The Impact of Land Use Consolidation Program on Agricultural Productivity: A Case Study of Maize (*Zea mays* L.) Production among Households in Nyabihu District, Western Rwanda.

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Abstract: The high population growth in Rwanda has resulted in land fragmentation and poor crop yields in many rural farms hence necessitating the government to introduce the land consolidation policy in the country with the aim of boosting crop yields and effecting rural household development. The purpose of this study was to determine whether the land consolidation policy is effective in boosting maize production yields among the maize growers in the sector. Specifically, the research analyzed maize production before and after the land consolidation policy. To achieve the objective of the study, a survey was conducted with 40 households selected randomly from Mukamira Sector where the policy was implemented from 2004. The results showed that maize production in the Sector increased by 347% from a mean yield of 2027.5 kg to 9071.9 kg per household per season as a result of the policy (p=0.05). According to chi-square test there is a significant relationship between maize income as a dependent variable, fertilizer use and land size as independent variables (p=0.05). However, two major constraints were observed that hamper maize production and these were the low output prices and small land holdings. This study concludes that land consolidation policy has had great impact in the sector due to increased use of mineral fertilizers, certified maize seeds and better crop husbandry practices. To overcome the low prices of maize grains, there is need for farmers to market their produce as cooperatives rather than as individuals so that they may consolidate their bargaining power as cooperatives. Input suppliers need to open businesses near the farmers to try and provide good service.

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1. Introduction

Rwanda's economy is largely agrarian. More than 80% of the Rwanda's projected population of 10.5 million depends on farming. The total land area of the country measures 24,700 square kilometers. Although about 79% of the country's land is classified as agricultural, only 11% of the land represents permanent crop land. The remaining agricultural lands are covered with forests, marshlands and marginal lands in the hillsides where permanent and routine cultivation of crops are not tenable. Of the total arable land of 2,294,380 ha, 1,735,025 ha is cultivated with food and cash crops and the remaining represents pastures and bushes. Over 80% of the population live in rural areas and subsist on smallholder farming.

With an average of 407 persons per square Km, Rwanda represents the most densely populated nation in the continent. Hence the land distribution is highly fragmented and skewed in Rwanda Land in Rwanda is the most valuable, productive and contested asset. Proper management of land is therefore a must. However, most of the laws governing land administration and management in the country had been formulated by the colonialist and have remained the same till 1990's. Several reforms and policies are under implementation in Rwanda, among these, the Land Use Consolidation policy is the key for agricultural transformation.

Land consolidation is sometimes incorrectly interpreted to be only the simple reallocation of parcels to remove effects of fragmentation. In reality, land consolidation has been associated with broader social and economic reforms from the time of its earliest applications in Western Europe. The first consolidation initiatives of Denmark in the 1750s were part of a profound social reform to free people from obligations to noble landlords by establishing privately-owned family farms. The consolidation of fragmented holdings did result in improved agricultural productivity but this was not the only objective of these reforms. This chapter illustrates the

wide range of rural development objectives, ranging from agricultural improvement to village renewal and landscape development and protection, which can be addressed through land consolidation projects. It describes various land consolidation approaches and concludes with an overview of conditions that should be put in place before land consolidation projects can be undertaken (FAO, 2003).

The overarching strategies of economic development and poverty reduction in Rwanda that envisions social transformation through agriculture require shifting from such subsistence farming to commercial oriented agriculture. In Rwanda, the growing demographic pressure on land and continued fragmentation of household's plots by inheritance forced the land use patterns to be inevitably re-organized. Volume of food crop production is a function of physical land area and the productivity of land under cultivation. Crop productivity, often measured as the ratio of farm outputs to inputs, reflects the efficiency of usage of inputs. However the efficiency of the inputs depends on the size of the farm land. Land fragmentation thus affects productivity and competitiveness of smallholder farms. Furthermore, the inherent difficulties in mechanizing farm chores in small farms also impede public and private investments.

The Land Use Consolidation Policy was enunciated in 2004 by the Government. The process of land consolidation, the method of reversing the action of land fragmentation, is not new in the World countries. In Britain land consolidation took place so long ago, that many writers and even experts tend to forget that it took place at all (Simpson, 1976). Some of the earliest attempts at land consolidation, as a method of land reform, took place in Scandinavia, particularly in Finland (FAO, 2003), Sweden (Osterberg and Petterson, 1992) and Denmark (Bins, 1950) in the 18th and 19th centuries. According to Clout (1987), at least half of Western Europe's farmland was considered to need consolidation in the 1950s, a time when Europe had pressing needs of reconstruction after the Second World War.

Land use consolidation had been also implemented in Central and Western European countries since 1989 as part of an overall strategy of transition from centrally planned agriculture to privatization and market development in order to increase farmer's revenues. It was also implemented in Latin America, Asia and Southern Africa to mitigate land fragmentation. In Kenya, the customary land tenure failed to meet the needs of an expanding population which then resulted in low subsistence levels and influenced land reforms needing land consolidation to stop further fragmentation in Kikuyu, Kiambu and Maranga Districts (Mackenzie, 1993).

The land use consolidation policy was implemented for the first time in 2008 by the Government of Rwanda, through the Ministry of Agriculture, as part of the Crop Intensification Program (CIP). The CIP was initiated by the same Ministry in September 2007 with a goal to increase agricultural productivity of high potential food crops and to provide Rwanda with greater food security and self-sufficiency. The implementation of this program involves various components, including Land Use Consolidation as the main pillar, the proximity advisory services to farmers, inputs (seeds and fertilizers) distribution and post-harvest technologies (e.g. driers and storage facilities).

The program is also supported by other initiatives like land husbandry, irrigation and mechanization infrastructure development to bring more land under production, avoid dependency on rain-fed farming system and use of farm power in the context of a market-oriented agriculture. The LUC policy is in line with Rwandan Government efforts to mitigate hunger and poverty. It correlates not only with CIP but also with the "Villagisation" known as new resettlement program "Imidugudu" which started earlier in 2004. Therefore, its implementation process involves various stakeholders (e.g. Ministries, NGOS, Civil Society Organizations and the Private Sector).

The implementation process of LUC Policy in Rwanda Land use consolidation is a multi-sector process. Although the technical plan for land use was drawn by MINAGRI through its implementing agency Rwanda Agriculture Board in conjunction with local administration authorities. Based on the agro ecological potential and the land area available in each district, the CIP estimates the consolidated area that can be grown with priority crops in each district. Through negotiations with district authorities, target figures are agreed and captured in the performance contracts of the respective districts. The district -and sector agronomist, IDPs in cells and Farmer Promoters (abajyanama bubuhinzi) in villages then mobilize the farmers for growing the priority crops in a consolidated fashion. At national level, stakeholders under the IDP steering committee framework include MINAGRI, MINALOC, MINIRENA, MININFRA, NGOs, Private Sector, Province and District authorities (RGB, 2012).

Eight priority crops (Irish potato, cassava, beans, maize, wheat, rice, banana and Soybean) have been selected for promotion under land use consolidation policy. The rotation system is based on comparative advantage, crop suitability in a specific agro-ecological zone and its contribution to the overall

food security. Crops like Irish potato, cassava, beans and maize have shown a competitive advantage with a positive trade balance, according to the recent cross - border trade study (MINAGRI, 2010).

In an effort to address both marketing and post-harvest challenges, the Government of Rwanda (GOR) has decided to establish driers and food storages facilities where land has been consolidated. Consolidated use of lands allows farmers to benefit from the various services under CIP such as: (i) efficient delivery of inputs (improved seeds, fertilizers), (ii) proximity extension services, (iii) post harvest handling and storage facilities, (iv) irrigation and mechanization by public-and private stakeholders and (v) Concentrated markets for inputs and outputs.

Maize is one of the major crops in Rwanda and is ranked fifth among food crops and second among cereals after sorghum. In 2000, approximately 32% of the land allocated to cereals production was occupied by maize MINAGRI (2001). Maize is currently cultivated in the whole country and is essentially intercropped with beans. Consumption of maize is consistently increasing and maize is becoming an important cash crop for small-scale farmers, especially in the maize growing regions. According to an earlier survey by the department of statistics, MINAGRI (1990), volume traded for the rural areas during that period was estimated at about 5,000 tons while in the year 2000 this figure was estimated to be about 50,000 tons. Maize supplies a high quantity of carbohydrates to the population. The crop has become popular especially in urban areas amongst manual laborers and is targeted by the ministry of Agriculture (MINAGRI), to contribute to the nutritional status of the population.

According to MINAGRI (2010), maize is currently fourth after bananas, sweet potatoes and white potatoes in providing energy per capita. Maize has more uses than any other cereals. It is used mainly as food for human consumption, but it is also the number-one feed grain in the country, being the main source of calories in animal feeding and feed formulation. Maize is one of the priority crops that have been chosen by the government of Rwanda in its effort to increase household incomes and the nutritional status of Rwandan people through increased production and marketing.

The statistics from the Ministry of Agriculture indicate that consolidated lands have been increasing since the policy's adoption, from 28,788 Ha in 2007 to 254,000 Ha in 2010 and 502,916 Ha in 2011. The same statistics show that maize and wheat production have increased six-fold. They also show that production of Irish potato and cassava has tripled while the production of rice and beans increased by 30% in the past 4 years. A survey conducted by the National Institute of Statistics Rwanda (NISR) revealed that poverty in the country has dropped by 11.8 percent since 2006. However, data to show the before and after the LUC progamme are minimal and hence the justification for this research in Nyabihu district one of the districts chosen by MINAGRI to implement the policy.

2. Material and Methods

This study was carried out in Mukamira sector (division), Nyabihu district, in Northern Rwanda in 2012. Nyabihu district is divided into 12 Sectors, namely, Bigogwe, Jenda, Jomba, Kabatwa, Karago, Kintobo, Mukamira, Muringa, Rambura, Rugera, Rurembo, and Shyira which are further subdivided into 73 Cells (Uwihanganye, 2008). The surface area of the district is 512 km^2 with a population of 280,210 and a population density of 541 people per km^2. Using simple random sampling method, a sample of 40 households was drawn from a sampling frame of the households in Mukamira sector. Using this sample, a household survey was conducted on each household and data collected. Data was analyzed using descriptive statistics and Friedman Test with the help of SPSS computer program. The demographic situation of the district is presented in Table 1.

Table 1: Basic indicators of health and hygiene in district

No.	Indicators related to the health	National indicators	Situation in 2007	Situation in 2012
1	General population	-	280,210	-
2	Life expectancy	55	49	**55**
3	Child mortality/000	50	20	**10**
4	Pregnancy mortality/0000	200	750	**500**
5	**Malnutrition of children%**	**10**	**20**	**10**

Source: Nyabihu District report (2007)

Through land use consolidation policy, Nyabihu District identified the paths in particular to develop irish potatoes, maize, and wheat, because these crops are specially adapted to the soil and climatic condition. Table 2 depicts the yields of crops planted in 2007 season A under land use consolidation.

Table 2: Production, yield and surface cultivated (Season 2007A).

Crop	Surface in ha	Yield in kg / ha	Productions in tons
Sorghum	0	0	**0**
Maize	5181	968	**5.013**
Wheat	3549	746	**2.647**
Rice	0	0	**0**
Beans	2667	715	**1.908**
Pease	192	661	**127**
Ground nuts	0	0	**0**
Soya beans	0	0	**0**
Banana	2569	6436	**16,534**
Irish potatoes	8741	7786	**64,167**
Sweet potatoes	1558	5836	**9,093**
Yams	821	4675	**3,838**
Cassava	690	6142	**4,238**
Market gardening	2318	7761	**17,991**
Fruits	1471	8186	**12,041**
Total	**29257**		**137,597**

The sample size for this study was based on the population cultivating maize under the land consolidation program. The following formula
n c = N X n / N+ n (Bouchard, 1995) was used to determine the sample size of 70 beneficiaries in Mukamira Sector, where N is the total population of the district; n is the selected sample from the study sector; and n c is the sample size. Therefore, n c= 70x96/70+96= 40.

The following formula n i= Ni x n/N was used to determine the sample size at cell level; where: n.i= the sample size proportion to be determined; n=the sample size; N=the total population and Ni= the population in stratum i. Interviews were conducted in the local language (Kinyarwanda) and data collected using a structured questionnaire. The questionnaire was written in English and translated to Kinyarwanda language to enable smooth administration of interviews.

The collected data were processed and analyzed using the SPSS programme (Statistical Package for Social Sciences version 17) to achieve both descriptive and inferential statistics. The Statistical tests applied include paired sample test, Chi-square test and Friedman Test.

3. Results

In Table 3, many farmers cultivated maize in Mukamira Sector. Maize has been chosen by Nyabihu District leaders in the LUC because that crop adapts easily to climate. About 51% of male and 429% of females (93%) of households surveyed cultivated maize crop. The varieties of maize cultivated before LUC is depicted in Table 2.

Table 3: Number of respondents who cultivated maize by gender in the sector

Products	Male		Female		Total	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Maize	22	51.2	18	41.9	40	100
Total	22	55	18	45	40	100

Table 4: Varieties of crops grown in Mukamira sector before LUC

Varieties	Frequency	Percentage
Nyirakagori	5	11.6
Manyiginya	14	32.6
Mayizeri	19	44.2
Others	2	4.7
Total	40	100

In Table 4, about 12% of households cultivated Nyirakagori, 32,6% (Manyiginya), 44,2% Mayizeri and 4,7% grew other varieties.

The types of fertilizers used by households growing maize are depicted in Table 5. In Table 5, only two types of fertilizers were used; organic manures and inorganic fertilizers. From Table 5, 23.3% of respondents used organic manures only as fertilizer before land consolidation program.

Table 5: Fertilizer types used

Fertilizers	Gender			
	Male	Female	Total	Percentage
Organic Manures	3	7	10	23.3
Mineral fertilizers	0	0	0	0
Both	0	0	0	0
Total	3	7	10	23.3

The trend of maize production before LUC is depicted in Fig 1.

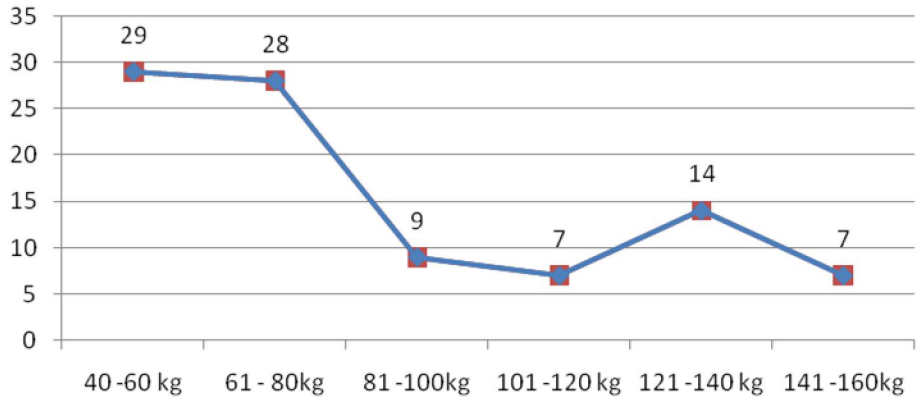

Figure 1: Situation of maize production before land consolidation

Figure 1 depicts maize yields produced by the respondents: 29% of households surveyed produced 40– 60 kg; 28% produced 61 – 80 kg; 9% produced 81– 100 kg, 7% (101-120 kg), 14% (121-140 kg) and 7% (141-160kg). Total production before land consolidation was 81,100kg for all farmers.

The varieties of maize after LUC are depicted in Table 6.

Table 6: Varieties of maize grown after land consolidation (LUC) by gender

Varieties grown	Gender			
	Male	Female	Total	Percentage
Tamira	3	4	7	17.5
Hybrids 6 x 18	8	7	15	37.5
Hybrids 6 x 3	8	4	12	30
Pool 9	3	2	5	12.5
Others	0	1	1	2.5
Total	22	18	40	100

Table 9 shows that four varieties of maize crop were cultivated after land consolidation in Mukamira Sector. A significant proportion grew hybrids 18 and 24. This indicates the increased access to selected seeds under the program**.** The proportion of households using organic manures, mineral fertilizers and both fertilizers is shown in Table 7.

Table 7: Fertilizers used after land consolidation program

Fertilizer types	Gender			
	Male	Female	Total	Percentage
Organic Manure	9	3	12	30
Mineral Manure	11	10	21	52.5
Both	2	5	7	17.5
Total	22	18	40	100

From Table 7, more than half of the households are using inorganic fertilizers (52.5%); 30% are using organic manures only and 17.5% are using both fertilizers.

The maize yields under LUC program is depicted in Fig 2. Figure 2 above indicates that 25% of households produced 100- 200 kg and 201 -300 kg; 17% (310-400 kg), 15% (401-500kg), 10% (501-600kg), 3% (601-700kg), 3% (701-800kg), and 3% (above 800kg). Total production of maize was 362,875kg for the 40 farmers.

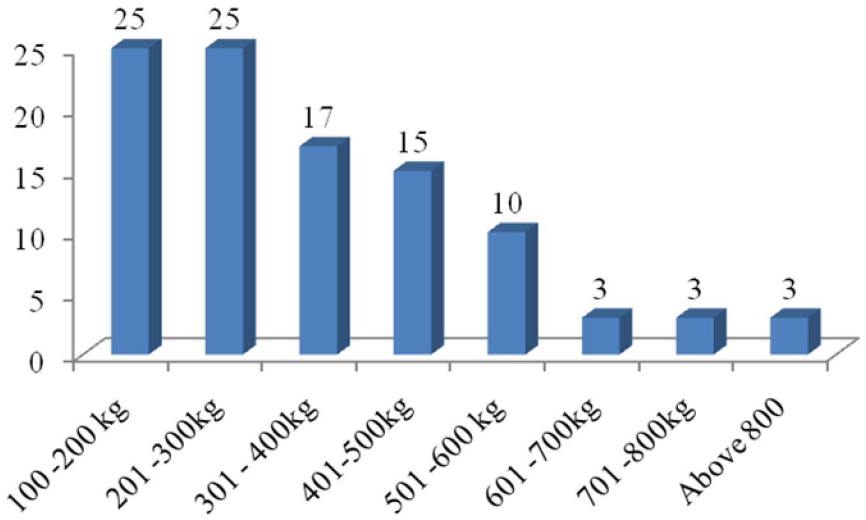

Figure 2: Maize yields after consolidation program

The average production of maize after land consolidation policy program shows that there is a 347% yield increase which indicates that land consolidation policy was very effective ($p<0.05$).

Table 8: Yield before land consolidation and after land consolidation

Kilograms	N	Average yield(kg)/household/season
Maize yield before	40	2027.5
Maize yield after	40	9071.875

4. Discussion

Land consolidation has always been regarded as an instrument or entry point for rural development. Early concepts of rural development were virtually the same as agricultural development because of the predominant role of agriculture in rural areas at the time. Improving the agrarian structure was viewed as being identical to maintaining the social viability in rural areas; what was good for the farmers was good for rural areas. An overall objective of early projects was thus to increase the net income from land holdings by increasing the volume of production and decreasing its costs. With this focus on agricultural development, these projects served to consolidate parcels and enlarge holdings and included provisions such as irrigation and drainage infrastructure to improve water management, construction of rural roads, land leveling, soil improvement measures and changes to land use such as converting agriculturally inferior land into forest land or wetlands (FAO, 2003). Such agricultural improvements are still essential but rural space is now no longer regarded as one of agricultural production alone. Concepts of rural development have become much broader and have expanded to include increased environmental awareness and a wide range of nonagricultural applications. The emphasis of land consolidation projects has shifted from a focus on restructuring

agriculture to one of achieving more efficient multiple use of rural space by balancing the interests of agriculture, landscape, nature conservation, recreation and transportation, especially when land is required for the construction of major roads.

The results of the survey indicate that Land Consolidation program has achieved some benefits to communities in the district through increased land use management awareness, adoption of improved maize varieties and fertilizers and thereby increasing substantially the per hectare household yields of maize.

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