender of the household head, non-agricultural income, and land size. This suggests that whether a participating household benefits from LUC or not does not depend on any of these factors.

Table 8. Probit regressions results, % of farmers "very satisfied" with program

	Coeff.	Standard error	z-score	p-value
Household size	-0.00076	0.009744	-0.08	0.938
Member of coop.	0.006598	0.055666	0.12	0.906
Female headed HH	0.011206	0.041365	0.27	0.786
HH head age	-0.00105	0.001392	-0.75	0.451
HH head has some schooling	-0.08002	0.052161	-1.53	0.125
HH head finished primary school	-0.05171	0.085339	-0.61	0.545
Log of non-agricultural income	0.001391	0.003668	0.38	0.705
Land size (ha.)	0.010472	0.026839	0.39	0.696
Years in LUC program	0.016073	0.015041	1.07	0.285
Access to fertilizer subsidy	0.084921	0.060973	1.39	0.164
Monthly visits by extension agent	0.210296	0.054204	3.88	0.000
Seasonal visits by extension agent	0.047594	0.064513	0.74	0.461
Log of value of agricultural production	0.084834	0.019763	4.29	0.000

Note: marginal effects reported; standard errors clustered by site; agroecological zone dummy variables omitted

Table 9. Probit regressions results, % of farmers reporting higher yields

	Coeff.	Standard error	z-score	p-value
Household size	0.005712	0.010567	0.54	0.589
Member of coop.	0.013917	0.050677	0.27	0.784
Female headed HH	0.059397	0.049133	1.21	0.227
HH head age	-0.00157	0.001478	-1.06	0.287
HH head has some schooling	-0.08151	0.029437	-2.77	0.006
HH head finished primary school	-0.14838	0.063281	-2.34	0.019
Log of non-agricultural income	0.002149	0.003612	0.59	0.552
Land size (ha.)	-0.00472	0.005322	-0.89	0.375
Years in LUC program	0.004929	0.01685	0.29	0.770
Access to fertilizer subsidy	0.159072	0.039079	4.07	0.000
Monthly visits by extension agent	0.217613	0.061967	3.51	0.000
Seasonal visits by extension agent	0.113728	0.041075	2.77	0.006
Log of value of agricultural production	0.114809	0.020024	5.73	0.000

Note: marginal effects reported; standard errors clustered by site; agroecological zone dummy variables omitted

Table 10. Probit regressions results, % of farmers reporting "big positive change"

	Coeff.	Standard error	z-score	p-value
Household size	0.004161	0.007059	0.59	0.556
Member of coop.	0.072046	0.046605	1.55	0.122
Female headed HH	0.025101	0.049742	0.5	0.614
HH head age	-0.00228	0.001047	-2.17	0.030
HH head has some schooling	-0.08223	0.041106	-2	0.045
HH head finished primary school	-0.13087	0.064074	-2.04	0.041
Log of non-agricultural income	0.003928	0.003062	1.28	0.200
Land size (ha.)	0.005746	0.027248	0.21	0.833
Years in LUC program	0.028995	0.01582	1.83	0.067
Access to fertilizer subsidy	0.087618	0.038531	2.27	0.023
Monthly visits by extension agent	0.070407	0.072691	0.97	0.333
Seasonal visits by extension agent	-0.00795	0.06372	-0.12	0.901
Log of value of agricultural production	0.112496	0.017071	6.59	0.000

Note: marginal effects reported; standard errors clustered by site; agroecological zone dummy variables omitted

Impacts of LUC: Continuous Treatment Modelling Results

As discussed above, a key challenge for addressing research questions related to the causal impact of a program or policy on outcomes is the identification strategy- that is, how can we distinguish between the impacts of the program, and the impacts of other factors that also affect outcomes? To address this issue, we also attempted an empirical strategy based on propensity score matching with continuous treatment.

Our motivation for using a continuous treatment is based on some limitations of the data that rule out other approaches, as well as some features of the data that suggest continuous treatment may be a promising approach. Typically, empirical studies of the

impact of programs such as LUC make use of a control or comparison group to represent what *would have happened* to the beneficiaries in the absence of the program. Data is collected from the treatment and comparison groups both before and after the implementation of the program, allowing for a standard difference-in-difference framework to be applied, which can provide compelling evidence of the causal impact of an intervention such as LUC.

In our case, however, there is only a single round of data available, and no comparison group against which outcomes can be compared.[6] As a result, our data do not allow us to use a difference-in-difference framework. Hence, we must seek a different strategy to measure the causal impact of the program.

Our approach is to use length of exposure as a continuous treatment measure. The concept of this approach is to compare farmers who have been participating in LUC for a longer period of time to those who have joined more recently, under the assumption that the benefits of the program may unfold over time. In the case of LUC, there is reason to believe many of the benefits might unfold over time rather than occurring instantaneously. For example, following consolidation, it may take farmers some time to figure out how best to take advantage of the new arrangements in terms of labor allocation, approaches to marketing, etc. In addition, an advantage that our data have in this regard is that there is substantial variation in the dataset in terms of when farmers joined LUC in different areas.

Our continuous treatment with propensity score matching methodology follows the approach laid out by Hirano and Imbens (2004). The approach has been used in several recent empirical studies in development contexts. These include Aguero et. al. (2007), who study the impact of South Africa's Child Support Grant on child nutrition, and Keswell and Carter's (2011) study of a South African land reform policy. Both of these cases are similar to ours in that a comparison group of non-beneficiaries was not available for the analysis, and in addition there was significant variation in the data in terms of when the respondents had participated in the program.

As described in Hirano and Imbens (2004), the approach is to first identify a set of variables to estimate the propensity score, similar to standard binary propensity score matching. These variables are used in a regression to predict the value of the treatment variable, in this case the number of years since joining LUC. The estimated propensity scores derived from this estimation are then used as a control variable in the estimation of a dose-response model, which is used to estimate the impact of an additional year in LUC on outcomes. A key assumption of the model is that the variables used to estimate the propensity score account for all sources of variation in years since treatment that would also affect outcomes.

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[6] The household survey did include some non-LUC farmers, but the sample size and sampling approach do not allow for these observations to be used as a comparison group in a rigorous analysis.

Our variables used to estimate the propensity score consisted of size of landholding, primary crop, gender and literacy of the household head, household size, a dummy variable indicating whether the household owned livestock, and geographic dummies corresponding the northern, southern, eastern, and western areas of the country.[7]

We used these propensity score variables to estimate the impact of an additional year in LUC on the following five outcomes:

- Value of agricultural output
- Agricultural revenue
- Per capita household expenditure
- Food security, as measured by the probability that the household had gone without food in the past week
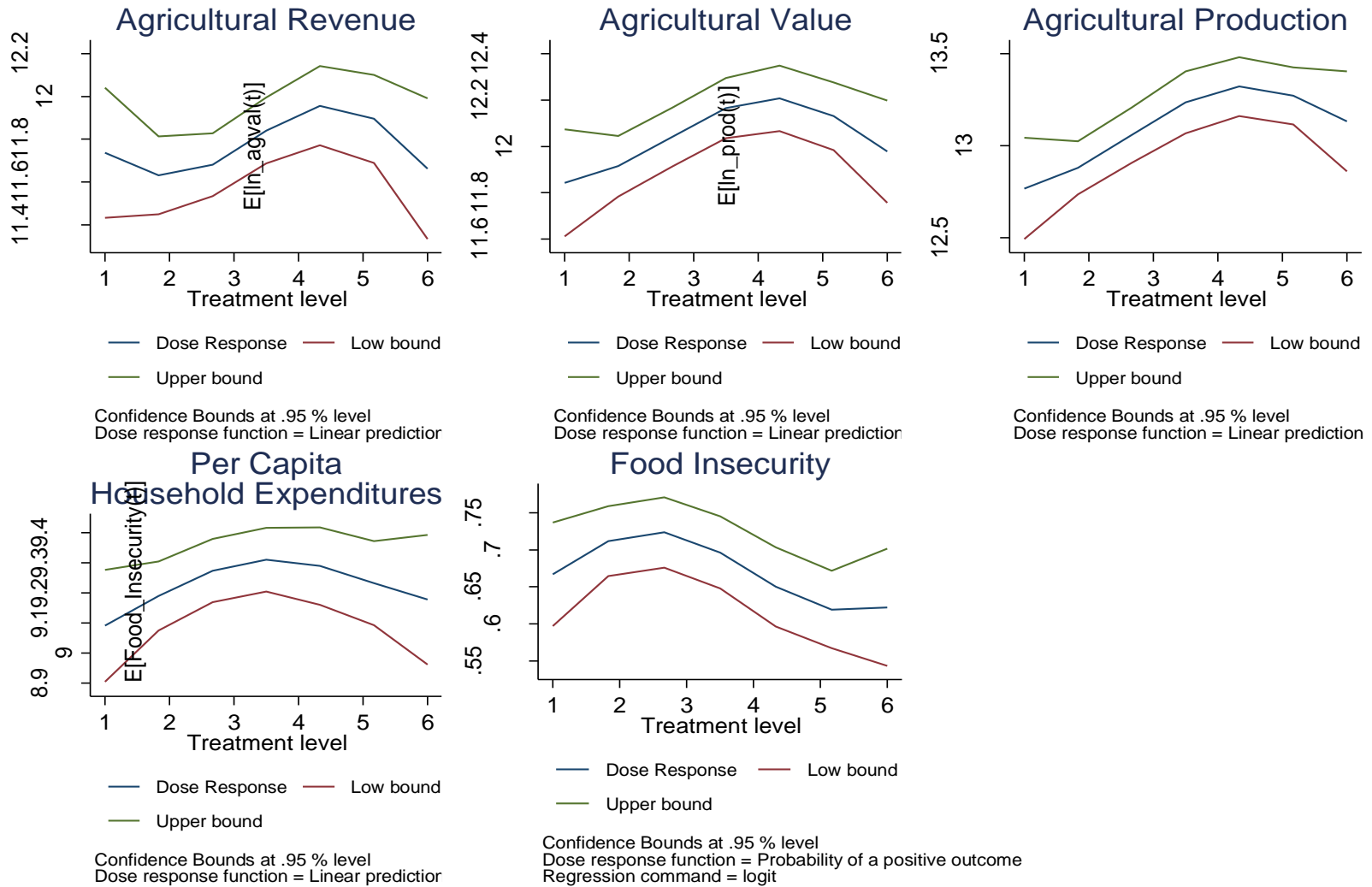- Agricultural productivity measured by value of output per hectare

The results did not yield strong conclusions about the impact of LUC. In no case were the regression coefficients on the treatment variable statistically significant, meaning that we cannot conclude that additional years in the program led to greater impacts on any of the five outcomes. However, it is important to bear in mind that this finding may be due to data limitations rather than a true lack of impact of LUC.

Figure 13 provides a graphical illustration of the results of the estimations. Each figure shows how the average value of each outcome varied with time since joining the program, after accounting for the matching variables. As reflected in the regression results, the graphs do not show a clear and consistent relationship. However, the general pattern suggests improving outcomes with additional years in the program in most cases. For example, agricultural productivity increases steadily over the first four years since joining the program, before levelling off and declining slightly for farmers who had joined LUC five and six years prior respectively.

As a result, these findings should not be interpreted as evidence against the impact of LUC on outcomes. Rather, they should interpreted as showing that our data and empirical strategy were not sufficient to be able to detect strong relationships between LUC and outcomes. In the absence of panel data with a rigorously defined counterfactual, our ability to generate strong evidence concerning program impact is limited.

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[7] We experimented with a number of different propensity score specifications before settling on the final set of variables described here.

Figure 13. Continuous Treatment Modelling Results

Agricultural Revenue

Confidence Bounds at .95 % level
Dose response function = Linear prediction

Agricultural Value

Confidence Bounds at .95 % level
Dose response function = Linear prediction

Agricultural Production

Confidence Bounds at .95 % level
Dose response function = Linear prediction

Per Capita Household Expenditures

Confidence Bounds at .95 % level
Dose response function = Linear prediction

Food Insecurity

Confidence Bounds at .95 % level
Dose response function = Probability of a positive outcome
Regression command = logit

Caveats and limitations

While the findings in this previous section yield useful insights about the program, when interpreting them it is important to bear in mind some caveats and limitations of the analysis. In this section, we discuss the main limitations and resulting implications for interpretation of the results.

One important caveat is that all of the analytical findings presented in the "Quantitative Outcomes: Impacts of LUC" should be interpreted as suggestive, rather than definitive. The main reason for this caveat is the possibility that selection bias due to observed variables may be influencing the results of the estimations of the statistical models. Such selection bias occurs when an observed relationship between two variables is in fact driven by a third factor that has not been accounted for in the analysis- where this is the case, it can lead to a mistaken interpretation of a causal relationship between the first two variables. For example, the analysis reported in Table 9 found that access to subsidized fertilizer was associated with farmers reporting greater increases in yields. However, suppose fertilizer subsidies tended to be more available in areas in which higher potential crops are being grown. In that case, the relationship we observe might be because growing higher potential crops leads to greater reported increases in production, rather than that fertilizer subsidies themselves cause greater reported increases in production. Our analysis takes into account a wide range of factors that could lead to such bias to reduce it to the greatest extent possible. However, the possibility for selection bias that we have not accounted for remains a potential concern.

The limitations of the regressions point to a broader issue with the overall analysis that should be noted, which is that it is limited in terms of its ability to make definitive statements about the causal impacts of LUC on outcomes of interest such as agricultural productivity, food security, household expenditure, etc. The present study allowed for a single round of data collection that could only be collected in 2013, six years after implementation of LUC had begun. As a result, it was not possible to use more rigorous empirical methods, for example by collecting data both before and after the implementation of LUC, or identifying a comparison group prior to implementation that could be used to provide a rigorous representation of the counterfactual. While the analysis has yielded a range of useful insights on other issues related to the implementation of LUC, it is limited in terms of being able to precisely measure the impact of LUC on outcomes.

Finally, it is important to note that among the original research questions in the TOR that the research sought to investigate, there were several that the research was not able to effectively address. These were as follows:

- Evaluate the degree of adoption of LUC in places it has been introduced as well as factors influencing adoption. If farmers choose to opt out of CIP-LUC, what is the response of the program's implementers?

As discussed above, the quantitative data analysis included a control group that could have been used to study non-adopters, but subsequent analysis found that the control

group was too small and not representative enough to allow for meaningful research findings. Thus, the analysis does not consider issues related to non-adopters.

- Is there an entity to which farmers can take their claims if they are dissatisfied with the CIP-LUC or prefer not to participate? If so, are these avenues for recourse effective?

The research did not cover this question.

- Assess the impacts of land use consolidation in terms of:
  - o Total Factor Productivity (TFP) and crop yields;
  - o Access to and efficiencies in the delivery of extension services;
  - o Access to roads, irrigation, and other farm infrastructure;
  - o Capacity to reduce transaction costs;
  - o Access to markets and credit;
  - o Tenure security;
  - o Agricultural income – average and seasonal/annual variance;
  - o Intra-household distribution of agricultural income;
  - o Food security and nutrition, disaggregated by age and gender;
  - o Ability of farmers to withstand risks of: 1) market price fluctuations, 2) spoilage, post-harvest losses; 3)drought, flooding and other environmental risks; and 4) crop diseases and pest attacks;
  - o Asset ownership (e.g. land, livestock, bicycle/motorcycle, radio, etc.), disaggregated by gender and age;
  - o Social capital (e.g. cooperative membership, collective action, and relationships of mutual support and trust);
  - o Erosion control and soil stability;
  - o Soil fertility and health; and
  - o Water quantity and quality

As discussed above, some limitations to the data meant that quantitative analysis was limited to illustrating the present situation with regard to LUC farmers as well as some suggestive results related to impacts, but the analysis could not obtain rigorous estimates of the impacts of LUC on these outcomes. In addition, some outcomes such as tenure security and intra-household distribution of agricultural income were not included in the analysis.

- Analyze potential impacts on farmer livelihoods and the environment of implementing resettlement policies to advance land use consolidation.

The role of resettlement policies in the context of LUC did not come up in our focus group discussions as raising a distinct set of issues, and thus is not considered in the analysis.

5. CONCLUSIONS AND RECOMMENDATIONS

We summarize the main conclusions and recommendations that emerge from the findings in terms of conclusions related to the impact of LUC, as well as implications for future programming as follows:

- **Most but not all farmers are satisfied with LUC and believe it has brought them benefits, including increased yield.** Data from both the focus group discussions and the household survey suggest that satisfaction with LUC is quite high. Nearly two-thirds of farmers reported they were "very satisfied" with LUC, while most also believed their yield had increased as a result of LUC, and felt that LUC had a large and positive impact on their families. Farmers who participated in the focus group discussions likewise reported very high satisfaction with LUC. A vast majority of farmers (88.6%) believe the right crop was chosen for the LUC program and that delivery of seeds and fertilizer was timely.

  While the overall picture is positive, it is important to note that there is a minority of farmers have had negative experiences. Just over 10% report being dissatisfied with LUC, while 18.5% claim that their yields have been lower since joining LUC.

- **While both satisfaction and agricultural productivity of land are high, food insecurity, vulnerability to shocks, and poverty remain a serious problem for LUC farmers.** As noted above, farmers are generally positive about LUC and believe it has brought them benefits. In addition, land productivity as measured in value of output per hectare is substantially higher among LUC farmers compared to farmers in other countries in the region – over 70% higher than a sample of Kenyan farmers, and over double and triple the productivity of samples of Tanzanian and Ugandan farmers.

  However, many problems at the household level persist. Food security remains a pervasive problem amongst LUC households. Two-thirds of the farmers reported their household did not have enough to eat in the past week. Over half the respondents in the survey had experienced some kind of shock in previous three years that affected their household's ability to eat or changed their asset ownership. In particular, households remain vulnerable to drought and floods, high food prices and high input prices. Additionally, farmers exhibit low levels of per capita expenditures consistent with high rates of poverty.

  These findings show that even with any improvements that may have resulted from LUC, many LUC households continue to struggle to meet basic needs. Moreover, further improvements to already high levels of land productivity may be difficult to achieve. As a result, more effective strategies for improving living standards for rural households may focus on improving access to non-farm income generating activities, as well as relieving population pressures on land by increasing the percentage of labor force in non-agricultural sectors.

- **Our statistical analysis was not able to establish conclusively the extent to which LUC has caused changes in outcomes for participating farmers and their households.** Using our household-level dataset, we used a continuous treatment with propensity score matching approach to attempt to measure the impacts of LUC on measures of agricultural production and household well-being. Unfortunately, our data did not allow us to draw firm conclusions about the impact of the program.

- **Participation in LUC provides farmers with important access to inputs, such as improved seed and fertilizer, as well as frequent visits by extension agents and these aspects should be emphasized.** Eighty-three percent of the farmers included in the household survey reported using improved seed, while over three-fourths used fertilizer (either organic or chemical). Additionally, our regression analysis showed that access to subsidized fertilizer and more frequent visits from extension officers were associated with greater satisfaction and higher reported higher yields under the program. Thus, subsidized fertilizer and at least monthly visits from extension agents are highly valued by the farmer who receive them, suggesting that these aspects of LUC should be emphasized as the program expands.

- **Although LUC is voluntary by law, many farmers felt some degree of pressure to participate and initially exhibited resistance to the program. Working with farmers to understand and address these concerns when rolling out the program to new areas should receive greater emphasis.** Twenty-four percent of farmers in our survey indicated that their participation in LUC was not voluntary. Concerns about coercion in joining the program were also raised in almost all of the focus group discussions. Moreover, 45% of farmers in our survey felt there had been resistance to the program when it was introduced. In addition, in contrast to LUC's emphasis on mono-cropping, just under one-third of respondents indicated that they would prefer to intercrop. Focus group discussions also revealed that farmers had concerns about switching to the LUC-prescribed crop, price fluctuations, and tensions between farmers who were not accustomed to working together on the consolidated plots. While our data cannot confirm the extent to which these perceptions were accurate, these results do highlight the importance of understanding farmers' concerns and taking them into account in program design.

- **Farmers tend to perceive positive trends in environmental outcomes overall with only a very small minority viewing them as having gotten worse following LUC.** The majority of farmers report improvements in soil fertility, the quality of erosion ditches and prevalence of soil erosion, fodder availability, livestock integration, and the prevalence of tree plantations. The only negative trend was related to the quantity of downstream water, with a slight majority reporting a decrease. It is important to bear in mind that these perceived

environmental trends are not necessarily attributable to the impacts of LUC itself, but rather reflect how the situation has changed since LUC was introduced.

- **Farmers tend to lack access to storage and post-harvest processing for crops, though these are part of CIP, which may prevent farmers from fully realizing the benefits of LUC.** Both the household survey and focus group discussions suggest that farmers lack of access to storage and post-harvest processing. In the household survey, only 22% of farmers had access to storage and only 12% processed crops post-harvesting, which was corroborated by the focus groups. As such, just over 59% of total output was sold on average. Inadequate access to storage and processing may be a limiting factor for maximizing sale of output and food security throughout the year, thus affecting agricultural revenue and household well-being.

- **Challenges in access to markets and good prices for CIP crops persist,** as revealed during focus group discussions with farmers. Possible avenues for ameliorating marketing challenges include provision of market information services, establishing crop collection points, linking farmers to contract farming opportunities, and forming cooperatives where they have not been established in order to strengthen farmer bargaining power.

- **The collection of accurate and systematic data on the LUC program should be improved.** Currently, data on LUC is not being collected in any consistent format, which makes it difficult for program managers to assess progress or compare different implementation experiences to uncover good and bad practices. Also, there is no clear mechanism to verifying the accuracy of the data sets available. A consistent reporting mechanism should be established for tracking the number of hectares included under LUC, the number of farmers participating and key outcomes for farmers related to agricultural productivity and household well-being.

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