



Where Sustainable Agriculture means Agricultural Productivity? The case study of Gikongoro in Southwestern Rwanda

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Thesis Submitted in Partial Fulfillment for the Award of a Master's in Science Degree in Environmental Science at Lund University, Lund, Sweden

LUMES 2003-2004

Philippians 4: 13:

“I can do all things through Christ who strengthens me.”

“Allt förmår jag genom Honom som ger mig kraft.”

“Je peux tout, grâce à Celui qui me fortifie.”

“Nshobozwa vyose na Kristo ampa inkomezi”

“Si tu diffères de moi, mon frère, loin de me léser, tu m’enrichis.”

“If you differ from me, my brother, far from wronging me, you improve me.”

(Antoine de Saint-Exupéry, Citadelle)

To my young brother to whom I did not say goodbye

Acknowledgment

I would like to express my sincere gratitude to the following persons for contributing directly or indirectly to the achievement of this work:

- All teachers and classmates who contributed to my learning at LUMES,
- All farmers in Gikongoro, MINAGRI, different NGOs and institutions that shared with me their experience, knowledge and their time,
- Turaj S. Faran, my supervisor for your assistance, comments and constructive critics. Without your help, this Thesis would not be what it is now.
- All those LUMES-students for looking critically to my work and strengthen its content,
- Gakuba Alexis, “Conseiller en Développement Rural et en Environnement (UAP Cooperation Canadienne) for your advises and rich documentation you provided and Jean Baptist Rwigema, the coordinator of the project “Projet de Développement de Cultures de Rente et d’Exportation (PDCRE) in Gikongoro, for your advises and help during my field work,
- Diomède Ntemako and Audace Nikoyagize of Human Rights in African Great Lakes Region for your wonderful help and accommodation you grant for me in Kigali-Rwanda
- Jeanne, my wife for your love, support, and understanding whenever I did not do what I should do for you because of this work,
- Whoever who contributed in whatever to the achievement of this work
- Finally, thanks to the Might God for all wonders He grants.

Abstract

The thesis examines the extent to which farmers in Gikongoro in Southwestern Rwanda can improve food productivity by applying sustainable agriculture principles. The causes and effects of such low productivity as suggested by the farmers themselves obtained through a questionnaire-based survey and supported by literature review. The study reveals that such factors include demographic pressure, deforestation, soil erosion and land degradation. These factors are interlinked and influence each other. The analysis from the study suggests that conventional agriculture or industrial agriculture may not solve the problem of food insecurity and improve environmental degradation. However, sustainable agriculture improves simultaneously agricultural productivity, food security and environmental degradation but it needs financing money.

Keywords: *Sustainable agriculture, low agricultural productivity, environmental degradation, food security, causes and consequences, Rwanda, Gikongoro*

Sammanfattning

Denna uppsats undersöker vilken möjlighet bönderna i Gikongoro i sydvästra Rwanda har att förbättra födoämnesproduktionen genom att tillämpa hållbara jordbruksprinciper. Orsakerna och effekten av sådan produktivitet, som föreslagits av bönderna själva i ett frågeschema grundat på inspection, stöds i litteraturen. Studien visar sådana faktorer som folkökning, skogsskövling, erosion och landförsämring. Dessa faktorer är sammanlänkade och påverkar varandra. En analys av studien antyder att konventionellt eller industriellt jordbruk inte kan lösa problemet med födoämnesbrist utan försämra miljön. Men, hållbar agrikultur baserad på mänsklig kunskap, naturlig, social, fysisk och finansiell tillgång förbättrar samtidigt jordbrukets produktivitet, födoämnestillgången och miljön.

Nyckelord: *Hållbar agrikultur, födoämnesbrist, miljö försämring, orsakerna och effekten, Rwanda, Gikongoro*

Résumé

L'objectif principal de ce travail est d'étudier comment l'agriculture durable peut améliorer la mauvaise production agricole qui prévaut au Sud-Ouest du Rwanda, dans la province de Gikongoro. Un questionnaire d'enquête élaboré à cette fin a permis aux agriculteurs eux-mêmes d'inventorier les principales causes et conséquences liées à cette insécurité alimentaire. L'analyse des données du questionnaire révèle que les principales causes qui sont derrière cette mauvaise production agricole sont liées à la haute densité démographique, à la dégradation du sol due à l'érosion du sol et à la déforestation. Ces facteurs sont interconnectés et s'influencent mutuellement. Les résultats issus de l'analyse des données du questionnaire d'enquête, des interviews et des autres travaux faits en ce domaine démontrent que l'agriculture industrielle ne peut pas résoudre le problème de l'insécurité alimentaire sans toutefois aggraver la dégradation de l'environnement jusqu'ici en mauvaise santé. Cependant, l'agriculture durable basée sur l'éducation des agriculteurs, la technologie, les micro-crédits agricoles peuvent améliorer en même temps la production agricole et l'environnement. L'aide financière de la communauté internationale est indispensable pour réussir cette tâche.

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Acronyms and Abbreviations

ACDI:	L'Agence Canadienne de Développement International
CLD:	Causal Loop Diagram
EICV:	Enquête Intégrale sur les Conditions de Vie des ménages
FAO:	Food and Agricultural Organization
Frw:	Rwanda franc
GOR:	Government of Rwanda
Govt:	Government
IFAD:	International Fund for Agricultural Development
IFRI:	International Food Policy Research Institute
MDG:	Millennium Development Goals
MINAGRI:	Ministry of Agriculture
MINECOFIN:	Ministry of Finance and Economic Planning
MINEDUC:	Ministry of National Education
MINITERE:	Ministry of Lands, Human Resettlement and Environment Protection
NGOs:	Non-Government Organizations
SARE:	Sustainable Agriculture, Research and Education
SALA-IDA:	Swedish Association of Local Authorities-International Development Agency
SIDA:	Swedish International Development and Co-operation Agency
USDA:	United States Department of Agriculture

1 Introduction

1.1 General Introduction

The Millennium Development Goals (M D G) of 2000 was a commitment by the states to reduce global poverty levels and halve the extreme poverty and hunger by the year 2015. According to [farmers' World network \(2002\)](#), today the world's population is 6.2 billion people; however, 1.2 billion live on less than US\$ 1 a day. Out of these, 799 million are in the developing countries. The Food and Agriculture Organization (FAO) observed that 153 million children are malnourished and among them six million die out of hunger each year. An estimated 2 billion people in developing countries depend on small and inadequate subsistence agriculture for their income and subsistence. Most of these people are poor and mainly are located in the rural areas ([FAO, 2001](#)).

In Sub-Saharan Africa, the ratio of poor people is higher, with almost every country's rural dwellers exceeding three-quarters of the total population. Today, Africa faces enormous food security challenges and the projections for food improvement in Africa are not encouraging. As the population of Sub-Saharan Africa projects a two-fold increase during the next quarter century ([World Bank, 1995](#)), it is also expected that food insecurity will grow and population growth will increase pressures on natural resources. Approximately 39% of people are malnourished within Sub-Saharan Africa, and [FAO \(2001\)](#) forecasts an increase in food insecurity through 2010, while the rest of the world continues progressing in this area. The number of hungry children in Sub-Saharan Africa will increase by 24%, to 39% by 2020 ([Pretty, 2000](#)).

However, many researchers agree that, despite the complexities of food insecurity in Sub Saharan Africa, there will have to be increase in food production from existing agricultural land and technology that are locally available. "Sustainable agriculture, offers new opportunities, by emphasizing the productive values of natural, social and human capital. All these assets are in abundance in Africa and further more they can be regenerated at low financial cost" ([Pretty, 2000](#)).

1.2 Link to Sustainable agriculture

Observing closely to the farming sector, there are some criteria that need to be met in order to include three main components of sustainability such as economic, natural and social. To use the goals of Sustainable Agriculture Research and Education (SARE¹), sustainable agriculture must include these below key aspects:

- Provide more income agricultural households,
- Promote sustainable environment, and
- Promote stable and prosperous farm families.

SARE¹: Sustainable Agriculture Research and Education
<http://www.sare.org/bulletin/explore/>.

1.3 Objectives of the Study

The objectives of the study are to:

- Determine causes of low agricultural productivity in the region,
- Determine the consequences from low agricultural productivity in the region,
- Assess the type of agricultural production likely to increase productivity,
- Come up with recommendations to solve the problem.

1.4 Rationale of the Study

Low agricultural productivity has been occurring in southern Rwanda for many years but no concrete action has been taken to redress the situation. According to the Ministry of Finance and Economic Planning (MINECOFIN, 2002), many researchers concentrate more efforts on problems linked to natural factors such as irregular rainfall and climate change. However, other factors such as social, political and economic have to be taken into consideration in order to understand better the problem and find an adequate solution for it. Therefore, the understanding of the interconnection between these factors will help the government, local farming households, organizations and other donors to find appropriate solutions to the problem of food insecurity existing in the country.

1.5 Study Area

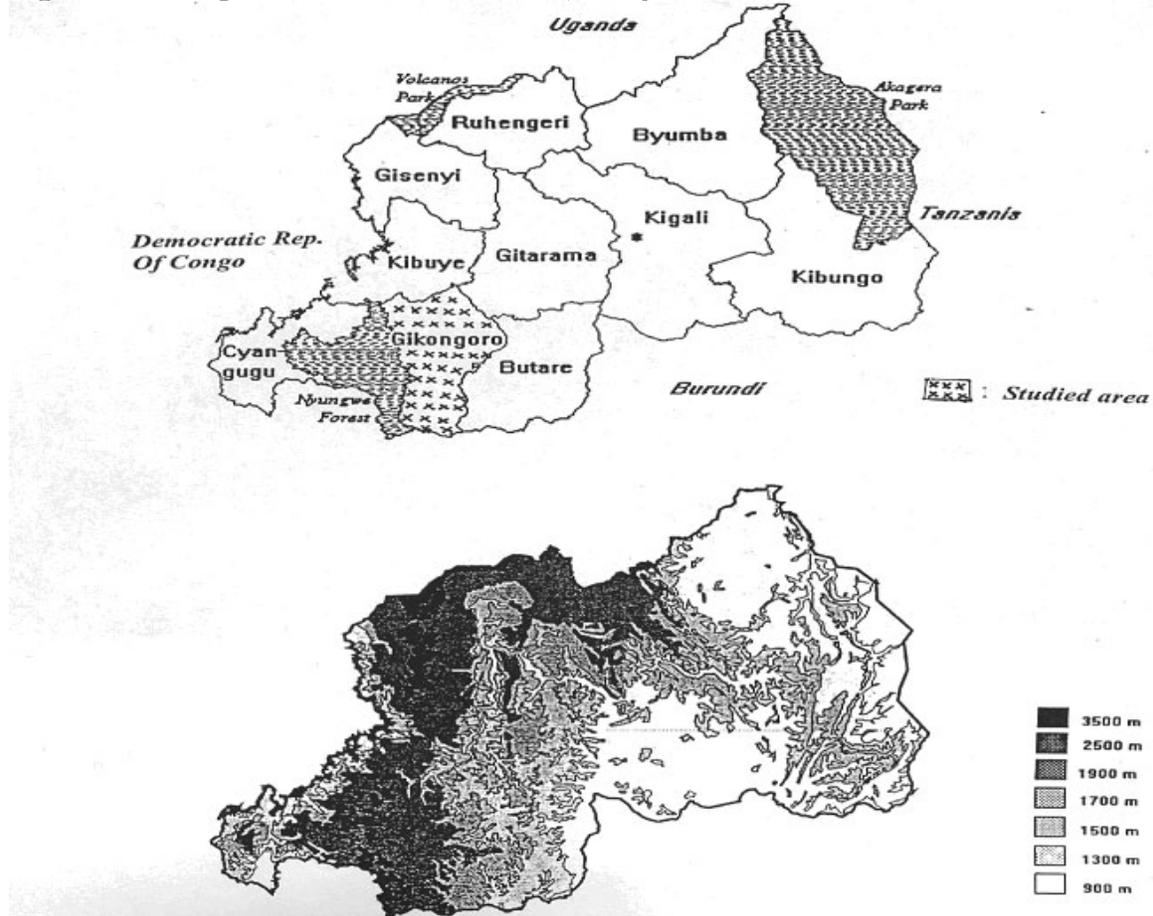
The present study covers the Southwestern Rwanda, in Gikongoro province. Its geographical location is shown on [Figure 1.1](#) below. Topographically, the area is characterised by high mountains with steep slopes where erosion and environmental degradation are considerable (see the map of elevation, [Figure 1.1](#)). The selection of the study area was guided by the low food productivity and high food insecurity comparatively to other provinces of Rwanda.

Rwanda observes a big difference within “Préfectures” (Provinces). According to the Ministry of Finance and Economic Planning (1999-2001), statistics show that, Ruhengeri in the north province of Rwanda and Gikongoro (South-west of Rwanda) are the most poor with low agricultural production. In Gikongoro, 77.2% of the population are poor and live in extreme poverty, 75% of households in Gikongoro do not have selected seeds and 59% of agricultural households have less than 0.2ha (MINECOFIN, 2002).

1.6 Geography and the Problem Background

Rwanda is a small, landlocked country located close to the equator in the highland region of East-central Africa between latitudes 1°04' and 2°51' South and longitudes 28°53' and 30°53' East, with an area of 26,338 sq. km. Tanzania is to the East, Uganda to the North, Democratic Republic of Congo to the West, and Burundi to the Southern border as it is shown in the figure 1.1 below.

Figure 1. 1: Map of Rwanda: Prefectures, study area and elevation



Source: Adapted from Jennifer M. Olson, 1994

Rwanda has a population of about 8,128,553 in 2002 and a growth rate of 3.7 percent according to [MINECOFIN \(2002\)](#)². It has a very high population density of 303 inhabitants per sq. km. This high population density hides obvious disparities because some areas have population density values over 1000 persons per sq. km ([MINITERE, 2002](#))³. About 95% of the population resides in the countryside on an unproductive small plot, and 90% of them rely on subsistence agriculture ([Homer-Dixon, 1998](#)). The poverty assessment done in 1993 published that there was declining agricultural productivity over time, ([World Bank, 1998](#)). In 1994, the situation has been worsened by the civil war where parts of human capital and livestock have been killed. In many provinces, problems caused by the war, genocide and associated population movements exacerbated existing problems.

² MINECOFIN: Ministry of Finance and Economic Planning, 3rd Census of Population and housing of Rwanda, August 2002

³ MINITERE: Ministry of Lands, Human Resettlement and Environmental Protection

1.6.1 History of agriculture in Rwanda

The history of agriculture in Rwanda can be seen in three different periods: Pre-colonial period, colonial period and present period.

1.6.1.1 Pre-colonial Practices

Rwanda is a hilly country covered with over a thousand hills. In the pre-colonial period, Rwanda literally translated “the country of thousand hills” was predominated by grass and trees (grasslands) (Guichaoua, 1989). These grasslands developed because of grazing and frequent burning over a number of centuries. The burning would enhance the growth of grass pasture for the livestock. However, the burning process would inherently reduce the amount of organic matter in the soil and hence reducing the soil’s water holding capacity. Further, on, the burning would also reduce the soil nutrients. Therefore, in the long term, the grasslands were degraded consequently less and less biomass produced unlike before when the area was forested (Kangasniemi, 1998)

In the pre-colonial period, the farmer’s main crops were sorghum, finger millet (eleusine), taro (colocase), peas, cowpeas and bananas. Some farmers had also explored the cultivation of beans, sweet potatoes as well as maize in small-scale (Jones and Egli, 1984). To enhance soil fertility the farmers practiced shifting cultivation to allow fallow periods for soil nutrient regeneration. They would also add cattle manure into their farms to boost soil fertility. Farming of crops took place mainly on small plots on the hilltops and upper slopes (Meschy, 1989). The valleys were utilized mainly for grazing especially in the dry season.

1.6.1.2 Colonial Period: New Changes

The Belgian administrators arrived in Rwanda in 1916 and colonized the country until 1962. This new administration developed a number of policies aimed at combating recurrent annual famine. The policies pointed towards increasing and stabilizing the production and availability of food to the Rwandan people. In 1924, a law was passed requiring all farmers to plant 15 acres with famine crops besides 35 acres of other crops. The famine crops included sweet potato, cassava among other tuber crops such as white potato that are non-seasonal crops. The famine crops would see the farmers through periods of drought when cereal and other seasonal crops would not yield enough to sustain the farmer’s food requirements. To achieve this, relatively bigger land was required compared to the small plots that the farmers cultivated in the pre-colonial period (Guichaoua, 1989).

The new policies gave rights to farmers to cultivate in the valleys. As a result, large tracts of forests were cleared in valleys to pave way for agriculture (Olson, 1994). The new system of crop production as well as the newly introduced famine crops increased at the expense the old crops and fallow. The pick of this impact was particularly in the 1950s that marked the onset of rapid population growth. The developed policies and the new

crops increased the food supply and hence the living conditions despite the population pressure (Kangasniemi, 1998).

Furthermore, in the year 1931, the Belgian administrators enforced another law for land use. By this law, the farmers were obliged to plant a number of coffee trees and other cash crops (Olson, 1994). The farmers were also to plant some trees as communal forest. The coffee and the other cash crops were to provide the small-scale farmers and the colonial administrators with revenue. The forests on the other hand, were to provide fuel wood for energy as well as protect the soil against soil erosion.

1.6.1.3 Recent Period: More People more problems

Some of the policies introduced during the colonial period were not popular among the local people. Therefore, by the end of the colonial period (1960s), the unpopular and forced policies were revised or abolished. The population of Rwanda kept growing rapidly. As a result, agricultural land kept expanding proportionally. Because of the expansion, by late 1970s, almost all-cultivable land except the national parks had been opened up for agriculture. In the 1980s, agricultural activities spilled over to marginal lands. “Without offsetting measures, both options were likely to increase soil degradation” (Clay, 1994). Consequently, food production stagnated and per capita food production declined significantly.

1.6.2 Geographical Poverty Profile

According to household living condition survey (MINECOFIN, 1999-2001), poverty and access to factors of production such as access to land and incidence for food security have been studied and the situation of these factors is presented in the table below.

Table 1. 1: Access to land, basic services and food poverty by locality

Province	% Landless	% with land size < 0,2 hectares	Incidence of food poverty
Butare	5.9%	61.7%	75.5%
Byumba	2.4%	25.3%	65.7%
Cyangugu	13.0%	37.3%	72.0%
Gikongoro	3.2%	59.0%	80.2%
Gisenyi	7.2%	26.0%	68.5%
Gitarama	3.4%	25.2%	61.8%
Kibungo	1.7%	11.5%	62.3%
Kibuye	2.7%	31.2%	79.4%
Kigali- Ngali	7.8%	17.1%	74.0%
Kigali-urban	88.8%	6.6%	20.6%
Ruhengeri	5.3%	35.9%	83.7%
Umutara	4.8%	8.5%	62.2%
Total	11.5%	28.9%	67.8%

Source: Modified from MINECOFIN (1999-2001)

From the table above, the largest numbers of agricultural households whose farm land is less than 0.2 ha are found in the provinces of Butare (61.7%), Gikongoro (59.0%), Cyangugu (37.3%) Ruhengeri (35.9%) and Kibuye (31.2%). The lack of land for farming may have negative impacts on agricultural productivity and concerning the incidence of food poverty, the provinces most affected are Ruhengeri (83.7%), Gikongoro (80.2%), Kibuye (79.4%), Butare (75.5%) and Kigali- Ngali (74%) (MINECOFIN, 1999-2001)

1.7 Scope and Limitations

The discussion of this thesis is limited to an analysis of the various factors responsible for low agricultural production and environmental degradation in southwestern Rwanda (Gikongoro province) and their consequences. It will focus more on the interaction between natural, economic and social factors. According to Wolf, (1998) sustainable agriculture approach involves the interaction between different disciplines. Thus, it will be an appropriate tool to use in order to improve agricultural productivity and environment protection simultaneously (Wolf, 1998). Considering only for example economic factor may not enhance a sustainable agricultural productivity and sustainable environment.

The limitation for this work was that a certain number of other ministerial department and organizations that would have been contacted could not be reached due to the time and other financial constraints. In few cases also, the persons responsible were not available at the time of the study and in other situation; people do not respect the appointment. The use of three different languages (French, English and Kinyarwanda) by the majority of the population has obliged me to translate the questionnaire in all these languages and it took me a lot of time to explain and get right answer. These might affect the results in the long run; however, all efforts were made to be objective as far as possible.

2 Methodology

The methodology will use a qualitative approach. Methods such as case study, focus group discussion will be informed using methodological tools such as interviews, observation on the ground, scientific documents such as books, journals, projects reports and website (internet).

During the study, a brief and comprehensive questionnaire was designed to suit the different data required for the study. The content of the questionnaire was explained to the respondents who later filled it. However, the questionnaire was administered directly to those who could not read and write. It was also translated from English to French or from English to Kinyarwanda⁴. Additional detailed questions were asked during the focus group discussion. In all, 40 persons including authorities and communities responded to the questionnaire. The major source however was the 25 local inhabitants (farmers). It is important to mention that the information collected was not limited only to the questions posed in the questionnaire.

The 25 local farmers, all members of various development and agricultural cooperatives, were selected per random from different municipalities of the province of Gikongoro.

Besides, informal contacts with interested groups have been established and individually based discussions with students in the fields of land-use planning, agronomy, and economics and various people in order to complete my knowledge on agriculture practices and environmental degradation in Rwanda.

In addition to observations, contacts and interviews, the study used discussions with participants gathered in a two-day workshop looking at how to arrest the strategies in order to increase the productivity in their respective municipalities. The discussions were organised in communes of Gikongoro, Mushubi and Nshili in Gikongoro Province (see plate 2-1) where I got the opportunity to take part in their meeting held in two communes (Gikogoro and Mushubi) and discussed with some farmers about agricultural issues.

2.1 Questionnaire

In order to identify the problems and be able to suggest some solutions, different authorities and NGOs working closely with the local communities in agriculture sector were contacted. Kigali Institute of Science, Technology and Management, the National Population Office, Ministry of Agriculture (MINAGRI), Ministry of Finance and Economic Planning (MINECOFIN), Ministry of National Education (MINEDUC), Ministry of Lands, Human Resettlement and Environment Protection (MINITERE), World Bank in Kigali, WFP, SIDA, FAO, CECI have been contacted. The choice of this category of institutions and organizations was because they work closely in collaboration with the local communities in agriculture sector. Thus, they were better placed in responding to the questions posed.

⁴ The author is not from Rwanda but he understands Kinyarwanda. He speaks Kirundi, which is much closed to Kirundi.

The table below indicates these ministries, NGOs, academic bodies and members of the local community to whom the questionnaire was administered.

Table 2. 1: Ministries, Organizations, Academic bodies and communities responded to the interview

Ministry, Organization, Academy body, Local Community	Number of Responded
Ministry of Agriculture(MINAGRI)	5
Ministry of Finance and Economic Planning	1
Ministry of Education	1
Universities	2
Ministry of Lands, Human Resettlement and Environmental Protection	1
Swedish International Development and Co-operation Agency (SALA-IDA)	2
L'Agence Cannadienne de Coopération (ACDI)	1
World Bank	1
World Food Program (W F P)	1
Local Community** ⁵	25
Total (n)	40

Contacts were made with each individual and the choice was guided by the age, gender, employment and how they were closed to agricultural sector. Additional interviews were conducted in order to know more the causes of low agricultural productivity in the Southwestern Rwanda. The key elements of the questionnaire were based on social, economic and natural causes on agricultural productivity in the region (see questionnaire).

In order to have contact with the focal population of farmers, a group of local community representatives in Gikongoro's centre was met for the administration of the questionnaires at their meeting with the authorities from the Ministry of Agriculture. They were from different municipalities (Nshili, Nyaruguru, Mudasomwa, Karaba, Kaduha, Mushubi, and Gikongoro). The plate shown below is an example of focus team discussion representing other household farming.

⁵ On 23 of August 2004, I met a group of local communities in Gikongoro's centre during their meeting with the authorities from the Ministry of Agriculture. They were from different municipalities (Nshili, Nyaruguru, Mudasomwa, Karaba, Kaduha, Mushubi, Gikongoro)

On 24 of August, I went with the coordinator of "Projet de Développement de Cultures de Rente et d'Exportation (PDCRE) to meet farmers in Mushubi and Nshili minicipalities.

Plate 2. 1: Discussion group



The coordinator (in front of participants) of the project “Projet de Développement de Cultures de Rente et d’Exportation (PDCRE)” was meeting farmers in Mushubi municipality. It was after the meeting that I interviewed some of the local farmers (selected farmers for discussion) to respond to my questions as shown in the photo below. The names of the farmers selected for interview may be found in appendix

Plate 2. 2: Selected group for interview and discussion



Behind the methodological tools already mentioned, a Causal Loop Diagram (CLD) has been used to sum up and show the interconnection between variables.

3 Theoretical Framework and Literature Review

3.1 Introduction

This thesis is an attempt to apply sustainable agriculture principles to the problem of low agricultural productivity in Southwestern Rwanda. To do this it would be advantageous to discuss what is meant by sustainable agriculture and how it has been applied elsewhere. This section discusses the concepts in the following order.

- First, the term “sustainability” is analyzed in order to gain good understanding of the goal of “sustainable agriculture”. Definitions of the concepts from different authors are also reviewed.
- Secondly, literature on agriculture transformation and agriculture development in developing countries are analyzed in order to understand why agricultural productivity does not increase despite the high number of labour engaged in an agriculture sector in developing countries.
- Finally, some cases of food production improvement and mechanisms that have been used in some African countries will be discussed.

3.2 What does “Sustainable” Mean?

According to [Gold \(1999\)](#) of the Alternative Farming Systems Information Center (AFSIC), the term “‘sustain,’ from the Latin *sustinere* (*sus-*, from below and *tenere*, to hold), to keep in existence or maintain, implies long-term support or permanence. The original term was ‘sustainable development,’ a term adopted by the Agenda 21 during the Rio World conference on Environment and Development in 1992.”([Gold, 1999](#))

The Brundtland Report, 1987, defines sustainability as "*Meeting the needs of the present generation without compromising the ability of future generations to meet their needs.*" This would imply that any development activity should not only look at the current social-economic benefits but also into the potential long-term impacts. Iroquois in his ‘seventh generation’ philosophy emphasizes that leaders should consider the likely impacts/effects of their current actions on their descendants into the seven generations to come. To achieve this in the context of agriculture, agricultural sustainability analysis would include economic, environmental and social aspects ([Gold, 1999](#))

3.3 What does Sustainable Agriculture Mean?

[Duesterhaus \(1990\)](#) and [Jules Pretty \(1999\)](#) define ‘sustainable agriculture’ as “*farming that makes the best use of natural goods and services whilst not damaging the environment. It minimizes the use of no renewable inputs (pesticides and fertilizers) that damage the environment or harm the health of farmers and consumers. In addition, it makes better use of the knowledge and skills of farmers*”.

[Miller \(2004\)](#) talking about sustainable agriculture argues that in order to increase agricultural productivity as well as improve on environmental care the following tools should be taken into account:

- (1) “Slowing population growth”,
- (2) “Reducing poverty so that people can grow or buy enough food for their survival and good health”, and

(3) “Developing and phasing in systems of sustainable agriculture (also called low-input agriculture or organic farming) over the next three decades”. The table below summarises different components of sustainable agriculture that can contribute to increase agricultural production and thereby decrease environmental degradation.

Table 3. 1: Components of More Sustainable Agriculture

Increase	Decrease
High yield	Soil erosion
Organic fertilizers	Aquifer depletion
Irrigation efficiency	Overgrazing
Crop rotation	Loss of biodiversity
Soil conservation	Food waste
Subsidies for more sustainable farming	Poverty

Source: Miller, 2004

Sustainable agriculture calls for wise utilization of the existing natural and human resources to meet the needs of the current generation as well as conserve the agricultural resources for future use. According to the [Farmers’ World Network, \(2002\)](#), sustainable agriculture has to fulfil the five goals enlisted below.

- Produce crops that are high yielding and nutritionally qualitative with minimal inputs
- Minimize use of external and non-renewable inputs whose effects may damage/harm the health of the farmer and or the environment
- Contribute to the improvement of the farmer’s general welfare and life quality
- Allow genuine participation of all stakeholders including farmers and other rural people in all stages of problem identification and solution seeking as well as technology development to increase self-reliance and enhance development of social capital
- “Enable local communities to protect and improve their wellbeing and environments”.

Considering all these definitions and concepts, sustainable agriculture should aim at increasing agricultural productivity in an environmentally friendly manner. In trying to understand how and why agricultural productivity in developing countries is decreasing, it is advantageous to take a comprehensive look at all the elements that may affect the sustainability of agriculture. Sustainable agriculture framework identifies five main assets categories (Table 3.2) or type of capital upon which sustainable agriculture is built

Table 3. 2: Main assets upon which Sustainable Agriculture is built

Assets or Capital ⁶	Specific Agriculture Relevance ⁷
<i>Human capital</i> represents the skills, ability to labour and good health. “At a household level, human capital is a factor of the amount and quality of labour available. This value according to household size, skills level, leadership potential, health status, etc”.	In developing countries, labour can be affected by illness such as HIV/AIDS, Malaria, TB and migrations, etc
<i>Social capital</i> represents the social resources upon which people draw in pursuit of their livelihood objectives.	Civil unrest has devastated social structures and disrupted farming and agricultural trade, etc
<i>Natural capital</i> is the term used for the natural resource stocks such as nutrients, erosion protection, the atmosphere, biodiversity as land, trees, etc.	Soil fertility, agricultural biodiversity, access to land, access to water, etc.
<i>Physical capital</i> comprises the basic infrastructure and producer goods needed to support livelihoods.	Trade-related infrastructure(transportation of crops to appropriate markets), access to market information, relevant technology
<i>Financial capital</i> concerns the action of saving and accessing to credit.	Trade may be local and international , or refer to diversification strategies, etc

Source: World Bank Report 2000/2001 and Reports Farmers’ World Network 2002

“These five assets are transformed by policies, processes and institutions to give desirable outcomes, such as jobs, welfare, economic growth, clean environment, sustainable use of natural resources, better health and schools. If achieved, these outcomes then feedback to help the five capital assets” (World Bank Report 2000/2001).

In many developing countries, some of these assets are locally available but misused others need to be provided or to be improved in order to increase agricultural productivity.

3.4 Some Case Studies of the Application of Sustainable Agriculture

A survey of sustainable agricultural practices among small-scale farmers with average farm area less than one hectare was conducted between the years 1999 to 2000. The farmers were sampled from 52 developing countries from Latin America, Asia and Africa. In total 208 projects were analyzed among which 45 were in Latin America, 63 in Asia and 100 in Africa. Approximately 8.98 million farmers of the above-mentioned category had adopted some new agricultural practices and technologies on 28.92 million hectares. These practices and technologies aimed at improving food production and involved the following four mechanisms:

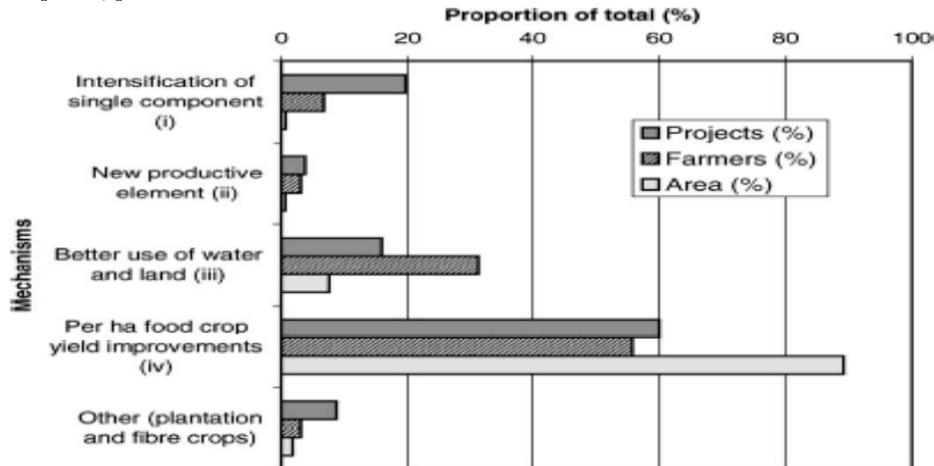
“(i) intensification of single component of farm system; (ii) addition of new productive element to a farm system; (iii) better use of water and land, so increasing cropping

⁶ From World Bank Development Report 2000/2001

⁷ From Reports Farmers’ World network by Emerson and Martin Wallis

intensity; (iv) improvement in per hectare yields through introduction new locally appropriate crop varieties and animal breeds” (Pretty, et. al., 2002). The results of the studies are shown in below figure.

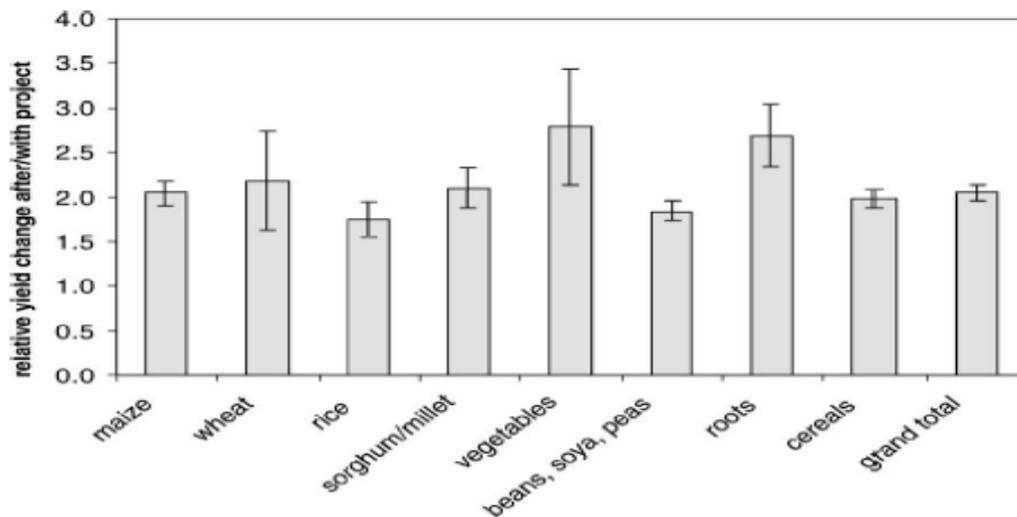
Figure 3. 1: Frequency of occurrence of each type of improvement mechanism by Projects, farmers and area



Source: Pretty et al, 2002

Food production per hectare increased by 93% because of the new locally suitable yielding crop varieties and animal breeds. The weighted averages are 37% increase per farm household, and a 48% increase per hectare in these projects. The projects also analyzed the yield data according to the crop types (Figure 3.2)

Figure 3. 2: Relative change in yield grouped by crop type



Source: Pretty et al, 2002

Figure 3.2 illustrates that, the largest relative increases in yield was observed in the vegetables, roots, and the smallest for rice and beans/Soya/peas.

This reveals that adoption of some practices and technologies would substantially benefit the rural poor most likely in a sustainable way. The improvements in food security may spread much faster among the rural farmers if supported by favorable policy reforms as well as improvement in market conditions (Pretty, *et al*, 2002). In Kenya, Ethiopia, India and Nepal, sustainable agriculture led to significant improvement of agricultural productivity.

▪ Kenya, Ethiopia, India and Nepal

According to [Appropriate Technology Journal \(2001\)](#), the Association for Better Land Husbandry in Kenya encourages the education and skill of self-help groups of farmers (human asset), promotes sustainable agriculture, and helps Trade-related infrastructure such as transportation of crops to appropriate markets, access to market information, relevant technology (financial asset). The review of 26 communities in eight Districts, 75% of households “are now free from hunger during the year”. The other study concerning sustainable agriculture has been done in south-west Ethiopia where 12,500 farm households have used new varieties of vegetables, fruit and forest trees, organic manures, plant for pest control, and introduced veterinary services on about 5000 hectares. Yields have risen by 60% and there has been a 70 % improvement of nutrition.

In India, the Watershed Development and Soil Conservation of the government of Rajasthan have facilitated the formation of 15,000 watershed users’ groups how to use sustainable practices, such as strips of “vetiver”, better use of water and other grasses on the contour, and regeneration of common land with shrubs and trees. “The harvest of millet and sorghum yields have doubled to 400-875 kg/ha without addition of fertilizers and grass strips have improved yields by 50-200% to 450-925kg/ha” ([Appropriate Technology, 2001](#)).

In Nepal, the Jajarkot Permaculture programme promoted sustainable food production in 31 villages of Jajarkot Khalanga. The programme was based on the skills and knowledge of local people and professionals through social asset formation. The result revealed that 40% of the 580 participating households organized in 44 groups are now entirely food self-sufficient through increased used of regeneration technologies ([Appropriate Technology, 2001](#))

As mentioned previously, each developing country has its own particular point to be focused when it concerned sustainable agriculture. In the case of Sub-Saharan Africa in general and Rwanda in particular, different factors leading to low agriculture productivity will be discussed and different suggestions from the results of the case study will be given in following section and chapters.

3.5 Why Food insecurity in Sub-Sahara Africa

Population in Sub-Saharan Africa has been growing at a rate of 3 % while the food production has been growing at a rate of 2% per annum (Benneh, 1996). This implies that the amount of food produced may not cope with the food demand from the existing population. This presents a food insecurity scenario unless some external food supply is available.

In the 1960s and 1970s, many African countries changed their agricultural policies in favor of industrialization (Martinussen, 1999). In the affected countries, agricultural policies, as well as most agricultural research focused more on cash crops while giving the food crops little priority (Club of Rome, 1989). Such kind of change also took place in Rwanda during the colonial period. During this period, farmers were obliged to plant crops for export even in non-compatible agro-climatic zones. This implies that less of financial allocations were set aside for the promotion of food crops despite its contributions to their national economies and well-being of the citizens (Todaro, 1989).

The problem of food insecurity is further aggravated by natural and social events such as the droughts, ethnic and political conflicts. World Bank (1996a), observe that food production per capita index in the year 1993 declined in 33 out of 44 sub-Saharan African countries (note that Rwanda was in civil war at around this time). World Bank (1996b) predicts that food shortage in Africa is likely to increase more than 20 times as compared to the present trend.

Most of the residents in the rural sub-saharan Africa are poor and mainly depend on subsistence farming for their food and income. Majority of them cannot afford to buy food to offset their food deficit. Thus, increasing food supply to meet the food demand poses a challenge and Rwanda as one among these Sub-Saharan Africa countries is facing to the same challenge of food insecurity (Benneh, 1996).

▪ **Rwanda Case**

In 1960s, the government of Rwanda (GOR) promoted the production of export cash crops such as coffee, tea and cotton .The driving force was the high prices of these commodities on the international market and the Belgian agricultural law that forced farmers to plant at least coffee and other cash crops. This encouraged most of the farmers to grow these cash crops as they may earn quite huge sums of money from it. However, when the prices of these crops fell drastically in the end of 1980s, coupled with the Structural Adjustment Programme (SAP) of the International Monetary Fund (IMF) and World Bank (WB), the government reduced subsidies that were allowed to households farmers (Africa Environment Outlook, 2002).

The fall of cash crop prices coupled with removal of subsidies, resulted in decline in agricultural productivity in both cash crop and food crop production. This would be attributed to the fact that the farmers had insufficient income to afford adequate input for their farming. Hence the crop yields dropped appreciably resulting in food insecurity and increase in poverty levels.

The problem of food insecurity in Africa is highly correlated to its poor economic background (Salih, 1995). The fact that a high percentage of the population depend on agriculture for their livelihoods implies that much of their income comes from the sale of agricultural products. Consequently, if production is low, then they will prefer to consume the food rather than sell to earn income. This limits their purchasing power largely during the periods of crop failure and consequently their food security.

Since 1980, Great Lakes Region countries (Rwanda, Burundi and Democratic Republic of Congo; which are Sub-Saharan African countries as well have been experiencing major changes in their climate, especially concerning vegetation cover and rainfall-which are very crucial in determining agricultural output. Low food productivity in Rwanda is most severe in the southern part of the country in the province of Gikongoro ([Olson, 1994](#)).

In Rwanda, population pressure may have been a major factor leading to increasing food insecurity. Both natural and human activities such as commercial logging, cutting of trees for household fuel wood, overgrazing and clearance in search for more fertile soil for agricultural purposes have led to considerable environmental degradation ([MINECOFIN, 1999-2001](#))

Despite the fact that Sub-Saharan Africa presently faces the greatest challenge than any part of the world concerning food insecurity, poverty and environmental degradation. [Crosson and Anderson \(1999\)](#) affirm that sustainable agriculture can deliver the necessary improvements in food production.

4 Results and Analysis of Data

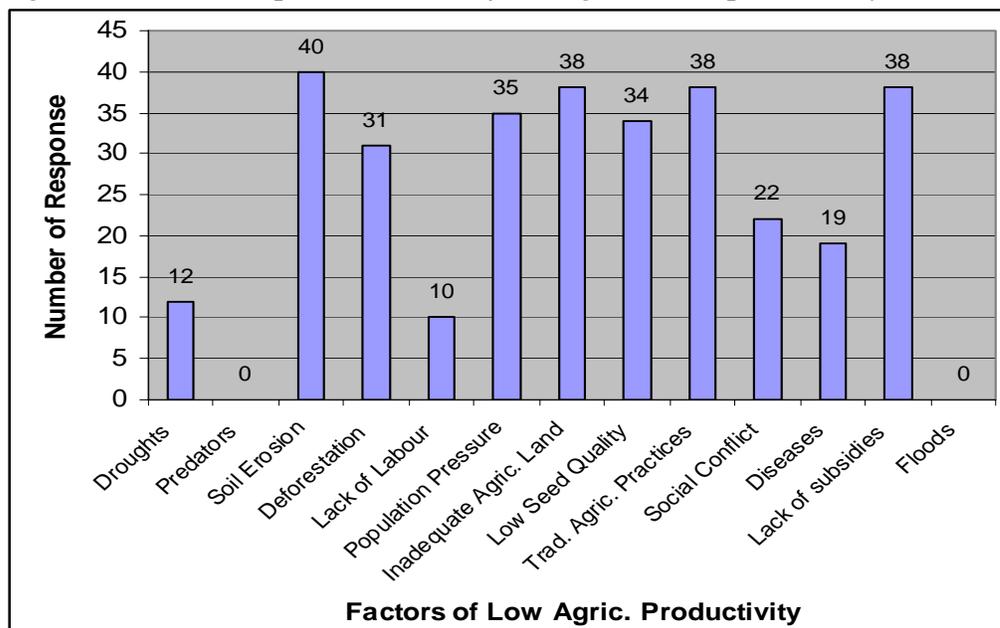
4.1 Introduction

The results of the survey are presented and discussed in sections 4.2 and 4.3 below. The results from survey data are compared with literature from other researches done in the same domain. The results - causes and consequences of low agricultural productivity- are also summarized in the form of a causal loop diagram. Then, the chapter goes ahead to examine sustainable agriculture as a solution. The case study was conducted in Southwestern Rwanda in Gikongoro “Préfecture”⁸ (see the figure 1.1). It is a highland Prefecture (located mostly at elevation above 1,800m) with serious declines in food production, which have led to severe food insecurity in recent years (Olson, 1994). According to the [Third Census of Population and Housing](#) of Rwanda done in 2002, Gikongoro has a population of 489,729 (233,454 male and 256,275 female). About 59% of farm families have less than 0.2 hectares of farmland as shown in the table 1.1. The average household size consists five people and in all province, the majority of the households live below the threshold of poverty that is estimated at income of USD 425 per household per annum (Govt of Rwanda, 2003).

4.2 Causes of Low Agricultural Production: Data Analysis

From the survey and data collected, several factors are responsible for agricultural low productivity in Southwestern Rwanda. Natural, economic and socio-cultural are the most important with highest rank as shown by the figure below.

Figure 4. 1: Most important causes of low agricultural productivity



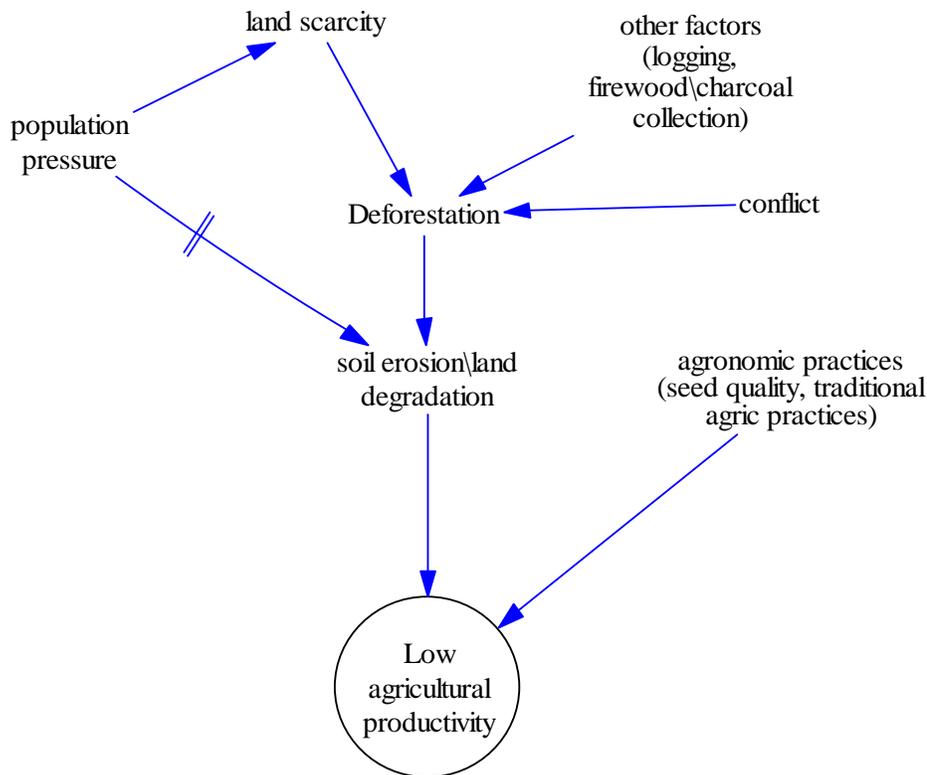
⁸ Préfecture is the equivalent of “Province” in English

According to the figure above, erosion leading to soil degradation, deforestation, population pressure, inadequate agricultural land (lack of land), low seed quality, Unskilled labour and lack of subsidies are the major factors leading to the decline of agricultural productivity.

All respondents, 40 (n=40) representing 100%, responded that soil erosion leading to soil degradation and acid soil (agataka gasharira in Kinyarwanda) is the main problem in Gikongoro province. Lack of land for agriculture, poor knowledge of modern agricultural practices, lack of subsidies or unskilled labour represent each 95%⁹; other factors such as population pressure (87.5%), low seed quality (85%) contribute also to low agriculture productivity.

All the issues identified in figure 4.1 are interconnected and interact dynamically. The nature of the interaction is presented in the conceptual model below and will guide the format in which they will be discussed.

Figure 4. 2 Conceptual maps of causes of low agricultural productivity

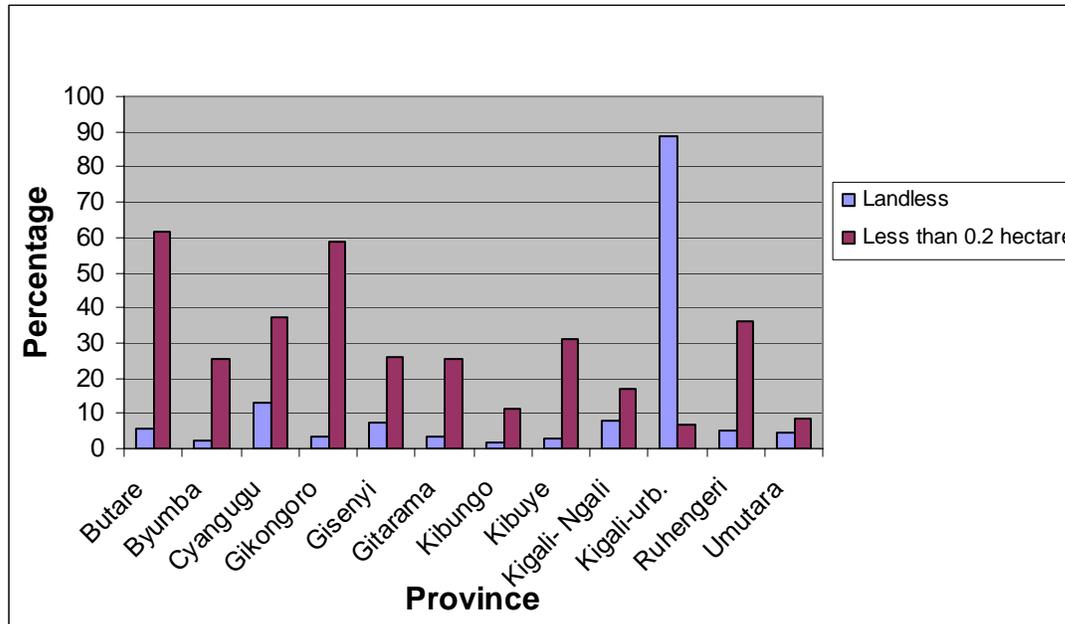


⁹ 95%=(38×100):40

4.2.1 Land Scarcity

The most important asset for poor rural farmers is land. According to the [Government of Rwanda \(2002\)](#), Rwanda has the lowest land to person ratio in Sub-Saharan Africa and as such, access to land in Rwanda is a big problem (Guichaoua (1989)) cited in [Musahara \(2001\)](#). About 11.5% of the population is landless, 28.9% have less than 0.2 hectares ([MINECOFIN, 1999-2001](#)) and more than 60% of people have less than 0.5 ha. The figure below represents the situation of landlessness and land size less than 0.2 ha per farmer in all provinces.

Figure 4. 3: Land scarcity in Rwanda



Source: Adapted from MINECOFIN, 1999-2001

On the figure above which was based on a study done by MNECOFIN during the period 1999-2001, we see that landless people represent 3.2 % in Gikongoro and people having less than 0.2 hectares represent 59%. Furthermore, during the fieldwork, 38 (95%) responded that there is a problem of lack of land for farmers in Gikongoro. The main cause of such land scarcity is the high population pressure found in Rwanda.

4.2.2 Population Pressure

About 35 of the respondents considered population pressure as one of the major causes of low agricultural productivity. The population size of the country grew from 1.9 million in 1948 ([Olson, 1994](#)) to 8,128,553 of inhabitants in 2002 ([MINECOFIN, 2002](#)). According to Prioul and Sirven in [Olson \(1994\)](#), the Gikongoro population grew from 100 people/km² in 1948, to 228 people/km² in 1978 and to 287 people/km² in 1991. “Since the inheritance system in Rwanda and Burundi¹⁰ provides for equal division of the father’s land among his sons, the population growth has resulted in increasingly smaller farms being inherited” ([Olson, 1994](#)). As a result, farming activities have on the one

¹⁰ The author of this paper is from Burundi and knows the system of inheritance in Rwanda and in Burundi.

hand led to intensification of agricultural activities on currently used land. On the other hand, it has also led to the expansion of agricultural activities to previously forested land and marginal areas such as valleys, grasslands, and high sloping areas. (Boserup, 1965; Clay and Lewis 1990; Olson, 1994).

4.2.3 Social Conflict

A discussion of any socio economic activity in Rwanda cannot be complete without consideration of intense conflict experienced in the region in recent years. Between April and August of 1994, as many as 1 million people were killed in “the now famous Rwanda genocide with more than 2 million rendered refugees” (Tara, 1997).

The first fighting occurred inside the Akagera National Park, in October 1990. Further more, according to African Wildlife Foundation report in June 1995, “both the Mutara Reserve (30,000ha) and a large part of the Akagera National Park have been devoted to grazing for around 600,000-700,000 cattle from Uganda during and after the war and the parks have lost two-third of their original size (MINITERE, 2002). The same source confirms that the Akagera National Park had 241,000ha before the war but only 90,000ha is remaining after the war. The last example is Gishwati forest resource that is the second most important mountain forest in Rwanda, which has lost more than half of its size: ¹¹It had 28,000ha before the war, after the war, only 600ha left (Kanyamitwe, 1998)

In Rwanda, the large number of refugees within limited area exerted considerable pressure on vegetation cover and hence deforestation. Basically, in four ways, firstly as part of the war strategy, large sections of forested region were destroyed to get at enemy troops seeking refuge within them. Secondly, forest tracts were cleared in many instances to create space for displaced refugees. Lastly, these refugees very often have no access to commercial energy and as such had to resort to firewood as main energy source. The need to build shelter for these refugees also contributed to the problem and place for grazing for the cattle.

4.2.4 Deforestation

Deforestation, the conceptual model in figure 4.2 shows, is actually a consequence of a variety of the factors some of which have been identified in sections 4.1 to 4.2.3. In addition, the model reveals that other factors such as commercial logging and the dependence on firewood that is a result of the general lack of access to commercial energy also contribute to deforestation. As much as 31 of the interviewees identified deforestation also as a cause of low food productivity. This is corroborated by data from Ministry of Lands, Human Resettlement and Environment Protection (MINITERE), in 1960, Rwanda had a forest cover of about 607,000 ha. By 1995, it has reduced drastically to about 221,000 ha. Since the civil war in 1994, deforestation is estimated to be growing at 7% per annum (MINITERE, 2002).

¹¹ MTRPE:Ministère des Terres,de la Réinstallation et de laprotectin de l’Environnement

4.2.5 Erosion

Ordinarily vegetation cover protects the soil from the direct impact of raindrops and at the same time provides protection to the soil against erosion (Wischmeier and Smith, 1978). Where there has been massive deforestation as expressed above, the soil is then exposed to such impacts, more so in steep slopes (recall that population pressure drives people into marginal lands that very often include areas with high slopes) (Clay et al., 1990). The process of the erosion is that water from the hill slopes brings particles such as coarse sand gravel, etc. and excessive sedimentation in the valley bottoms. Consequently, it erodes and brings with it nutrients and organic soil cover. Gikongoro province area is situated in these zones, which are at high risk as already discussed (see the map of the study area). The plates below show some examples of erosion due to the reduction of vegetation cover in Southwestern Rwanda

Plate 4. 1 and Plate 4. 2: Cases of erosion



Source: *Fieldwork*¹², 2004

Naturally, nutrients reside in the organic part of the soil and where such soil cover has been lost to erosion, the consequence is reduced fertility and hence lowered agricultural productivity. Clay and Lewis established the link between the declines in productivity and the steepness of slope as the table below shows.

¹² Plates have been taken by Gakuba Alexis (ACDI). The area is closed to Nyungwe forest in Gikongoro province.

Table 4. 1: Decline in productivity of cropped fields by steepness of field slope in Rwanda

Steepness of field slope	0-5 degrees	6-9 degrees	10-14 degrees	15-20 degrees	21+ degrees
Decline in productivity	46.7%	46.2%	52.3%	50.1%	55.7%
Number of fields assessed	1041	740	907	837	755

Source: Clay and Lewis, 1990

According to data from the above table, fields experiencing serious decline in agricultural productivity are located on slope of 15 degrees or greater. According to local administration in Gikongoro province, the situation is dramatic because third to quarter of farmers grow their crops on field with slope of 15 degrees or greater (almost the whole province is located on Crête Congo-Nil, above 1,800m of altitude. This implies that about a third of farmers in the district suffer productivity losses of up to 50%.

4.2.6 Other Factors

Figure 4.1 shows other factors perceived as causes of low agricultural productivity. The most important in this context are persistence in use of traditional agronomic agricultural practices such as slash and burn agriculture for instance. In addition, during the interview, communities recognized that they do not have enough knowledge about new technologies and practices in agricultural sector. Authorities in Gikongoro responded also that they do not have enough tools, means, and skilled people in agriculture domain and veterinary in order to assist communities during their daily problems.

Moreover, farmers and authorities contacted in Gikongoro underlined the lack of small and big livestock and therefore a lack of manure. Farmers do not have enough knowledge of how to create “terrasses anti-érosives” (erosion ditches) and how to plant properly grass strips in order to prevent soil erosion as shown in the plate 4.5 below.

Plate 4. 3: Radical terraces with anti-erosive grass



The other problem linked to literacy and consequently to low farming productivity in Gikongoro is ignorance and conservatism (SIDA/Sala-Ida, 2003-2004)¹³.

Lack of subsidies is also a very important factor with probable significant impacts on agricultural productivity. Thirty-eight of the respondents agree it is a major cause. However, details of how this affects productivity are not discussed in this paper. Only, the small farmers interviewed acknowledged that they do not receive the micro credit from the bank or the government. This study acknowledges that there are also probably equally important factors, such as policy choices concerning focus on cash crops at the expense of food crops that are recognized (see literature review section) but have not been mentioned in the survey.

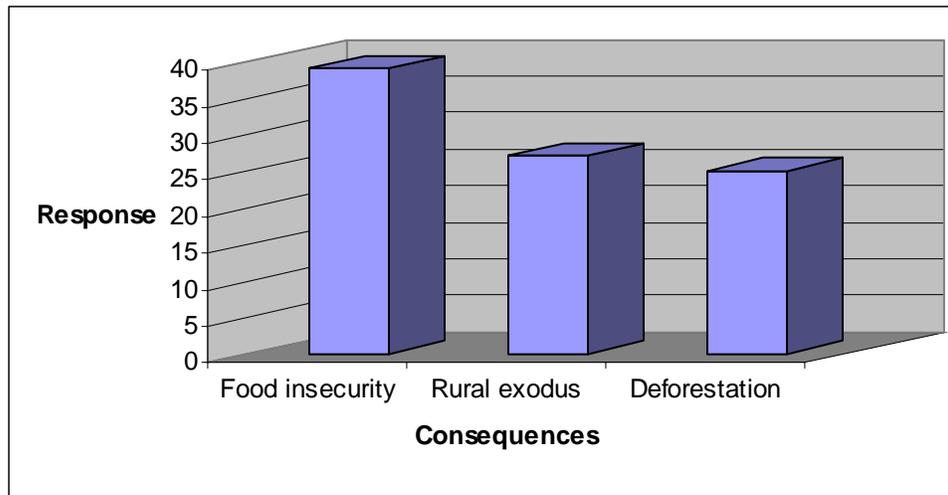
4.3 Consequences of low Agriculture Productivity

The results from the survey data showed that 97.5% (number of responses=39) the first consequence from low agricultural productivity is food insecurity¹⁴. According to definition of the World Bank (1986), food insecurity is “*the inability to acquire or consume an adequate quality or sufficient quantity of food in socially acceptable ways, or the uncertainty that one will be able to do so*”. The second and third consequences from low agricultural production are respectively rural exodus and deforestation as shown in the figure below.

¹³ SIDA:Swedish International Development and Co-operation Agency. SALA-IDA means Swedish Association of Local Authorities-International Development Agency. They help in development sector in Gikongoro and in Butare Préfectures,

¹⁴ Food insecurity is the opposite of food security

Figure 4. 4: Main Consequences from low Agricultural Productivity in Gikongoro



4.3.1 Food Insecurity in South-Western Rwanda

As mentioned previously, the main objective of sustainable agriculture is to increase agricultural productivity and thereby provide surplus that in return can generate profitable farm income, promote environmental care, and promote stable prosperous farm families and communities ([Farmers' World Network, 2002](#); [Miller, 2004](#); [Jules Pretty, 1999](#))

Nevertheless, this is not the case in southwestern part of Rwanda because Gikongoro is the poorest Prefecture in Rwanda with per capita farm incomes in 1988 estimated at USD 85 that corresponds to less than one third of national average ([IFAD](#))¹⁵. 97.5% of the interviewed people affirmed that there is food insecurity prevailing in Gikongoro. Farmers (16 out of 25) interviewed during the fieldwork affirmed that they eat once a day despite hard work they do everyday. This prevalent situation has caused environmental degradation because people, for survival purposes, are obliged to cut forest and gather timber forest or make charcoal for sale in order to make ends meet. The second consequence from low agriculture productivity is deforestation.

4.3.2 Deforestation

Deforestation is both a cause and an effect of low food productivity. Low productivity drives farmers in search of more lands that are fertile, in many cases forested lands. Then farmers slash and burn of forest in order to have additional farmland as showed in the plate below. In addition, it increases the need for other sources of income, especially logging and firewood gathering.

¹⁵ IFAD : International Fund for Agricultural Development.

Plate 4. 4: A cleared field for farming

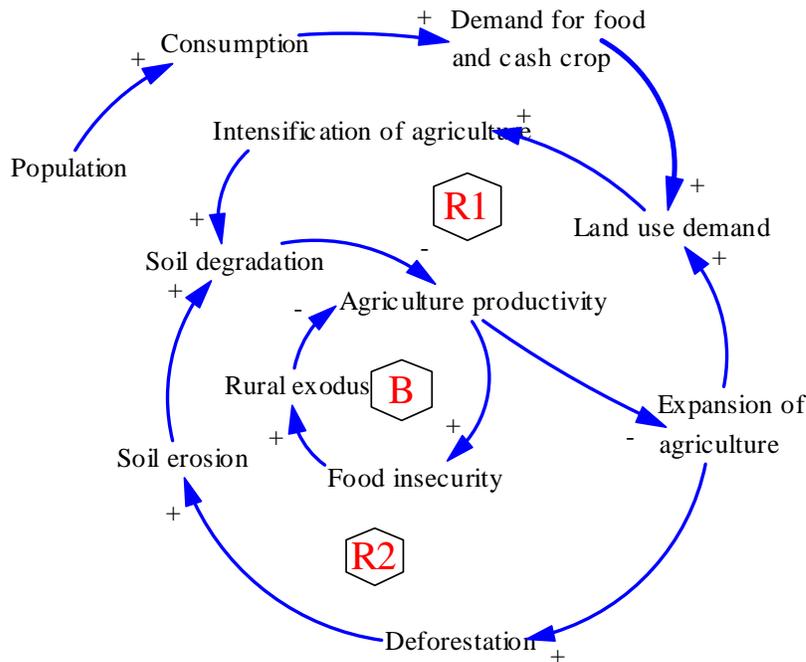


4.3.3 Rural Exodus

Food insecurity, population pressure, lack of land and unemployment in rural areas, has greatly led to rural-urban migration. Interviewed people, representing 72.5% affirmed that rural exodus is a serious consequence from low agricultural productivity in the region. According to [World Bank in collaboration with the Ministry of Finance and Economic Planning, Ministry of Gender and Social Affairs, the Ministry of Agriculture, and Réseau des Femmes \(1998\)](#), the town of Kigali is growing fast since 1991. Since Rwanda has a predominantly young population, persons aged below 25 years comprise 67% of the total population. Hence, the agricultural sector is losing vigorous young people that could increase food productivity if they were trained. The towns without enough jobs are gaining many people. They thus resort to prostitution, drugs and other social vices like armed robbery ([third Census of Population and Housing of Rwanda, 2002](#)). The Vice-Governor in charge of Economic affairs affirmed that young people of Gikongoro had migrated in other prefectures where they can increase their agricultural productivity or in Kigali town in order to have some income to help their families in rural areas. In some municipalities like Gikongoro, Karaba and Nyaruguru, food insecurity and hunger are chronic and permanent leading to the dependence of food aid. Unfortunately, data on trends in food crop or cash crop production over the years is not available to buttress this point.

A summary of causes and consequences of agricultural productivity are presented in the CLD below.

Figure 4. 5: CLD of causes and consequences linked to low agricultural productivity



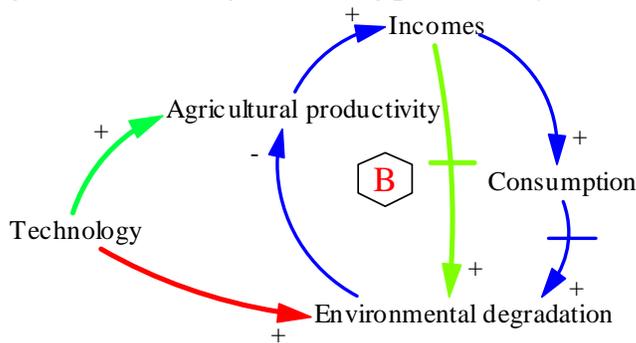
The CLD above shows that high population increases consumption and this leads to the increase of food demand and cash crop. As previously mentioned, cash crops has been introduced during the colonial period in Rwanda in order to generate more incomes to the country. Then the demand of food and cash crop increases the demand for land use and more land use leads to more intensification of agriculture. More intensification of agriculture increases soil degradation. The result from this situation is low agricultural productivity. Low agricultural productivity leads to the expansion of agriculture. The expansion of agriculture leads to the increasing of demanding land and it becomes a vicious reinforcing loop (**R1**). On the other hand, the expansion of agriculture leads to the loss of forests and rangelands. This situation increases soil erosion and this increase soil degradation and less agricultural productivity that may lead to increase in food insecurity. Again, food insecurity makes farmers expand their agricultural land and it becomes a second vicious circle (**R2**). In addition, low agricultural productivity increases food insecurity and consequently and food insecurity pushes vigorous young farmer leaving rural area to the town and forced to do no small jobs or begging in order to have some incomes to buy some food (rural exodus) and the number of labor decreases. Consequently, agricultural productivity decreases (**B**).

4.4 Solution: Applying Sustainable Agricultural Principles

Increasing food production is urgently needed in Southwestern Rwanda due to rapid population growth. This is to ensure food security and poverty alleviation especially in the rural areas. However, as mentioned previously, the way to increase agricultural productivity is different from one country to another because it depends on how human capital, social capital, natural capital, physical capital and financial capital are available locally as mentioned early (table 3-2). Agricultural productivity depends also on the type

of agriculture that each country adopts. Some researchers think that conventional agriculture based on industrialized farming may be a solution of food insecurity in Gikongoro. However, as shown on the figure (4.6) below and discussed later, it is shown that conventional agriculture may not be a solution to the food insecurity in Rwanda. Conventional agriculture may worsen the state of environment that is already in agony in the region. On the other hand, sustainable agriculture enables agricultural productivity and does not cause as big a threat to the environment as conventional agriculture does (Eicher, 2003). The Causal Loop Diagram (CLD) below summarizes different components needed to raise agricultural productivity and incomes in conventional agricultural productivity¹⁶.

Figure 4. 6: CLD of increasing productivity in conventional agriculture system¹⁷



The CLD above shows that technology (mechanization, monoculture, synthetic inputs) lead to the increase of agricultural productivity in one hand. More agricultural productivity leads to more incomes. More incomes increase consumption and this may reduce the environmental condition (increases environmental degradation) in the long run which in turn leads to reduction in agricultural productivity(B). On the other hand, technology on which conventional agriculture is based depends on the use of chemical fertilizers, pesticides, intensive irrigation, leads to environmental degradation and this decreases agricultural productivity. However, by time there will be a delay with the increasing of incomes, the improvement of environment then follows as put forward in the Environmental Kuznets Curve¹⁸ theory.

Does the Environmental Kuznets Curve (EKC) fit well in the case of Rwanda? On the other hand, can conventional agriculture succeed in the context of Rwanda? From the environmental constraints in Rwanda discussed earlier, the EKC will not work in the case of conventional agriculture in Rwanda. This is because an increase in agricultural productivity in conventional agriculture to cope up with the increase in food demand due

¹⁶ Conventional agriculture: An industrialised agricultural system characterized by mechanization, monocultures, and the use of synthetic inputs such as chemical fertilizers and pesticides, with an emphasis on maximizing productivity and profitability (Eicher, 2003)

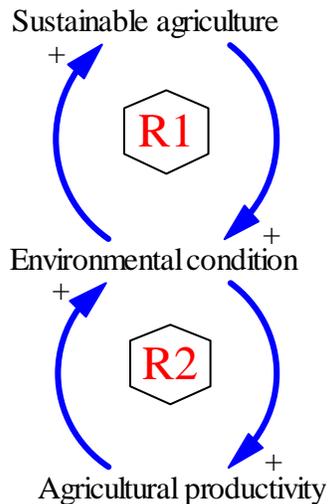
¹⁷ The thinking model (CLD) was built according to Michael. P. Taodaro and EKC's ideas.

¹⁸ In 1995, Simon Kuznet proposed that there was an inverted U-shaped relationship between income distribution and economic growth (Yandle et al, 2002). This theory has been extended to environmental problems such as deforestation, and pollution (see Panayotou, 1995)

to rapid increase in population usually is achieved by increasing inputs such as chemical fertilizers, pesticides, irrigation, etc. These in turn would affect the environment negatively e.g. fertilizers and pesticides may leach and or runoff to ground and surface water and hence cause soil and water pollution. This in turn will lower the agricultural yields per unit area. With decline in yield and ever-increasing food demand, the farmers will expand their farmland. This would imply cutting down of forests and encroachment of steep sloping areas. As a result, soil erosion may increase leading to further environmental degradation. Consequently, the agricultural yield per unit piece of land will decline triggering an increase in food insecurity.

Therefore, in the case of Rwanda where the farming environment is already degraded, applying conventional agriculture, may worsen the situation and hence an alternative farming strategy need to be applied. Sustainable agriculture seems to solve the problem.

Figure 4. 7: CLD of increasing agricultural productivity based on sustainable agriculture



In the CLD above, sustainable agriculture would include the use of technologies such as creation of terraces, education to farmers and labourers as well as exploring the cultivation of alternative but potentially suitable crops and the use of manure in place of chemical fertilizer. This kind of agriculture would improve the environmental condition in the farmlands and hence the agricultural productivity may increase.

Sustainable agriculture improves the farm environmental condition due to a number of reasons; first educated farmers may adopt the most suitable agronomic technologies and most suitable crops that would result in minimal negative impacts to the environment while optimizing on agricultural yields. Second, the use of organic manure instead of chemical fertilizers and the avoidance of pesticides would reduce leachates of nutrients and pollutants to water and soil and hence pollution.

The net result of improvement in the environmental condition would be increased crop yields per unit area of cultivated land. Though it is not possible to establish whether the yield increase would be more in sustainable agriculture per unit land as compared to the case of conventional agriculture, it is worth noting that the improvement in environment in sustainable agriculture would ensure long-term productivity unlike in the conventional agriculture.

Assuming that there will be ready market and good prices for the agricultural produce, the improvement in agricultural productivity may indirectly result in further improvement in environmental condition. This would be achieved from the fact that the higher income generated would increase the farmers capacity to manage the environment on assumption that part of the income will be re-invested in environmental care. On recognition that market and price of agricultural products may heavily influence the agricultural productivity, there is need for the government of Rwanda to address these two issues. This would be achieved if the government would have a control over the prices of agricultural products as well as protect the domestic market from cheap exports. Adopting sustainable agriculture would therefore lead to a win-win situation in Rwanda.

5 Conclusions

The present study was undertaken with first aim of identifying factors leading to low agriculture production in the study area. It has been found out that the major problems include the high population pressure, soil erosion, land scarcity, deforestation and traditional practices and conservatism, acts as the main causes of low agricultural productivity in South-western Rwanda. The study also shows the consequences of such developments on food security prevailing in the region which are mainly deforestation, rural exodus, and food insecurity.

The main challenge is how to increase agricultural productivity in a region where there is high population density, inadequate farming land. What is more the land has already been damaged due to the outmoded methods of cultivation. From the surveys carried out in the study area, combined with literature review, sustainable agriculture based on improving, human asset, social asset, natural asset, physical asset and financial asset can improve agricultural productivity and environment.

However, taking into account many constraints discussed in this study, the government of Rwanda cannot resolve all the problems by itself. As a recommendation, it is recommended that farmers should be taught how to incorporate natural, social and economic factors locally available into their production system. They have to be trained in using new technologies based mostly on tools locally available. This may take long time; however, the short-time solution from this study's point of view is a synergy of efforts from many actors. Thus, Rwanda government, NGOs, International community and other donors should help in development of rural areas of Rwanda. International Food Policy Research Institute (IFPRI) in its 1995 publication (*A 2020 vision for food, agriculture, and the environment*), talking about agricultural development in Sub-Saharan Africa countries concluded that : *“Unless action is taken, with the utmost commitment and urgency on the part of national governments, and the International Community, the already disastrous situation facing many countries of Sub-Saharan Africa risks reaching unmanageable dimension”*.

Increasing productivity in Rwanda is a big challenge to the government itself considering multiple constraints. To reach the goal, Rwanda in general and in the Southwestern part of Rwanda in particular, the following further recommendations should be taken into serious thought.

- The government has to make available inputs, credit, and other incentives necessary to facilitate farmers to buy selected seeds, hoes, small livestock farmers, which are needed to increase organic matter to improve soil fertility especially in Gikongoro.
- The government of Rwanda has to encourage farmer holdings to mitigate soil erosion through conservation investments and reforestation. Investments should be used to create radical terraces, grass strips, anti-erosive ditches on the steeper slopes.

- The international community, NGOs, etc should help the government of Rwanda to promote sustainable agriculture at large scale in order to increase agricultural productivity.
- The government of Rwanda should strategize on how to protect the local market from cheap imported food supplies as well as exercise some control on prices.
- The financial and technical help from international community is needed to help Rwanda government because recently from civil war and with environmental degradation, it may be difficult for Rwanda to succeed by itself.

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Appendix: Questionnaire

I. Which of the following are the causes of low agriculture productivity in Southern region in order of importance?

- a. Natural:
 - Droughts,
 - Floods,
 - Destruction by predator,
 - Soil erosion,
 - Deforestation,
 - Others
- Socio-cultural and economic
 - Lack of labor,
 - High demography,
 - Lack of fertilizers,
 - Lack of subsidies,
 - Lack of land,
 - Low seeds quality,
 - Poor knowledge of modern agricultural practices,
 - Genocide and social conflicts,
 - HIV/AIDS, malaria, other diseases
 - Others

II. What in your opinion are the main consequences of low agricultural productivity?

III. Please, do you have other comments to make with respect to this subject?

Thank you

Names of some farmers (local leaders) selected as discussion group in Mushubi municipality (Plate 2-2): From the left to the right: **Karimunda Osée, Nzabakiliho Elias, Mukasakindi Euphrasie, Mukasitake Liberata and the author of this document.**