

Tool and Guideline # 4

Practical Tools on Sustainable Agriculture

**Rwanda Environment Management Authority
Republic of Rwanda
Kigali, 2010**

PREFACE

In 2010, REMA prepared 11 practical technical tools intended to strengthen environmental management capacities of districts, sectors and towns. Although not intended to provide an exhaustive account of approaches and situations, these tools are part of REMA's objective to address capacity-building needs of officers by providing practical guidelines and tools for an array of investments initiatives.

Tools and Guidelines in this series are as follows:

#	<i>TOOLS AND GUIDELINES</i>
1	Practical Tools for Sectoral Environmental Planning : A - Building Constructions B - Rural Roads C - Water Supply D - Sanitation Systems E - Forestry F - Crop Production G - Animal Husbandry H - Irrigation I - Fish Farming J - Solid Waste Management
2	Practical Tools on Land Management - GPS, Mapping and GIS
3	Practical Tools on Restoration and Conservation of Protected Wetlands
4	Practical Tools on Sustainable Agriculture
5	Practical Tools on Soil and Water Conservation Measures
6	Practical Tools on Agroforestry
7	Practical Tools of Irrigated Agriculture on Non-Protected Wetlands
8	Practical Tools on Soil Productivity and Crop Production
9	Practical Technical Information on Low-cost Technologies: Composting Latrines & Rainwater Harvesting Infrastructure
10	Practical Tools on Water Monitoring Methods and Instrumentation
11	11.1 Practical Tools on Solid Waste Management of Imidugudu, Small Towns and Cities : Landfill and Composting Facilities 11.2 Practical Tools on Small-scale Incinerators for Biomedical Waste Management

These tools are based on the compilation of relevant subject literature, observations, experience, and advice of colleagues in REMA and other institutions. Mainstreaming gender and social issues has been addressed as cross-cutting issues under the relevant themes during the development of these tools.

The Tool and Guideline # 4 provides practical information on sustainable agriculture practices including technical information on staple and cash crops.

These tools could not have been produced without the dedication and cooperation of the REMA editorial staff. Their work is gratefully acknowledged.

Dr. Rose Mukankomeje

Director General, Rwanda Environment Management Authority

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Practical Tools on Sustainable Agriculture

1. INTRODUCTION

1.1 Overview

The present Government Policy is to increase crop production and raise productivity in the coming years. The opportunity is the increasing focus on land consolidation, crop processing industries, and introduction of new crops of the high market value crops. The opportunities to increase crop production will vary from one area to another. Local development plans will address specific needs to achieve goals.

The government views agriculture as a major driver of national economic growth. Vision 2020 sets out key targets to be achieved by the agricultural sector, which includes:

- Increase the proportion of the country farmed under modern agricultural methods from 3 to 50 percent;
- Increase in fertiliser use from an average of 0.5 to 15 kg ha⁻¹ yr⁻¹;
- Expansion of soil protection from 20 to 90 percent of the country;
- Increase in agricultural production from 1612 to 2200 kcal day⁻¹ person⁻¹ (minimum daily needs are typically 2100 kcal); and
- Major increases in export earnings from crops such as tea and coffee.

Most land in Rwanda is farmed as very small landholdings, primarily for household subsistence. More than 60 percent of households cultivate less than 0.7 ha. Fifty percent cultivate less than 0.5 ha and about 30 percent cultivate less than 0.2 ha. Small plot sizes are aggravated by the fact that most farms consist of multiple scattered plots. Subsistence agriculture in Rwanda is generally characterised by the high diversity of crops grown throughout the country.

The main types of cultivated crops are food staples, namely: bananas (plantain), beans, sorghum, potatoes (including sweet potatoes), cassava, and maize. Of these, bananas are the most important staple crop in Rwanda, providing a major component of daily calorific intake as well as a key income source. On the other hand, cash crops occupy less than three percent of the harvested land area and consist mainly of coffee and tea. It is important to note that most food crops are inter-cropped and are not cultivated as monocultures, as is the case with some cash crops (e.g. tea). Inter-cropping is a common land-use strategy applied by poor farmers to help them minimise the risk of crop failures.

Crop cultivation practices are generally characterised by very low levels of inputs (e.g. fertilisers and pesticides) and limited mechanisation throughout the production process. As a consequence, crop yields remain low. The yields of several food crops are falling despite increases in the cropped area. Productivity varies in different parts of the country. The most fertile areas are the volcanic soils of the northwest as well as the larger river valleys and extensive marshlands. In lowland areas in the east, soils are relatively fertile, but there is a long dry season during which irrigation is required to sustain crops.

Traditionally, the lowland savanna landscapes in Rwanda have been pastoral areas, in which large herds of Ankole cattle ranged over large open spaces. As a result of the growing population, much of the lowland areas, especially the wetter and more fertile areas, have been

converted to arable farming. Highland areas to the west are characterised by steep slopes and high rainfall. Soil erosion by surface runoff and landslides are common. In highland areas, soils are deep but often heavily leached of nutrient and mineral content. As a consequence, soils in these parts are typically acidic (with a pH of less than 5.0). At low pH levels, aluminum in soil becomes increasingly soluble, which are toxic to plants and could lead to high soil phosphorus fixation. In addition, the organic matter in highland soils is rapidly depleted by deforestation and tillage, which make these areas problematic for long-term cultivation.

Livestock are an integral part of subsistence farming in Rwanda. Livestock production is mostly located in the east and in some southern parts of the country. Three major types of livestock are grown, namely: cattle, sheep, and goats. Patterns of livestock ownership, particularly of cattle, mirror levels of household prosperity. Larger farms in the east and central region have greater numbers of cattle, in contrast to in the north, west, and southwest. In the most impoverished regions, such as the Southern Province, farm sizes are generally less than 0.5 ha per household and few farms own cattle. Consequently, there is a shortage of animal products, including milk, meat, and manure. In these areas, MINAGRI is promoting a One Cow, One Household programme which aims to increase agricultural production by supplying manure and reduce child malnutrition through milk production.

As part of land reform and land redistribution, the government has imposed limits on farm sizes. Consequently in some areas particularly the east, large herds have been confined within insufficient pasture areas, which has resulted in overgrazing and land degradation. In addition, the government is actively encouraging farmers to reduce the size of their herds in exchange for improved livestock breeds.

1.2 Purpose

The objective of this guide is to propose practical information on sustainable agriculture practices including technical information on staple and cash crops. It is intended to be a tool for integrating environmental considerations in planning agriculture initiatives.

Although not intended to provide an exhaustive account of approaches and situations, this tool is intended to address capacity-building needs of officers by providing information on sustainable agriculture practices. This tool can be used as field guides or as checklists of elements for discussion during training and during implementation of agriculture initiatives and investments.

This document was produced to address REMA's proposed policy action to strengthen the resource capacity of environmental and related institutions at national and district level for environmental assessment, policy analysis, monitoring, and enforcement.

2. SUSTAINABLE AGRICULTURE PRINCIPLES

2.1 General Practices and Policies

Agriculture will change dramatically in Rwanda. New technologies, mechanization, increased chemical use, specialization and government policies will maximize production. Although these changes will have positive effects and reduced many risks in farming, there may be significant environmental costs including topsoil depletion and ground and surface water contamination.

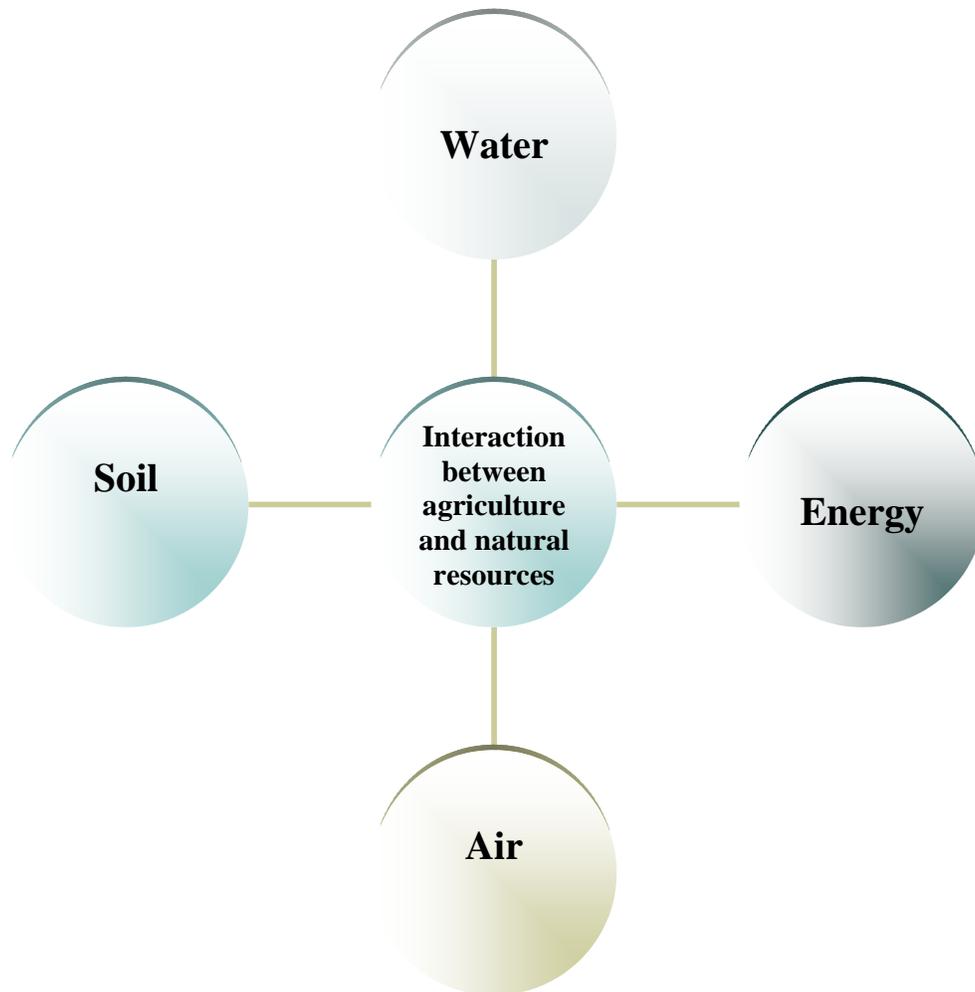
Sustainable agriculture is garnering increasing support and acceptance within mainstream agriculture. Sustainable agriculture addresses many environmental and social concerns, but it offers innovative and economically viable opportunities for growers, consumers, policymakers and many others in the entire food system.

What are the practices and policies that constitute the concept of sustainable agriculture?

- Sustainable agriculture integrates three main goals: environmental health, economic profitability, and social and economic equity. A variety of philosophies, policies and practices have contributed to these goals. People in many different capacities, from farmers to consumers, have shared this vision and contributed to it.
- Sustainability rests on the principle that we must meet the needs of the present without compromising the ability of future generations to meet their own needs. Therefore, stewardship of both natural and human resources is of prime importance. Stewardship of human resources includes consideration of social responsibilities such as working and living conditions of farmers and consumer health and safety both in the present and the future. Stewardship of land and natural resources involves maintaining or enhancing this vital resource base for the long term.
- A systems perspective is essential to understanding sustainability. The system is envisioned in its broadest sense, from the individual farm, to the local ecosystem, and to communities affected by this farming system both locally and globally. An emphasis on the system allows a larger and more thorough view of the consequences of farming practices on both human communities and the environment. A systems approach gives us the tools to explore the interconnections between farming and other aspects of our environment.
- A systems approach also implies interdisciplinary efforts in research and education. This requires not only the input of researchers from various disciplines, but also farmers, farm workers, consumers, policymakers and others.
- Making the transition to sustainable agriculture is a process. For farmers, the transition to sustainable agriculture normally requires a series of small, realistic steps. Family economics and personal goals influence how fast or how far participants can go in the transition. It is important to realize that each small decision can make a difference and contribute to advancing the entire system further on the "sustainable agriculture continuum." The key to moving forward is the will to take the next step.
- Finally, it is important to point out that reaching toward the goal of sustainable agriculture is the responsibility of all participants in the system, including farmers, labourers, policymakers, researchers, retailers, and consumers. Each group has its own part to play, its own unique contribution to make to strengthen the sustainable agriculture community.

2.2 Interaction between Agriculture and Natural Resources

Interaction between agriculture and natural resources can be summary at these 4 levels:



Water

When the production of food and fiber degrades the natural resource base, the ability of future generations to produce and flourish decreases. Water is the principal resource that has helped agriculture and society to prosper, and it has been a major limiting factor when mismanaged.

- Water supply and use practices include: improving water conservation and storage measures, providing incentives for selection of crop species, using better irrigation systems, and managing crops to reduce water loss.
- Water quality: The most important issues related to water quality involve salinization and contamination of ground and surface waters by pesticides and fertilizers.

Pesticide and nitrate contamination of water can be reduced using many practices discussed in detail in *Tool and Guideline # 8*.

- **Wildlife:** Another way in which agriculture affects water resources is through the destruction of habitats within watersheds. The conversion of wild habitat to agricultural land reduces fish and wildlife through erosion and sedimentation, the effects of pesticides, removal of local plants species, and the diversion of water. The plant diversity in and around agricultural areas should be maintained in order to support a diversity of wildlife. This diversity will enhance natural ecosystems and could aid in agricultural pest management.

Energy

In sustainable agricultural systems, there is reduced reliance on non-renewable energy sources and a substitution of renewable sources or labour to the extent that is economically feasible.

Air

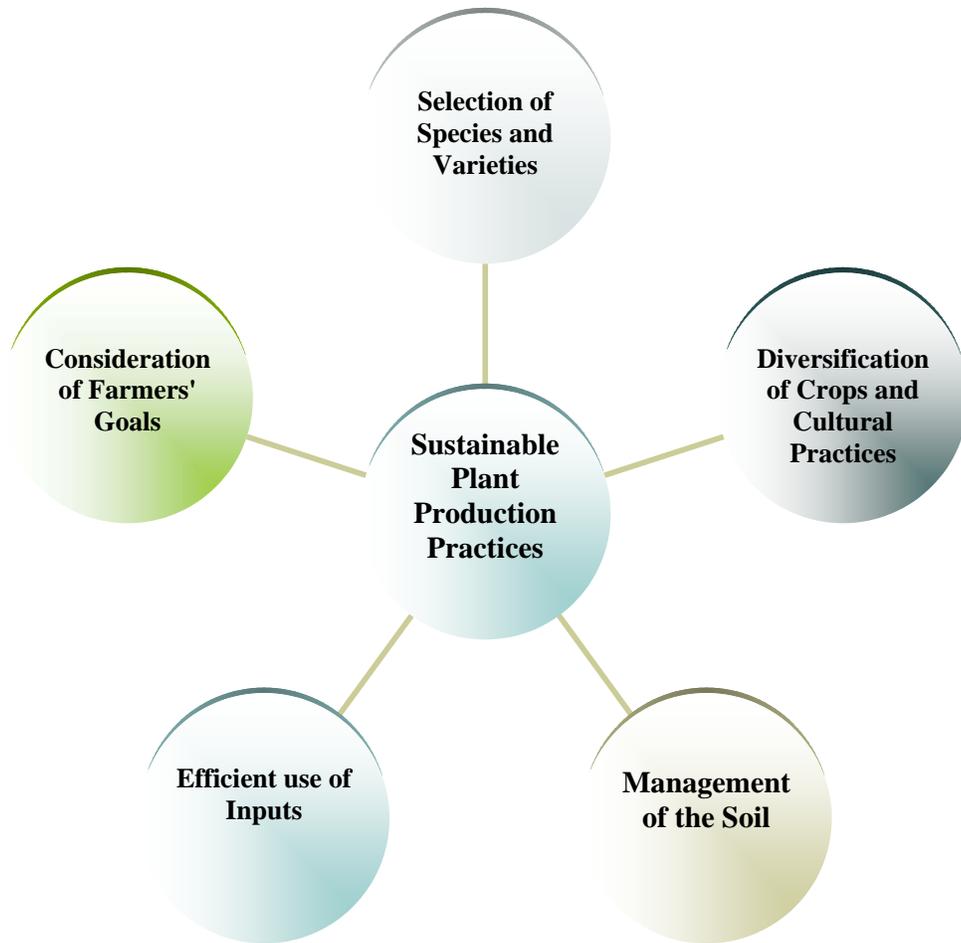
Many agricultural activities affect air quality. These include smoke from agricultural burning; dust from tillage, pesticide drift from spraying; and nitrous oxide emissions from the use of nitrogen fertilizer. Options to improve air quality include incorporating crop residue into the soil, using appropriate levels of tillage, and planting wind breaks, cover crops or strips of native perennial grasses to reduce dust.

Soil

Soil erosion continues to be a serious threat to the continued ability of Rwanda to produce adequate food. Numerous practices have been developed to keep soil in place. These have been suggested in *Tool and Guideline # 5* on soil and water conservation measures. These measures include crop rotation, contour tillage, cover crops, strip farming, terracing and radical terraces, tied ridging, contour bunds, infiltration galleries and agroforestry.

2.3 Sustainable Plant Production Practices

Sustainable production practices involve a variety of approaches. Specific strategies must take into account topography, soil characteristics, climate, pests, local availability of inputs and the individual grower's goals. Despite the site-specific and individual nature of sustainable agriculture, several general principles can be applied to help growers select appropriate management practices:



Selection of Species and Varieties

Species and varieties must be well suited to the site and to conditions on the farm. Preventive strategies, adopted early, can reduce inputs and help establish a sustainable production system. Pest-resistant crops should be selected which are tolerant of existing soil or site conditions. When site selection is an option, factors such as soil type and depth, previous crop history, and location (e.g. climate, topography) should be taken into account before planting.

Diversification of Crops and Cultural Practices

Diversification of crops (including livestock) and cultural practices must enhance the biological and economic stability of the farm. Diversified farms are usually more economically and ecologically resilient. While monoculture farming has advantages in terms of efficiency and ease of management, the loss of the crop in any one year could put a farm out of business and/or seriously disrupt the stability of a community dependent on that crop. By growing a variety of crops, farmers spread economic risk and are less susceptible to the radical price fluctuations associated with changes in supply and demand.

Properly managed, diversity can also buffer a farm in a biological sense. For example, in annual cropping systems, crop rotation can be used to suppress weeds, pathogens and insect pests. Also, cover crops can have stabilizing effects on the agro-ecosystem by holding soil and nutrients in place, conserving soil moisture with mowed or standing dead mulches, and by increasing the water infiltration rate and soil water holding capacity.

Optimum diversity may be obtained by integrating both crops and livestock in the same farming operation. Mixed crop and livestock operations have several advantages. First, growing row crops only on more level land and pasture or forages on steeper slopes will reduce soil erosion. Second, pasture and forage crops in rotation enhance soil quality and reduce erosion; livestock manure, in turn, contributes to soil fertility. Third, livestock can buffer the negative impacts of low rainfall periods by consuming crop residue that in "plant only" systems would have been considered crop failures. Finally, feeding and marketing are flexible in animal production systems. This can help cushion farmers against trade and price fluctuations and, in conjunction with cropping operations, make more efficient use of farm labour.

Management of the Soil

Management of the soil can enhance and protect soil quality. A common philosophy among sustainable agriculture practitioners is that a "healthy" soil is a key component of sustainability; that is, a healthy soil will produce healthy crop plants that have optimum vigour and are less susceptible to pests.

While many crops have key pests that attack even the healthiest of plants, proper soil, water and nutrient management can help prevent some pest problems brought on by crop stress or nutrient imbalance. Furthermore, crop management systems that impair soil quality often result in greater inputs of water, nutrients, pesticides, and/or energy for tillage to maintain yields. In sustainable systems, the soil is viewed as a fragile and living medium that must be protected and nurtured to ensure its long-term productivity and stability. Methods to protect and enhance the productivity of the soil include using cover crops, compost and/or manures, reducing tillage and maintaining soil cover with plants and/or mulches.

Efficient use of Inputs

Sustainable farmers maximize reliance on natural, renewable, and on-farm inputs. Equally important are the environmental, social, and economic impacts of a particular strategy. Converting to sustainable practices does not mean simple input substitution. The goal is to develop efficient, biological systems which do not need high levels of material inputs. Sustainable approaches are those that are the least toxic and least energy intensive, and yet maintain productivity and profitability. There may be situations where the use of chemicals would be more "sustainable" than a strictly nonchemical approach or an approach using toxic "organic" chemicals.

Consideration of Farmers' Goals

Management decisions should reflect not only environmental and broad social considerations, but also individual goals of farmers.

3. SUSTAINABLE AND ENVIRONMENTAL ISSUES

3.1 Staple Crops

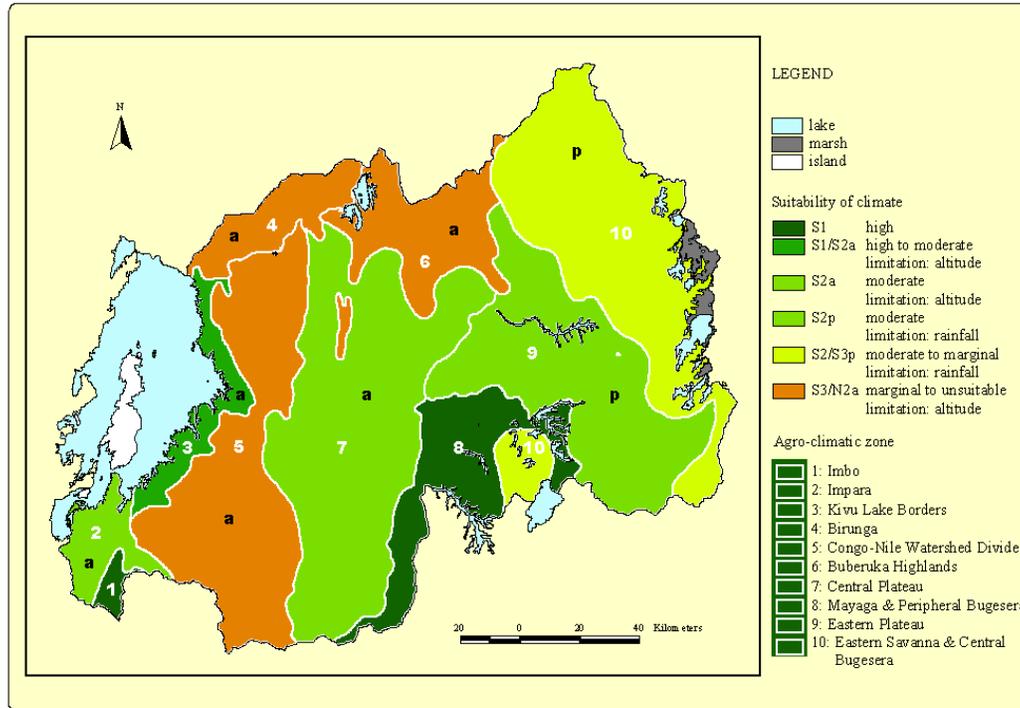
Agriculture is the backbone of the Rwandan economy. It employs close to 90 percent of the population and contributes 42 percent to the GDP. The Rwandan agriculture sector is characterized by small family farms with an average size less than one hectare of land. Food crops such as sweet potatoes, beans, manioc, sorghum, bananas and Irish potatoes constitute close to 92 percent of the crop production and two thirds of productions is for family consumption.

The section indentifies major sustainable and practical environmental practices for each of the main cash staple crops.

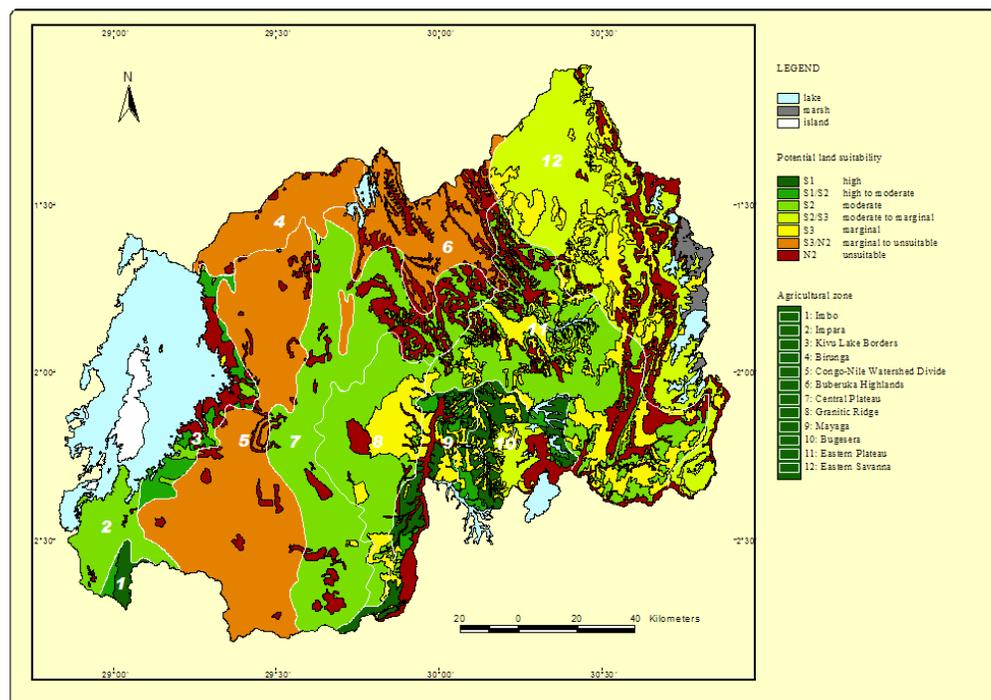
Banana

<i>Facts</i>	<i>Sustainable Issues</i>	<i>Practical Environmental Practices</i>
<ul style="list-style-type: none"> Banana is the most important crop in Rwanda occupying 23% of arable land and contributes 60 to 80% of household income in banana growing area. The country produces about two million tons per year, making it the 6th in production in Africa and 11th in the world. The crop is produced in all provinces, especially in Eastern and Western provinces. Highland bananas (Musa AAA-EA) are traditional food and cash crop in the East and Central African highlands. They remain unique in the world. - The banana rate of consumption in Rwanda is 144 kg/pers/yr 	<ul style="list-style-type: none"> The banana fruit is available fresh throughout the year. It is an important food security crop and reliable household income. Banana is mainly produced by the subsistence farmers who are using traditional and indigenous technologies, without use of external input. This has resulted in low yield of about 6t/ha/year. The recent decline in production may be due to both the biotic and abiotic factors. The biotic factors being pests, diseases and weed infestation, while the abiotic factors being mainly poor management, and lack of adequate pruning/de-suckering. This, in turn, induces competition between plants for nutrients and water making it easy to attack for insects and pests. Strategies are needed for improving banana production in Rwanda including crop improvement, pest and disease management, socioeconomics and market factors, natural resource management, and post-harvest and utilization. 	<ul style="list-style-type: none"> Introduction of new infrastructure, practices and technologies such as modern warehouses, recycling programs, safer and more comfortable packing plants, soil conservation measures, environmental education campaigns, waste management, pollution control, and wildlife conservation are required. Specific farm boundaries close to wildlife conservation plantations are required i.e. plantation should be at least 3 km away from parks and wildlife habitats. A strict regulation on the use of pesticides is required. Managing and reducing agrochemicals is one of the most complicated challenges. Integrated pest management techniques that use nature's check and balance systems should be favoured. Weeds can be controlled by planting low-growing carpets of vegetation. Birds and insect predators help control bugs. With these methods, most farmers can reduce the use of insecticides and herbicides. Plantation workers must receive proper safety equipment and health check-ups. Banana program certification standards could promote

Banana|Bananes|Ibirayi
Potential areas for the cultivation in Rwanda
Climatic suitability



Land suitability



Source:

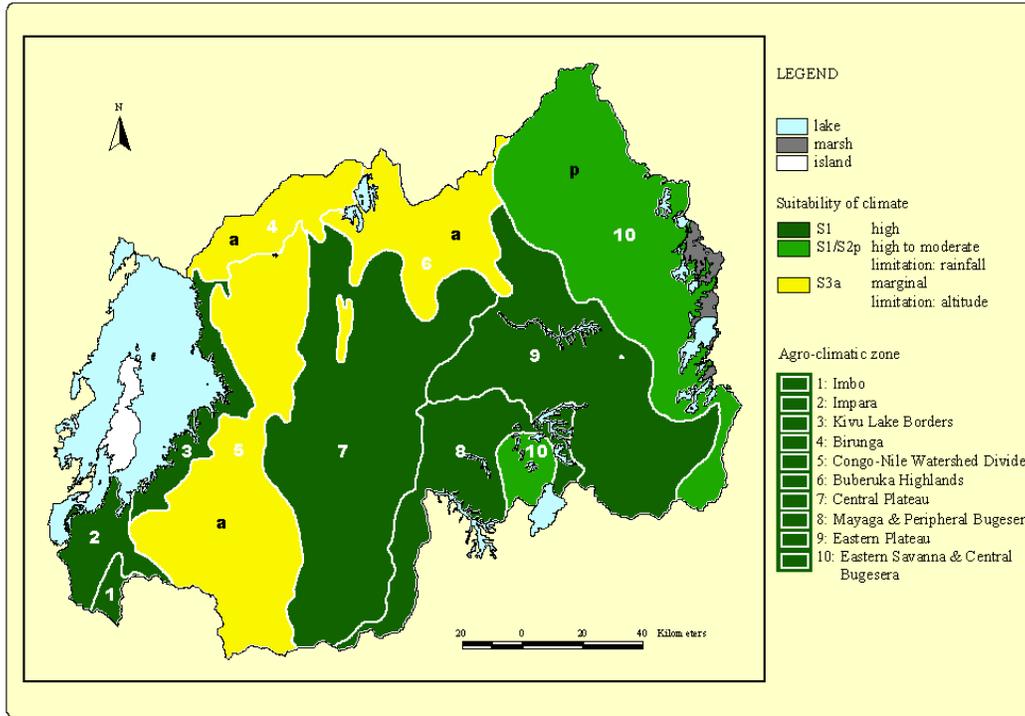
AMIS-Rwanda

Sorghum

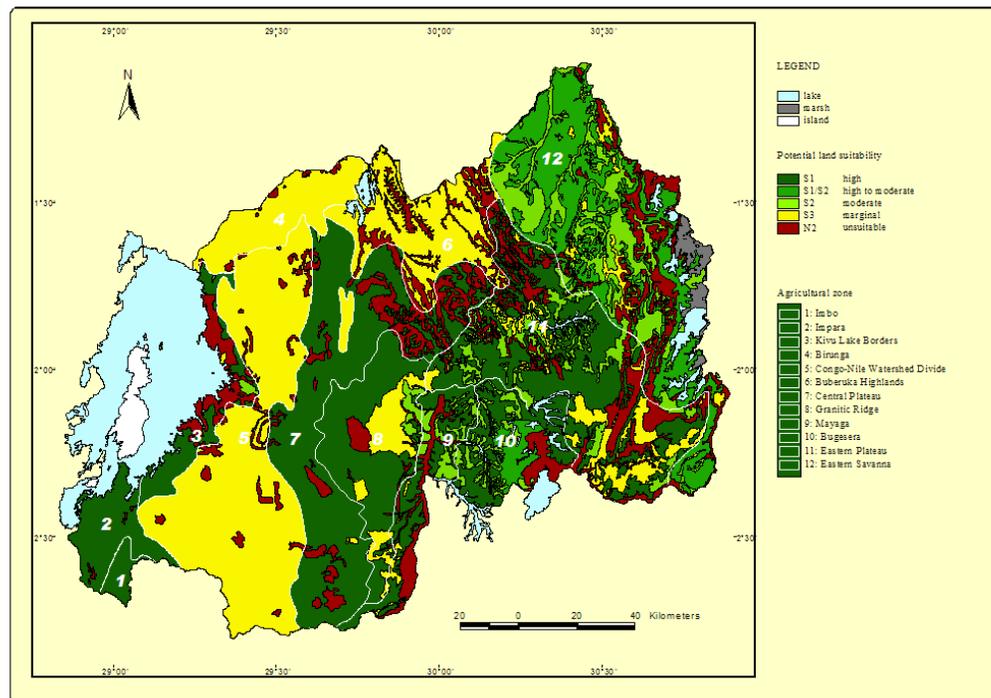
<i>Facts</i>	<i>Sustainable Issues</i>	<i>Practical Practices</i>	<i>Environmental</i>
<ul style="list-style-type: none"> Sorghum is one of the most important cereals grown in Rwanda during the long rainy season. 	<ul style="list-style-type: none"> Sorghum is cultivated for its great role in brewing local beers and its nutritious porridge prized by children and mothers. Beside that, sorghum production is a source of income for small farm holders. Strategies are needed to increase sorghum productivity and income of sorghum farmers in the three agro-ecologic zones which are high land altitude, mid land altitude and low land altitude zones. It is possible both to reduce the impacts of sorghum cultivation on the environment and to benefit producers financially, but it requires good planning and proper execution. There are a number of strategies by which sorghum farmers can reduce the environmental impacts of production. In general, the adoption of better practices can reduce the impact of sorghum production by maintaining productivity on existing lands indefinitely and reducing runoff and pollution. 	<p>Several practices can help to reduce the impacts such as:</p> <ul style="list-style-type: none"> Seed systems to ensure that smallholder farmers have access to seed of improved sorghum varieties. Introduction of new practices and technologies such as modified tied ridging, in combination with fertility improvement treatments (modified tied ridging involved using a plough to make furrows between crop rows, and “tying” the furrows with soil every meter or two to trap rain water in the field). This operation can be implemented in place of the first weeding. The use of farmyard manure, and combining minimal amounts manure with inorganic nitrogen. Introduction of legume rotations to improve soil fertility Seed priming (this is the practice of soaking the seed overnight in water, before planting). The purpose is to improve the rate of emergence. Environmental friendly weed control strategies. Soil erosion measures to improve soil productivity. Reducing pesticide use. 	

Sorgho| Sorghum | Amasaka
 Potential areas for the cultivation in Rwanda

Climatic suitability



Land suitability



Source: AMIS-Rwanda

Rice

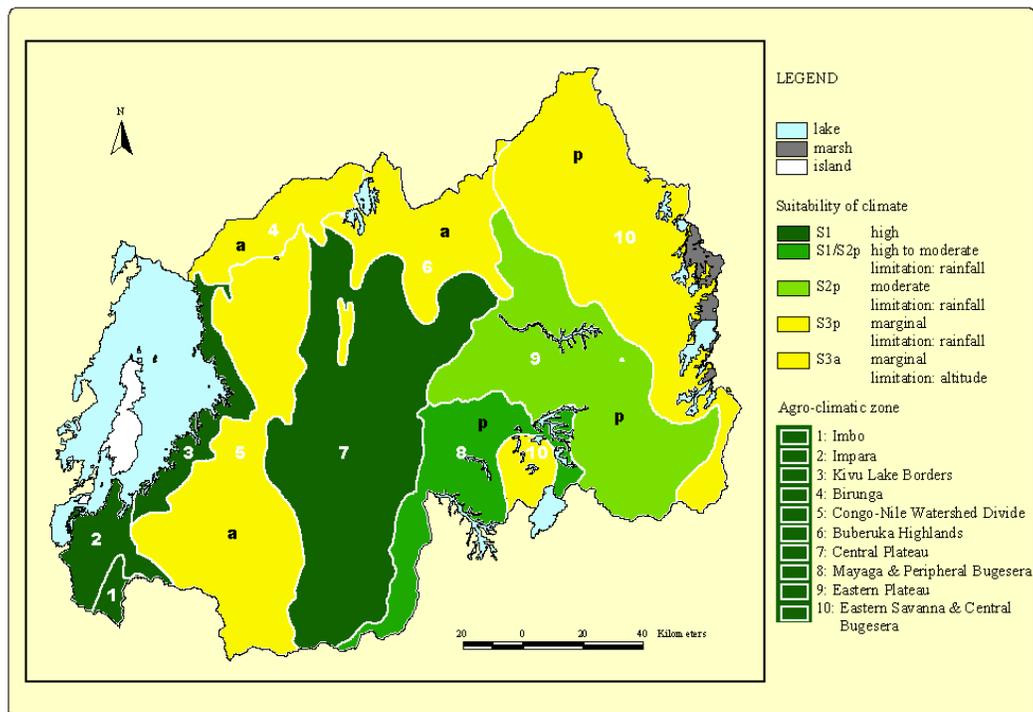
<i>Facts</i>	<i>Sustainable Issues</i>	<i>Practical Environmental Practices</i>
<ul style="list-style-type: none">• Rwanda is a mountainous country. As a result, the temperatures are generally low. Annual average temperatures range from 15 to 25 degree centigrade. Temperatures are much lower in lowlands producing areas.• Rwanda has also about 165 000 ha of marshes of which 66 000 ha can be developed into rice fields. Currently about 12 000 ha are irrigated.• Rice production in Rwanda was estimated at 55 000 t in 2007	<ul style="list-style-type: none">• Low temperature is a serious abiotic constraint for rice production. Rwanda's highland terrain makes it difficult to find rice seed adapted to the cold temperatures.• Poor water control is the most limiting factor to full exploitation of the potential rice production area in Rwanda, together with a lack of high yielding, short-duration varieties adapted to local production conditions and poor knowledge of crop management.• Blast (leaf and panicle) and Bacterial blight (mainly panicle blight) are the major diseases in all rice ecologies of Rwanda. Pathogen evolution is so fast that within 3 to 4 growing seasons most grown varieties become susceptible to the extent of causing total crop failure.• Diopsis thoracica is the main rice insect pest in Rwanda. Growers widely use insecticides (sumicombi) for control. This pest is severe in rice schemes where rice is at various growing stages as a result of the common practice of planting at different dates/ periods.• Green hoppers can also become very common in all rice schemes.	<ul style="list-style-type: none">• There are limited adverse environmental effects associated with rice farming. However, higher production and using traditional methods that include misuse of fertilizers and herbicides may lead to soil degradation.• Technologies that reduce pesticide and fertilizer use can contribute a clean environment and sustainable rice production i.e. ecologically based pest management (insects, diseases, weeds, and rodents)• Reduce water use and the water footprint of rice production by adopting water-saving technologies.• Strategies are needed to address technology needs for increased and sustainable rice productivity and competitiveness in Rwanda. This can be achieved through selection and dissemination of varieties with improved productivity and superior cooking and eating characteristics, provision of capacity building to farmers and extension agents

Sweet potato

Facts	Sustainable Issues	Practical Environmental Practices
<ul style="list-style-type: none"> Sweet potato is a major staple food in Rwanda and one of the second largest produce in terms of tons after bananas. Nutritionally, sweet potatoes, especially yellow and orange varieties, are a good source of Vitamin A, which is essential for eyesight, growth, cell division, bone and teeth development, reproduction and maintenance of the immune system. 	<ul style="list-style-type: none"> The ability of sweet potato to adapt to a wide range of growing conditions, in both fertile and marginal areas, as well as its rapid growth rate as a ground cover to help in the control of weeds, makes it a versatile crop for Rwandan farming systems. Some of the major physical, biological and socio-economic constraints to sweet potato production in Rwanda are low yield potential, narrow sweet potato genetic base, lack of improved varieties, pest and disease attacks and poor agronomic practices. 	<ul style="list-style-type: none"> Reduce post harvest yield losses (perishability nature of the crop and distance to markets). Environmental friendly weed control strategies. Soil erosion measures to improve soil productivity. Reducing pesticide use.

Patate douce | Sweet Potato | Ibijumba Potential areas for the cultivation in Rwanda

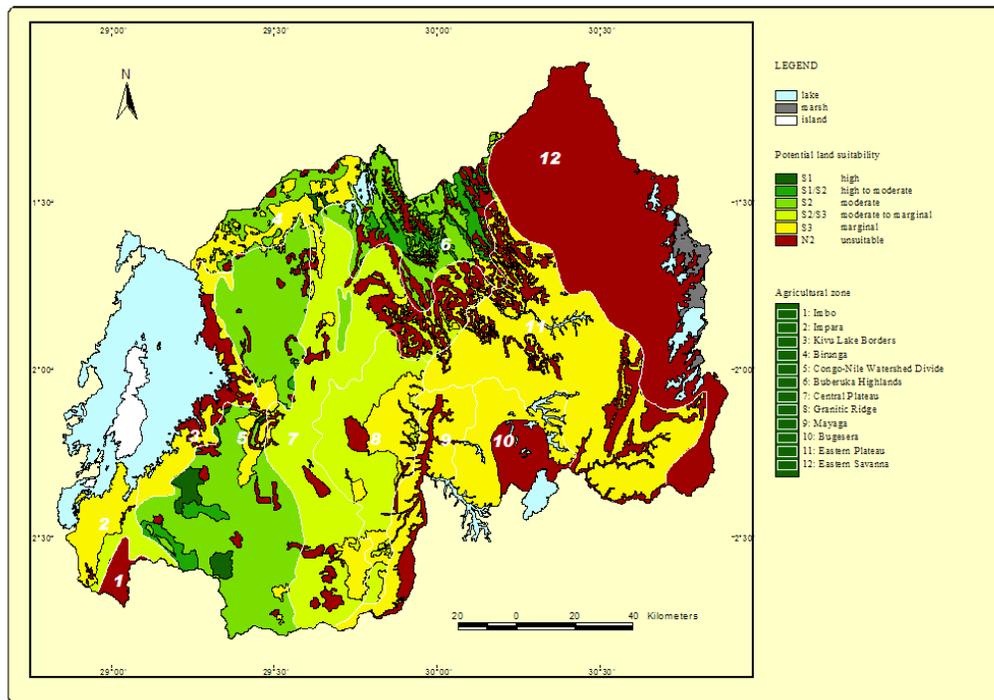
Climatic suitability



Source: AMIS-Rwanda

Patate douce | Sweet Potato | Ibijumba
Potential areas for the cultivation in Rwanda

Land suitability



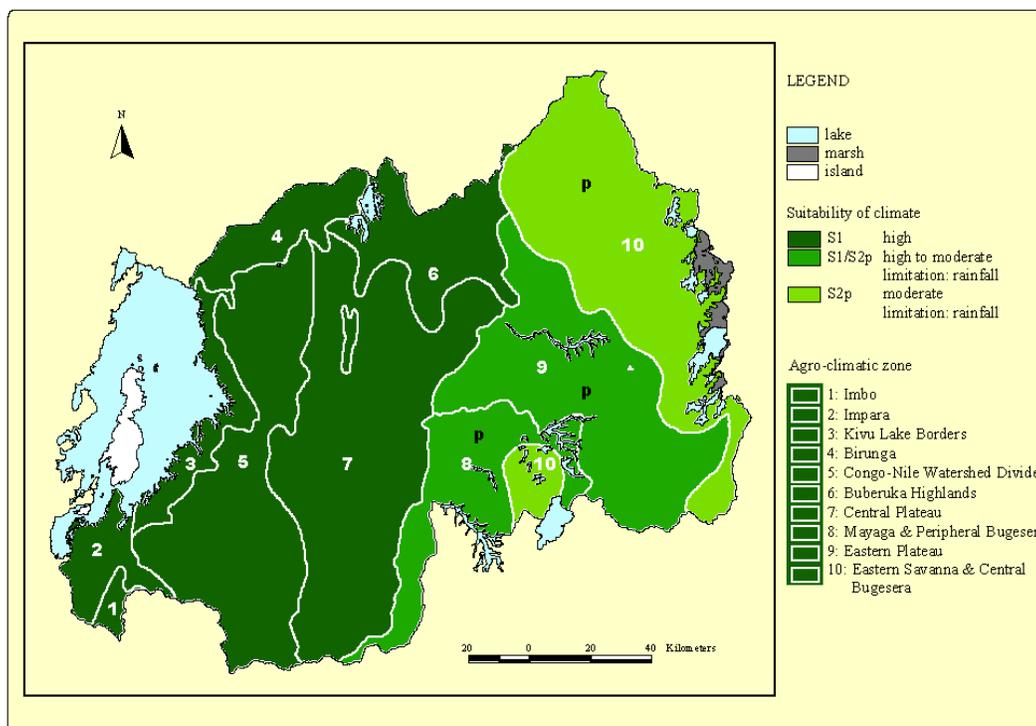
Source: AMIS-Rwanda

Green beans production

Facts	Sustainable Issues	Practical Environmental Practices
<ul style="list-style-type: none"> Rwanda has the highest per capita Common bean (<i>Phaseolus vulgaris</i>) consumption in the world, an indication of its importance in rural and urban livelihoods. Bean contributes over half of dietary protein and a large part of the calories intake. Annual consumption in some areas exceeds 60 kg per person. Beans are also a valuable source of vitamin-B complex, iron, zinc and other essential minerals. 	<ul style="list-style-type: none"> The crop is grown by smallholder farmers, especially women, and plays an important role in the sustainable livelihoods, providing for both food security and income generation. Beans are produced mainly in Eastern, Southern and Western Provinces; however, climbing beans are also produced in the Northern Province. 	<ul style="list-style-type: none"> Environmental friendly weed control strategies. Soil erosion measures to improve soil productivity. Reducing pesticide use.

Beans|Haricots |Ibishyimbo Potential areas for the cultivation in Rwanda

Climatic suitability



Source: AMIS-Rwanda

3.2 Cash Crops

Rwanda has considerable agricultural potential. There are large areas with fertile soils suitable for growing many crops with international market potential, including soils with the right pH for tea and coffee, and high altitude locations with adequate rainfall where production of top quality tea and coffee is possible.

Excellent potential for producing a wide range of tropical fruits and spices also exists in most of the country. Recently more households have begun to grow vegetable produces such as avocados, papayas, mangos, tomatoes and other vegetables along side the staple food crops.

An important asset is in the current practice of producing coffee and new cash crops without chemical inputs, except for the use of pesticides on coffee growing areas. This provides a good basis for growing organic crops that command good international market prices if adequately certified. In coffee, however, a biological solution to control plant pests must still be found. Finally, farmers' familiarity with good agronomic practices, including the use of modern inputs, must be mentioned.

Another important favourable factor for the development of cash and export crops is the existence of many farmer groups, associations, cooperatives, and national NGOs working in the rural areas. Most farmer organizations have little means, but represent the spontaneous structuring of the rural world and signal peoples' willingness to face the challenge of the future jointly, and in an organized manner.

Rwanda is a landlocked country. High costs of transport affect the cost of fixed assets and of inputs, which must be imported, and the cost of transporting finished products to foreign buyers. The general underdevelopment of the rural areas increases the cost of any ancillary service that economic operators require. The yields of most cash crops are low by comparison with other producing countries. As a result, despite very low labour costs and grower remunerations significantly lower than elsewhere, Rwanda is a high cost producer. To survive in export markets, Rwanda needs to produce high quality products, cashing in the opportunities offered by the natural conditions, and by the skills already developed among growers and in the processing industry, and to market them in new and innovative ways.

An estimated 10 percent of the rural households grow tea and coffee, which are cultivated on 3 percent and 1 percent of total cultivable land respectively. Currently, there are an estimated 500,000 small holder coffee farmers in Rwanda and an estimated 20 percent of the coffee and tea producers are women. The country's good performance in coffee export is estimated to have affected 2 to 3 million people. Rwanda has been supplying the competitive global coffee market with quality specialty coffee over the last few years. The Government's goal is to transform all coffee produced in the country to high standard specialty coffee.

The section identifies major sustainable and practical environmental practices for each of the main cash crops.

Coffee

<i>Facts</i>	<i>Sustainable Issues</i>	<i>Practical Practices</i>	<i>Environmental</i>
<ul style="list-style-type: none"> • Coffee is an important foreign currency earner and important export crop. • Tea and coffee account for 70 percent of export earnings. • Rwanda has rich volcanic soils, fairly good rainfall regimes and moderate year long temperatures favour the slow maturation of the coffee beans, creating a distinctive taste in the cup. • Coffee is produced mainly in the three out of four provinces of the country, namely western, eastern, and southern provinces. In the western province, coffee is produced entirely along the shore of Lake Kivu. • Rwanda climate is ideal for growing Bourbon Arabica production at an altitudes ranging from 1300 to 1800 meters above sea level. 	<ul style="list-style-type: none"> • Rwandan coffee is produced using few chemical fertilizers and insecticides. Soil fertility is maintained using traditional mulching and manure application techniques. • Coffee production is indeed a smallholder activity. Today some 430,000 households produce coffee, and the typical family farm has about 200 trees. • Coffee production is facing pressure of pests and diseases, inadequate cultural practices and absence of high yielding varieties. Selection of high yielding varieties with high cup quality and develop technologies for improving cultural techniques for control of pests and diseases should be prioritized. • Coffee is grown either as standalone crop or as intercropped with food or perennial crops. • Coffee cropping systems can also be defined based on the availability of mulch for the coffee fields. Available mulches are from eucalyptus, grevillea, sorghum thatches, and banana leaves. Most of the coffee farmers prefer to use the sorghum thatches and eucalyptus leaves as mulch because they are both most cultivated in the area, and easily available. • In South Rwanda, coffee is mostly produced on steep slopes, where production might mainly 	<ul style="list-style-type: none"> • Poor management practices in coffee cropping systems affect the crop productivity. Poor management is related to lack of adequate mulching materials and, which accelerate water erosion on mostly steep slope where coffee is usually located. Most of the coffee fields show signs of soil erosion. • In young or immature coffee trees installed on steep slope, soil erosion will be the most present if the soil cover is absent and if the area is intensively and frequently rainy. If soil conservation measures are not taken, this may increase soil erosion risks and soil fertility degradation. • Stream pollution issues are associated with wastewater from coffee washing stations. Wastewater pollution at washing stations processing produces large quantities of organic residue-pulp and skins (1T of parchment coffee produces nearly 5T of pulp; e.g., more than 80 percent of the coffee cherry weight is waste organic matter or water contained therein.) • The typical washing station in Rwanda discharges 100 tons of pulp in a season. Coffee washing wastewater, high in carbohydrates and organic matter, is typically discharged untreated directly into streams. Usually this takes place in a season when stream flow is decreasing. The waste stream can quickly reduce available oxygen in the receiving water (stream or wetland), affecting downstream 	

<i>Facts</i>	<i>Sustainable Issues</i>	<i>Practical Practices</i>	<i>Environmental</i>
	<p>be affected by inappropriate management practices. Based on the fact that most of the coffee trees are very old, this situation could result in decreased yields.</p> <ul style="list-style-type: none"> • Best land management practices need to be considered as yields and production are the major concerns for the farmer. • Both coffee yield and production need to be increased to any possible extent. 	<p>fishponds, drinking water sources, and fragile wetlands and swamps.</p> <ul style="list-style-type: none"> • When separated out of wastewater, coffee pulp and skins can be composted and used as a soil amendment (If dried, but not fully composted, pulp and skins can also be used as mulch.) Run-off from compost piles is also a potential source of surface water contamination. • The Government of Rwanda plans for the establishment of 240 washing stations in the country in 2010, producing 44,000 tonnes of fully washed coffee. 	

Tea

<i>Facts</i>	<i>Sustainable Issues</i>	<i>Practical Practices</i>	<i>Environmental</i>
<ul style="list-style-type: none"> • The tea crop is an intensively managed perennial monoculture crop cultivated on large-and small-scale plantations. • Tea and coffee account for 70 percent of export earnings. • The evergreen and long-lived tea plantations, consisting of genetically diverse cultivars provide a relatively steady microclimate and food supply for insect and mite communities. • Tea plantations roughly resemble a "single species forest", and insect and mite species are thought to coexist by way of intra-tree distribution or well-defined stratification/ecological niche formation. • Weeds are a major component of the tea ecosystem and serve as alternative hosts for pests as well as a refuge for natural enemies. • Tea is produced in the Western and Northern 	<ul style="list-style-type: none"> • A good deal of work is still required to formulate an adequate programme for the development of the tea sector, combined with a coherent policy aimed at providing incentives to private investors and at securing adequate income for smallholder tea growers. • These ought to include at least the general strategic lines of development of new tea planting and processing capacity, going beyond the statement of principles of the current privatization policy, the implementation of which also needs to be very significantly accelerated. • The lack of progress on privatization has indeed been a stumbling block for several years. Donors are reluctant to assist the sub-sector, pending evidence of concrete progress under the privatization policy. • Government preliminary plans include the 	<ul style="list-style-type: none"> • The drainage systems of several wetlands planted to tea needs rehabilitation. • New areas can also be planted, with careful attention to producing top quality products, to introducing organic tea with all the related measures aimed at increasing the use of farm yard manure and at strengthening land conservation, and to secure timely construction of new factories, which is essential for the financial survival of such initiatives. 	

provinces; it is the second export crop after coffee.

expansion of the tea plantation two or threefold.

Existing factories in Rwanda must be expanded so that they can adequately handle even the currently available green leaves in case of a bumper crop, and the potential production that can be attained if measures are taken to increase yields.

Horticulture

<i>Facts</i>	<i>Sustainable Issues</i>	<i>Practical Practices</i>	<i>Environmental</i>
<ul style="list-style-type: none"> Horticulture encompasses fruits, vegetables and ornamental plants i.e. avocado, citrus, passion fruit, mango, pineapple, apple and some exotic vegetables such as tomato, sweet and hot pepper and some indigenous vegetables namely eggplant and nightshade. 	<ul style="list-style-type: none"> <i>Avocado</i>: The total annual national production of avocados is 81697t. Most of the avocados in Rwanda are produced in the Southern Province (49%), followed by Western Province (26%). <i>Pineapple</i>: The pineapple crop is produced mainly in the Northern Province, with an annual total production of 4823t, accounting for about 47% of national production. This is due the influence of juice processing plant at Nyirangarama. The Southern province is the second largest producer with 2299t, accounting for about 39% of national production. <i>Mango</i>: The mango production is produced in all four provinces of Rwanda. However, it is well suited for the Eastern province. Mangos require hot low altitude climates with rainfall ranging from about 500 to 2500mm. Most importantly the Eastern province is characterized by dry periods of three months, a prerequisite for mango production which requires a dry period of about 3 months for successful flowering to take place. <i>Citrus</i>: The Western province is by far the largest producer of lemons accounting for about 62% of national production. The Southern province is second contributing 30% to national production. <i>Sweet orange</i>: The production of sweet orange is fairly distributed 	<ul style="list-style-type: none"> Introduction of new infrastructure, practices and technologies such as modern warehouses, recycling programs, safer and more comfortable packing plants, soil conservation measures, environmental education campaigns, waste management, pollution control, and wildlife conservation are required. Technologies that reduce pesticide and fertilizer use can contribute a clean environment and sustainable rice production i.e. ecologically based pest management (insects, diseases, weeds, and rodents) Reduce post harvest yield losses (perishability nature of the crop and distance to markets) Environmental friendly weed control strategies. Soil erosion measures to improve soil productivity. Reducing pesticide use. 	

across provinces.

- *Tomato*: The tomato crop is produced in all provinces however; the Eastern province is the major producer.
- *Carrot*: The carrot is a cool season crop; as a result the conditions in the western parts of Rwanda are most ideal, making the Western Province main producer.
- *Onion and Leek*: The onions are produced throughout the country. However, the Southern Province is the major producer with 48%.
- *Cabbage*: The cabbage crop is an important vegetable produced in all Provinces.
- *Passion*: The passion fruit is mainly produced in the Western province.
- *Japanese plum*: The Japanese plum is mainly produced in all provinces, however, the Northern Province, is the major producer.
- *Cape gooseberry and strawberry*: The production of these two fruit crops is still at small scale in Rwanda; however, they are potential crops and will become major crops in the near future.

HORTICULTURAL MAP OF RWANDA

MINOR CROPS DIVERSITY



4. MAINSTREAMING GENDER AND SOCIAL ISSUES IN SUSTAINABLE AGRICULTURE

It is estimated that women contribute up to 70 percent of the labour to agricultural production. Rural women carry out a variety of tasks, both productive and household responsibilities to support their families. Women are engaged in all forms of farming including food and cash crops, and livestock, in particular small animals such as pigs and chickens. They are also engaged in off-farm income generating activities such as basket making, food processing, pottery, embroidery, petty trading and paid and unpaid agricultural labour. Rural women work an estimated 14-17 hours a day. Most women are subsistence farmers, while a few are engaged in cash crop production such as coffee and tea. Women have always played an important role in agriculture, undertaking a wide range of activities relating to food production, processing and marketing. Beyond the farm, women play a key role in land and water management. Women are most often the collectors of water, firewood and fodder. They have access to a store of local knowledge on the medicinal use of plants; they have been in the forefront of soil conservation programmes; and it is women who perform most of the household labour devoted to animals. Five main gender issues have emerged as being of particular significance in the agriculture and rural development sector:

- Equal access to land & water resources and credit;
- Gender differences in roles and activities;
- Gender and agricultural extension and research;
- Gender, agricultural biodiversity and commercialisation; and
- Women's empowerment and equal access to decision-making.

These are inter-linked and all require social change which needs to have substantial political support if the limits to growth are to be overcome.

4.1 Access to Land & Water Resources and Credit

Although landlessness affects only a small size of the rural population (2 percent) a large number of the farming households (60 percent) cultivate less than 0.7 hectare of land. In 1996 an estimated 27 percent of the family farms were managed by women. The level of women's access and control over land is not known due to the lack of statistics. In 2005, Rwanda adopted the Organic Land Law which aims to achieve three basic goals: (i) formally recognize land rights in the form of long-term secure lease rights; (ii) resolve uncertainty over landholdings caused by the post-conflict situation; and (iii) encourage consolidated use, increased productivity and improved stewardship of land. The Law stipulates equal rights of women and men to land ownership.

Farmers, especial women, are increasingly pushed on to marginal plots that are dispersed, remote and usually less fertile. This land may be ill suited to continuous cultivation and vulnerable to land and water degradation, particularly through soil erosion and deforestation. Insecure land tenure reduces the incentive to invest in land improvements and good land husbandry, such as tree planting or terracing. It also offers little incentive for investing in permanent crops, and means a lack of collateral for credit for improved inputs and fertiliser.

Land ownership rights of women can also prevent from owning or inheriting land. When women do own or have access to land they often have a limited access to agricultural support services, such as credit with which they can purchase inputs, and to advice and training in agricultural technology. This limited access may arise from a range of factors, including legal restrictions, lack of collateral (e.g. land title); lack of information about credit availability; and lack of small-scale services such as micro-credit schemes. Rwanda aims to establish a land administration system that would ensure land tenure security through land registration and issuing of land title deeds.

Through a participatory spatial planning process and technical support, land registration process is expected to be socially inclusive. Currently, land registration is being piloted in four districts (Gasabo, Kirehe, Karongi and Musanze). Women participated in the committees that coordinated the registration process in the communities. To ensure land ownership of family members, a joint registration (under the name of both the husband and wife) is promoted and the names of children were also included in the registration. While this joint registration of land guarantees land ownership for women married under the civil law, it does not include those married under the customary law and those in polygamous unions. However the land registration includes children of polygamous and customary marriages as long as their names are included on their fathers' identification cards. These issues require closer examination as many women will be left out from land ownership because their marriages (customary and polygamous unions) are not recognized by the law. There is the need to educate women (in particular rural women) and men about the legal reforms regarding marriage and property rights.

4.2 Gender Differences in Roles and Activities

Another issue is the problem-ridden conceptualisation of women's and men's work in rural environments and, in particular, the failure to recognise the importance of their differing roles. These three roles can be described as follows:

- The productive role: this refers to market production and home/subsistence production undertaken by women which generates an income;
- The reproductive role: this refers to the child-bearing and child-rearing responsibilities borne by women (which are essential to the reproduction of the workforce; and
- The community management role: this refers to activities undertaken by women to ensure the provision of resources at the community level, as an extension of their reproductive role.

An understanding of these three roles can inform gender-aware planning that takes into account the differential impact of programmes and projects on women and men because of women's triple role. In Rwanda, there is a distinct division of labour between women and men in agriculture production, processing and marketing. Men are responsible for 67 percent of the land clearing, where as women do 80 percent of sowing, 65 percent of food processing, 61 percent of hoeing, and 72 percent of storage and transportation of produces. Other tasks typical for women include cleaning, cattle feeding, and food processing and selling. Although women are responsible for 34 percent of the marketing of agricultural products, they don't always make the decisions on the income from the sales. Men make 60 percent of the decisions on cattle sale compared to 14.8 percent by women and 25.2 percent of the decision are made jointly. Overall the level of women's participation in the booming coffee and tea export is not known due to the lack of gender statistics. Although women are strongly involved in coffee production, their control of the commercial process is limited.

Agricultural Extension and Research

Much has been written about the past failures of government extension services to reach women farmers. They seldom participate in group training, extension meetings and, most importantly, access to inputs such as fertiliser and credit.

Agricultural Biodiversity and the Commercialisation of Agriculture

As predominantly small farmers, women have been largely responsible for activities such as the selection, improvement and adaptation of plant varieties. This has both supported and increased agricultural biodiversity of agriculture. In the move to greater commercialisation and privatisation of agriculture in Rwanda, there is also a danger that small-scale farming will suffer. Diverse food production systems can be under threat, and, with them, the accompanying local knowledge, culture and skills of the food producers.

Empowerment and Access to Decision-making

This challenge is perhaps the most difficult and long-term. There is a need for women to be empowered to the point where they can exert influence and participate in decision-making on issues that affect their lives. Given the extensive participation of women in all aspects of agricultural production, the mainstreaming of gender into the agriculture sector is a key strategy not only for the promotion of equality between men and women, but also for sustainable agricultural and rural development and economic growth. In conclusion, women's high involvement in economic activities requires strategic approach for growing their capital accumulation so that women can further invest and grow their income. Moreover, the fact that women are organized in associations and cooperatives presents an opportunity to increase their access to various services including literacy and numeracy training, reproductive health and others. There is also the need to provide affordable childcare services close to cooperatives and other working places. Women's leadership should be promoted within the associations-based enterprises and cooperatives.

Annex 1: Reference and Useful resources

- REMA (2009): Rwanda State of Environment and Outlook Report, Rwanda Environment Management Authority, P.O. Box 7436 Kigali, Rwanda <http://www.rema.gov.rw/soe/>
- Amis- Rwanda, The Information Gateway of the Agricultural and Livestock Sector of Rwanda. Amis- Rwanda is an exchange platform for all stakeholders of the agricultural and livestock sector. You can access and download pdf documents, media files, search through yellow pages of the institutions or companies and through the white pages of resources persons. <http://amis.minagri.gov.rw/content/information-gateway-agricultural-and-livestock-sector-rwanda>
- CIDA, Environmental Handbook for Community Development Initiatives (2002), Second Edition of the *Handbook on Environmental Assessment of Non-Governmental Organizations and Institutions Programs and Projects (1997)* <http://www.acdi-cida.gc.ca/acdi-cida/ACDI-CIDA.nsf/eng/JUD-47134825-NVT>
- USAID, Environmental Guidelines for Small-Scale Activities in Africa: Environmentally Sound Design for Planning and Implementing Development Activities, U.S. Agency for International Development, Office of Sustainable Development, Draft Version, January 2005, www.encapafrika.org.
- Sustainable agriculture extension manual for Eastern and Southern Africa: (<http://www.mamud.com/sustagafrica.htm>)
- The UN Food and Agricultural Organization (FAO) Aquastat Web site: <http://www.fao.org/nr/water/aquastat/main/index.stm>
- FAO. Agriculture Food and Nutrition for Africa: A Resource Book for Teachers of Agriculture: <http://www.fao.org/docrep/W0078E/w0078e00.htm>
- The African Conservation Tillage Network (<http://www.act.org.zw/>) is a network of practitioners who promote adoption of conservation tillage practices in Africa to assure a more sustainable use of soil resources, combat desertification, improve food security and alleviate rural poverty.