

An Assessment of Rwanda's Agricultural Production, Climate Change, Agricultural Trade and Food Security

Faustin Gasheja
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WP/23/2017

**THE KENYA INSTITUTE FOR PUBLIC POLICY RESEARCH AND
ANALYSIS (KIPPRA)**

AND

**UNITED NATIONS ECONOMIC COMMISSION FOR AFRICA
(UNECA)**

An Assessment of Rwanda's Agricultural Production, Climate Change, Agricultural Trade and Food Security

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KIPPRA Working Paper No. 23
2017



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Published 2017

© Kenya Institute for Public Policy Research and Analysis

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ISBN 9966 058 64 5

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This paper has been published under the KIPPRA/UNECA Project on Regional Assessment of Agricultural Production, Climate Change, Agricultural Trade and Food Security in the East African Community.

Foreword

Climate change and climate change variability is a threat to food production patterns, thus exacerbating food and nutrition insecurity across Africa. Therefore, tackling poverty, hunger and food security is a priority for the Africa Union Agenda 2063 which underscores the right of Africans to live healthy and productive lives. Further, the African Union has set a target to eliminate hunger and food insecurity by 2025 towards achieving the Sustainable Development Goal (SDG) 2 on ending hunger, achieving food security and improving nutrition. Unfortunately, Africa is not on track in meeting these targets mainly because the region is not producing enough food due to climate change and low adoption of technology. However, climate change has variable impacts on food production, with both production losses and gains across the region. As a result, regional trade is critical for facilitating the distribution of agricultural products to enhance food security in the region.

The East Africa Community (EAC) region is particularly vulnerable to climate change. The region is already experiencing increased climate change impacts, including extreme weather conditions, persistent drought, floods, and landslides and rising sea level which threaten food security and efforts to eradicate poverty. Despite the huge potential to produce enough food, the agricultural production system in the region is mainly rainfed, which consequently leads to high food and nutrition insecurity.

Finding solutions to perennial food security challenges in the EAC is crucial and urgent as climate change impacts intensify in frequency and severity. Looking beyond just agricultural production systems is thus critical in tackling this peril. Thus, there is need to apply other approaches such as the nexus approach which allows for evaluating integrative systems where, for instance, trade facilitates food security in a changing climate environment. Although agriculture production is vulnerable to climate change, food security is not necessary a result of low production but a combination of other factors such as poor food distribution caused by perverse subsidies and other trade barriers. The EAC has been able to attain a common market status, which could facilitate trade in the region and thus mitigate food shortages.

Despite the various measures and programmes adopted in EAC, some parts of the region continue to face food deficits due to restrictive trade policies and barriers to trade. Opportunities exist for adopting existing policy frameworks by member countries to address food security needs.

Preface

The project on Regional Assessment of Climate Change, Agricultural Production, Trade in Agricultural Production and Food Security in East African Community (EAC) was carried with support from the ACPC-CLIMDEV Work Programme. The ClimDev-Africa Programme is an initiative of the African Union Commission (AUC), the United Nations Economic Commission for Africa (UNECA) and the African Development Bank (AfDB). It is mandated at the highest level by African leaders (AU Summit of Heads of State and Government). The Programme was established to create a solid foundation for Africa's response to climate change and works closely with other African and non-African institutions and partners specialized in climate and development.

Over the last few years, our understanding and certainty about how climate is changing and the possible impacts this could have has grown immensely. This notwithstanding, agricultural production systems in the EAC region are highly vulnerable to climate change, consequently affecting food and nutrition security. The region is the most developed regional economic community (REC) in Africa, and cross border trade plays a critical role in facilitating food security. In response, the United Nations Economic Commission for Africa–African Climate Policy Centre (ACPC) is increasing its efforts to improve the capacity of EAC member states for mainstreaming climate change impacts in development policies, frameworks and plans.

The three-year project was launched in May 2014 covering Burundi, Kenya, Rwanda, Tanzania and Uganda. The activities carried in this study were linked to the ClimDev-Africa Programme work stream II, which focuses on solid policy analysis for decision support, and was spearheaded by the Kenya Institute for Public Policy Research Analysis (KIPPRA). The overall objective of the project was to assess whether or not agricultural production systems and trade policies in EAC can be adjusted to alleviate the impact of climate change on food security, and promote sustainable development. The project outputs include pre-project report, country scoping studies, indepth EAC studies on climate change, crop production model, economic policy and trade and finally a comprehensive regional report.

Acknowledgements

The study was conceptualized and commissioned by the African Climate Policy Centre (ACPC), United Nations Economic Commission for Africa (UNECA), under the leadership of Dr Fatima Denton, Director of the Special Initiative Division, UNECA. Dr Tom Owiyo and Dr Johnson Nkem, senior experts at ACPC, guided the conceptual framing and provided oversight during implementation. Regular technical support was provided by ACPC researchers, Dr Wifran Moufouma Okia, Mr Nassirou Ba, Dr Habtamou Adessou, and research fellows Yosef Amha and Rivaldo.

The study was conducted as a part of the activities of the Climate Change and Development in Africa (ClimDev-Africa) Programme supported by the UK Department for International Development (DfID), European Union Commission, Norway, Sweden, France, Nordic Development Fund, and the United States Agency for International Development (USAID).

The Executive Director of KIPPRA and the Executive Secretary of UNECA would like to acknowledge the KIPPRA technical team comprising Nancy Laibuni (Project Coordinator), Dr August Muluvi, Dr Christopher Onyango, Mr John Nyangena, Mr Simon Githuku, and Mr Nixon Murathi; and the project consultants Dr Richard Mulwa, Dr Miriam Omolo, Dr Wilfred Nyangena, Prof. Caleb Mireri, and Dr Wellington Mulinge. In addition, we appreciate the Eastern and Southern Africa Region Office of the World Meteorological Organization, led by Dr Elijah Mukhala and the consultants, Mr Nicholas Maingi and Dr Joshua Ngaina for their contributions to the project.

The regional Partner Institutions included Economic Policy Research Centre (EPRC)–Uganda team lead by Dr Isaac Shinyekwa, Sokoine University–Tanzania team led by Prof. Siza Tumbo, University of Burundi team led by Dr Alex Ndayiragije, and Kigali Independent University team led by Mr Paul Muzungu. The participation of the stakeholders in various stages of the preparation of the report was highly valuable in enriching the report.

The Economic Commission for Africa and KIPPRA would like to express their appreciation to all the government Ministries, State Departments and Agencies in Burundi, Kenya, Rwanda, Tanzania and Uganda for their active participation and providing the data and information used in preparing the report.

Executive Summary

Rwanda is a small, hilly, landlocked country located in Eastern and Central Africa region between Burundi, Uganda, Tanzania and the Democratic Republic of Congo (DRC). It is located 2° south of the Equator in Central Africa and covers a surface area of 26,338 square kilometres. Due to high altitude, the country experiences average annual temperatures ranging from 16° to 20°C. The climate is moderate and characterized by temperate conditions, especially in higher altitudes in the Northwest of the country. The topography is hilly to mountainous with altitude ranging from 950 to 2,500 meters above sea level. Rwanda has the highest population density in Africa. Moreover, the country is characterised by agro-ecological diversity, with 12 agro-ecological zones.

The objective of this study is to assess the spatial effects of climate change on agricultural production, and food security in the East African Community region, especially in Rwanda.

Agriculture is the backbone of Rwanda's economy. It contributes 34 per cent of Gross Domestic Product (GDP). About 81 per cent of all households depend on agriculture, which employs around 70 per cent of the Rwandan population that lives in rural areas. Agricultural production is predominantly at a subsistence level because a large number of rural household's farm plots are too small to support commercial production.

The Government of Rwanda adopted the Crop Intensification Programme (CIP) in 2008 with a goal to increase agricultural productivity of high potential food crops and to provide Rwanda with greater food security. The implementation of this programme involves various components, including Land Use Consolidation (LUC) as the main pillar, proximity advisory services to farmers, inputs (seeds and fertilizers) distribution, improving post-harvest technologies (e.g. driers and storage facilities) and access to extension services. The priority food crops in the programme include Irish potatoes, maize, wheat, rice, cassava, soybean and beans. These have been selected for promotion under land use consolidation policy because the volumes of production of these food crops determine the levels of food security in Rwanda.

Rwanda's collective vision for development is embodied in Vision 2020 which seeks to transform the country from a subsistence agriculture economy into a knowledge-based middle income economy by 2020. To meet these objectives, EDPRSII is developed around four strategic thematic areas (Economic Transformation, Rural Development, Productivity and Youth Employment, and Accountable Governance), which will drive rapid and sustainable economic growth, and help reduce poverty country wide.

Despite its significant contribution to the GDP, Agriculture is highly sensitive to climate variability. Higher temperatures eventually reduce yields of desirable crops and tend to encourage weed and pest proliferation. During the 2000 drought, the Ruhengeri and Kigali-Ngali provinces (particularly the Bugesera region) saw dramatic reductions in maize of 203 per cent and 192 per cent from the 1990 levels. Beans production losses were significant in the Kigali-Ngali and

Gitarama provinces with 247 per cent and 192 per cent reductions from 1990. The 1997 La Nina drought also resulted in livestock losses in cattle, goats, pigs and poultry in the above regions, particularly the Umatara Province. Estimated costs of cattle losses were Rwf 20 billion.

The analysis has brought out the fact that the climate in Rwanda is complex with wide variations across the country and strong seasonality. A study by Stockholm Environment Institute entitled “Economics of Climate Change in Rwanda” (2009) provides evidence showing that there are likely significant indirect health effects of floods. It has estimated that the direct measurable economic costs of this event were US\$ 4 to US\$ 22 million (equivalent to around 0.1–0.6% of GDP) for two districts in Rubavu and Nyabihu alone.

The main environmental problem faced by farmers in Rwanda is climate change. Recent extreme events that Rwanda has experienced include those of 1997, 2006, 2007, 2009, 2012, and 2015. The agricultural sector has consequently been affected, causing low productivity especially in the Northern and Eastern parts of the country due to unpredictable weather variability, among others.

In 2006, the Government of Rwanda through an initiative of the President developed the Girinka Programme (one cow per poor family) as a response to the alarmingly high rate of childhood malnutrition and as a way to accelerate poverty reduction and integrate livestock and crop farming. The one cow per poor family programme distributed a total of 27,688 cows to poor households in 2011. The programme has contributed to an increase in agricultural production in Rwanda, especially milk production and products, reduced malnutrition and increased incomes.

Analysis of rainfall trends show that rainy seasons are tending to become shorter with higher intensity. This tendency has led to decreases in agricultural production and events such as droughts in dry areas and floods or landslides in areas experiencing heavy rains. To respond to these changes, Rwanda has introduced a number of measures, although most of these were initiated for agricultural purposes rather than for climate change adaptation per se. Later, some of these adaptation measures started to be seen as important in addressing negative effects of extreme rainfall and higher temperature. Some of these comprise soil and water conservation measures such as bench terraces, ditches combined with erosion fences, and tree plantation. Erosion fences (55.5%) and ditches (37%) are the dominant measures used by farmers.

Food security is a priority for the Government of Rwanda. The 2012 Comprehensive Food Security and Vulnerability and World Food Programme revealed that almost four in five (79%) or about 1,717,000 households had acceptable food consumption and could be considered food secure. The Western province accounts for the largest numbers and highest rates of food insecure households (37%). Kigali has by far the highest proportion of households with acceptable food consumption (93%) followed by the Eastern province (86%), which is relatively better off than other provinces but most prone to rainfall deficit. At district level, Rutsiro (53%), Ngororero (44%), Rusizi (49%), Nyamasheke (37%) and Karongi (37%) have the highest percentages of households with unacceptable consumption. If a

major rainfall deficit were to affect the East (which happens every 4-5 years), an additional 170,000 households would become food insecure (CFSV&WFP,2012).

Rwanda trades with neighbouring countries across a number of border points, including airports. It is currently exporting agricultural products including maize flour, wheat flour, beans, rice, meat, and dairy. The DRC is Rwanda's largest regional export market accounting for 70 per cent of formal exports and almost 80 per cent of informal exports to the EAC and DRC region in 2011. Burundi is Rwanda's second largest cross-border market, with US\$ 12.7 million in total exports in 2011 and US\$ 2.7 million in total imports. Rwanda is a net exporter to Burundi of maize, maize flour, wheat flour, cassava flour, potatoes, and milk. Informally, Rwanda's cross border exports are dominated by local agricultural produce (40%) and livestock (26%). Manufacturing goods such as processed food, fast-moving consumable goods and re-exports of paraffin are also significant. However, Uganda is a net exporter of maize, maize flour, potatoes, rice, cassava and milk to Rwanda while Rwanda is a net exporter of beans to Uganda. Finally, Tanzania is a generally food secure country with modest exports of agricultural commodities to neighbouring countries. Tanzania informally exported to Rwanda 110,997 metric tons (MT) of staple food commodities, including 42,819 MT of maize, and 15,403 MT of beans.

Rwanda has policies and strategies which are positively contributing to agricultural productivity, enhanced trade and addressing climate change. However, there is need to improve road networks and food commodity markets as an incentive for agriculture productivity and enhanced trade. Good policies and strategies, as well as improved infrastructure, favour the reduced greenhouse gas emissions and resilience to climate change in Rwanda.

The trade of food and agricultural products can contribute to both climate change adaptation and mitigation, and trade measures will likely be used by policy makers to encourage mitigation.

Abbreviations and Acronyms

ACORD	Association de Coopérative et de Recherche pour le Développement
AEZ	Agro-ecological Zone
BNR	Banque Nationale du Rwanda
CDKN	Climate and Development Knowledge Network
CIA	Central Intelligence Agency
CFSVA	Comprehension Food Security and Vulnerable Analysis and Nutrition
CIP	Crop Intensification Programme
COMESA	Common Market for Eastern and Southern African
DRC	Democratic Republic of Congo
EAC	East Africa Community
EDPRS	Economics Development Poverty Reduction Strategy
FAO	Food Agriculture Organization
FNSMS	Food and Nutrition Security Monitoring System
GDP	Gross Domestic Product
GHG	Green House Gas
IPCC	Inter-Governmental Panel on Climate Change
LUC	Land Use Consolidation
MINAGRI	Ministry of Agriculture and Natural Resources
MINECOFIN	Ministry of Finance and Economic Planning
MINECOM	Ministry of Trade and Industry
MINIRENA	Ministry of Natural Resources
NAEB	National Agricultural Export Board
NAP	National Agricultural Policy
NBR	National Bank of Rwanda
NISR	National Institute of Statistics of Rwanda
PSTA	Plan for Agricultural Transport Strategy
RAB	Rwanda Agricultural Board
REMA	Rwanda Environmental Management Authority
SSA	Sub-Saharan Africa
USAID	United States Agency for International Development
WFP	World Food Programme
WTO	World Trade Organization

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1. Introduction

Rwanda is a small landlocked country located in the Eastern and Central African region between Burundi, Uganda, Tanzania and the Democratic Republic of Congo (DRC). The climate is moderate and characterized by temperate conditions, especially in higher altitudes in the Northwest of the country. The topography is hilly to mountainous with altitude ranging from 950 to 2,500 meters above sea level (CIA, 2005). Rwanda is located 2° south of the Equator in Central Africa and covers a surface area of 26,338 square kilometres. The countryside is covered by grasslands. The Eastern slopes are more moderate, with rolling hills extending across central uplands. These gradually reduce in altitude to the plains, swamps, and lakes of the eastern border region. The average elevation throughout the country is about 5,200 metres; 1,585 metres above sea level. Due to the high altitude, the country experiences average annual temperatures ranging from 16°C to 20°C (Rwanda Agricultural Management–REMA, 2009).

The agricultural sector constitutes the backbone of economic development in Rwanda. It contributes 34 per cent of the Gross Domestic Product (GDP) and employs around 80 per cent of the Rwandan population that lives in the rural areas (Rwanda Agricultural Board–RAB, 2010).

The government adopted the Crop Intensification Programme (CIP) through the Ministry of Agriculture in 2008. The goal was to increase agricultural productivity of high potential food crops and to provide Rwanda with greater food security and self-sufficiency. The implementation of this programme involves various components. They include Land Use Consolidation (LUC) as the main pillar, the proximity advisory services to farmers, distribution of inputs (seeds and fertilizers), improving post-harvest technologies (e.g. driers and storage facilities) and access to extension services (Ministry of Agriculture–MINAGRI, 2011). It is expected that the programme will have positive impacts on crop production, food security and household income.

Despite its significant contribution to GDP, Rwandan agricultural production presents some constraints. Like other Sub-Saharan countries, agricultural production is largely subsistence with little commercialization for the local market, because there is no value added. Low productivity is mainly due to low use of inputs, and is exacerbated by lack of innovative post-harvest technologies to improve the quality of agricultural products.

In addition, recent climate change patterns have also threatened on-going economic improvements. Climate-related events such as heavy rainfall or too little rainfall occur more frequently than in past years and are affecting human well-being. Agriculture is highly sensitive to climate variability and extreme weather conditions such as droughts, floods and severe storms. This is especially so to Rwanda where nearly all farming activities are dependent on nature. The increased potential for droughts, floods and heat waves will pose challenges for farmers and agribusiness operators. Droughts are often responsible for famine, food shortages, and a reduction in plant and animal species. People are often displaced as they search for food and pasture.

Climatic change impedes trade; primarily and most apparently, it impedes trade in agricultural products (Stockholm Environment Institute, 2009). The Stockholm Environment Institute (2009) estimate that the direct measurable economic costs of floods in Rwanda were US\$ 4 million to US\$ 22 million (equivalent to around 0.1–0.6% of GDP) for two districts in Rubavu and Nyabihu alone. In addition, there are indirect health effects of floods, in addition to the costs of replacement of infrastructure. The measurable economic costs are equivalent (noting it includes market and non-market effects) to around 0.6 per cent of GDP in 2007. When the full effects of the events are included, the total economic cost would likely be significantly higher.

Although farmers are not necessarily involved in trade in the East African Community, since they are mostly producers, a lower production diminishes surplus that could be traded. This is because climate change compromises food production, which hampers the ability of farmers to produce enough and have surplus to trade (CUTS, 2014).

When unfavourable climate persists for an extended period of time, it can also ultimately discourage farmers. This can prompt them to either abandon agricultural activities altogether or spur them to assume work in another sector. Climate change can also affect trade by altering the comparative advantage and input costs of a country's specific products (CUTS, 2014).

Nevertheless, during the 2000 drought, the Ruhengeri and Kigali-Ngali provinces (particularly the Bugesera region) saw dramatic reductions in maize, with 203 per cent and 192 per cent, respectively, from 1990 levels. Losses in beans production were significant in the Kigali-Ngali and Gitarama provinces with 247 per cent and 192 per cent reductions from 1990. The 1997 *La Nina* drought also resulted in livestock losses of cattle, goats, pigs and poultry in the above regions, particularly the Umatara Province. The estimated costs of cattle losses were Rwf 20 billion (Uwizeyimana, 2004).

In Rwanda, food flows relatively freely across the borders within the Eastern African Customs Union, which was established in 2005, although there are still some non-tariff trade barriers. Free flow of goods also applies to intra-regional trade, although more exceptions apply, including a list of sensitive goods such as milk, maize and wheat that are excluded from tax exemption (USAID, 2009).

Although a steep increase in agricultural production could in future tilt the balance in favour of exports, Rwanda still remains (formally) a net importer of food when all trade is considered. The cereal balance sheet as calculated by the Food and Agricultural Organization (FAO) in September 2012 also indicates that Rwanda is a formal importer of cereals. Informal trade was estimated to represent 23 per cent of total cross-border trade in 2010. In 2011, according to reports of the National Bank of Rwanda, Rwanda's informal exports exceeded informal imports, leaving the country with a positive trading balance. The commodities that are informally traded are livestock and food products. Rwanda exports beans, maize and even wheat while she informally imports rice.

Rwandan exports to other East African Community (EAC) member countries (representing 21.9% of total exports) increased by 7.0 per cent in 2014 from US\$ 122.94 million to US\$ 131.56 million. Imports from EAC countries increased by 5.9 per cent from US\$ 516.39 million in 2013 to US\$ 546.80 million in 2014. As a result, trade deficit deteriorated by 5.5 per cent from US\$ 393.45 million in 2013 to US\$ 415.24 million in 2014.

Table 1.1: Trade flow of Rwanda within EAC (US\$ million)

		2011	2012	Jan-Dec 2013	Jan-Dec 2014
Export to EAC	Value in US\$ millions	80.71	115.59	122.91	131.56
	% change	19.02	13.22	30.05	7.01
	Share of total formal exports	20.82	23.94	21.45	21.94
Imports from EAC	Value in US\$ millions	785.77	532.56	516.39	546.80
	% change	53.07	-32.23	13.29	5.89
	Share in total formal imports	11.56	21.22	22.98	22.79
Trade balance		-705.07	-416.96	-393.45	-415.24

Source: BNR (2014), Statistics Department

Rwanda's main agricultural exports to other EAC member countries include tea sold at the Mombasa commodity exchange, raw hides and skins of bovine, coffee and leguminous vegetables. With regard to imports, the main products are: fertilizers, cereals, flour and seeds, refined and non-refined fat and oil of animal or plant origin, as well as meat and fish.

In terms of destination, exports to Tanzania, which are mainly composed of forestry products, Irish potatoes, other vegetables, paraffin, iron steel, shoes and articles of leather, modern beer, fertilizers, pesticides and pineapple, decreased by 40.3 per cent while exports to Burundi and Uganda increased by 8.6 per cent and 7.6 per cent, respectively (BNR, 2014).

Agriculture is vulnerable to climate change in a number of dimensions. Higher temperatures eventually reduce yields of desirable crops and tend to encourage weed and pest proliferation. Greater variations in precipitation patterns increase the likelihood of short-run crop failures and long-run production declines. Although there might be gains in some crops in some regions of the world, the overall effects of climate change on agriculture are expected to be negative, threatening global food security.

Food security is a complex matter and is not solely an agricultural issue. Food security emanates from complex interactions of different sector players, making it a cross cutting issue. Following the FAO (2003) definition of food security, there are four dimensions to this phenomenon: availability, accessibility, utilization and stability. These dimensions are affected by different factors; for example, climate change has increasingly become a key determinant of agricultural production in most countries. In Sub-Saharan Africa (SSA) in general, and Rwanda in particular, the changing weather patterns tend to be detrimental to crops such as grains and pulses, which are important for food security.

Food security exists when all people, at all times, have access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life.

Sustainable food security in Rwanda depends on the success of agriculture production and trade in the region within favourable climate change.

The Rwandan government has drafted policies to address the challenges of food insecurity. However, assessment of Rwanda's agricultural production, climate change, agricultural trade and food security is vital to the management, reduction and mitigation of potential risks.

1.1 Objectives of the Study

The study aims to explore the spatial effects of climate change on agricultural production and food security in the East African Community region. This is achieved by examining current, medium, as well as long term effects using crop response model by:

1. Downscaling of climate models output and analysis for historical, current and future trends at both temporal and spatial time scale in the East African Community; and
2. Providing a synthesis of the impacts of climate change/scenarios on agricultural production systems in the East African Community.

1.2 Methodology

The methodology used in conducting this research includes desktop literature review on agricultural production, climate change, food security and trade as well as review of journal articles and published documents. Assessment of previous studies to identify major agricultural production activities in the country has been done using data from the Ministry of Agriculture and Animal Resources (MINAGRI), National Bank of Rwanda (NBR) and National Institute of Statistics Rwanda (NISR), Ministry of Finance and Economic Planning (MINECOFIN) and Rwanda meteorology agency.

2 Agriculture Production, Food Security and Policies in Rwanda

2.1 Agriculture Production in Rwanda

Agriculture is the most important sector in Rwanda, generating over 30 per cent of GDP. Agriculture production remains predominantly at a subsistence level because a large number of rural household's farm plots are too small to support commercial production. Although Rwandan agriculture is constrained by demographic pressures to maximize on returns from land, it has been recognized that raising agricultural productivity is critical for attaining transformation and commercialization.

However, in Rwanda a large number of agricultural operators were mainly involved in crop and livestock farming (66.6%) while 32.8 per cent undertook crop farming activities only and less than 1 per cent undertook livestock farming activities only. For those undertaking both crop and livestock farming activities, the largest number were in the Northern Province (71.6%) while the smallest number was in Kigali City (26.3%) (NISR, 2013).

Table 2.1: Arable and cultivated land

Years	2010	2011	2012	2013
Total arable land ('000 hectares)	2,294.38	2,294.38	2,294.38	2,173,167

Source: MINAGRI (2014)

The total land area of the country measures 24,700 square kilometres. The total arable land in 2010 to 2012 was 2,294,380 hectares while in 2013 total arable land was 2,173,167 hectares of food and cash crops, with the remaining representing pastures and bushes (Ekise et al., 2013).

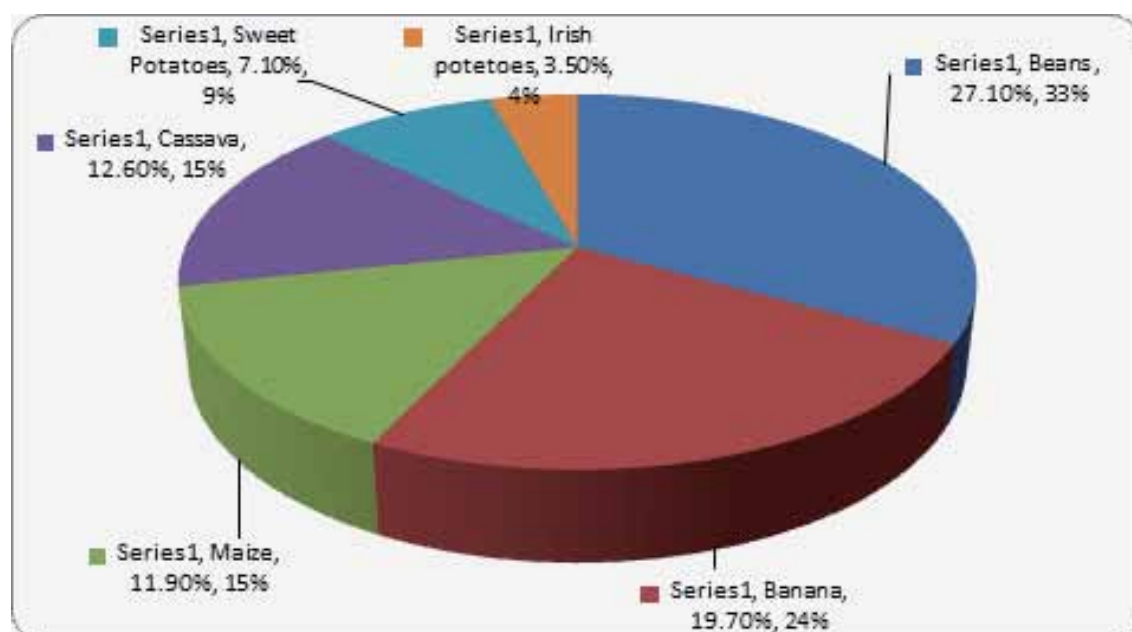
In terms of land area under crops, the main crops grown in season 2013 were beans (27.1%), bananas (19.7%), maize (11.9%) and cassava (12.6%). Sweet potatoes and Irish potatoes both accounted for around 10.6 per cent of the agricultural land, sweet potatoes 7.1 per cent and Iris potatoes 3.5 per cent.

Table 2.2: Harvest area of agricultural commodities in Rwanda (hectares)

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Sorghum	171,608	179,991	179,307	196,732	170,298	162,322	143,210	146,338	133,375	129,260	97,143	109,121
Maize	104,628	103,100	106,976	109,400	113,312	141,168	144,896	147,129	184,658	223,414	253,698	292,326
Wheat	12,046	20,728	22,191	24,157	22,084	27,528	52,336	42,438	49,386	42,874	35,016	35,200
Rice, paddy	6,423	7,667	12,167	13,922	13,123	15,005	18,455	14,433	12,975	14,731	14,701	17,569
Beans, dry	358,002	356,899	319,349	313,018	360,318	358,208	336,577	345,851	319,252	343,319	479,899	480,012
Bananas	358,863	358,419	363,383	361,251	238,092	230,064	226,666	223,590	216,953	225,361	220,384	342,695
Irish Potatoes	124,972	134,034	133,418	135,622	139,043	124,621	127,226	126,167	150,777	169,493	164,779	164,691
Sweet potatoes	195,370	147,290	163,070	148,526	138,353	147,563	149,724	123,386	112,194	106,007	109,388	112,436
Cassava	130,457	134,386	133,876	115,694	118,860	142,881	163,099	180,210	197,394	210,076	182,278	186,995

Source: MINAGRI (2014)

Figure 2.1: Agriculture land by group of crops



Source: NISR (2013)

In Rwanda there are nine priority crops (Irish potatoes, sweet potatoes, cassava, beans, maize, wheat, rice, bananas and tea) that have been selected for promotion under the land use consolidation policy for the purpose of increasing food production.

Table 2.3: Land area coverage for major cash crops ('000 hectares)

Crop/ year	2005	2006	2007	2008	2009	2010	2011
Coffee	20.10	22.51	26.39	29.00	31.32	32.71	35.10
Tea	11.39	11.67	11.90	12.50	12.58	13.55	15.10
Sugar cane	3.40	3.60	3.60	3.60	3.60	3.70	3.70

Source: NISR (2012)

Land coverage in hectares for the major cash crops is undoubtedly very small with reference to the land coverage of agricultural production. The coffee land area in hectares increased on a very small level from 2005 to 2011. The land area coverage for sugar cane (which to some extent is constant) needs more focus and attention from the Government of Rwanda. This should take into consideration the potentiality of its increment in terms of agriculture and consumption.

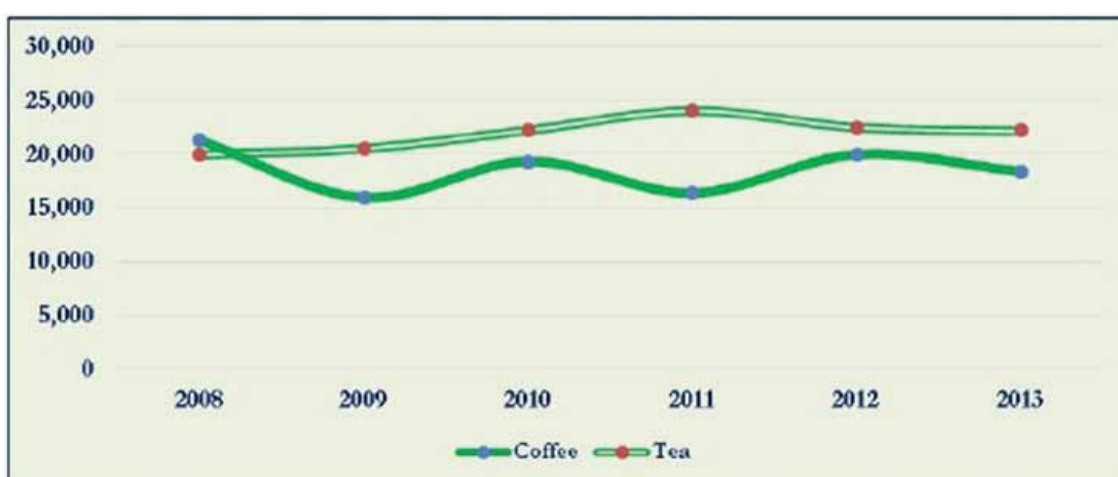
Rwanda has one sugar industry which cannot cover at least 25 per cent of the local market. The county can increase land coverage of sugar cane by utilizing the swamp of Nyabarongo and Kagera.

In addition, the cash crop land area can still be increased through sensitization of the population living on the hill side of the country to plant a crop such as tea which, unlike many other crops, is compatible with the topography of the area.

Table 2.4: Production of major cash crops in tonnes

Year	2008	2009	2010	2011	2012	2013
Coffee	21,283	15,941	19,319	16,372	19,955	18,346
Tea	19,965	20,535	22,248	24,066	22,502	22,184
Sugar cane	63,001	100,663	115,304	-	-	-

Figure 2.2: Production of major cash crops in tonnes



Source: NISR (2014)

Cash crop production increased during the last five years, especially tea, whereas coffee fluctuated during the last five years from 20,724 tonnes in 2008 to 19,319 tonnes in 2010, 21,820 tonnes in 2011 and 19,995 tonnes in 2012.

Rwanda should emphasize on the production of cash crops such as coffee and tea, which are regarded to be of high quality in the international market, and thus could bring substantial foreign currency in the country.

Table 2.5: Cash crop yield kg per hectare

Item	Coffee	Sugar cane	Tea
1993	5,190.57	357143	11181
1995	5,932.97	200000	5921,47
1997	6,740.91	200000	12712,7

1999	7033,82	200000	12917,7
2001	7063,85	200000	13890,8
2002	6938,21	204545	11914,4
2003	6902,5	200000	12387,2
2004	6902,41	272727	12387,2
2005	6277,47	172544	12393,1
2006	7226,99	161142	14447,7
2008	4830,77	175000	16784,4
2011	5837,92	-	15974,8
2012	4787,85	-	16073,6

Source National Agricultural Export Board–NAEB (2013)

Experience from countries such as Kenya suggests that extension providers are desirable only in high agricultural potential regions and for high-value cash crops such as coffee. In other cases, however, private extension is not a substitute for public extension. Therefore, the public sector should fund extension significantly but in ways that do not duplicate services already being provided by sustainable alternative service providers.

Cash crops such as coffee, tea and sugar cane are grown on commercial scales for export and domestic consumption in Rwanda.

Table 2.6: Production of major cash crops in tonnes

Years	2008	2009	2010	2011	2012	2013
Coffee	29.00	31.32	32.71	35.10	41.76	52.034
Tea	12.50	12.58	13.55	15.10	15.38	15.616
Sugar cane	3.60	3.60	3.7	-	-	-

Source: NAEB

Coffee and tea command quality premiums and are Rwanda's largest exports by a wide margin. Tea and coffee constitute by far the principal export crops of the country, representing 71 per cent of total value of Rwanda exports. Coffee, which has been the main source of foreign currency for many years, has been surpassed by tea since 2000 when tea exports amounted to US\$ 25.9 million against US\$ 22.3 million of coffee export (NAEB, 2013). The main reasons for the change are the fall in international coffee prices and the sharp decline in both quantity and quality of Rwanda coffee production. On the other hand, production of tea is increasing and prices on the international market are still rewarding for good quality tea such as that produced in Rwanda.

Figure 2.3: Cash crops production

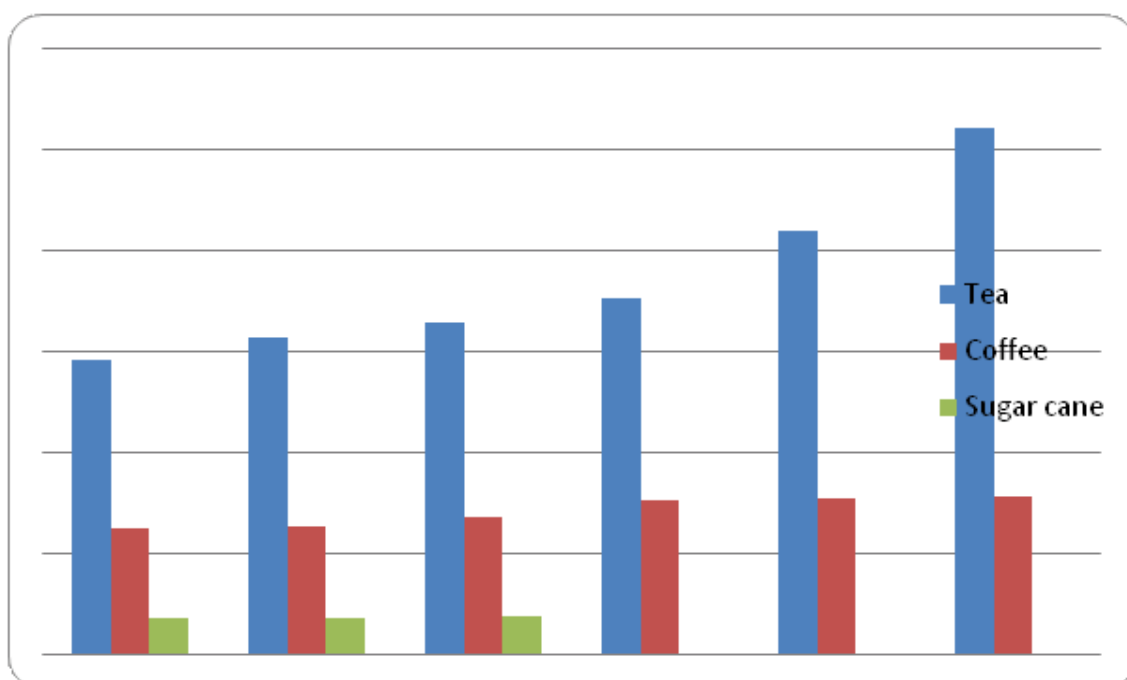


Table 2.7: Main food crop production in (thousand metric tonnes)

	2008	2009	2010	2011	2012	2013
Total crops	8,234,188	9,254,763	10,139,259	11,212,264	11,703,817	12,093,574
Cereals	461,163	615,059	738,080	848,658	871,725	989,202
Sorghum	144,418	174,553	161,229	151,754	138,695	157,492
Maize	166,853	286,946	432,404	525,679	573,038	667,834
Wheat	67,869	72,479	77,193	90,684	75,913	70,129
Rice paddy	82,025	81,081	67,253	80,541	84,079	93,746
Pulses	392,305	431,139	436,954	421,257	489,595	505,366
Beans	308,563	327,728	327,497	331,166	432,857	438,236
Groundnuts	11,122	15,353	14,369	14,756	11,638	14,414
Soya	50,931	54,203	57,089	37,426	18,544	24,838
Peas	21,689	33,855	37,999	37,909	26,556	27,878
Roots and tubers	3,815,126	4,264,961	5,192,652	5,783,263	6,189,937	6,363,451
Irish potatoes	1,161,943	1,289,623	1,789,404	2,171,517	2,337,706	2,240,715

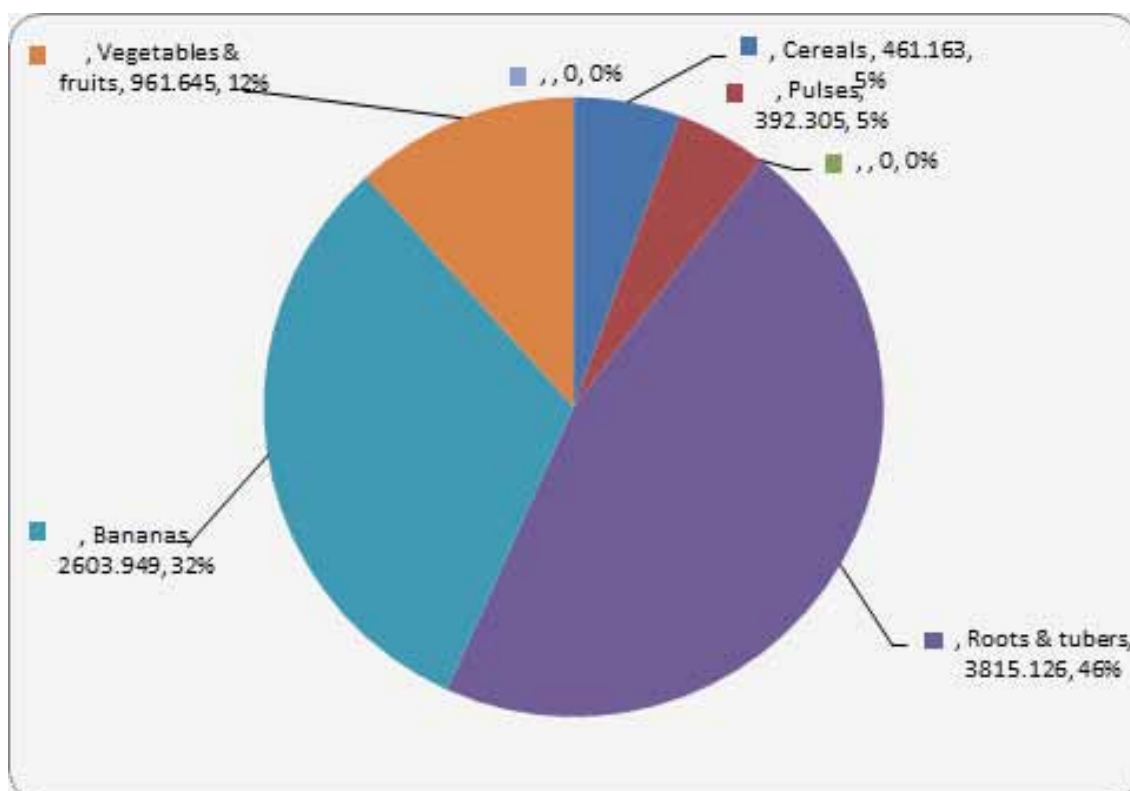
Sweet potatoes	826,440	803,228	840,072	845,099	1,005,305	1,081,224
Cassava	1,681,823	2,019,741	2,377,213	2,579,399	2,716,421	2,948,121
Bananas	2,603,949	2,993,482	2,749,152	3,036,273	3,219,466	3,291,853
Vegetables and fruits	961,645	950,122	1,022,421	1,122,814	933,094	943,703

Source: MINAGRI (2014)

Crop production has continued to follow an upward trend in 2010-2013, with Season B improvements supplementing the Season A shortfall due to weather shocks. In Season A, low rains observed in November 2010 had a negative impact on seasonal crops, especially in some regions of the Eastern and Southern Provinces.

In particular, maize and beans that were planted late in Season A (late October to early November) were hit by drought and their yields subsequently decreased. In contrast, in Season B, the rain was reported to be good with most of the respondents in the Crop Assessment reporting that rain was sufficient for main crops such as beans, sorghum, maize and Irish potatoes. There was also a significant effort with the Crop Intensification Programme in Season B to compensate for the Season A shortfall.

Figure 2.4: Food crop production



Rwandan agriculture has made major advances in the last decade. In terms of production, significant improvements are evident. In particular, wheat and maize production has improved dramatically. However, while these gains are significant, the current yields are still low when set against the full forecasted potential. The primary role of the Strategic Plan is to set guidelines for scaling up recent successes in the agricultural sector, review the challenges and define programmes and policies that will further increase sector growth. Most agricultural production relies on rainfall and is spread across diverse agro-ecological zones that can be differentiated by the topography and soil types.

According to MINAGRI (2010), maize is currently fourth after bananas, sweet potatoes and Irish potatoes in providing energy per capita. Maize has more uses than any other cereal. Not only is it used mainly as food for human consumption, but it is also the number-one feed grain in the country. It is the main source of calories in animal feeding and feed formulation. Maize is one of the priority crops that have been chosen by the Government of Rwanda in its effort to increase household incomes and the nutritional status of the Rwandan people through increased production and marketing.

Increased production has had a positive impact on both sector growth and rural poverty reduction. The overall agricultural growth rate between 2008 and 2010 was 5.8 per cent per annum. However, for food crops, beans are the chief crops cultivated by Rwandan households (grown by 90% of households cultivating any land), followed by sweet potatoes (45%), maize (42%), cassava (40%), bananas (28%), Irish potatoes (15%) and sorghum (13%). The CFSVA and Nutrition Survey 2012 identified geographical patterns in food production, with more households involved in cultivation in the north and western provinces.

In the past recent years, there has been significant expansion of interventions that drive productivity gains. This includes successful land consolidation, increased areas under irrigation, and protection against soil erosion and expansion of cultivated terraces. Access to important services, including agricultural finance and proximity extension services has been improved. Thus, farmers are now more likely to use specific crops according to agro-climatic zones. As a result of these interventions, production of maize, wheat, roots and tubers, soybeans, rice, cassava have increased (MINAGRI, 2013).

In terms of yield, significant improvements are evident. In particular, wheat, maize and beans production has improved dramatically. However, while these gains are significant, when set against the full forecasted potential, the current yields are still low. Putting the recent improvements in perspective, we can observe vast improvements in food availability over the last decade. Table 2.8 shows significant improvements in yields of cereals, selecting only maize and wheat, roots and tubers, cassava and Irish potatoes.

The aggregate yields of food crops in Rwanda have increased substantially as a result of increased use of inputs, particularly the improved seeds and fertilizers. However, the subsequent increase in marketing has not yet shown dynamism. Nevertheless, the prevalent conditions create a scenario for drawing viable

Table 2.8: Food crop yield kg per hectare

Item	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Bananas	5,800	5,094	6,744	6,136	7,872	8,750	8,293	9,149	9,756	14,194	15,625	
Beans, dry	6,897	6,715	6,207	6,378	7,952	9,185	9,151	9,441	10,258	9,688	9,020	9,130
Cassava	79,036	74,775	57,198	67,561	64,378	54,550	103,117	112,077	120,430	122,765	149,026	157,657
Maize	8,763	7,672	7,670	8,889	8,531	7,201	11,515	19,503	23,416	23,529	22,587	22,845
Potatoes	83,133	82,084	80,407	96,891	91,740	77,618	91,329	102,216	118,679	128,118	141,869	136,056
Rice	18,132	26,400	30,668	32,668	36,665	37,964	44,673	44,843	44,432	55,195	57,193	53,362
Sorghum	10,730	9,544	9,134	11,586	11,003	10,103	10,055	11,928	12,088	12,714	14,277	14,433
Sweet potatoes	66,149	59,009	55,700	59,629	57,251	56,993	55,168	65,099	74,877	80,541	91,903	96,163
Wheat	6,171	7,653	7,987	9,083	8,510	8,948	12,968	17,079	15,631	20,478	21,680	19,924

Source: MINAGRI (2014)

strategies that would sustain the initial momentum gained under the intensification process. This would take the country beyond producing enough food crops for security to producing exportable surpluses.

Rwanda's cereals yields, measured as kilogrammes per hectare of harvested land, show that wheat, rice, maize and sorghum had a positive trend due to the policies of Crop Intensification Programme. In 2013, the crop yields survey results showed that Irish potatoes had high yields in the Northern and Western Provinces. Sweet potatoes had high yields mainly in the Northern and Southern Provinces while vegetables had high yields mainly in the Northern Province, Kigali City and Eastern Province. Cooking bananas had high yields mainly in Western and Eastern Provinces and Kigali City. Fruits had high yields mainly in the Northern and Southern Provinces; banana also being a fruit.

2.2 Development in Total Number of Livestock

In 2010, 68.2 per cent of rural households had access to livestock, with most rural households having goats (53%), cattle (47.3%), chickens (5.5%) and pigs (24.1%). The One-Cow per Poor Family Programme distributed a total of 27,688 cows to poor households in 2011. Since the beginning of the programme, a total of 113,579 cows have been distributed to poor families and 19,352 cows have been “passed on”.

In 2011-2012, the Rwanda Agricultural Board (RAB) Animal Resources Extension department continued with dissemination of productivity enhancing technologies in animal breeding, disease control, and animal nutrition. The number of goats, sheep, pigs, poultry and rabbits has increased by 10.5, 7.7, 3.1, 25.0 and 9.1 per cent, respectively. Generally, livestock increased by 11.5 per cent compared to an increase of 16.3 per cent in 2010. Additionally, eggs, honey, meat and fish have also seen similar magnitudes of improvement.

Table 2.9: Livestock population by type (‘000 head)

Category	2008	2009	2010	2011	2012	2013
Cattle	1,195	1,219	1,335	1,143	1,135	1,132
Sheep	718	743	799	829	807	798
Goats	2,520	2,735	2,688	2,971	2,673	2,702
Pigs	587	602	706	707	807	1,011
Rabbits	451	790	792	865	994	1,106
Poultry	2,218	3,272	3,537	4,421	4,688	4,803

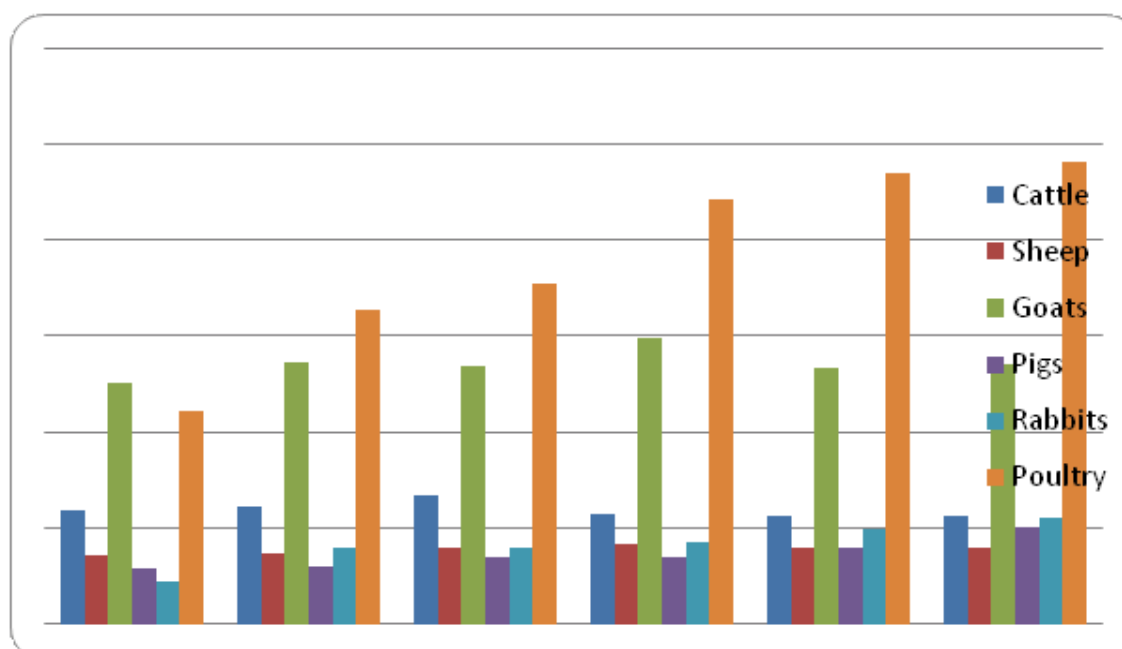
Source: RAB/ Animal Resource Extension

Animal production and the integration of livestock into smallholder farming is a key contributor to food security. In terms of volume, milk production increased by 8.6 per cent, rising from 257,480 in 2008 to 628,266 thousand litres in 2013. This was due to improvement in the breeds of cattle distributed to farmers under one cow per household government project.

Table 2.10: Animal products (in tonnes)

Product	2008	2009	2010	2011	2012	2013
Milk	257,480	334,727	372,619	442,337	503,130	628,266
Meat	56,900	65,863	70,928	73,633	74,519	81,087
Fish	12,594	14,104	15,007	15,526	17,566	24,550
Eggs	2,327	3,268	5,203	5,736	6,324	6,757
Honey	1,654	2,684	2,921	3,221	3,785	4,286
Hides & skin	4,496	4,098	4,072	4,017	3,814	5,207

Source: Rwanda Agriculture Board–RAB (2012)

Figure 2.5: Livestock development

The increase in cattle numbers has contributed to a significant increase in milk production. Subsequently, there has been an increase in the average consumption of milk per capita from 6.8 l/year in 2007 to 20 l/year in 2007 (MINAGRI, 2008).

Although production of livestock products has increased, demand still outstrips supply especially for milk and eggs, which contributes to food insecurity (lipid and protein intake). Hides and skins production increased by 60 per cent.

During the same period, meat production also increased by 3.8 per cent. The production of eggs increased by 10.2 per cent from an increase of 59.2 per cent in 2013 while production of fish rose by 3.5 per cent compared to an increase of 8.8 per cent in 2013. The production of hides and skins declined by 1.4 per cent compared to a decrease of 0.6 per cent.

Additionally, eggs, honey, meat and fish have also seen similar magnitudes of improvement.

2.3 Climate of Rwanda

Climate change contributes to biodiversity loss, desertification, forced human migrations, water shortages, weather related disasters and poverty. Rwanda is currently highly vulnerable to climate change because it strongly relies on rain-fed agriculture both for rural livelihoods and exports of highland tea and coffee. Rwanda also depends on hydropower for half of its electricity generation; a driver of economic growth. The biannual seasons no longer reflect the weather being experienced. Rwanda has experienced a temperature increase of 1.4°C since 1970, higher than the global average, and can expect an increase in temperature of up to 2.5°C by the 2050s. Rainfall is highly variable in Rwanda but average annual rainfall may increase by up to 20 per cent by the 2050s from 1970.

Early signs suggest that rainfall intensity is increasing, which may lead to a greater risk of flash flooding and landslides. This will also increase crop losses and damage to infrastructure.

The climate in Rwanda is complex, with wide variations across the country and strong seasonality. The annual average temperature of Rwanda is 18°C and ranges from 13°C to 25°C. There are two rainy seasons, March-May and mid-September to mid-December, with an annual average rainfall of 1,295 mm.

2.3.1 Environment and climate change

Table 2.11: Climate change projection

Year	2010	2011	2012	2013
CO₂ emissions per capita	0.84	0.89	0.94	0.99
Annual average temperature	20.51	20.55	19.84	20.63
Total average rainfall (mm)	1,288.68	1,334.89	1,230.73	1,202.17

Source: NIST (2013)

The highest monthly average rainfall observed in April is 157 mm. The annual mean temperature varies eastward from 15°C to 21°C from western highland to the eastern plains and hills, respectively. In the North-West, temperatures range from 13°C to 20°C.

Recent analysis of rainfall trends for Rwanda show that rainy seasons are tending to become shorter with higher intensity, leading to decreases in agricultural

production. There are also events such as drought in dry areas and floods or landslides in areas experiencing heavy rains (Mutabazi, 2011).

According to Rwanda’s Second National Communication, monthly and annual total rainfalls recorded between 2004 and 2010 were generally lower than the average recorded between 1961 and 1990. Moreover, rainfall in April, the month with the highest rainfall, has dramatically reduced (27%, 48%, 88%, 70% and 52% of the average rainfall recorded for this month between 1961 and 1990, 2000, 2001, 2002, 2003 and 2005, respectively).

The average number of rainfall days per month has also declined from 146 days between 1971 and 1990 to 131 days between 1991 and 2009. Similarly, the monthly average rainfall totals decreased between 1991 and 2009. This is also confirmed by the annual average rainfall totals, which decreased from 1,020 mm to 920 mm. On average, the annual total number of rainfall days decreased from 148 days to 124 days between 1971 and 2009.

Despite the overall downward trend in annual rainfall, the recorded rainfall for July, September, November and December has been higher than normal. This is seen with percentages of 144% (in 2001), 189% (in 2003), 165% (in 2006) and 153% (in 2006) when compared with the 1961-1990 period. For example, the mean monthly total rainfall for July in 2001 was 120.8 mm compared with only 8.4 mm for the period 1961-1990. Most of this rain fell in one day, on 22nd July 2001, resulting in heavy floods. Rainfall in Rwanda has therefore become increasingly erratic and unpredictable. Rising temperatures have also been observed.

The country has a particularly variable and complex pattern of rainfall, within tens of kilometres. Average rainfall is around 1,250 mm per annum. In broad terms, the annual cycle is bimodal, with two wet seasons: the long rains from mid-September to mid-December and from March to May. The two wet seasons arise from the Inter-Tropical Convergence Zone (ITCZ) moving northwards and

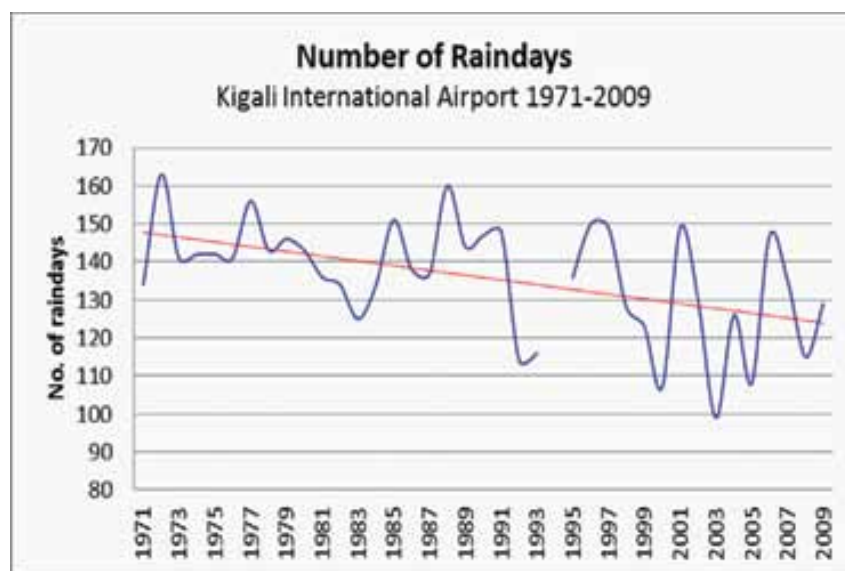
Figure 2.6: Total average rainfall in Rwanda



Figure 2.7: Erratic rainfall trend

Erratic, more intense rainfall

Declining number, more intense of rain days over last 30 years



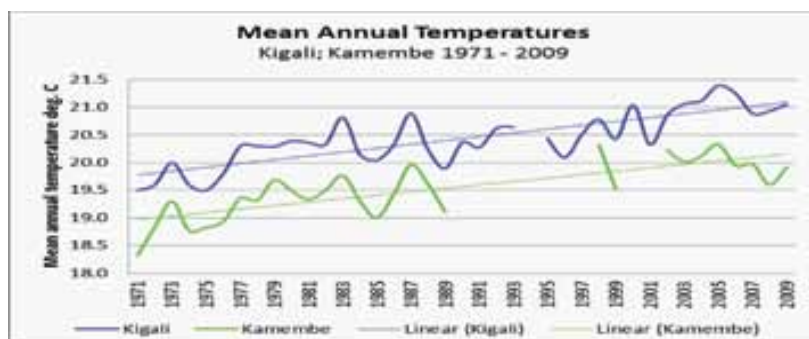
retreating southwards, respectively. Overall, there are significant inter-annual and spatial variations in the strength and timing of these rains.

Rwanda rainfall is driven primarily by the progression of the Inter-Tropical Convergence Zone (ITCZ). The ITCZ follows the annual progression of the sun as it goes to the Northern Summer solstice around 23 June and the Southern Summer solstice around 23 December each year (Rwanda Meteorology Agency, 2014).

Rwanda has a complex existing climate, with wide variations across the country and with very strong seasonality. It is primarily a mountainous country, with average altitude of 900 m in south-west, 1500 to 2000 m in the south and the centre of the country, 1,800 to 3,000 m in the highlands of the north and the west and 3,000 to 4,500 m in the regions of Congo-Nile Crest and the chain of volcanoes. The equatorial climate is modified by this widely varying altitude across the country. It leads to a more temperate climate than much of the rest of East Africa. Average annual temperature in Rwanda ranges between 16°C and 20°C, though they are much lower than this in the higher mountains. The warmest annual average temperatures are found in the eastern plateau (20 - 21°C) and Bugarama Valley (23 - 24°C). Cooler temperatures are found in the higher elevations of the central plateau (17.5 - 19°C) and highlands (less than 17°C). Temperatures vary little through the year. The monthly average increased from 19.8°C in 1971 to 21.0°C in 2009, and saw an unprecedented rise of 1.2°C in just 39 years.

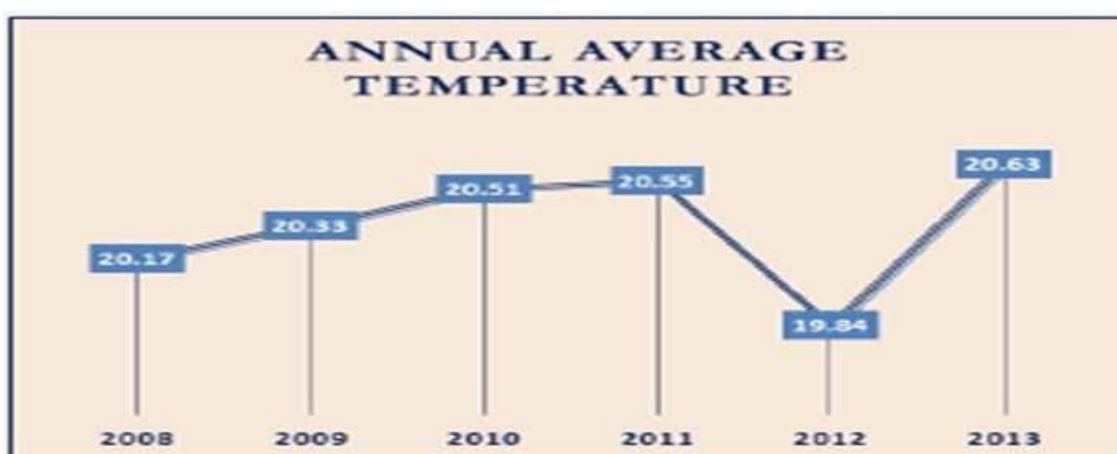
Figure 2.8: Variation in annual average temperatures (°C)

Temperatures in Rwanda on the rise
(2°C increase over last 30yrs)



Source: (REMA, 2010)

Figure 2.9: Annual average temperature



Source: NISR (2013)

2.3.2 Impact of climate change on agriculture in Rwanda

In the mountainous areas of North-West Rwanda, climate change is leading to more volatile, highly variable rainfall (reduced rainfall days but greater intensity during rainy periods), placing agriculture which is predominantly rain-fed in a vulnerable and unpredictable position. In the North Western part of Rwanda where the project will be located, flooding and landslides are the dominant climate-related hazards due to the steep sloping terrain.

Major flood occurred in Rwanda during 1997, 2006, 2007, 2008, 2009 and 2012. Rainfall resulted in infrastructure damage, fatalities and injuries, landslides, loss and damage of agricultural crops, soil erosion and environmental degradation.

Figure 2.10: Floods at Rambura, Nyabihu District, September 2007 and Musanze District, 2012



There are major floods and landslides that have occurred in the North West region in the last decade. In 2012, for example, Rwanda experienced heavy rains between January and May. The average rainfall increased from 40–70 mm in 2011 to 80–115 mm for the same period in 2012. This resulted in floods, landslides and in the destruction of public infrastructure and properties.

Moreover, in January to May 2012, 32 people died because of these rains; 1,434 houses, 11 roads, 4 bridges as well as 3 dykes were destroyed (MINIRENA, 2013).

2.3.3 Drought conditions in Rwanda

Climate change has resulted in Rwanda experiencing recurrent droughts and poor rainfall as never before. Rainfall trend analysis shows that rainy seasons are tending to become shorter but with higher intensity. This tendency has led to decrease in agricultural production due to drought especially in dry Eastern areas. In the North and Southern region, there have been severe landslides and soil erosion due to heavy floods, resulting in destruction of infrastructure and crops including loss of human and animal lives. The climate change-induced droughts are now threatening Rwanda's twin goals of food security and poverty reduction.

Drought has impacted on farmers with crop failures while livestock lack pastures and water. The drought prone areas in Rwanda host a national park and in case of drought, wildlife is also threatened by pasture shortage, sometimes accompanied by bush fires.

Figure 2.11: Crop failure in Eastern Province due to the 2006 prolonged drought



Source: REMA (2009), Rwanda State of Environment and Outlook

2.3.4 Main cropping seasons in Rwanda

The moderate tropical climate of Rwanda is characterized by mild temperatures (20°C average). The average yearly rainfall is 1,400 mm with important geographic variations. Precipitation is heaviest and most regular in the western and north-western areas, while the eastern region has less abundant and more erratic rains.

The rainfall pattern can be described as bimodal with a single rainfall season (lasting from September to June). Within this season, there are two well-defined rainfall peaks, one around November and another around April. There is no clear cut separation between the two rainfall peaks as in other East African regions with a proper dual season rainfall regime, such as Kenya or Somalia. There is just a drier minimum around February. However, the fact that the rainy season is fairly long (about 10 months), and has two fairly distinct peaks, leads to the existence of two distinct cropping seasons, described in agricultural terms as a dual/double agricultural season.

Households grow crops in two successive growing cycles generally separated into season A and season B. Season A generally extends from September to January and season B from March to June. There is a drier interlude in February (when season A harvests take place) and a marked dry period in July-August (when season B harvest takes place). There is also a cropping season C, confined to marshland and recession agriculture, unrelated to the rainfall regime.

2.3.5 Agro-ecological zones of Rwanda

Rwanda is characterized by relatively high degrees of agro-ecological diversity. One of the principal causes of this diversity is the county topography. Rwanda can be classified into 12 agro-ecological zones (AEZs). These are in: Rusizi district, Imbo, Impara, Nyamasheke district, Kivu lake borders, Musanze district, Birunga, Rutsiro district, Congo Nile watershed divide, Nyamasheke district, Buberuka Highland, Gicumbi district, Central plateau, Huye district, Granitic ridge Ruhango district, Mayaga Gisagara district, Bugesera district, Eastern Plateau, Rwamagana district, Eastern Savana and Nyagatare district.

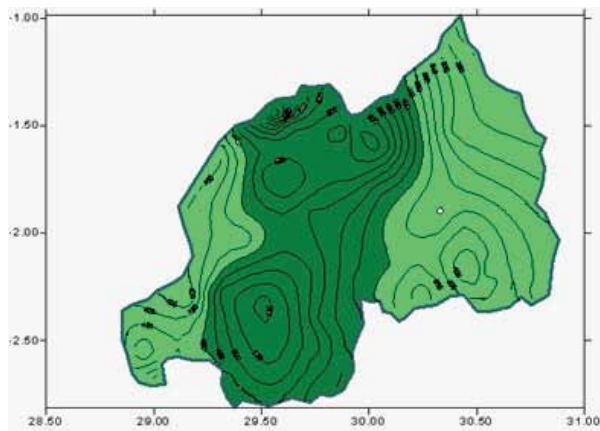
2.4 Food security

The food security of any household or individual is typically determined by the interaction of a broad range of agro-environmental, socio-economic and biological factors. As with the concepts of health or social welfare, there is no single direct measure of food security.

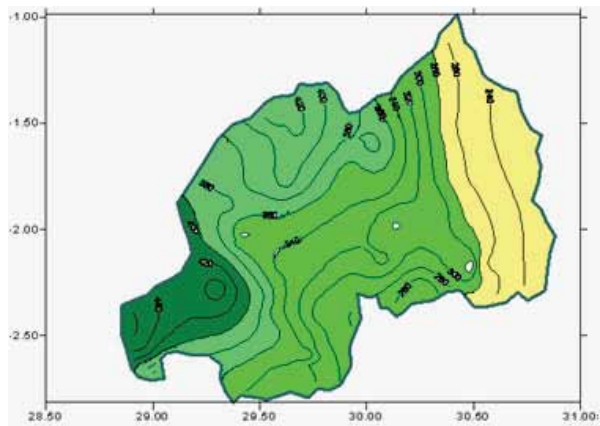
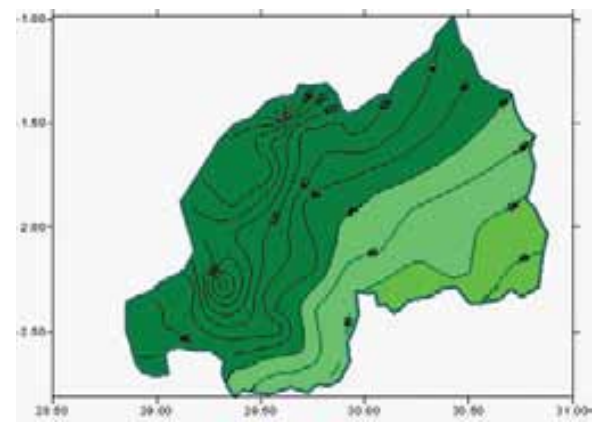
Food security exists when all people, at all times, have access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. Food security is divided into three components: food availability, food access and food utilization.

Figure 2.12: Map cropping seasons in Rwanda

(a) March-May Seasonal rainfall

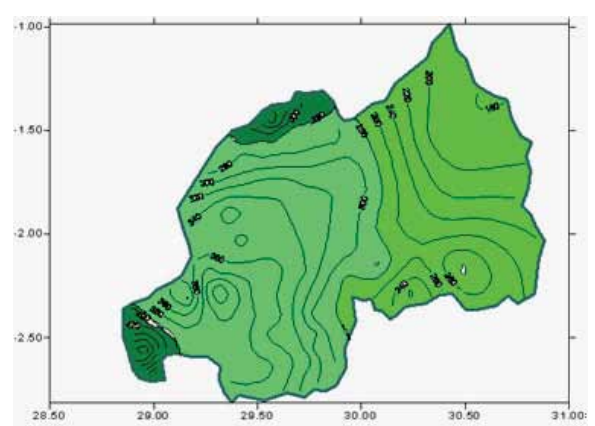


(b) June–August seasonal rainfall



(c) September-December season rainfall over Rwanda

(d) December-February season rainfall over Rwanda

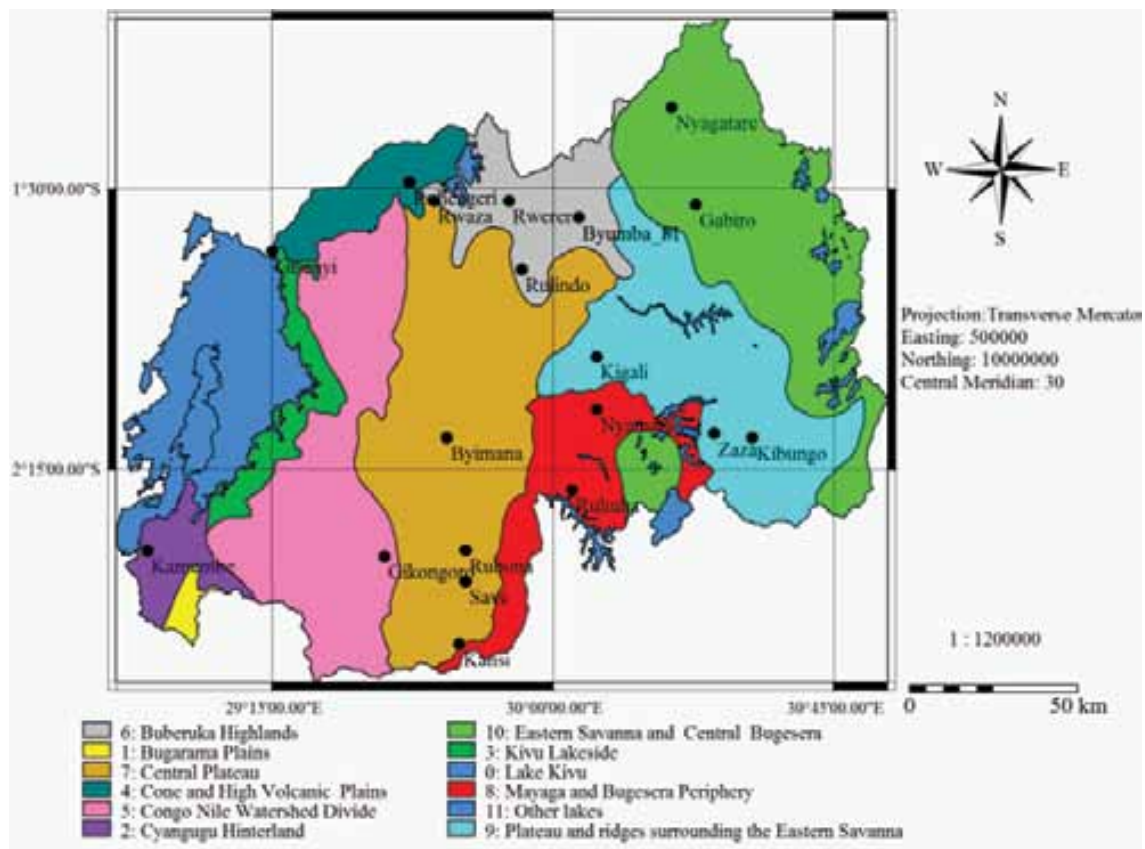


Firstly, food availability is the quantity of food that is physically present in a country or area. This is through all forms of domestic production, commercial imports and food aid. Secondly, food access represents the households' ability to regularly acquire adequate amounts of food through a combination of their own stock and home production, purchases, barter, gifts, borrowing or food aid.

Thirdly, food utilization refers to households' use of the food to which they have access, intra-household food distribution, and individuals' ability to absorb nutrients – the conversion efficiency of food by the body.

The agricultural sector constitutes the cornerstone of food security and economic development in Rwanda, as in many other parts of Africa. Recent estimates show that agriculture contributes 30 per cent to national GDP and generates about 80 per cent of total export revenues (MINAGRI, 2009).

Figure 2.13: Map of agro-ecological zones of Rwanda.



Because of its relevance, the sector has received particular attention over time from the government and other development agents. Consequently, main development frameworks such as the country's Vision 2020 and Economic Development Poverty Reduction Strategy (EDPRS) are articulated around the agriculture sector, among other sectors. Since 2000, Vision 2020 has driven many agricultural development interventions as well as the overall economic development process. Subsequently, the agricultural transformation plan known as PSTA I and PSTA II (2009-12) are leading major changes observed in the agricultural sector. Among the objectives of this transformation includes achieving food and nutrition security for all Rwandans, halving poverty, and promoting and supporting private sector initiatives through trade-improving policies. Other objectives are value addition and support to public private partnerships (PPPs), and technology creation, adaptation and transfer by investing in research and skills development to respond to the needs of both farmers and the private sector.

These priorities are conditional upon sustainable agricultural intensification, which in turn require adoption of new technologies that involve purchased inputs to increase labour and land productivity (Dorward et al., 2009).

Policies to improve agricultural productivity in Rwanda have been sufficiently initiated. However, the remaining challenge is to strengthen post-harvest handling so that the agricultural production surplus obtained during peak seasons is

maintained to avoid post-harvest losses and shortages when there is an off-season (Byerlee et al., 2011). Subsequently, if there are strategies to avoid crop losses at the farm and post-harvest stages, then these are likely to induce low production and other related transaction costs such as price increment.

2.4.1 Policies governing agricultural production and food security

Agricultural policy

The Ministry of Agriculture and Animal Resources (MINAGRI) is a government organization with a mission to transform and modernize the agriculture sector in order to ensure food security and contribute to the national economy. The Ministry has been designing and implementing different policies aimed at increasing animal production and diversifying both subsistence and commercial agricultural production. Different support line organizations are in place in addition to a number of development partners. Two line agents facilitate the implementation of policies in this very sector, namely the Rwanda Agricultural Development Board (RAB) and the National Agricultural Export Board (NAEB).

The Rwanda Agricultural Development Board (RAB) is a line organization of MINAGRI with the sole responsibility of implementing national policies in agriculture and animal husbandry. RAB has four directorates that translate agricultural policies into various intervention areas at the farmer level. These include: agricultural extension, research, livestock extension, and infrastructure and mechanization. RAB has a number of programmes that take into account government development priorities in the agriculture sector. Some of these programmes are crop-based, seed, livestock and capacity building of farmers. Due to its critical role in agriculture, RAB also contributes to the design of policies in agriculture and animal resources. The National Agricultural Export Development Board (NAEB) is an implementing agent of MINAGRI's policies and strategies regarding the export of agricultural and livestock products.

In 2004, a National Agricultural Policy (NAP) guided the policy implementation in this very domain until 2009. In 2009, a strategic Plan for Agricultural Transformation (PTA) was developed and it guided the development of the sector for the period 2009–2012 (PSTAI). During the PSTAI, the major programmes were considered, namely:

1. Crop Intensification Programme (CIP)

The CIP was initiated by the same Ministry in September 2007 with a goal to increase agricultural productivity of high potential food crops. The implementation of this programme involves various components, including Land Use Consolidation (LUC) as the main pillar, the proximity advisory services to farmers, inputs (seeds and fertilizers) distribution and post-harvest technologies (e.g. driers and storage facilities).

2. The professionalization of agriculture

This entails rationalization of farm enterprises, farm planning and capacity development of farmers and farmer organizations.

3. Rational soil and water use

Watershed management will be carried out through progressive and radical terracing to reduce soil erosion.

Rational water use will be done through the development of flood-prone valley bottoms, and water harvesting, conservation as well as utilization.

4. Promotion of commodity chains and agribusiness development

Since intensification will result in increased production, it will be necessary to integrate production into a market economy to ensure profitability of farm enterprises through improved market systems.

5. Strengthening of agricultural research and extension services

Emphasis will be placed on new technologies and their availability and appropriateness. Furthermore, the promotion and acquisition of these new technological skills in rural areas will be considered.

6. Agricultural finance

One of the major constraints faced by farmers especially in rural areas is lack of access to credit facilities. MINAGRI will therefore put in place mechanisms for financing rural activities. Financial institutions will develop micro-finance schemes to facilitate increased investments in the agricultural sector.

Vision 2020

Vision 2020 aims at transforming Rwanda from a subsistence agriculture economy to knowledge-based society earning 900 US\$ per capita. This is in the hope of making Rwanda a middle income country by 2020. The Economic Development and Poverty Reduction Strategy (EDPRS) is the framework for achieving Vision 2020 and the Millennium Development Goals (MDGs).

It describes modernization of agriculture and animal husbandry as one of the six pillars for building a diversified, integrated, competitive and dynamic economy.

- By 2020, it is expected that the country will reach a middle-income status with per capita GDP of US\$ 1,240 from US\$ 220 in 2000.

- Agriculture is a priority sector, with an emphasis on moving the sector from subsistence to commercial production by attracting increased investment. The target for agricultural growth until 2020 has been revised upward to 8.5 per cent per year. It recognizes that the private sector will drive the economy. The State's responsibility will be to initiate, pilot, coordinate and monitor efforts.
- Some Vision 2020 goals, such as GDP per capita and the percentage of farmers using fertilizers, were exceeded in 2010, and have been revised to drive further improvements.

Table 2.12: Selected national and agriculture-related goals in Vision 2020

Indicator	2000	2010	2020
Population (million)	7.7	10.1	12.71
GDP/Capita (constant 2000 US \$)	220	400	1,240
Poverty (in % of population)	64	40	20
Agricultural GDP growth (%)	9	8	8.5
Agricultural as % of GDP	45	47	25
Agricultural as % total population	90	75	50
Fertilizer application (kg/ha/annum)	0.5	8	45
% banks' portfolio to agriculture sector	1	15	20
Soil erosion protection (% total land)	20	80	90

Source: MINECOFIN, revised 2012

Economic Development and Poverty Reduction Strategy

The Government of Rwanda has developed the second Economic Development Poverty Reduction Strategy (EDPRS II) towards achieving Vision 2020. Vision 2020 targets rapid economic growth, including GDP growth of 11.5 per cent per annum, and increasing the GDP per capita to US\$ 1,240 by 2020.

The Vision 2020 also aims to close the external trade balance by increasing exports to 28 per cent per annum and maintaining the current import growth rate at 17 per cent per annum (MINICOFIN, 2011).

In 2007, the Government of Rwanda developed the first Economic Development and Poverty Reduction Strategy, EDPRS I, from 2008-2012. EDPRS II, from 2013-2017, has now been validated and the structure and objectives of this Strategy are closely coordinated with its thematic areas and priorities. As the country's medium-term economic development plan, EDPRS II establishes the framework within which the government will change the structure of the economy, and thus move towards achieving or surpassing the long-term targets of Vision 2020 and the MDGs.

EDPRS II aims to increase the pace of economic growth and further reduce the incidence of poverty. It aims to lay the basis for sustainable growth into the future. The overarching goal of EDPRS II is to accelerate progress to middle income status and better quality of life for all Rwandans through sustained growth of 11.5 per cent and accelerated reduction of poverty to less than 30 per cent of the population. There are four thematic areas: economic transformation, rural development, productivity and youth employment, and governance that is accountable. The first three are particularly of relevance to the agricultural sector. Each EDPRS II thematic area lists key priorities for different sectors to achieve thematic outcomes. Those priorities that relate to agriculture are listed below.

1. Economic transformation

- a) Diversification of the economic base and better external and internal connectivity.
- b) Private sector investment in value chains and agri-processing facilities.

2. Rural development

- a) Increased agricultural productivity to reduce poverty.
- b) Rural infrastructure development to connect farmers to markets.

3. Youth and productivity

- a) Skills development and sensitization, focused on youth.
- b) Support entrepreneurship, access to finance and agri-business development.

4. Governance that is accountable

- a) Institutional development to generate improved service delivery.
- b) Transparency and increased participation.

Agriculture is recognized in EDPRS II as a priority sector of the economy that will both stimulate economic growth and make the greatest contribution to poverty reduction. The overriding policy objective for the sector is to increase rural household incomes, provide incomes from diversified sources and increase food security. The government will develop markets and support the private sector to assume an increasingly important role. Public investments and policies will create an enabling environment to reduce the cost of doing business, thus helping private operators flourish.

Agricultural production policies

The aim of agriculture policies is to create conditions favourable to sustainable development and promotion of agricultural and livestock production. This is to ensure that there is national food security. Moreover, integration of agriculture and livestock in a market-oriented economy will help generate increasing incomes for the producers.

1. Soil conservation and land husbandry

In Rwanda, 90 per cent of domestic crop land is on slopes ranging from 5 per cent to 55 per cent. Thus, investing in land management structures and training are central to improving productivity.

The actions under this programme involve scaling up the successes of both PSTA I and PSTA II with progressive and radical terraces, accompanied by soil fertility management and soil erosion control. Through substantial investment in soil erosion protection under PSTA II, the 2010 target of 80 per cent of the land area under soil erosion protection was achieved. More than 45,700 hectares of hillsides with slopes up to 40 per cent have been terraced. Water management infrastructure has been built, lime and organic fertiliser applied, water user associations formed, and farmers trained in irrigation. For less steep slopes, progressive terracing and agro-forestry have proven successful in reducing soil erosion and increasing the economic returns from the land.

However, there is still lack of information on soil fertility and erosion rates. In addition, to construction of terraces, a systematic programme of soil conservation needs to be implemented throughout the country. Soils are easily degraded, although good soils are the basis of successful agriculture. Soil erosion results in decreased soil depth and loss of plant nutrients. Therefore, this strategy proposes soil protection and management programmes at the watershed level, which encompass both cultivated and uncultivated lands. Seven pilot projects of integrated watershed management have already been implemented, and these must be scaled up. Soil testing capabilities also need to be expanded and the nutrient levels of inputs monitored. This strategy will address these needs to improve information around soil management. Consequently, this will continue to develop a sustainable approach to land husbandry and soil protection.

Rwandan agriculture in the last five years has been driven mainly by improvement in land management (soil erosion mitigation and terracing), irrigation, input provision and increasing the national livestock herd. Developing and strengthening cooperatives has increased the sector's human capacity, accompanied by targeted extension, for example, to improve the quality of coffee for export. There are also emerging initiatives to kick-start the market and facilitate commercialization; for example the rapid development of a decentralized rural finance network. However, the first four areas,

land, water, fertiliser and cattle have driven the major increases in sector productivity, improved rural incomes and reduced poverty.

2. Irrigation and water management

Irrigation was identified as a key strategic activity in PSTA II. Rwanda signed the CAADP compact which it establishes in its Pillar I on Land and Water management that the government should allocate at least 2 per cent of public funds for irrigation development. Irrigation is important in increasing agricultural productivity by allowing multiple cropping, and reducing vulnerability to weather shocks. This plan therefore proposes continued investment in irrigated agriculture, to harness Rwanda's fresh water resources and increase production, and provide security to rural households.

The total area under irrigation was just over 25,590 hectares in 2012. It included 2,490 hectares of hillside irrigation, 23,000 hectares of marshland irrigation and around 100 hectares of small scale irrigation (garden plots with rainwater harvesting). MINAGRI has a mid-term (2011-2017) plan with a cumulative development target of 8,000 hectares of hillside and 32,000 hectares of marshland irrigation schemes. This irrigation development will take place in line with the National Irrigation Policy, the law on Water Users Associations, and the Irrigation Master Plan. The lines of action in this strategy will reinforce implementation of these key documents.

3. Agricultural mechanization

Currently, there are relatively low levels of domestic mechanization and manufacturing of the required tools. Only about 12 per cent of farm operations are mechanized, and the target is to achieve 25 per cent mechanization by 2017. Mechanization has many benefits. It contributes to improving productivity of cultivated land and facilitates expansion of cropping areas, improving overall food security. Mechanization also eases labour constraints including seasonal shortages. In addition, it reduces the requirement for physical drudgery, leading to both improved production and lifestyles for farmers. Agro-processing and value addition through mechanized equipment can also generate employment and raise rural incomes. Certain interventions are already facilitating the mechanisation process.

A power tiller assembly line in the SEZ is under construction to assemble and improve distribution of power tillers. MINAGRI has also set up a workshop facility in Kafue, Kigali where new imported machinery is stored in the workshop and then sold through a lease agreement with farmers, where the machine serves as collateral. When the farmer has made the full capital and interest payment, they own the machinery. A mobile workshop has also been established to install and service farm machinery. This strategy aims to accelerate the mechanization through further provision of necessary equipment, tools and training.

4. Inputs to improve soil fertility and management

There has been an increase in fertilizer use since 2007. The fertiliser application rate in CIP areas has reached an annual average of 29 kg/ha/year in 2011-2012 compared to a national average of 4.2 kg/ha/year from 1998-2005. This has increased crop yields, especially for maize and wheat. Maize yields increased from 0.65 MT/ha in 2000 to 2.5 MT/ha in 2010 while wheat yields increased by 2.5 times during the same period.

Fertiliser has been used primarily on maize, wheat, rice, potatoes, coffee and tea. These crops are among the strongest in market linkages and they give farmers a better chance to recover the fertiliser expenditures plus profits. However, application rates are still below recommended levels for these crops. For the other crops, it will be profitable to begin to apply fertilizers. Increasing the volume of production will require demonstration to farmers of the benefits of fertiliser use and widening the input subsidy programme. Increasing fertiliser use is the first strategic focus of this sub-programme.

5. Seed development

Sufficient quantities of quality seed are a critical resource for agricultural development. In Rwanda, there is strong public sector involvement in all seed sector components, and further private sector involvement is needed. There have already been significant achievements in regard to the legal framework concerning seeds and increased production. Other achievements have been in the building of basic infrastructure for reinforcing production and quality control.

Under PSTA II, farmers received both high quality seed varieties and advisory services in seed and crop production. However, there are challenges that still remain. They include inadequate quantities of seeds produced nationally for some crops, which forces the government to import seeds particularly for maize and wheat. Other challenges include poor quality of internally produced seed—quality deterioration has occurred during seed production and storage; and poor sanitary status of seeds—the prevalence of crop pests and diseases.

2.4.2 Food Security Policy in Rwanda

Food security in Rwanda is affected by seasonal patterns although the percentage of food insecure households seems to have increased in March 2013 compared to March 2012 (24% compared to 23% in March 2012).

According to the Food Nutrition Security Monitoring System 2013 (FNSMS), households are more food secure in March (77% and 76% in 2012 and 2013, respectively) compared to September (63% and 69% in 2011 and 2012, respectively).

In March 2013, 24 per cent of households had either poor or borderline food consumption compared to March 2012 when these categories of households were representing 23 per cent. This insignificant difference shows that the overall food security situation is comparable to one year ago.

Like in previous rounds of the FNSMS, the Western Province remains the province with the highest percentage of food insecure households. This is especially along Lake Kivu and the Congo Nile Crest where 37 per cent and 32 per cent of households, respectively, reported unacceptable food consumption in March 2013.

However, food insecure households are mainly poor and vulnerable households. They are without diversified livelihood activities and cultivate no or only small plots of land (<0.5 ha).

Beans are the most common staple commodities across all regions in Rwanda. Maize, cassava, Irish potatoes, sweet potatoes and bananas are also very important. Beans and maize are cultivated generally in all districts of the country. Irish potatoes are mainly cultivated in the Northern and Western parts of the country and bananas in the Eastern parts.

Staple food prices are usually lower in January, February, after season A, and in July August following the season B harvest. Prices are higher in October-November and May-June during the lean periods.

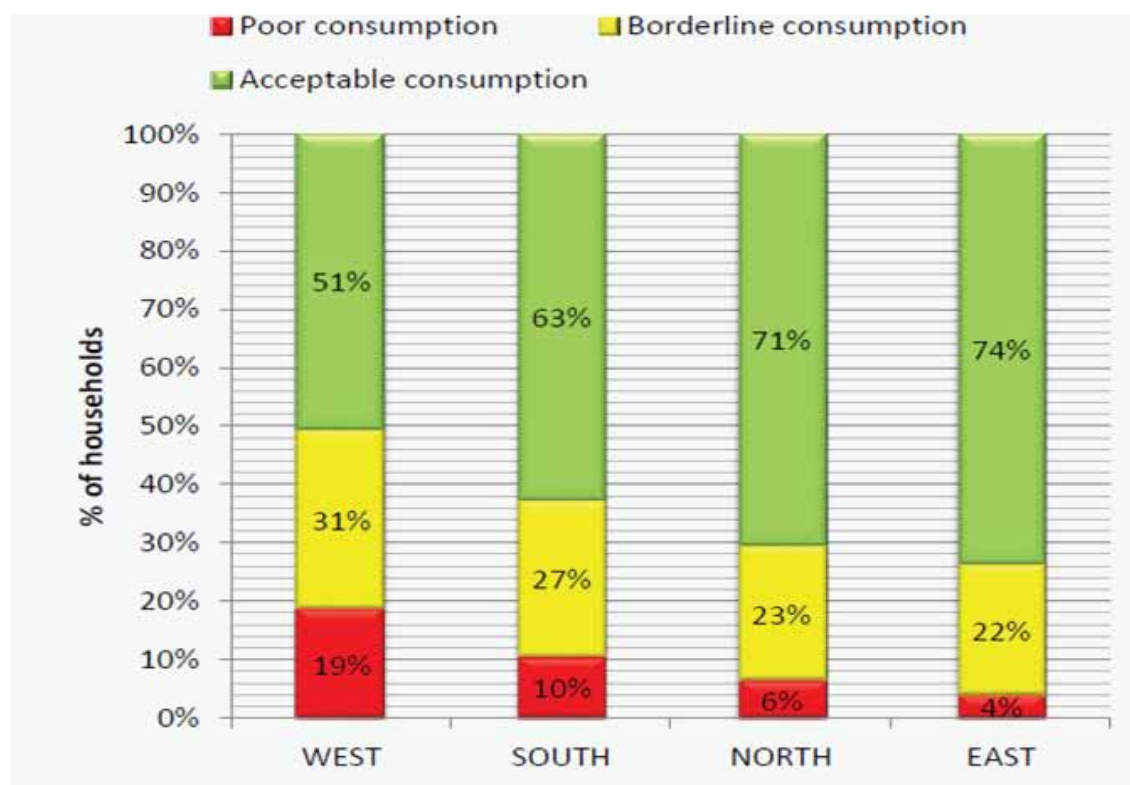
2.4.3 Food insecurity by province

With four provinces in Rwanda plus Kigali City, Western Province remains the province with the highest percentage of households with unacceptable food consumption (31%) followed by the Southern Province with 27 per cent while the lower percentage is found in Eastern Province (22%).

The Southern Province comes in at second place in the order of food insecurity since (FNSMS round 1). However, FNSMS round 5 found that food security of households improved significantly only in the Southern Province between September 2011 and September 2012 for reasons that need to be further looked into (FNSMS, 2014).

A compatible agriculture sector is one that sustainably increases productivity, resilience (adaptation), reduces greenhouse gas emissions (mitigation) while enhancing the achievement of national food security and the countries' development goals (FAO, 2012).

Rwanda issued its National Agricultural Policy in 2004 with the objective of improving food security and the nutritional status of the population, and increasing income levels of rural households. To achieve these objectives, Rwanda adopted a strategy to transform agriculture into a modern, professionally-operated and market-oriented system. The government is to promote professionalism, specialization, innovation and public-private partnerships in the transformation process.

Figure 2.14: Food insecurity by province

Source: WFP (2014)

The government implemented various programmes during the review period, such as the One Cow per Poor Family Programme (GIRINKA), the Crop Intensification Programme (CIP), and the Land Husbandry, Water Harvesting and Hillside Irrigation (LWH) Programme.

Rwanda has policies and strategies that are positively contributing to agricultural productivity, enhanced trade and addressing climate change. However, there is need to improve road networks and food commodity markets as an incentive for agriculture productivity and enhanced trade. Good policies and strategies, as well as improved infrastructure, favour the reduced greenhouse gas emissions and resilience to climate change in Rwanda.

The trade of food and agricultural products can contribute to both climate change adaptation and mitigation, and trade measures will likely be used by policy makers to encourage mitigation. It has been argued that, in this context of climate change and agriculture, it is imperative to identify and implement both correct international climate change and agricultural trade rules.

3. Agricultural Production Trade and Policies

3.1 Agricultural Production Trade

Agriculture is at the heart of Rwanda's economy. The sector occupies 79.5 per cent of the labour force, contributes one-third of GDP and generates more than 45.0 per cent of the country's export revenues. Agriculture is also important for national food self-sufficiency. It accounts for well over 90.0 per cent of all food consumed in the country. The agricultural sector grew at an average of 4.9 per cent over the last five years, contributing about 36.0 per cent to overall Gross Domestic Product (World Bank, 2011).

In the short and medium term, Rwanda intends to continue focusing its efforts on the traditional cash crops of tea and coffee and pyrethrum, as well as on the nascent, non-traditional horticultural crops and plants, including various fruits and vegetables. Other crops included are flowers (mainly fresh roses), essential oils (pyrethrum, patchouli, etc), stevia, dairy, meat, poultry and fish.

Integration with the East African Community (EAC) also provides Rwanda with a ready market for agricultural trade, although this presents challenges as well as opportunities.

Table 3.1: Evolution of Rwanda's trade with EAC in US\$ million (2006-2012/2013)

Year	2006	2007	2008	2009	2010	2011	2012	2012/13
Export to EAC	36.50	45.30	47.25	47.34	54.16	80.70	115.59	128.52
Import from EAC	241.73	316.17	461.10	449.65	513.35	785.77	532.56	527.36
Trade Balance	-205.22	-271.14	-414.85	404.31	-459.19	-705.07	-416.96	-398.84

Source: BNR (2013)

Because of trading with EAC countries, Rwanda's total trade recorded a significant growth in exports while decreasing in imports. The total trade declined by 16.8 per cent from US\$ 788.10 million in 2011/2012 to US\$ 655.88 million in 2012/2013. Rwanda's exports amounted to US\$ 128.52 million in 2012/2013 from US\$ 102.32 million in 2011/2012 with an increase of 25.6 per cent. However, imports declined by 23.1 per cent, amounting to US\$ 527.36 million from US\$ 685.78 million in 2011/2012. These developments have narrowed the trade deficit to US\$ 398.84 million from US\$ 583.47 million in 2011/2012.

Rwanda's main exports were flavoured or non-flavoured tea, raw hides of bovine, roasted or non-roasted coffee, bars and rods of iron or non-alloy steel, leguminous

vegetables and beer made from malt. On the other hand, major imports from EAC countries are cement, refined and non-refined palm oil, animal or vegetable fats and oils, mineral or chemical fertilizers, clothing and other worn articles, cane or beet sugar and chemically pure sucrose, among others.

Rwanda, Burundi and Uganda are all part of the EAC. Among the steps taken to lower barriers to cross-border trade is the Common External Tariff (CET) which was introduced in 2009. It removed virtually all internal tariffs. Additionally, simplified trade regimes have been introduced through the EAC and the Common Market for Eastern and Southern Africa (COMESA) to support small-scale traders (USAID, 2013).

3.1.1 Cross-border trade profiles

Rwanda trades with neighbouring countries across a number of border points, including airports. These crossing points vary considerably in the extent of their development, administration, geography and the volume of trade passing through them. These factors can impact on the trade that occurs across and around them.

Burundi

Burundi is Rwanda's second largest cross-border market, with US\$ 12.7 million in total exports in 2011 and US\$ 2.7 million in total imports. Rwanda is a net exporter of maize, maize flour, wheat flour, cassava flour, potatoes and milk to Burundi. In turn, Burundi is a net exporter of cotton, palm oil and sugar to Rwanda.

Tanzania

Tanzania is generally a food secure country, with modest exports of agricultural commodities to neighbouring countries. Tanzania informally exported to Rwanda 110,997 metric tonnes (MT) of staple food commodities, including 42,819 MT of maize and 15,403 MT of beans. However, because of the relatively long distance between urban centres on each side of the border, informal trade with Rwanda is virtually non-existent. Formally, Tanzania was a net exporter of maize, beans and rice to Rwanda and a net importer (although in negligible amounts) of Irish potatoes and cassava.

Democratic Republic of Congo (DRC)

Rwanda is currently exporting agricultural products, including maize flour, wheat flour, beans, rice, meat and dairy. The Rwanda Ministry of Trade and Industry (MINICOM) estimates the market potential of the region at US\$ 1.1 billion in North Kivu and US\$ 1.2 billion in South Kivu, with US\$ 387 million within Goma and Bukavu alone. Goma, in North Kivu, has an approximate population of 800,000 people and Bukavu, in South Kivu, 1 million.

Uganda

Porous borders between Uganda and Rwanda mean that trade often flows within the region in response to short-term seasonal price fluctuations. Overall, however, Uganda is a net exporter of maize, maize flour, potatoes, rice, cassava and milk to Rwanda, while Rwanda is a net exporter of beans to Uganda.

Table 3.2: Rwanda's informal trade in staple crops, May 2009-April 2010

Crops	Imported value in Rwandan francs	Exported value in Rwandan francs	Balance of informal trade
Sorghum	725,763,140	28,180,706	(697,582,434)
Dried beans	604,475,007	1,352,501,629	748,026,622
Maize flour	494,476,340	1,219,526,299	725,049,959
Maize	407,380,194	124,886,147	(282,494,047)
Husked rice	453,825,409	-	(453,825,409)
Irish potatoes	236,647,863	1,111,648,193	875,000,330
Cassava flour	65,004,895	481,888,737	416,883,842
Wheat flour	319,702,648	-	(319,702,648)

Source: MINAGRI (2010)

Those staples that have a notable informal two-way trade, specifically beans, maize flour and Irish potatoes, may indicate seasonality – where regional comparative advantage does not warrant longer term storage within a specific country. The commodities move between the regional production areas to areas of consumption based on harvest cycles and moving across borders as demanded. While this trade is interesting (particularly since informal exports represent 20% of total exports) and shows positive informal trade balances in Irish potatoes and beans, with a specific opportunity in sorghum, these values represent relatively small volumes of commodities (roughly 3,000 MT sorghum imported, and 9,000 MT Irish potatoes and 4,500 MT dry beans exported).

3.2 Rwanda Trade Policy

Rwanda has decided that having an open liberalized economy is a precondition for its economic growth. The trade policy, therefore, does not look at reviewing alternatives to Rwanda's commitment to liberalization. Rather it looks at establishing the right strategies to ensure that Rwanda benefits fully from liberalization and ensures that the potential negative effects are mitigated.

Effective participation in international trade represents a formidable avenue to promote economic growth and contributes towards putting the economy on a sustainable growth path. To this end, a well-articulated trade policy is needed to

promote broad-based, sustainable economic growth and inclusive development that targets poverty elimination. Even though the Ministry of Trade and Industry is responsible for developing trade in Rwanda, current interventions affecting trade development and competitiveness in Rwanda can be found in numerous policy documents. The implementation is performed across a number of institutions and ministries. There is therefore need to harmonize and consolidate trade policy interventions into a coherent trade policy. The trade policy document creates a structured policy framework for the coordination of these interventions. It also provides the policy framework for the Government of Rwanda's mobilization of resources (MINICOM, 2010). The trade policies highlighted are:

1. Increased productivity and diversified sustainable productive capacities for trading nationally, regionally and internationally

This trade policy reflects a deliberate and biased policy to marshal all necessary policy tools into creating a sustainable competitive production advantageous for Rwanda's trade development. Measures to promote this accomplishment will include encouraging public and private sector investment into competitive and (environmentally) sustainable productive capacities. It will also include upgrading technology, and developing agriculture and other commodities. Moreover, it will improve production by adding value through agro-processing, developing the manufacturing sector, human skills development, with particular attention to women, and improving physical infrastructure including trade facilitation and transport.

2. Enhanced participation of importers and exporters of goods and services in regional and international trade, taking advantage of trade opportunities

The primary long to medium term measures relating to development and exploitation of existing and new markets for exports of Rwanda reside with trade-related infrastructure development. These include physical infrastructure such as roads, trade facilitation and trade logistics. Domestic and regional barriers that make integration of rural and urban as well as regional economies difficult must be addressed. This is especially between rural and urban traders, and between Rwanda importers and exporters on the one hand, and their regional counterparts on the other.

In the medium term, the development of the common market in East Africa through the East African Community and in Eastern and Southern Africa through COMESA deserves priority attention. The realization of a common trading and investment bloc will create the necessary impulses for Rwanda and its regional partners to develop robust and dynamic industries and champions sustained by domestic demand from the regional community. A key measure, therefore, is full and faithful implementation of the EAC and COMESA common market programmes. Ultimately, the EAC and COMESA

will become building blocks for the African Common Market and Economic Community. Of priority to Rwanda in these regional trade agreements is the mainstreaming of export services.

Special attention should be given to outreach and specifically designed support for capacity building of institutions and groups directly working with economically vulnerable groups. These include the rural and urban poor, women and the youth. Capacity building for a pro-poor trade support network under the Rwanda Development Board has to include community-based enterprises. It should also include small traders and groups directly doing business with the economically most disadvantaged people, including women and the youth.

Assistance will be given to co-operative associations to become more effective participants. The government will strengthen the capacity of enterprises to formulate, manage and implement export development strategies. Priority will be given to traditional sectors with high export potential (agri-commodities such as coffee, tea and pyrethrum) and non-traditional sectors with good market perspectives (horticulture, essential oils, creative industries, leather and skins). This is with respect to expected employment creation, potential for women's formal and decent work, small business creation potential and contribution to a green economy.

The government will ensure adequate resource allocation and skills development for trade development. It will retain and deepen involvement of trained and skilled manpower in trade.

3. Increasing investment, including foreign direct investment, into production of competitive goods and services for the export market

The government will promote investment into viable export products or clusters targeting the agriculture, manufacturing and services export sectors. FDI will be targeted at strengthening supply and productive capacities for achieving export value addition, diversification and for meeting international product standards.

Special economic zones for manufacturing and export will be created through multi-facility industrial parks with incentives aimed at export activities. In addition, the government will establish an above average infrastructure and free port style fiscal regime aimed at promoting Rwanda's potential role as a logistics and dispatch centre for the Great Lakes Region.

With a view to encouraging investment in the agriculture sector, a feasibility study could be undertaken to examine existing agronomic and management practices and the possibilities for management tie-ups with multinational companies such as Nestle and fair trade groups. The study could also look at the possibility of providing subsidies to agriculture and industrial development consistent with Rwanda's commitment under the WTO agreements. The

country's investment laws and other related legislations will be re-examined to increase Rwanda's attractiveness as a destination for investments.

The training of officials in the government and in the private sector on investment issues will be important. It could encompass investment in dispute settlement, bilateral investment agreements and on key measures for attracting foreign direct investments (FDI). Decentralized local on-the-job training and advice by Rwandan trainers is needed on a continuous basis, combining basic technical production/agricultural training with basic business and management skills training at the community level. This is especially for groups with limited access to economic information and business training, including the rural and urban poor, women and young people.

4. Increased human resource skills in trade and development through training and retraining in private and public institutions

Improved coordination between Ministries, sectors, between public and private sectors on all key issues for trade development including, *inter alia*, development and improvement of the supply and productive capacities (infrastructure, investment, industry and enterprise, intellectual property, competition policy), and trade issues will be undertaken.

The government will also pursue increased financing for development activities from ODA, regional development banks, and from aid for trade to implement this objective. Such inter-sector consultation and coordination will include facilitating the integration of the business sector priorities on policy and regulatory reform for export success.

The Government of Rwanda actively seeks to involve rural farmers, traders, exporters, women groups, business associations, SMEs and other relevant stakeholders in all trade-related capacity building and training for trade development. Public-private sectors training and retraining centres under the Ministry of Trade and Industry, including foreign investors and international development aid agencies in specialized areas of trade and development is essential. The government also conducts such training at regional level to address specific trade issues such as ensuring uniformity in industrial packaging policy, compliance with international standards, and improved public-private sector.

5. Strengthened science, technology and innovation policies, strategies and institutions including intellectual property laws, in support of industrial development and creative knowledge-based industries.

The government will implement recommendations contained in the Rwanda Intellectual Property Policy and Implementation Strategy. In order to ensure progression towards building a knowledge-based society, the government

will improve the infrastructure environment for investment, ICT technology, learning, financing and human skills development, related private sector development, and research for development and innovations. It will consider establishing a research centre for intellectual property (IP) development. It will also implement institutional reforms such as the creation of a Rwanda Development and Intellectual Property Forum, which will provide the locus from which to launch a technological revolution.

It would also be important to implement legislative reforms such as better aligning of the system of utility models under the new IP Code to offer incentives and rewards for incremental innovation, among others. The Infrastructure Investment Policy will ensure building of infrastructure for scientific skill development, research, science training, funding for building universities, establishing international links for technology transfer and improving communications.

It will be important to integrate into the national plan (EDPRS). Thus, policy measures that articulate respect for IP rights, also taking into account the obligations, and consistent with treaties to which the country is a party, need to be put in place. IP that contributes to economic prosperity in line with the country's development objectives will be an integral part of the legislative reforms and the country's business culture from an early stage.

As trade policy measures, government will improve its engagement in regional and international IP negotiation processes and organisations, especially in the World Trade Organization (WTO) and World Intellectual Property Organization (WIPO). This is particularly intended to pursue adequate implementation of the WIPO Development Agenda. Furthermore, the government will obtain need-based and coordinated technical assistance and capacity building, and establish a strategy for impact assessment and policy review.

4. Climate Change and Agricultural Food Production

4.1 Climate Change and Its Implications on Agricultural Food Production

The agriculture in Rwanda depends almost exclusively on the quality of the rainy season. The increased frequency of droughts, floods, landslides and erosion makes the country particularly vulnerable to climate change. This considerably decreases the country's food availability.

Agriculture is highly sensitive to climate variability and extreme weather conditions such as droughts, floods and severe storms. This is especially so in Rwanda where nearly all farming activities are dependent on nature. The increased potential for droughts, floods and heat waves will mostly pose challenges for farmers and agribusiness operators. Additionally, the enduring changes in climate, water supply and soil moisture could make it less feasible to continue or expand crop production in certain regions, hence affecting the country's ability to realize its Vision 2020 targets.

According to the IPCC 2013 report, the impact of climate change and its associated costs will disproportionately affect developing countries. The change could undermine the achievement of the Millennium Development Goals, i.e. poverty reduction and safeguarding food security. This major component of development assistance in support of agricultural production worldwide is increasingly under pressure to meet the demands of rising populations.

Changing temperatures, erratic rainfall, floods, landslides and droughts all have significant consequences in the livelihoods, health, food security, educational opportunities and the survival of people living in poverty (REMA, 2011).

4.1.1 Vulnerability of the agricultural sector to climate change

Climate change is a reality for Rwanda. The observed shift in the rainy seasons (September-November) and (March-May) and short or prolonged dry seasons in some regions distorts growing seasons, thus confusing farmers on the planting dates. As a result, this affects timing of field preparation and planting, affecting crop growth, intensification of crop diseases and pests, resulting in lower yields.

The shift in rainfall patterns, on the other hand, leads to reduction in amounts of rain water harvested, therefore affecting both hillside and valley irrigation projects through either decreased water levels in ponds/dams or high amounts of water, which destroys dam/pond embankments causing erosion and silting.

Floods observed in the Northwest and in the marshes of the Nyabarongo and Akanyaru rivers have not only resulted in the loss of food production, property and leaving people homeless and also without food, but has also led to serious soil erosion and has potential for destruction of irrigation infrastructure both on the hill slopes and down the valleys.

Drought and erratic rainfall affect 60 to 90 per cent of households particularly in the districts of Bugesera, Nyaza, Gisara, Huye, Rusizi-Nyamasheke and others. This has resulted in less production of staple foods, leading to sharp increases in prices that make food unaffordable to the majority.

In the past 10 years, these disasters have occurred throughout the country, exacerbated by poor farming practices, deforestation and environmental degradation. These climatic events have affected health, water quality, transportation and agriculture, leaving the country drained of its wealth and increasing the level of poverty (SEI et al., 2010).

4.1.2 Observed impacts of climate change in Rwanda

The major climate change-related impact already observed includes the lowering of water levels in lakes and rivers, and loss of associated biodiversity. A significant decrease in agricultural productivity caused by the changing climatic conditions is leading to poor performance of crops. This has triggered a worsening of food security situation, malnutrition and poor health throughout the country.

The southern part of the country is already rainfall constrained and prone to aggravating dry spells and prolonged droughts. In the past five years alone, crop failures and poor performance of traditionally cultivated species were observed. Extreme floods in western Rwanda have led to the death of dozens of people and have destroyed roads and other infrastructure such as houses, leaving many people homeless as well as destroying significant amounts of agricultural production. Auto-adaptation is already on-going, with people flood proofing their homes through stone walls, and road construction companies investing in stronger canalization and run-off management. Moreover, established river channels are being strengthened and partially reinforced through cementation, and local authorities are investing in drainage systems.

The spreading of disease, especially malaria and other waterborne diseases, has been observed. The worsening food security situation has negative impacts on health especially on the already vulnerable groups such as children, pregnant women, the elderly people and the poor. Linkages to the effects of HIV and AIDS have not been formally established, but may be significant.

In terms of water availability (drinking water, production and irrigation, hydro-electricity), Rwanda is believed to have sufficient water resources. These are characterized by a good hydrological network (with the sources of the Nile originating in Rwanda's highlands), lakes and 860 wetlands covering 16 per cent of the surface area of Rwanda.

However, a lowering of water tables as well as impact of reduced water flows has been observed. This impact is at least partially attributed to climate change stresses (other drivers are related to non-climatic causes such as sub-optimal water resource and watershed management), which limit water availability. Rainfall variability is related to overall impact on hydrological flow, water storage

and availability, leading to more floods and dry spells while ground water recharge diminishes.

In other extreme climate-related incidences, following torrential rainfall events, flash floods occur and flood water accumulates in low laying valleys and forms ponds. These impede on settlements and production land. Negative impacts are mostly observed on: (i) irrigation potential for agricultural production; (ii) availability of good drinking water; and (iii) feasibility of hydro-electrical schemes in place/planned in Rwanda. These, for example, lower water flows or exacerbate more extreme flash floods, often carrying high sedimentation loads. This leads to increasingly high levels of siltation, worsened by the severe erosion problem. These may adversely impact on micro-hydropower schemes, which will have to deal with more erratic water supplies, as well as higher maintenance costs that need to be factored into designs.

4.2 Cost of Climate Change Impacts in Rwanda

The study of Stockholm Environment Institute entitled “Economics of Climate Change in Rwanda” (2009) analyzed the impacts of climate change events and found that they are economically significant. The most severe of the recent events was the 2007 floods. The study has estimated that the direct measurable economic costs of this event were US\$ 4 to US\$ 22 million, equivalent to around 0.1–0.6 per cent of the GDP) for two districts alone.

However, this only includes the direct economic costs of household damage, agricultural losses and fatalities. It does not include the wider economic costs from infrastructure damage (including loss of transport infrastructure), water system damage and contamination, soil erosion and direct and indirect effects to individuals.

The total economic costs of the 2007 floods are, therefore, much larger and would increase further when other national level effects are considered. It is clear that these events have economic costs that would be very significant in terms of national GDP. The continued annual burden of these events leads to reductions in growth over time.

The study also estimated the costs of adaptation in Rwanda and found that this cost will rise in future years. The aggregated estimates provide a possible range, with implications for the source and level of finance required. Estimates of medium-term costs to address future climate change are typically of the order of US\$ 50–300 million per year for Rwanda by 2030, focused on enhancing climate resilience. Note that the investment in 2030 builds resilience for future years when potentially more severe climate signals occur. However, higher values (in excess of US\$ 600 million/year) are plausible if continued social protection and accelerated development are included. Note that these are primarily development activities.

4.3 Effect of Soil Erosion and Floods on Food Security

Rwanda has had an increased number of rainfall deficits and excesses over the past 30 years. These climate change extremes have had a considerable impact on all sectors of the Rwandan economy, including infrastructure, human resettlement, and agriculture and natural resource management. Heavy rains in areas with no vegetation cover results into serious soil erosion on the hill sides as well as flooding of valley bottoms. The former leads to adverse land degradation, reducing agricultural productivity while the later destroys farmers' crops. Both cases are known to cause food insecurity.

Climatic change has resulted in Rwanda experiencing recurrent droughts and poor rainfall as never before. Rainfall trend analysis II is showing that rainy seasons are tending to become shorter but with higher intensity.

This tendency has led to decreases in agricultural production due to drought, especially in the dry Eastern areas, whereas in the North and Southern region, there are severe landslides and soil erosion due to heavy floods resulting in destruction of infrastructure and crops, including loss of human and animal lives.

Figure 4.1: Effects of erosion, flooding and destruction of crops in Gishwati area, Nyabihu District



Figure 4.2: Effects of erosion, flooding and destruction of crops in Nyabarongo watershed

Nyabarongo River – May 2012



Figure 4.3: Scarce biomass caused by drought



Source: REMA (2009)

Such droughts have significantly affected agriculture production, resulting into crop failure and livestock deaths. The above caused food insecurity, famine and migration of people to areas with sufficient rainfall.

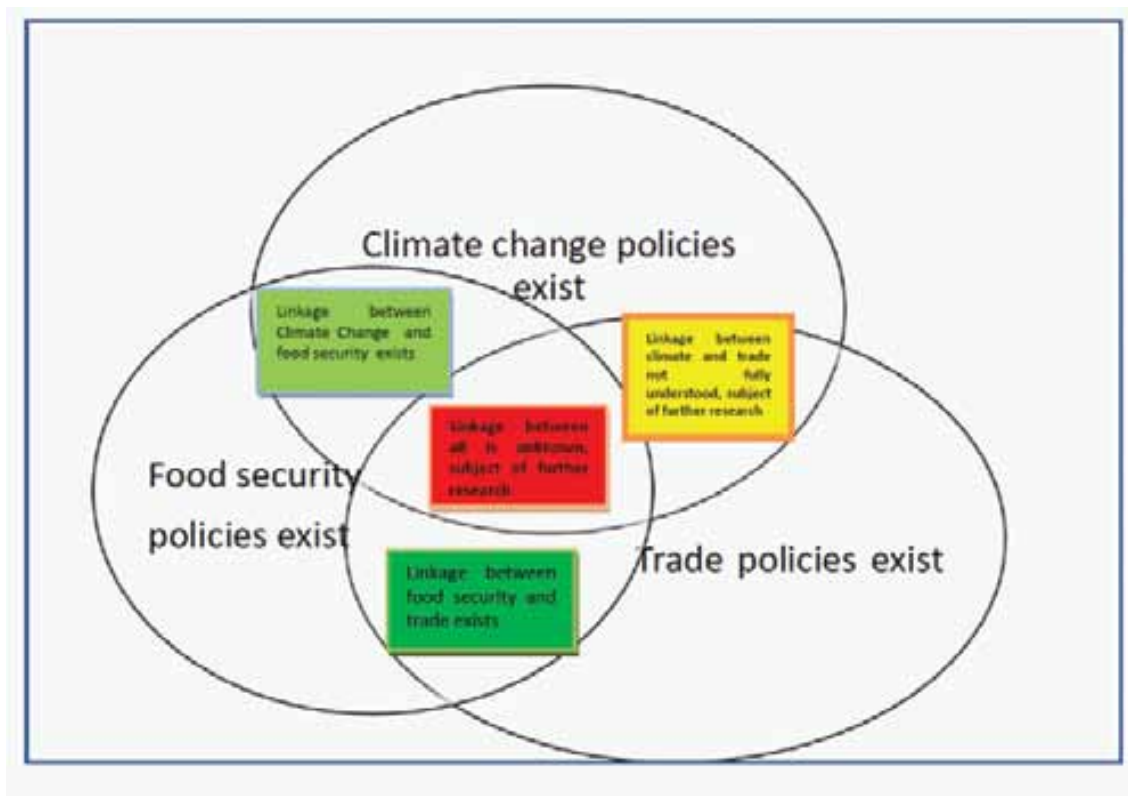
In 2005, Bugesera region experienced the above situation; crops failed, cows died and people were forced to migrate to other parts of the country in search of food. In this year, statistics indicate that rainfall had reduced to 300 mm per year from 700-800 mm per year experienced before the 1990s. This made cereal and legume production almost impossible. Due to these conditions, pests such as caterpillars that destroy sweet potatoes and beans became a frequent phenomenon in the region.

4.4 Linking Climate Change, Trade and Food Security

The study conducted by ACORD Rwanda (2012) on climate change, food security and trade examined and found that there exists national policies in the three areas and these complemented one another. Preliminary findings were presented to participants for validation and the key findings, according to the experts, are best illustrated by the Venn diagram below.

Rwanda has related policies in each of the three policy areas of trade, climate and food security. The linkages between them all are not clear (red square).

Figure 4.4: The Linkage between climate change, food security and trade



Researchers asserted that Rwanda's trade policy considers elements of food security through the attention given to production in diversified agriculture (dark green). Unfortunately, they could not see much to link the policy to climate change. The linkage between trade and climate change was little understood and needed to be further investigated (yellow square) (ACORD Rwanda, 2012).

Rwanda is a dynamic economy, enjoying annual GDP growth averaging 8.5 per cent over the past five years (Government of Rwanda, 2011). Its economic growth plan, Vision 2020, seeks to transform the country from subsistence –agricultural economy to a knowledge-based, middle-income economy by 2020. However, climate change is a major threat to the economic prospects of this small, land-locked and densely populated nation. The economics of climate change in Rwanda study found that climate change is likely to cost 1 per cent of GDP per year by 2030 (CDKN, 2013).

Climate change will increasingly take a toll on agricultural production, energy generation, water resource management and public health. Agriculture employs 80 per cent of the population, and hydropower accounts for about 55 per cent of installed generation, making these sectors particularly vulnerable.

As an oil importer, Rwanda is also sensible to oil price spikes. Moving to renewable energy sources would provide domestic energy security. It would also reduce greenhouse gas (GHG) emissions and provide a major boost to the economy.

5 Conclusions and Policy Recommendations

5.1 Conclusions

The agricultural sector constitutes the dominant economic sector in Rwanda. Food security and economic development are essential in Rwanda as in many other parts of Africa. Agriculture is recognized in EDPRS II as a priority segment of the economy that will promote economic growth and make the greatest contribution in poverty eradication. The superseding policy objective for the sector is to increase rural household incomes, to provide incomes from diversified sources and increase food security. The administration will develop markets and prop up the private sector to presume an increasingly important responsibility. Public investments and policies will create an enabling environment to lessen the cost of doing business, thus helping private operators prosper.

Food security in Rwanda depends on the success of agricultural production and trade in the region within favourable climate change. Even though the Rwandan administration has drafted policies to address these challenges of food insecurity, assessment of Rwanda's agricultural production, climate change, agricultural trade and food security is vital to the management, reduction and mitigation of potential risks relating to food security in Rwanda. Another significant insight from the analysis is that physical market accessibility and market affordability are two important determinants of food security in the research area. The results reveal that predicted market access (measured by distance and means of transport) have positive and significant effect on food availability (also measured by the quantity of crop).

The agricultural sector needs to be prioritized in the EAC region, and adaptive approaches to minimize the adverse effects of climate change on agriculture (include initiating reforestation and afforestation activities, improving irrigation efficiency, conserving soil moisture through appropriate tillage methods, crop diversification, etc) need to be considered urgently.

The energy sector should also be prioritized given that climate change is expected to affect both the supply of and demand for energy production. Energy diversification can be seen as an adaptation measure to increase resilience within the energy sector in responding to the anticipated impacts of climate change.

In Rwanda, there are four thematic areas: economic transformation, rural development, productivity, youth employment and governance that is accountable. The first three are particularly relevant to the agricultural sector. Each EDPRS II thematic area lists key priorities for different sectors to achieve thematic outcomes.

Rwanda has decided that having an open liberalized economy is a precondition for its economic growth. The trade policy, therefore, does not look at reviewing alternatives to Rwanda's commitment to liberalization, but rather at establishing the right strategies to ensure that Rwanda benefits fully from liberalization, and to ensure that the potential negative effects are mitigated. Effective participation in international trade represents a formidable avenue to promote economic growth and contribute towards putting the economy on a sustainable growth path. To this

end, a well-articulated trade policy is needed to promote broad-based, sustainable economic growth and inclusive development that targets poverty elimination.

Even though the Ministry of Trade and Industry is responsible for developing trade in Rwanda, current interventions affecting trade development and competitiveness in Rwanda can be found in numerous policy documents. The implementation is performed across a number of institutions and ministries. There is, therefore, a need to harmonize and consolidate trade policy interventions into a coherent trade policy.

The trade policy document creates a structured policy framework for the coordination of these interventions, and it provides the policy framework for the Government of Rwanda's mobilization of resources.

5.2 Policy Recommendations

Rwanda has relevant policies and strategies that are positively contributing to agricultural productivity, enhanced trade and addressing climate change. On this note, improving the *status quo* would require building on what is currently in place to make further improvements, especially strengthening the linkages at the policy level and in implementation processes.

1. Integrate food security, nutrition and disaster management programmes with the national poverty reduction programme to create a vulnerability reduction strategy. The analysis of the 2009 CFSVA and Nutrition Survey data shows links between the four components that need to be addressed through a broad multi-sector approach that includes investments in infrastructure, in agricultural productivity and diversity, and in the services sector, especially education and health.
2. Increase agricultural output target livelihood groups: Agriculturalists of all sectors with the potential to increase agricultural productivity, the availability of adapted and improved seeds and other inputs, including fertilizers should be prioritized. Seed fairs and private (for-profit) seed distribution networks should be promoted. In addition, agriculture extension officers should promote the use of sustainable practices to control erosion and loss of fertility within a sustainable agriculture model. Model gardens and demonstration plots may be useful. Such programmes must be developed locally to address specific local conditions.
3. Develop vocational skills and capacities for target livelihood groups: Labourers and vulnerable agriculturalists (e.g. limited access to land). Labourers typically have little access to land and depend on manual labour to sustain their livelihoods. Unskilled agricultural labour wages are translated into limited income for labourers. By developing skills and capacities, labourers will become more specialized workers which in turn can command higher income. Agriculturalists who have limited access to land similarly need to develop alternative livelihood strategies to supplement their own agricultural production. Such additional strategies could include skilled

and unskilled labour. Interventions to consider include: vocational training, Food-for-Training, investment in adult training programmes, and school implementation.

4. At a policy level, there is a need to integrate climate change, food security and trade linkages among stakeholders to enable holistic policy response. At national and regional levels, there should be strategies to raise awareness and understanding of linkages between climate change, food security and trade. Such campaigns would encourage stakeholders to adapt and implement relevant policies. At EAC level the Secretariat should guide the partner states to adopt a regional policy that addresses the linkages in an inclusive manner.

Irrigation has been identified as a key strategic activity in the agriculture sector framework known as 'SPAT' (Strategic Plan for Agriculture Transformation) to achieve food security and reduce dependency on rain-fed agriculture. Other practices to alleviate droughts include:

- Afforestation
- Rainwater harvesting
- Water storage (dams)
- Food chain management
- Disaster management policy and disaster institutional and legal framework
- Climate change adaptation measures (including a national adaptation programme of action to climate change (NAPA)).

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ISBN 9966 058 64 5

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