

# **Population pressure and farm fragmentation: Challenges facing agriculture in Rwanda**

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## **Abstract**

*Small farmers play a dominant role in rural area in Rwanda according to many researchers. These farmers have some particular characteristics: most of them have tiny farms, while purchasing and borrowing of land are frequent. In addition, the size of farms is not only very small but farms are further fragmented into diminutive size fields due to increasing population pressure. The magnitude of fragmentation has increased overtime. Effects of population pressure and farm fragmentation are studied based on a survey of 200 households from Rusatira and Muyira ex-communes in Butare province, Southern Rwanda during 2001. As Rwandan household activities were homogeneous the investigation was limited to these two communes. Differential impact of population pressure is observed between the two areas in terms of household characteristics; land use and performance indicators; technology adoption and evaluation of farm information; land tenure and rights; and credit use and sources. Policies should be implemented to improve the functioning of land rental markets in order to reduce land fragmentation, improve rural education and access to relevant information; and strengthen extension facilities to individual farmers.*

## **Résumé**

*Les petits agriculteurs jouent, selon plusieurs études, un rôle dominant dans le secteur rural au Rwanda. Ces agriculteurs ont certaines caractéristiques particulières: la plupart d'entre eux ont des minuscules exploitations agricoles, et l'achat et la location de la terre sont fréquents. En outre, la taille des exploitations agricoles est non seulement très petite mais elles sont également dispersées dû à la pression de la population croissante. L'ampleur du morcellement de la terre s'amplifie d'années en années et ses effets, et ceux de la pression de la population, sont étudiés sur base d'une enquête de 200 ménages des ex-communes de Rusatira et de Muyira dans la province de Butare, au Sud du Rwanda en 2001. Comme les activités des ménages rwandais sont homogènes, l'enquête s'est limitée à ces deux communes. Un impact différentiel de la pression de la population est observé entre les deux communes en termes de caractéristiques de ménage; d'indicateurs de performance et utilisation de la terre; d'adoption de technologie et évaluation d'information agricole; de droit foncier; et de sources et utilisation du crédit. Des politiques devraient être mises en application pour améliorer le fonctionnement du marché foncier afin de réduire le morcellement de la terre, améliorer l'éducation rurale et accéder à l'information appropriée; et renforcer la vulgarisation agricole.*

## 1. INTRODUCTION

Rwanda, with a surface area of 26,338 km<sup>2</sup>, is one of Africa's smallest countries, but exhibits the highest population density of all African countries based on a World Bank (1997) report. Agriculture is the dominant economic sector. However, Rwandan agriculture is beset by many problems. Waller (1993) identified the major obstacles to be a strong rural population, farm fragmentation, shortage of skilled manpower, technological backwardness, fragmentation of holdings, and limited infrastructure. In addition, a decline in agricultural production during the mid 1990's was attributed to factors including limited supplies of chemical inputs, lack of tenure security, resource depletion, adverse weather conditions, improper sectoral and macro economic policies, and inefficient marketing practices (World Bank, 1997). Strong population growth coupled with poor economic growth in other sectors have intensified these pressures. Identification of strategies and policies that shall contribute to the realization of a sound agricultural development policy in Rwanda is thus crucial for the stable future of this country.

The primary focus of the article is to examine population pressure and farm fragmentation in the study area, where farm fragmentation is defined as farmers operating two or more geographically separated tracts of land, taking account of the distances between those parcels. As population continues to increase, farm size declines while farm fragmentation occurs. The average farm size is 0.71 hectares per household (MINAGRI, 2000) with, however, some variation between regions. Research on land fragmentation often identifies it as the source of inefficiencies in agricultural production (Scott, 1987). In particular, the extent of farm fragmentation is assessed and reasons for farm fragmentation are identified; and the effects of farm fragmentation are investigated through relating land use intensiveness and labour use to farm size. Results are discussed with respect to their policy implications for agricultural development in Rwanda.

*Data for this article were collected during 2001 from 100 randomly selected households in each of Rusatira and Muyira communes using a standardized questionnaire. Farms studied are privately owned, and varied from 0.04 to 6 hectares. The size of farm only included land operated by each household (allocated land cultivated and all land rented in). Lands left idle and lands rented out were excluded.*

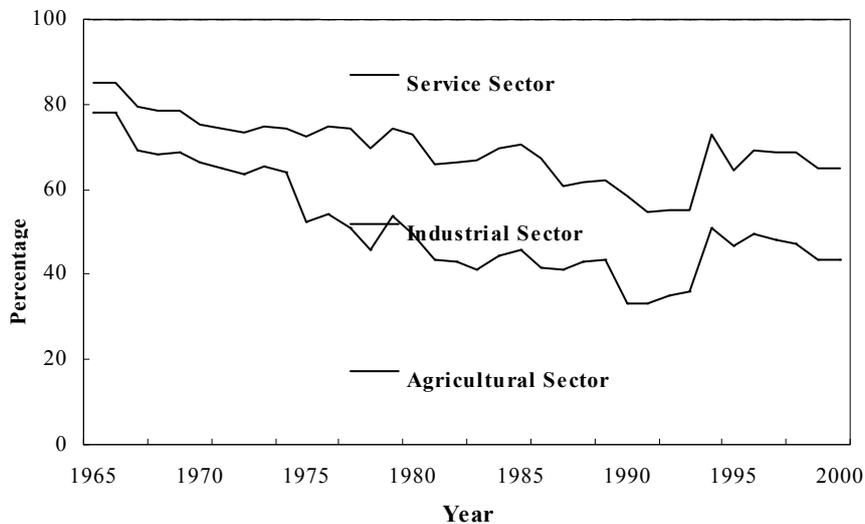
## 2. BACKGROUND TO THE STUDY

### 2.1 Characteristics of Agriculture in Rwanda

Agriculture is the most important sector of Rwanda's economy and a great part of the Rwandan population live in rural areas. It accounts for 40 percent of Gross Domestic Product - GDP (Figure 1), about 85 percent of total exports are agricultural, making it a leading foreign exchange earner (World Bank, 2002). More than 90 percent of the economically active population derives its livelihood from agriculture. Further, the expanding labour force is expected to be absorbed in the agricultural sector. Undoubtedly the significance of this sector will continue in the years to come.

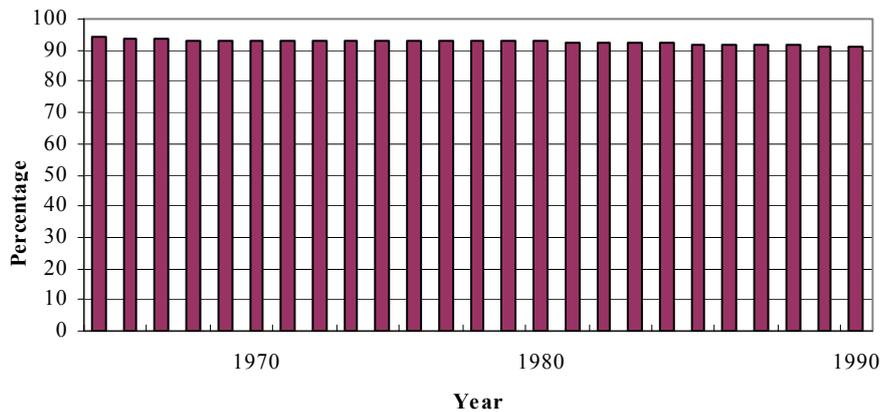
Figure 1 presents the composition of the three economic sectors in GDP. It indicates that the proportion of the agricultural sector has continued to decline. The share of the agricultural sector, which occupied around 80 percent of the GDP at the beginning of the 1960s, is about 40 percent today. Although the proportion of the agricultural sector in GDP has declined, its importance in employment has not changed at all. Figure 2 shows the proportion of the working population in the agricultural sector.

**Figure 1: Proportion of economic sectors in Rwandan GDP (1965-2000)**



Source: World Bank (2002)

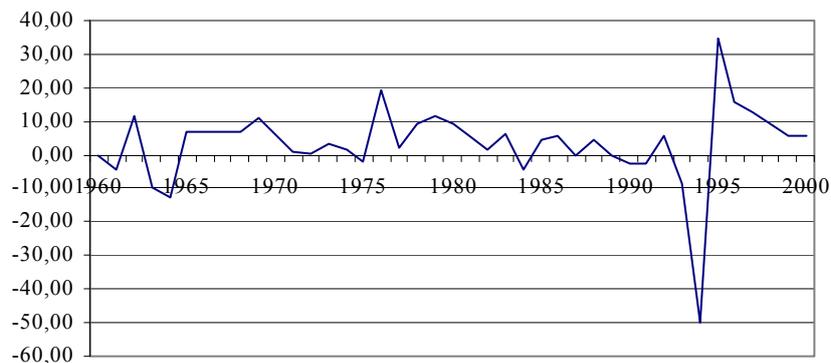
**Figure 2:** Proportion of the working population in the agricultural sector (1966-1990)



Source: World Bank (1999)

By analyzing the evolution of Rwandan real GDP growth rate in detail, it is clear that it is closely related to that of the agricultural sector. The growth rate, having increased up to the mid 1980s, declined thereafter to a level lower than the annual population growth rate. Such an evolution of GDP corresponds to the crisis of the agricultural sector. Figure 3 shows the evolution of real GDP growth rate.

**Figure 3: Rwandan real GDP growth rate (1960-2000)**



Source: World Bank (2002)

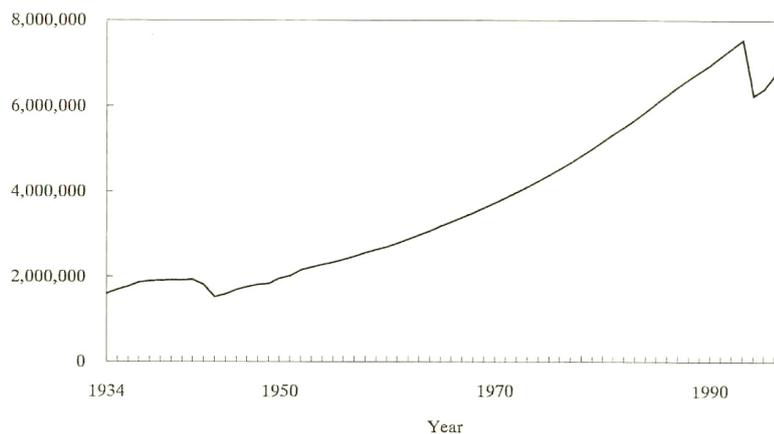
According to Takeuchi and Marara (2000: 8), there are at least two reasons to explain the stagnation of the agricultural sector. At first, the price of coffee - the most important of export goods - in the world market fell

sharply in the 1980s. This sudden decrease in coffee price, in addition to the fall of other export goods such as tin, triggered the Rwandan economic crisis. Secondly, some researchers insist that the Rwandan agricultural production system had reached its limit before the 1980s, thus causing the stagnation of food production. André (1997) argued that the cause of this food shortage could be attributed to the limit of land utilization. André (1997) further asserts that, although the agricultural method with intensive land use has developed in Rwanda, it could no longer work in the 1980s because of excessive land fragmentation.

## 2.2 Population Pressure

Rwanda remains one of Africa's most densely populated countries, with more than 290 inhabitants per square kilometer. This is certainly more than 400 if calculated from the area of cultivated land, which is undoubtedly the highest level in Africa (World Bank, 1999). The rate of population growth is very high, with the fertility rate around 8.3 and the annual population growth rate estimated at 3.1 percent (MINECOFIN-ONAPO, 1998). Various population projections have been calculated. It is estimated that on a medium growth rate hypothesis (World Bank, 1999), the population will double over the next 20 years (to 16 million inhabitants in the year 2022). If the above-mentioned population growth estimate is correct, the density shall rise to 865 inhabitants per arable square kilometer in 20 years. There is thus considerable pressure on the land, and it is increasing at a considerable rate, making population pressure one of the country's major challenges. Figure 4 depicts an increasing linear curve for Rwanda's population growth for periods between 1934 and 1997.

**Figure 4. Population of Rwanda (1934-1997)**



Sources: 1934-1964: ONAPO (1990)  
1965- 1997: World Bank (1999)

Another important characteristic of the Rwandan population is that a large majority of the population live in rural areas: urbanization has not yet developed. The proportion of the urban population was only around 5 percent in 1991 (MINECOFIN-ONAPO, 1998). In this sense, a strong rural population coupled with land fragmentation will have a considerable impact upon the development of Rwandan agriculture.

### 2.3 Patterns and Farm Size

In Rwanda, farms are small and often fragmented. The overall average farm size is 0.71 hectares per household (MINAGRI, 2000). There is, however, some variation in the average farm size between regions: the highest average farm size being 1.26 hectares (Gikongoro) and the lowest 0.37 hectares (Cyangugu) (MINAGRI, 2000). The average farm size in Butare is 0.48 hectares (Table 1). With respect to the patterns of farm size, about 79 percent of all households in Rwanda (and about 89 percent in Butare) have 1 hectare of land or less. Only 6 percent of all households in Rwanda (and 2 percent in Butare) have two hectares or more (Table 2).

**Table 1 Average farm size (in ha) in Butare compared to the national average, 2000**

	Farm size category (ha)							Total
	<0.25	0.25 - 0.50	0.50 - 0.75	0.75 - 1.00	1.00 - 2.00	2.00 - 3.00	>3.00	
Butare (ha)	0.14	0.35	0.60	0.85	0.142	0.219	0.393	0.48
RWANDA (ha)	0.14	0.36	0.62	0.86	0.138	0.238	0.511	0.71

Source: MINAGRI (2000)

**Table 2. Patterns of farm size in Butare compared to the national average, 2000**

	Farm size category (ha)							Total
	<0.25	0.25 - 0.50	0.50 - 0.75	0.75 - 1.00	1.00 - 2.00	2.00 - 3.00	>3.00	
Butare (%)	41	27	14	7	8	2	1	100
RWANDA (%)	29	26	16	8	15	4	2	100

Source: MINAGRI (2000)

## 3. LITERATURE REVIEW

### 3.1 Farm Size

Obtaining a universally accepted definition of farm size has been one of the problems encountered in farm size and efficiency studies (Mbowe, 1996). A review of literature, however, suggests that numerous definitions of farm

size have been adopted, ranging from acreage, value of farm products sold, days worked off-farm (for small-scale farms), level of farm income, to the level of total family income. Many authors combine two or more of these definitions. Farm size has commonly been taken to be synonymous with farm acreage because it can easily be ascertained and is easy to understand.

However, Britton and Hill (1975:15) state that when it becomes necessary to specify the criterion of size of a farm as a business, acreage is shown to be rather unsatisfactory indicator of business size. This is because the proportions in which land and other factors (labour, capital and so forth) combine in production vary between types of farming, and also between farms of the same type. Britton and Hill (1975:15), further argue that the 'best' unit of measurement of farm size, and size of enterprises within farms will depend on the purpose for which the measurement is to be used. In this article acreage was used as a measure of farm size as agricultural potential appears fairly homogeneous in the area, as suggested by Kay (1981).

### **3.2 Property Rights**

"Property rights specify the norms of behaviour with respect to economic goods that all persons must observe in their interactions with other people or bear the penalty cost of non-observance" (Pejovich, 1990). Johnson, cited by Barrows and Roth (1990), argues that efficiency requires a clear definition of rights, meaning that these must be established and allocated to specific individuals or groups, must be easy to identify and verify, and must have legal and tenure certainty. The greater the ambiguity in property rights the higher the transaction costs in discovering the owner, in making and enforcing a lease or sale contract, and the higher the residual uncertainty remaining after any given expenditure to identify ownership (Barrows and Roth, 1990).

Variants in forms of land tenure cause a range of optimal farm size in countries at various stages of economic development (Heady, 1971). Tenancy and small-sized farms are generally related in terms of the problems that they generate (Medina, 1980). Communal land tenure creates incentive problems to invest in land improvements, and tenancy arrangements that restrict farm sizes affect farm productivity (Lyne and Nieuwoudt, 1991).

High population pressure in Rwanda is a major factor leading to scarcity of farming land, reducing farming activities to small-sized farm units (Waller, 1993). Furthermore, the inheritance laws, which divide a family's land among all the remaining sons, ensure that, as the population increases, not only does the size of holdings fall, but also they are increasingly fragmented into small plots, scattered over a wide area.

Some authors (Johnson, 1972; Barrows and Roth, 1990) state that the traditional African system of “communal” land tenure has been empirically demonstrated by economists as inefficient when land has scarcity value. Since property rights are not broad enough, costs and rewards are not internalized, and contracts are not legal or enforceable (Barrows and Roth, 1990). Individualized freehold tenure, on the other hand, is viewed as superior because owners are given incentives to use land efficiently and leads to the maximization of agriculture’s contribution to social well being (Barrows and Roth, 1990).

In this study, land tenure was one of the important considerations in the selection of the study sample. Land rights are not defined according to land titles. None of the sampled farmers in the study area possessed a legal title for any parcel.

### **3.3 Farm Fragmentation**

Research on land fragmentation often focuses on fragmentation as the source of many problems in the agricultural sector with fragmentation identified as the source of significant inefficiencies in agricultural production. Land fragmentation is a characteristic of farms throughout the world. The 1970 Food and Agriculture Organization’s *World Census of Agriculture* estimates that 80 percent of the world’s farmland is fragmented. This is based on fragmentation defined as farmers having two or more plots of land per operational holding.

The negative impact of fragmentation on the agricultural sector as a whole is stressed by several studies (Scott, 1987; Mosher, 1966; Dahlman, 1980, and Gebeyehu, 1995). The most often cited cause of fragmentation is that holdings are fragmented when farms are divided among heirs.

According to Scott (1987: 22), problems of land fragmentation discussed in the literature may be categorized into four categories: physical problems arising from scattered plots, problems in achieving operational efficiency on the farm, problems in improving the land, and problems external to the farm. Scott (1987) further observes, “it is a commonplace description about African agriculture that fragmentation of holdings is the biggest single obstacle to better farming”. Another problem arising from land fragmentation cited by Dahlman (1980: 95) is the complication of keeping property rights to a multitude of scattered plots clearly defined. The conclusion that analysts inevitably reach with this approach is that lands should be consolidated.

Among the benefits of land fragmentation found in the literature, the risk reduction theory has probably gained the most widespread acceptance (Scott, 1987). Fragmentation of holdings is used as a risk averting mechanism against the unpredictable impact of weather, pests, diseases

and other natural calamities on crop yield (Gebeyehu, 1995). In addition, subsistence farmers can get access to varied soil types of different fertility status, which enable them to grow a variety of crops.

A second benefit of land fragmentation focuses on labour market imperfections. Fenoaltea (1976) points out that fragmentation could increase output by increasing available labour. Farmers sought to get as much labour time as possible from family members before hiring outside workers because of the high information costs and incentive problems in labour market transactions. McCloskey, as cited by Scott (1987: 31), states that labour demand redistribution is possible due to land heterogeneity.

A third benefit of land fragmentation that has gained recognition in the literature focuses on land needs in both crop production and livestock. According to Dahlam (1980: 125), land fragmentation was a means of enforcing participation in the common grazing of livestock while maintaining independent crop production. With farmers' lands merged, the costs of raising livestock independently would have been prohibitively high.

In this article, two measures of fragmentation were retained. One corresponding to the simple definition of fragmentation found in the literature, *number of plots cultivated*, and a second which incorporates an associated characteristic of land dispersion, *distance between parcels*.

#### **4. DESCRIPTION OF STUDY AREA, SAMPLING PROCEDURE, DATA COLLECTION AND ANALYSIS**

##### **4.1 Description of Study Area**

The study area chosen for this research was Butare province, Southern Rwanda. Butare is located about 148 kilometers South of Kigali (the capital city). It covers an area of 1690 square kilometers. It has a population of approximately 722,616 inhabitants (SNR, 2003). As Rwandan farm operator activities were homogeneous the investigation was limited to two communes<sup>3</sup>, Rusatira and Muyira. These communes are respectively 97 and 135 square kilometers in extent and have respective population densities of 289 and 255 inhabitants per square kilometer (Province annual report, 2000). The annual population growth rate is estimated at 3.1 percent (MINECOFIN-ONAPO, 1998). Four sectors were chosen as survey sites in each commune. Rusatira, Kinazi, Kabona and Buremera were chosen from Rusatira commune and Matara, Mulinja, Kibirizi and Mbuye from Muyira communes. These study areas were chosen because they have the highest population densities in the central plateau.

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<sup>3</sup> The current Rwandan local administration comprises four levels: Province - District - Sector - Cell. The sector population is generally several thousands, while the cell population is around several hundreds

Geographically the two communes are similar. They have similar climates. Temperatures vary little, ranging from 18 °C to 24 °C. Annual rainfall averages between 1,500 mm and 2,000 mm and is well distributed throughout the year. Both communes have a mountainous landscape, with altitude ranging from 1,400 to 2,000 m above sea level but differ in that Muyira is a planned commune whereas Rusatira is not, which accounts for farms being on average larger in Muyira (3.30 hectares) than Rusatira (1.50 hectares).

#### **4.2 Sampling Procedure and Data Collection**

The main objective of this study was to collect socioeconomic data that will be useful for understanding the environment for rural farming. This study was based on primary and secondary data sources. The primary data were collected by the author using a standardized questionnaire that consisted of both closed and open-ended questions. The secondary data were obtained from various sources such as; records of agricultural offices in the respective study areas, published official statistics, official reports, books and maps.

The collection of data was performed in two ways: the author and trained field assistants held interviews with respondents using the standardized questionnaire. Field observations were made and open discussions were held with farm operators both individually and collectively as well as with agricultural officials on issues such as the magnitude of agricultural land fragmentation, average costs per unit of production and degrees of technology adoption.

The survey collected information on farm operator and farm business characteristics, and in particular details of coffee production on these farms. Questions were designed to be answered by household heads who typically manage farm operations in Rwanda. In addition to the survey of households, some questions were posed to agricultural officials in order to obtain data at regional and national levels.

Data for this research were collected from December 2000 to February 2001 from one hundred randomly selected households involved in agriculture in each of Rusatira and Muyira communes. The sample was selected at random from a list of households provided by extension officers in the two study areas.

#### **4.3 Data Analysis**

The statistical method employed in the analysis reported in these pages is mostly descriptive, using means and the range of the relevant indicators. All variables were tested using the Pearson correlations test. The variables were placed in two categories, continuous and categorical; and were tested

for statistically significant differences between study areas, using one of the following statistical tests depending on their type and distribution as described by Siegal (1956):

The **t-test** to determine significant differences between two continuous variables with normal distributions;

The **Mann-Whitney test** to determine significant differences between two continuous variables with skewed distributions;

The **Chi-square test** in the analysis of categorical variables with larger frequencies

The variables used are presented in Table 3, along with their definitions and measurement.

**Table 3: Variable definitions and measurement**

Farm size	:	Hectares
Area under coffee	:	Hectares
Gender	:	Dichotomous (1,0) one for male, zero otherwise
Education	:	Scale ranging from zero to three to symbolize; no education, grade 6 and below, grade 7 to grade 12, and tertiary education, respectively.
Farming occupation	:	Dichotomous (1,0) one for full-time, zero otherwise
Soil analysis	:	Dichotomous (1,0) one if farm operator ever had farm soils tested, zero otherwise
Use of fertilizer	:	Dichotomous (1,0) one if fertilizer is used, zero otherwise
Training	:	Dichotomous (1,0) one for training, zero otherwise
Workshops attended in two years	:	Continuous number
Field extension officer visits	:	Scale ranging from zero to four (i.e., none, 1-3 times, 4-6 times, 7-9 times, and 10+ times, respectively)
Assessment of farm information sources	:	Likert-type scale ranging from zero to three representing rankings; not useful, less useful, useful, and very useful; respectively:
1. Economic advisors		
2. Experiment stations		
3. Field extension officers		
4. Field demonstrations		
5. Other farmers		
6. Farm magazines		

## **5. RESEARCH FINDINGS**

### **5.1 Household Characteristics**

Households' characteristics illustrating a demographic profile of respondents in the sample are presented in Table 4. Table 5 illustrates characteristics specific to land use and performance indicators in the two study areas. Table 6 shows evaluation of farm information by farm operators in the two study areas. Table 7 illustrates land tenure and rights; Table 8 shows prevalence of land rights in the study areas while Table 9 presents the relationship between population density, cropping intensity, farm practices and proportion of fallow land.

#### **Demographic Characteristics**

Table 4 compares personal and demographic characteristics between study areas. The farm operators in Muyira appear to be younger (44 years) compared to 52 years for Rusatira. With regards to gender of the household head, there is a difference between the two areas, with Muyira recording 79 percent male heads of household, compared to 71 percent for Rusatira. Gender was captured as a dichotomous variable, 1 for male head and 0 otherwise. Average farm size is 1.5 hectares and 3.3 hectares for Rusatira and Muyira<sup>4</sup>, respectively. With regards to formal education<sup>5</sup>, there is a difference between the two areas, with Muyira recording an education level of above grade 7, compared to grade 6 and below in Rusatira. Data on farmers' education were captured using the scale ranging from zero to three to symbolize; no education, grade 6 and below, grade 7 to grade 12, and tertiary education, respectively. Such categorization in the different levels of education had to be followed due to difficulties experienced by respondents in stating the exact number of years taken to attain a certain standard of education. A difference in the mean years of farming experience between farm operators in Muyira and Rusatira was observed (with 20 years for Muyira compared to 24 years for Rusatira). The mean size of sample households for Muyira was 4.5 members, while Rusatira had an average size of 5.0 members.

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<sup>4</sup> The relatively high average farm size reported in the study areas may be attributed to the fact that most of the sample farmers operated on lands belonging to relatives who died during the 1994 genocide.

<sup>5</sup> In Rwanda, formal education comprises six years for primary school, six years for secondary school, and four to five years for university.

**Table 4: Mean difference in farmers' personal and demographic characteristics in Rusatira and Muyira, 2001**

<b>Characteristics</b>	<b>Rusatira (n=100)</b>	<b>Muyira (n=100)</b>	<b>Significance</b>
Age (years)	52	44	.000 <sup>2</sup>
Gender (% male)	71	79	.000 <sup>3</sup>
Farm size (Ha)	1.5	3.3	.000 <sup>1</sup>
Education	0.8	1.3	.000 <sup>2</sup>
Farming Experience (years)	24	20	.006 <sup>1</sup>
Household Size (people)	.50	4.5	.053 <sup>1</sup>
Full-time Farming (%)	85	76	.000 <sup>3</sup>
Training	0.60	0.92	.000 <sup>3</sup>
Training workshops attended in two years	1.72	3.52	.000 <sup>2</sup>

Where<sup>1</sup> t-Test, <sup>2</sup> Mann-Whitney Test, <sup>3</sup> Chi-square Test. Figures in parenthesis represent valid cases.

Farming is a full-time occupation to 76 percent of farm operators in Muyira with 92 percent having received practical training in coffee growing, attending over three training sessions on average in two years. Eighty five percent of farmers in Rusatira are full-time farmers, and 60 percent have been trained in coffee growing with an attendance rate of one training session on average in two years.

Rwanda is a country in the very early stages of development with the overwhelming majority of the population economically dependent on land exploitation (Waller, 1993). There are negligible employment opportunities in the non-agricultural sector. Aside from the effects of particular social and political factors, according to Huang (1973), the average farm size is primarily determined by the population-land ratio in such a situation. The greater the population-land ratio the smaller the expected average farm size.

Lyne (1989) showed that even in the rural parts of the former KwaZulu homeland, high population pressure is a major factor leading to scarcity of farming land, reducing farming activities to small-sized farm units. Nieuwoudt (1990), further argued that compared with wage employment for skilled workers, farms of this size cannot produce attractive incomes, even under optimal technological conditions.

Off-farm employment exposes the farm operator and other members of farm households to outside opportunities, and so influences off-farm migration (Huang, 1973). This migration will release land to be used by the remaining farmers, thus increasing farm size. Different off-farm employment opportunities could arise because (a) of an improvement in off-farm income; or (b) an improvement in the farmer training or education

which enables him to obtain a job outside of agriculture. If it is due to (a) then it needs to be hypothesized that labour is not perfectly mobile otherwise the difference in off-farm income will disappear in different areas. Off-farm job opportunities in the study appear largely a function of education of the head of the household (Pearson Correlation = 0.55; correlation is significant at the one percent level of probability), which differ in the two areas. This implies that improving education will improve labour mobility from agriculture.

## 5.2 Land Use and Performance Indicators

From Table 5 significant differences in the means of selected land use characteristics and performance indicators are visible between the study areas. The ratio of rented land is relatively higher in Rusatira with 17.6 percent, compared to 12.2 percent in Muyira. However, the difference is not significant but demonstrates that the proportion of land rented falls with increase in size of farm operated. This is evidence on the other hand that land transactions take place in both communes, an indication that the sample was drawn from farm operators possessing secure land tenure rights. Muyira has a relatively high percentage of land under coffee, utilizing 37.2 percent of operated land as compared to the 33.9 percent in Rusatira. Coffee production contributed about 75 percent of gross total farm income in both Rusatira and Muyira. Even if no significant difference in the average coffee income per gross farm income between the two study areas was recorded, this shows that coffee growing is the most important farm activity on farms studied in both areas. Average number of plots cultivated - characteristic of land fragmentation - is 3.1 and 1.8 for Rusatira and Muyira, respectively. The geographic dispersion of land parcels, another dimension of land fragmentation, is here operationalized as the total “distance” (in kilometers) between each parcel cultivated and the household residence. The average distance traveled varied from 1.35 kms for Rusatira to 0.95 kms for Muyira.

If one takes the average distance between parcels and the number of plots cultivated in both study areas, this suggests that the distance involved is so long that it takes a considerable amount of the farmers’ working time.

**Table 5: Mean difference in land use and performance indicators between Rusatira and Muyira, 2001**

Land Use	Rusatira (n=100)	Muyira (n=100)	Significance
Rented land per total farm size (%)	17.6	12.2	.270 <sup>2</sup>
% of area under coffee	33.9	37.2	.059 <sup>1</sup>
Coffee income per gross farm income (%)	75.4	75.0	.246 <sup>2</sup>
Number of plots cultivated	3.1	1.8	.000 <sup>2</sup>
Distance between parcels (km)	1.35	0.95	.000 <sup>2</sup>

<b>Performance Indicators</b>			
Average Yield of coffee (Tons/Ha)	0.54	0.69	.000 <sup>2</sup>
Net Income (RWF/Ha) <sup>(i)</sup>	1728	3808	.000 <sup>2</sup>
Input costs (RWF/Ha) <sup>(ii)</sup>	525	456	.000 <sup>2</sup>
Labour costs (RWF/Ha) <sup>(iii)</sup>	1358	1385	.808 <sup>2</sup>

Where <sup>1</sup> t-Test, <sup>2</sup> Mann-Whitney Test. RWF denotes Rwandan Franc (During April 2005, \$1 = 570 RWF) <sup>(i)</sup> Net income reflects returns to management, rent earned on land and other fixed inputs. <sup>(ii)</sup> Includes farm variable costs. <sup>(iii)</sup> Includes family and hired labour costs. Figures in parenthesis represent valid cases.

With regards to measures of economic performance considered, the average yield of coffee on farms in the two study areas was relatively lower in Rusatira (0.54 tons/ha), compared to Muyira (0.69 tons/ha). Net farm income per hectare is substantially higher in Muyira (3808 RWF) compared to Rusatira (1728 RWF). Input costs per hectare are lower in Muyira (456 RWF), compared to Rusatira (525 RWF). Quantity discounts on bulk purchase of inputs like fertilizers and herbicides may explain the lower input costs per hectare on the larger-scale farms. No significant difference in labour costs per hectare between the two study areas was recorded. Labour costs per hectare (including family labour costs) were found to be 1358 RWF in Rusatira and 1385 RWF in Muyira.

### 5.3 Evaluation of Farm Information

Table 6 shows significant differences in mean evaluation of farm information sources between the study areas. Data on farm information sources available in the Rwandan coffee industry were captured on a Likert-type scale ranging from zero to three representing rankings; not useful, less useful, useful, and very useful, respectively, indicating the farm operators' assessment of the usefulness of farm information sources. This reflects the relevance of issues discussed when farm operators seek external extension assistance (Zinnah *et al.*, 1993). Information is the average score of the ratings for all the farm information source data.

Visit by field extension officer (VST) is an index ranging from zero to four (i.e., none, 1-3 times, 4-6 times, 7-9 times, and 10 + times, respectively) positively related to the number of field extension officer visits received by the farm operator in the last two seasons. The categories of the variable VST were determined after a means test showed significant changes in adoption of farm practices and farm visits by extension officers at the above intervals.

**Table 6: Mean difference in farmer's evaluation of sources of farm information in Rusatira and Muyira, 2001**

<b>Farm Information Sources</b>	<b>Rusatira (n=100)</b>	<b>Muyira (n=100)</b>	<b>Significance</b>
Field extension visits	1.01	2.25	.000 <sup>1</sup>
Economic advisors	0.32	1.15	.000 <sup>2</sup>
Experiment station	0.46	0.93	.001 <sup>2</sup>
Field extension officer	1.49	1.58	.511 <sup>1</sup>
Field demonstration	0.65	0.98	.027 <sup>2</sup>
Other farmers	1.37	1.2	.261 <sup>1</sup>
Farm magazines	0.08	0.62	.000 <sup>2</sup>
Information	0.73	1.08	.000 <sup>1</sup>

Where<sup>1</sup> t-Test, <sup>2</sup> Mann-Whitney Test. Figures in parenthesis represent valid cases.

Direct interaction with extension officers is the most important source of farm information, due probably to the high frequency of seasonal visits by extension officers (the mean of 1.49 and 1.58 in Rusatira and Muyira, respectively, indicate the number of visits - one to three - received by farm operators in both communes). But overall, farm operators in Muyira turn to a relatively wider source of information for technical advice.

Agricultural training status of the principal farm decision-maker is expected to bear positively on farm size (Berger *et al.*, 1984: 33). The higher the level of farmer's training the larger the farm size. Training may assist off-farm migration. It may also enable farmers to operate larger acreages.

#### **5.4 Land Tenure and Rights**

Table 7 shows significant differences in means of selected tenure characteristics between study areas. All these selected variables were captured as dichotomous variables, equal to one for yes, otherwise zero. None of the sample farmers in the study areas possessed a legal title for any parcel. With regards of tenure certainty, 42 percent of farm operators in Rusatira felt assured of their long-term tenure, compared to 54 percent of farm operators in Muyira. The percentage of farm operators who made any fixed improvements on their land is relatively higher in Muyira 51 percent, compared to 40 percent in Rusatira. Land purchases (and sales) are much less common, accounting for 18 percent (3 percent) and 10 percent (7 percent) of operated parcels in Rusatira and Muyira, respectively. Land disputes over ownership of boundaries (in the past five years) reported in the sample correspond with 11 percent in Rusatira, compared to 9 percent in Muyira.

**Table 7: Mean difference in land tenure characteristics between Rusatira and Muyira, 2001**

<b>Tenure Characteristics</b>	<b>Rusatira (n=100)</b>	<b>Muyira (n=100)</b>	<b>Significance</b>
Possession of title deed for land (% yes)	0	0	
Tenure certainty (% yes)	42	54	.090 <sup>3</sup>
Make improvements on land (% yes)	40	51	.103 <sup>3</sup>
Sale of land (% yes)	3	7	.000 <sup>3</sup>
Buy additional land (% yes)	18	10	.000 <sup>3</sup>
Land disputes (% yes)	11	9	.000 <sup>3</sup>

Where<sup>3</sup> Chi-square Test. Figures in parenthesis represent valid cases.

Tenure certainty was measured through farmers' judgment as to whether they feel assured of their long-term tenure or not. Tenure certainty is expected to positively influence farm size, given that farmers are more likely to improve parcels over which they have a long-term interest, both in terms of their rights to cultivate the land on a continuous basis and to dispose of the land in ways that provide adequate compensation for the value of any improvements (Place and Hazell, 1993). Tenure certainty in the study appears to be positively correlated with the level of land improvement (Pearson Correlation = 0.39; correlation is significant at the one percent level of probability), indicating that tenure certainty motivates farmers to make improvement on their lands.

With regards to land rights, Table 8 shows that the right to sell is prevalent with 42 percent and 54 percent of all parcels in Rusatira and Muyira, respectively. Nevertheless, restrictions on transfer rights do exist in the study areas, and they are even greater when the need to obtain family approval is taken into account<sup>6</sup>. For example, only 18 percent and 16 percent of the permanently held parcels can be sold without approval, whereas 24 percent and 38 percent can be sold with approval in Rusatira and Muyira, respectively.

<sup>6</sup> Transfer rights were subdivided depending on whether or not the farm operators needed to obtain family approval before selling.

**Table 8: Prevalence of land rights in Rusatira and Muyira, 2001**

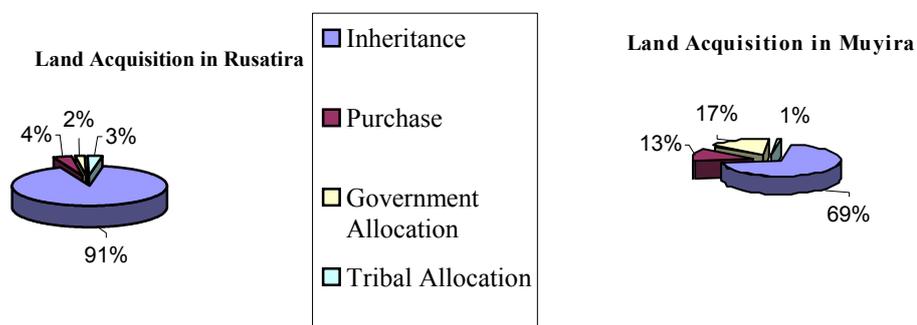
Land Rights	Rusatira	Muyira
	(Percentage)	
Permanently held parcels		
No right to sell	58	46
Right to sell with approval	24	38
Right to sell without approval	18	16

Although not shown in the table, there is considerable variation within the study areas in land rights across parcels and often across parcels operated by the same farm operator. Land rights are not defined according to land titles. None of the sampled farmers in the study areas possessed a legal title for any parcels.

The majority of parcels in both study areas were acquired through non-market channels such as inheritance, gift, government allocation, and appropriation. Inheritance is by far the most common method of land acquisition (93 percent and 69 percent in Rusatira and Muyira, respectively), while appropriation is becoming rare as unused land disappears (Figure 5). Figures of land acquisition refer to the main farm unit of farms studied.

Farmers inherit fragmented farms and inheritance laws ensure that, as the population density figures intimate, not only the amount of land per household falls, but it is increasingly fragmented into small plots, scattered over a wide area (Gebeyehu, 1995). According to Place and Hazell (1993) the lack of an active land market within Butare has limited the expansion of commercial farming in the region. Johnson (1972) further argues that in situations where individuals cannot sell land, the value of investment to the farmer declines because of lost flexibility in converting a fixed-place asset into another asset form.

**Figure 5: Methods of land acquisition in Rusatira and Muyira, 2001**



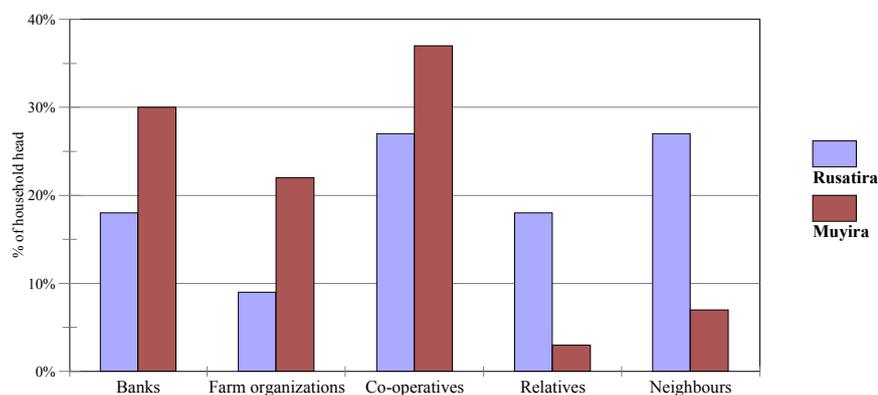
In the study areas, tenure certainty appears to vary somewhat between households. For instance women have less secure rights than men. Customary laws governing access to, utilization of and transfer of land in Rwanda are diverse (Place *et al*, 1994) and have led to land being excessively fractionated through heritage, and settlements generally scattered in rural areas (Takeuchi and Marara, 2000:27). Although the government has declared some policy change and enacted legislation affecting land rights, land transactions, size of holdings, imposed land taxes, the substance of the law, and the extent to which laws are enforced, an analysis of World Bank data has revealed that these changes have been largely ineffectual (Place *et al*, 1994). Further, Takeuchi and Marara (2000:27) contend that co-existence of this written (or 'modern') law with the customary laws has resulted in rights to land being so ambiguous that investment tends to be hindered.

Land fragmentation, as a result of continuous land distributions and growing population, creates a sense of insecurity among farmers, hence preventing them from making additional investment to increase production (Gebeyehu, 1995).

### **5.5 Credit Use and Sources**

Formal rural banking institutions are poorly developed. Less than 11 percent of farm operators in Rusatira and 27 percent of farm operators in Muyira used credit for the purchase of agricultural inputs in the past two years. Owing to the importance of collateral to the functioning of credit markets, the absence of well-defined and enforced private property rights in land may effectively prohibit the successful operation of formal credit markets in rural areas (Feder and Feeny, 1991). The absence of formal credit institutions within the two communes might explain the lack of credit use. A question was asked to assess whether sample farmers would consider borrowing capital to expand their farming activities if formal credit institutions were available. Almost all farm operators knew about borrowing and would consider this option. However, as shown in Figure 6, their preferred sources of credit differed considerably and favoured informal sources of lending rather than formal sources, such as banks and farm organizations. Co-operatives, neighbours and relatives were the most mentioned and preferred sources of credit by sample farm operators in Rusatira, while in Muyira 30 percent and over 20 percent of respondents would prefer formal banks and farm organizations, respectively. These findings suggest that borrowers face much lower transaction costs in informal credit markets.

**Figure 6: Preferred source of credit by farm operators sampled in Rusatira and Muyira, 2001**



### 5.6 Relationship between Population Density, Cropping Intensity, Technology Adoption and Proportion of Fallow Land

As can be seen from Table 9, there appears to be a close relationship between the density of population and intensity of cropping, which has led to an intensification of agricultural land through multiple cropping, change in crop mix, crop rotation and use of appropriate farm practices. The proportion of land under fallow is quite low: 5.13 percent in Rusatira and 5.47 percent in Muyira. Today, as a result of increased population pressure, fallow periods are being reduced. Where fallow periods are too short – less than two years – soil fertility deteriorates and crop yields decline (Benneh, 1996). Declines in crop yields force farmers to clear more forests and woodlands, including fragile and marginal lands where soil and climatic conditions are poorly suited to the cultivation of annual crops and yields are therefore low. The adoption rate of appropriate farm practices is relatively higher amongst farm operators in Muyira.

**Table 9: Population density, cropping intensity, technology adoption and proportion of fallow land**

	Population density	Cropping intensity	Adoption of soil analysis	Adoption of fertilizer	Adoption of farm practices	Proportion of fallow land (%)
<b>Rusatira</b>	334	452.53	0.16 (n=94)	0.15 (n=94)	0.31 (n=94)	5.13
<b>Muyira</b>	270	124.89	0.50 (n=89)	0.62 (n=89)	1.12 (n=89)	5.47
Significance			.000 <sup>3</sup>	.001 <sup>3</sup>	.000 <sup>3</sup>	

<sup>3</sup> Chi-square Test. **Population density**: the ratio of rural population and crop land including fallow land, **Cropping intensity**: the ratio of gross cropped land to net cropped land, **Adoption of farm practices**: is derived from combining the response scores on the rate of soil analysis and use of fertilizer by each farmer. Figures in parenthesis represent valid cases.

Households' characteristics illustrating a demographic profile of respondents in the sample; land use and performance indicators; adoption rates of improved farm practices, and evaluation of farm information; land tenure and rights; credit use and sources; and relationship between population density, cropping intensity, adoption of appropriate farm practices and proportion of fallow land show marked variation in the study areas.

## **6 . CONCLUSIONS AND POLICY IMPLICATIONS**

Agriculture is the most important sector of Rwanda's economy. It accounts for around 40 percent of GDP, and about 85 percent of total exports are agricultural. This makes it a leading foreign exchange earner. Ninety percent of the population derives its livelihood from agriculture, and it's the biggest wage employer. Further, the rapidly expanding labour force is expected to be absorbed into the agricultural sector. Undoubtedly the significance of this sector will continue in the years to come. However, Rwandan agriculture is beset by many problems, including land fragmentation.

Effect of population pressure and farm fragmentation is examined based on information collected from a sample of 200 individually (privately) owned farms in the Rusatira and Muyira communes in Butare Province during 2001. Farms studied ranged from 0.04 to 6 hectares. The sample was selected randomly from a population list provided by extension officers in the two areas.

Investigations of characteristics of the sample farmers revealed that, within a "stage of development" framework, the farm size can be viewed as being initially determined by a country's resource endowment, which over time may change with population growth and clearing of land (Huang, 1973). With development, increases in nonagricultural employment opportunities, changes in customary tenure security and provision of adequate information through training will cause pressures for the farm size to increase. An implication of the findings of this study is that the farm size will be constantly changing in response to dynamic conditions.

The pressure of population on agricultural land is quite high. As a result, farmers are left with small farms, which are fragmented. The magnitude of fragmentation has increased overtime. More than ever before, farmers must rent the land they operate, family land holdings have diminished in size, and they have tried to bring the steep and fragile slopes, once held almost exclusively in pasture and fallow, under cultivation.

The conclusion drawn from this research is that the need for consolidating land can be attained through institutions and policies improving rural education and access to relevant information; strengthening extension

facilities to individual farmers, and an efficient land (rental) market; although some positive level of land fragmentation may be optimal for farmers given the conditions in which they operate. The negative impact of fragmentation may reflect recent Rwandan policy to promote a rational allocation of land in order to reduce the present dispersed distribution of land.

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