



Demand Analysis Report- Republic of Rwanda



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Acronyms

<i>AAS</i>	<i>: Agricultural Advisory Services</i>
<i>ADB</i>	<i>: African Development Bank</i>
<i>AGDP</i>	<i>: Agricultural Gross Domestic Product</i>
<i>AMIS</i>	<i>: Agricultural Management and Information System</i>
<i>AMS</i>	<i>: Alternative Milk Sector</i>
<i>CIA</i>	<i>: Central Intelligence Agency</i>
<i>CICA</i>	<i>: Center for Agricultural Information and Communication</i>
<i>CIFAA</i>	<i>: Committee for Inland Fisheries and Aquaculture of Africa</i>
<i>CIP</i>	<i>: Crop Intensification Programme</i>
<i>COP</i>	<i>: Costs of production</i>
<i>CRS</i>	<i>: Catholic Relief Services</i>
<i>DRC</i>	<i>: Democratic Republic of the Congo</i>
<i>EADD</i>	<i>: East African Dairy Development</i>
<i>EAS</i>	<i>: Extension Advisory Services</i>
<i>EDPRS</i>	<i>: Economic Development and Poverty Reduction Strategy</i>
<i>FAO</i>	<i>: Food and Agriculture Organization</i>
<i>FFS</i>	<i>: Farmer Field Schools</i>
<i>GDP</i>	<i>: Gross Domestic Product</i>
<i>GIS</i>	<i>: Geographic Information System</i>
<i>GoR</i>	<i>: Government of Rwanda</i>
<i>HDI</i>	<i>: Human Development Index</i>
<i>HPI</i>	<i>: Heifer Project International</i>
<i>IAR4D</i>	<i>: Integrated Agricultural Research for Development</i>
<i>ICT</i>	<i>: Information and Communication Technology</i>
<i>IMF</i>	<i>: International Monetary Fund</i>
<i>INGOs</i>	<i>: International Non-Governmental Organizations</i>
<i>IPM</i>	<i>: Integrated Pest Management</i>
<i>IWM</i>	<i>: Integrated Water Management</i>
<i>M&E</i>	<i>: Monitoring and Evaluation</i>

<i>MCCs</i>	<i>: Milk Cooperative Centers</i>
<i>MEAS</i>	<i>: Modernization of Extension and Advisory Services</i>
<i>MINAGRI</i>	<i>: Ministry of Agriculture and Animal Resources</i>
<i>MINECOFIN</i>	<i>: Ministry of Finance & Economic Planning</i>
<i>MINICT</i>	<i>: Ministry of Information and Communication Technology</i>
<i>MINILOC</i>	<i>: Ministry of Local Government</i>
<i>NAEB</i>	<i>: National Agricultural Export Board</i>
<i>NAES</i>	<i>: National Agricultural Extension Strategy</i>
<i>NDS</i>	<i>: National Dairy Strategy</i>
<i>NGO</i>	<i>: Non-Governmental Organization</i>
<i>NSC</i>	<i>: National Sericulture Center</i>
<i>NUR</i>	<i>: National University of Rwanda</i>
<i>PAIGELAC</i>	<i>: Inland Lakes Integrated Development and Management Support Project</i>
<i>PASNVA</i>	<i>: National Agriculture Extension Support Project</i>
<i>PPP</i>	<i>: Purchasing Power Parity</i>
<i>PRA</i>	<i>: Participatory Rural Appraisal</i>
<i>PSTA</i>	<i>: Strategic Plan for the Transformation of Agriculture</i>
<i>RAB</i>	<i>: Rwanda Agriculture Board</i>
<i>RADA</i>	<i>: Rwanda Agricultural Development Authority</i>
<i>RARDA</i>	<i>: Rwanda Animal Resources Development Authority</i>
<i>RARI</i>	<i>: Rwanda Agricultural Research Institute (French acronym ISAR)</i>
<i>SMSs</i>	<i>: Subject Matter Specialists</i>
<i>UNDP</i>	<i>: United Nations Development Programme</i>
<i>USAID</i>	<i>: United States Agency for International Development</i>
<i>USDS</i>	<i>: United States Department of State</i>
<i>WFP</i>	<i>: World Food Programme</i>
<i>WRI</i>	<i>: World Resources Institute</i>
<i>WTO</i>	<i>: World Trade Organization</i>
<i>WVI</i>	<i>: World Vision International</i>
<i>7YGP</i>	<i>: Seven Year Government Plan</i>

1. Rwanda- Country Profile

Republic of Rwanda is a sovereign state in Central - East Africa and one of the smallest countries on the African mainland. Rwanda is in the African Great Lakes region and is highly elevated; its geography dominated by mountains in the west and savanna to the east, with numerous lakes throughout the country. Rwanda's green and mountainous landscape has earned it the nickname 'Land of a Thousand Hills.' Rwanda's economy is based mostly on subsistence agriculture. Coffee and tea are the major cash crops for export. The climate is temperate to subtropical, with two rainy seasons and two dry seasons each year. The important demographic details of the country are summarized in Table 1.

Table 1. Important demographic details of Rwanda

Capital	: Kigali (1°56.633'S 30°3.567'E)
Provinces	: Five
Population	: 11.2 million (76 th in the World)
Density	: 445/km ² (29 th in the World)
Area	: 26,338 sq km (10,169 sq miles) - (145 th in the world)
Water (%)	: 5.3
Major languages	: Kinyarwanda, French and English
Major religions	: Christianity, indigenous beliefs
Life expectancy	: 54 years (men), 57 years (women)
Currency	: Rwandan franc
GDP (PPP)	: Total \$20.343 billion; Per capita \$1,784
GDP (nominal)	: Total \$8.763 billion ; Per capita \$769
HDI (2013)	: 0.506 (151st)
Neighboring countries	: Burundi, Congo, Uganda and Tanzania

Source : National Institute of Statistics of Rwanda (2014 & 2015); IMF (2015); UNDP (2014)

1.1. Geography and Climate

Located a few degrees South of the Equator, Rwanda is located in Central - Eastern Africa, and is bordered by the Democratic Republic of the Congo to the west, Uganda to the north, Tanzania to the east, and Burundi to the south. At 26,338 square kilometres (10,169 sq mi), Rwanda is the world's 149th-largest country, and the fourth smallest on the African mainland. The

entire country is at a high altitude: the lowest point is the Rusizi River at 950 metres (3,117 ft) above sea level. The capital, Kigali, is located near the centre of Rwanda (Encyclopedia Britannica (2010); CIA, 2011).

The watershed between the major Congo and Nile drainage basins runs from north to south through Rwanda, with around 80% of the country's area draining into the Nile and 20% into the Congo via the Rusizi River and Lake Tanganyika. Rwanda has many lakes, the largest being Lake Kivu. This lake occupies the floor of the Albertine Rift along most of the length of Rwanda's western border, and with a maximum depth of 480 metres (1,575 ft), it is one of the twenty deepest lakes in the world. Other sizeable lakes include Burera, Ruhondo, Muhazi, Rweru, and Ihema, the last being the largest of a string of lakes in the eastern plains of Akagera National Park (Jorgensen, Sven Erik, 2005; Nile Basin Initiative, 2010). Mountains dominate central and western Rwanda. The centre of the country is predominantly rolling hills, while the eastern border region consists of savanna, plains and swamps (Munyakazi et al., 2005).



Fig.1. Location of Rwanda



Fig.2. Kagera and Ruvubu rivers

Rwanda has a temperate tropical highland climate, with lower temperatures than are typical for equatorial countries because of its high elevation. Kigali, in the centre of the country, has a typical daily temperature range between 12 and 27 °C (54 and 81 °F), with little variation through the year. There are some temperature variations across the country; the mountainous west and north are generally cooler than the lower-lying east. There are two rainy seasons in the year; the first runs from February to June and the second from September to December. These are separated by two dry seasons: the major one from June to September, during which there is often no rain at all, and a shorter and less severe one from December to February. Rainfall varies geographically, with the west and northwest of the country receiving more precipitation annually than the east and southeast. Global warming has caused a change in the pattern of the rainy seasons. According to a report by the Strategic Foresight Group, change in climate has reduced the number

of rainy days experienced during a year, but has also caused an increase in frequency of torrential rains. Both changes have caused difficulty for farmers, decreasing their productivity. Strategic Foresight also characterize Rwanda as a fast warming country, with an increase in average temperature of between 0.7 °C to 0.9 °C over fifty years (USDS, 2004; Adekunle, 2007; King, 2007; Strategic Foresight Group, 2013; Bucyensenge, 2014; World Meteorological Organization,2015).

The typical geography, climate and change in temperatures as well as pattern of rainy seasons have serious implications for capacity building of extension advisory service (EAS) delivery agents.

1.2 Economy

The per-capita GDP (PPP) estimated at \$1,784 in 2015, compared with \$416 in 1994 (Table 2). Major export markets include China, Germany, and the United States. The industrial sector is small, contributing 14.8% of GDP in 2014. Products manufactured include cement, agricultural products, small-scale beverages, soap, furniture, shoes, plastic goods, textiles and cigarettes. Rwanda's mining industry is an important contributor, and minerals mined include cassiterite, wolframite, gold, and coltan, which are used in the manufacture of electronic and communication devices.

Table 2. Gross domestic product descriptors of Rwanda in 2015

Descriptor	Units	Scale	2015
GDP, current prices	U.S. dollars	Billions	8.763
GDP per capita, current prices	U.S. dollars	Units	768.654
GDP based on purchasing-power-parity (PPP) valuation of country GDP	Current international dollar	Billions	20.343
GDP based on PPP per capita GDP	Current international dollar	Units	1,784.450
Population	Persons	Millions	11.400

Source: IMF (2015)

Rwanda's service sector is becoming the country's largest sector by economic output and contributing 43.6% of the country's GDP. Key tertiary contributors include banking and finance, wholesale and retail trade, hotels and restaurants, transport, storage, communication, insurance, real estate, business services and public administration including education and health. Tourism

is one of the fastest-growing economic resources and became the country's leading foreign exchange earner.

2. An Overview of Agriculture Sector, Policies, Programmes and Priorities

2.1 Agriculture Sector

Rwanda is a country of few natural resources, and the economy is based mostly on subsistence agriculture by local farmers using simple tools. Agriculture constituted an estimated 32.5% of GDP in 2014. Farming techniques are basic, with small plots of land and steep slopes. Since the mid-1980s, farm sizes and food production have been decreasing, due in part to the resettlement of displaced people. Despite Rwanda's fertile ecosystem, food production often does not keep pace with population growth, and food imports are required (FAO – WFP, 1997; USDS, 2004; WRI, 2006).

Subsistence crops grown in the country include *matoke* (green bananas), potatoes, beans, sweet potatoes, cassava, wheat and maize. Coffee and tea are the major cash crops for export, with the high altitudes, steep slopes and volcanic soils providing favourable conditions. Reliance on agricultural exports makes Rwanda vulnerable to shifts in their prices. Animals raised in Rwanda include cows, goats, sheep, pigs, chicken, and rabbits, with geographical variation in the numbers of each. Production systems are mostly traditional, although there are a few intensive dairy farms around Kigali. Shortages of land and water, insufficient and poor quality feed, and regular disease epidemics with insufficient veterinary services are major constraints that restrict output. Fishing takes place on the country's lakes, but stocks are very depleted, and live fish are being imported in an attempt to revive the industry (WTO, 2004; *Namata*; 2008).

The steep slopes and acidic soils of Rwanda's highland areas make them unsuitable for growing food crops. However, with the temperate climate and plentiful rain and sunshine, the slopes are perfect for growing tea. With ideal growing conditions, Rwanda's tea is high quality. Historically, it has been sold to blend with lower-quality tea from other countries. But for the future, Rwandans hope to be able to sell their own national brand.

Rwanda's other main high-quality crop is coffee. Together, tea and coffee make up nearly four-fifths of the country's agricultural exports. Barley for beer and green beans are also grown as cash crops; two-thirds of Rwanda's farmers grow beans. In the marshier areas, rice is becoming important. The target is to have 40,000 hectares under rice cultivation by 2020. Rwanda's government has set a goal to spend 10% of the national budget on agriculture.



Fig.3. Rwanda's rice field



Fig.4. Harvested maize

Plots of land are generally small (0.5 hectares on average) and often steep. To improve logistics and selling prices, farmers are being encouraged to grow specific crops in groups. These groups are then given help with improved seeds and fertilizers. Harvests of maize, wheat, cassava and beans have risen dramatically with this approach.

Plantains/bananas are of great importance to Rwandans. They are grown on over a third of the country's cultivated land and typically account for at least two-thirds of a small farmer's earnings. As well as being eaten in meals, the plantains are used in wine (*urwagwa*) and beer-making. The whole plantain plant is valuable. The outer stems are used to make ropes, the central rib of the leaf used to make fish traps and the juice from the stem is used for medicinal purposes.

Rwandan agriculture has made major advances in the last decade. Productivity and production for a number of crops have sharply increased and improved rural incomes. It is vital to continue this rapid progress to further reduce rural poverty. In the recent past there has been significant expansion of interventions which drive productivity gains, including successful land consolidation, increased areas under irrigation and protected against soil erosion, and expansion of cultivated terraces. Access to important services including agricultural finance and proximity extension services has been improved, and farmers are now more likely to use specific crops according to agro-climatic zones. There has also been an increase in the use of inputs, including agrochemicals and improved seeds. Post harvest infrastructure investments and subsidised transport has improved product quality and market accessibility. As a result of these interventions, production of maize, wheat, roots and tubers, soybeans, rice, cassava, horticultural products and meat and milk has increased.

The overall agricultural growth rate between 2000 and 2010 was 5.8% per annum. Over the last five years, extreme rural poverty fell from 39.5% to 26.4%, driven largely by interventions

to move agriculture from subsistence to a market economy. Malnutrition also declined between 2006 and 2009, where households with food shortages or in borderline nutritional conditions declined from 34.6% of the population to 21.5% . However, many poor Rwandans continue to live below the poverty line as 80% of the rural population consists of subsistence farm families with an average land size of 0.59 ha. Therefore progress in reducing poverty must continue to come largely from the agricultural sector (Strategic Plan, 2013).

2.2 Agriculture Policies, Programmes and Priorities

Vision 2020 is the primary socio-economic policy document of Rwanda on which all national and sectorial policies and strategies are based. It describes modernisation of agriculture and animal husbandry as one of the six pillars for building a diversified, integrated, competitive and dynamic economy. Vision 2020 seeks to transform Rwanda’s economy through a rapid increase in agriculture growth and a significant reduction in poverty. Agriculture is a priority sector, with an emphasis on moving the sector from subsistence to commercial production through attracting increased investment. The target for agricultural growth until 2020 has been revised upward to 8.5 % per year. The key national and agricultural sector-related targets of Vision 2020 are shown in Table 3.

Table 3. Selected National and agriculture related goals in Rwanda’s Vision 2020

Indicator	2000	2010	2020
Population (million)	7.7	10.1	12.71
GDP/capita (constant 2000 US\$)	220	400	1240
Poverty (%)	64	40	20
Agricultural GDP growth (%)	9	8	8.5
Agriculture as % of GDP	45	47	25
Agriculture as % total population	90	75	50
Land under “modernised” agric (%)	3	20	40
Fertiliser application (kg/ha/annum)	0.5	8	45
% banks’ portfolio to agric. Sector	1	15	20
Soil erosion protection (% total land)	20	80	90
Agricultural exports	<i>n.a.</i>	<i>n.a.</i>	<i>“5-10 times 2000 value”</i>

Source: MINECOFIN, Revised 2012

To meet the targets of Vision 2020, the overall goals of Rwanda’s Strategic Plan (2013) are:

- To transform Rwandan agriculture from a subsistence sector to a market-oriented, value creating sector
- To grow as rapidly as possible, both in relation to production and commercialization, in order to increase rural incomes and reduce poverty.

The intensification and commercialization of the Rwandan agricultural sector will be essential to reduce poverty and drive growth. The economic and poverty reduction strategy-II of Rwanda prioritizes rural development and embraces the sector as a source of jobs and economic transformation. The third agricultural sector strategy, seeks to facilitate the development of Rwanda's agriculture, through an approach based on following four key pillars for rapid sector growth (Strategic Plan, 2013):

1. Land, irrigation, inputs and infrastructure
2. Soft skills and farmer capacity
3. Value chains and markets
4. Private sector investment

Supporting these strategic pillars are cross-cutting programmes for institutional strengthening, gender equity, and environmental sustainability with focus on:

- Increased scale: Bulking up production of small farmers and linking them to markets
- Increased exports: Export support programme including certifications
- Investment: Strengthening value chains, accessing new markets, and active support for private operators in irrigations, inputs and agricultural finance
- Quality with improved production technologies
- Professionalization of farmers: Reorientation incentives in agricultural extension, privatization and extension to cover business advisory services and marketing assistance
- Modernization: Promote mechanisation appropriate for small farmers.
- New research orientations: Meeting market demands and diversifying livestock
- New sub-sectors: Exploring emerging value chains including fisheries and sericulture
- Access to finance: Restructure rural finance to make it more resistant to shocks
- Agro-processing: Creating off-farm employment and value addition

These activities are expected to increase production per hectare, generating income and food security for rural households to facilitate realization of goals of Vision 2020.

2.3 Strategic Programmes

The four strategic programmes, sub-programmes and lines of action in Rwanda's agriculture sector are summarized in Table 4.

Table 4. Strategic programmes and lines of action in Rwanda's agriculture

Programme 1 : Agriculture and Animal Resource Intensification	
Sub-programmes	Strategic Areas
Soil Conservation and Land Husbandry	<ul style="list-style-type: none"> • Land protection structures: construction of progressive and radical terraces • Agroforestry • Improve the understanding of soils
Irrigation and Water Management	<ul style="list-style-type: none"> • Public sector irrigation development • Private sector irrigation development • Applying lessons from IWM and development of IWM • Develop hydrological information for watershed management
Agricultural Mechanization	<ul style="list-style-type: none"> • Development of mechanization options and implementation of mechanization strategy • Facilitating investment and finance for mechanization • Maintaining mechanization services • Incorporating mechanization in irrigation schemes
Agrochemical use and Markets	<ul style="list-style-type: none"> • Accelerating privatization of input markets according to fertilizer strategy • Improve the input distribution network • Improve the infrastructure for fertilizer distribution • Improve soil fertility management through use of organic fertilisers and liming
Seed Development	<ul style="list-style-type: none"> • Implement a formal seed system • Facilitate the import of seeds and planting material
Livestock Development	<ul style="list-style-type: none"> • Improve milk quality, seasonality and productivity in line with the Dairy Strategy • Improved animal nutrition

	<ul style="list-style-type: none"> • Improved animal genetics in line with the 2012 Animal Genetics Improvement Strategy • Develop diversified small holder meat production in line with the 2012 Meat Industry Strategy • Extension of the Girinka Programme • Strengthen the veterinary service network and improve animal health
Nutrition and Household Vulnerability	<ul style="list-style-type: none"> • Support households in nutritious garden practices and diversifying food production • Improve nutrition related knowledge and practices for food insecure households • Develop a programme of bio-fortified food • Expansion of One Cup of Milk Per Child programme • Continue to maintain a national strategic food reserve • Strengthen Rwanda's food security information system
Programme 2: Research and Technology Transfer, Advisory Services and Professionalization of Farmers	
Research and Technology Transfer	<ul style="list-style-type: none"> • Market related research • Research on seeds, planting material and multi-crop rotations • Research on farmer's fields • Competitive research funding • Funding and international collaboration
Extension and Proximity Services for Producers	<ul style="list-style-type: none"> • Extending Farmer Field Schools (FFS) • Training for agricultural entrepreneurship • Facilitating relationships between cooperatives and farm advisors • Expansion of agricultural advisory services • Establish local forums for farmers and agricultural stakeholders

Farmer Cooperatives and Organisations	<ul style="list-style-type: none"> • Implement a capacity building programme for agricultural organisations • Develop a framework for share companies in farming areas
Programme 3: Value Chain Development and Private Sector Investment	
Creating an Environment to Attract Private Investment, Encourage Entrepreneurship and Facilitate Market Access	<ul style="list-style-type: none"> • Creation of farm management unit to focus on bulking up production • Public private partnerships and risk management in value chains investment and mitigate risk • Catalytic fund for agricultural entrepreneurship • Agricultural exports and cross border trade channels • Strengthen sanitary, phytosanitary and food safety (SPS) and sensitise producers
Development of Priority Value Chains: Food Crops	<ul style="list-style-type: none"> • Bananas, Wheat, Maize, Rice, Irish Potato, Cassava, Soya Beans, and Beans
Development of Priority Value Chains: Export crops	<ul style="list-style-type: none"> • Coffee, Tea, The pyrethrum value chain • Horticulture, floriculture and other emerging value chains
Development of Priority Value Chains: Dairy and Meat	<ul style="list-style-type: none"> • Dairy and Meat
Development of Priority Value Chains: Fisheries	<ul style="list-style-type: none"> • Research and technology development for fish and fish products • Strengthen existing fish supply chain • Implement a system of cage aquaculture, tank aquaculture and aquaculture parks • Establish industry to process fish wastes into animal feeds and fertilizers
Development of Priority Value Chains: Apiculture	<ul style="list-style-type: none"> • Strengthen beekeeping • Conduct market research and develop a promotion campaign

	<ul style="list-style-type: none"> • Increase and harmonise quality standards
Agricultural Finance	<ul style="list-style-type: none"> • Strengthen and consolidate SACCOs at the District Level under Agricultural Cooperative Bank • Establish a warehouse receipts system • Facilitate value chain finance relationships • Expand agricultural insurance and rural finance
Market oriented Infrastructure for Post-Harvest	<ul style="list-style-type: none"> • Promote efficient and equitable transport systems • Reduce staple crop post-harvest losses at producer and first aggregator level
Programme 4: Institutional Development and Agricultural Cross-Cutting Issues	
Institutional Capacity Building	<ul style="list-style-type: none"> • Develop a comprehensive human resource development plan • Develop staff incentives • Staff capacity building • Strengthen and improve coordination of the rural development group
Decentralisation in Agriculture	<ul style="list-style-type: none"> • Strengthen the role of districts in para-vet services and human disease control • Make districts partners in all ag extension programmes • Strengthen fiscal decentralisation
Legal and Regulatory Framework	<ul style="list-style-type: none"> • Formalise the National Irrigation Policy • Develop regulations for organic agriculture, pesticide and limestone use • Develop regulations around the value chain guarantee fund • Develop the legal basis for an agricultural catalytic fund
Agricultural Communication Statistical Systems, M&E and Knowledge Management	<ul style="list-style-type: none"> • Agricultural communication strategy development • Improvement of the agricultural statistical system • Collection and use of agricultural meteorology data • Agricultural M&E and MIS

Gender and Youth in Agriculture	<ul style="list-style-type: none"> • Institutionalise gender equality in sector entities • Develop capacities for gender sensitive programming • Enhancer gender responsiveness in agricultural service delivery • Continue to develop and strengthen and operationalize partnerships with gender focused institutions • Develop a TVET curriculum for specialisations • Target youth in entrepreneurship programmes • Develop an agricultural leadership programme for youth
Environmental Mainstreaming in Agriculture	<ul style="list-style-type: none"> • Soil conservation mainstreaming • Fertilisation from a plant nutrient viewpoint • Reducing pesticide hazards • Environmentally sound water management • Environmental considerations in rural roads • Planning for climate change

Vision 2020 recognizes that the private sector will drive the economy and the State's responsibility will be to initiate, pilot, co-ordinate and monitor efforts. (Vision 2020, MINECOFIN, 2000). The long, medium and short term goals for agriculture development are (Strategic Plan, 2013):

- (a) **Long term:** Focus on both increased production of staple crops and livestock products, and greater involvement of the private sector to increase agricultural exports, processing and value addition. Investing in high-value crops while also exploiting the opportunities offered by staple crops is key for the future, facilitating both domestic food security and higher rural incomes.
- (b) **Medium term:** Move Rwandan agriculture from a largely subsistence sector to a more knowledge-intensive, market-oriented sector, sustaining growth and adding value to products.
- (c) **Short term:** Continued rapid food production to ensure further reductions in rural poverty and malnutrition.

Over the strategy implementation period, MINAGRI' role in the sector will move from provider to facilitator, as capacity grows and private sector investment delivers demand driven agricultural products. This strategy, if realised, will support agricultural and GDP growth, and help meet the ambitious targets and Vision 2020, to reduce poverty and to make a significant positive impact on the population, particularly those living in rural areas.

3. An Overview of Allied Sectors, Policies, Programmes and Priorities

3.1 Horticulture

Given its potential to contribute to Rwanda's export diversification, horticulture has been identified as a priority export sector. Horticulture is a job-intensive and investment-attracting industry and this will generate jobs to a large proportion of Rwandans and provide foreign exchange. Besides economic receipts and jobs, other horticulture related benefits include improving nutrition, creating a better image for Rwanda, encouraging private-public sector partnerships in horticulture-related industries, and generating public awareness for the industry. Rwanda is blessed with the natural climatic conditions necessary to win in horticulture: the right soils, temperatures, rainfall, and sunshine, as well as an abundant and hard working labour force. As one Dutch flower investor from Kenya was quoted as saying: *"Rwanda is one of the last unexploited corners of Africa with the right conditions for horticulture."* Rwanda aims to achieve this vision by fostering investments and a carefully selected basket of fruits and vegetables (Horticulture Strategy for Rwanda, 2006).

Given its land size and structure, Rwanda must focus on quality and not the quantity of its Horticulture products. Three conditions are paramount to the realization of Rwanda's vision in Horticulture - create a production platform, attract and sustain investment as well as to identify and access opportunities. Coordination of public and private sector initiatives will be critical to attain the objectives. As the industry is still in its infancy, efforts on the part of all the stakeholders will be required for it to take off.

Horticulture Strategy for Rwanda (2006) proposed the following priority actions for Horticulture development.

- Develop vegetables value chain with export potential
 - French bean, snow peas, tomato, onion, fresh and dried chili, spices and other Asian vegetables, among others.
- Develop fruits value chain with high potential

- Avocado
- Pineapple
- Macadamia Nuts
- Passion fruits
- Apples
- Develop essential oils
 - Geranium, Patchouli, *Eucalyptus globulis*, and lemon grass.
- Develop floriculture industry including cut flowers, foliage and ornamentals
 - Large bud roses and summer flowers
- Facilitate communication among non-traditional export crop value chain actors

3.2 Sericulture

Sericulture is relatively a young industry in Rwanda and requires sustained support to make the sector economically meaningful. The National Sericulture Center (NSC) has invested in most key drivers of the sericulture industry, including the acquisition of silkworm seed, standard rearing techniques, improved mulberry productivity and capacity building at various levels of the value chain. Unfortunately cocoon production is still low. One of the major constraints in sericulture development initiatives is the lack of a dependable domestic cocoon market. Putting in place a system where farmers deliver cocoons and are paid promptly will stimulate increased cocoon production by several orders of magnitude. Other limiting factors include limited technical knowhow, inadequate extension service, lack of resilient silkworm seed adaptable to local conditions and lack of sufficient rearing houses and equipment.

Horticulture Strategy for Rwanda (2006) proposed the following priority actions for Sericulture development to ensure 5,000 ha of mulberry by 2017.

- Acquisition of low capacity silk reeling and testing machines to test silk quality, convert farmer's cocoons into grade 1 silk for export purposes, and provide a ready market for cocoons, motivating more farmers to join silk industry.
- Rehabilitation of existing 350 ha of mulberry to increase productivity.
- Prepare cuttings and support mother gardens for mulberry saplings.
- Upgrade the NSC, Mulinidi and Provincial Sericulture Centers and support selected cooperatives to become Egg Multiplication firms, producing more than 5000 boxes per year.
- Establish sericulture model farms in each province.

- Launch a campaign to identify and map land for mulberry expansion.
- Plant 150 ha of mulberry in 2013, with an increase to 5000 ha by 2017.
- When production stabilizes (1000 ha of mulberry) procure high capacity silk reeling machines.
- By 2017 egg production capacity should have increased to 47,500 boxes (annually) to feed into 5,000 ha generating 1187.5 tons of fresh cocoons, 142.5 tons of raw silk yarn translating into US\$ 3,562,500 and 7,837,500, respectively.

3.3 Animal Husbandry

The dairy subsector is important to the economic development of Rwanda, and dairy as a strategic commodity, offers a pathway out of poverty for large numbers of households keeping livestock and for those who provide services and value addition throughout the supply chain. The current "farm gate" value of milk is approximately Rwf 79.7 billion (US\$129.70 million). The dairy subsector contributes 15 percent to agricultural gross domestic product (AGDP) and 6 percent to GDP. Dairy's contribution to GDP is likely underestimated when considering ancillary products that can be attributed to dairy, e.g. hides, meat, traction/carting and manure. The dairy sector supports each pillar and cross-cutting issues of Rwanda's Vision 2020 directly or indirectly with its contribution to GDP, household income, and job creation.

Several challenges facing the dairy sub-sector as per NDS (2013) are:

- The number of improved dairy cattle will increase and the potential exists for the production of 650,000 mt of milk in 2017.
- An adequate supply of feed and the knowledge of how to prepare feed rations are challenges to improving productivity for dairy producers.
- Costs of production (COP) of milk in Rwanda are higher than in neighboring Kenya and Uganda, where production and processing benefits from economies of scale and the farm to consumer cold chain is better developed. This, combined with the transport costs required to reach these markets, makes Rwanda's milk less than price competitive to trade in these countries. However, there appear to be market opportunities to the west, in Burundi and the Democratic Republic of Congo (DRC), where production and processing are underdeveloped and milk COP is relatively high.
- The marketing costs beyond the farm gate to final domestic consumers are also high. Farmers' share of the final retail price is low (less than 30% for milk sold through the alternative milk sector (AMS) to less than 20% if farmers' milk is sold through the formal

sector) when compared to international standards of 50 percent. This is due to both the scale of production and processing as well as development of the cold chain.

- On the demand side, consumer demand for both raw and processed milk is not increasing fast enough to clear the projected supplies of raw milk because of affordability, accessibility and availability of milk.
- Milk quality is an issue of concern for the majority of milk marketed through the AMS and this limits domestic and export market opportunities.
- The retail price of processed dairy products is high compared to milk in the AMS, which impacts demand and diverts consumers to purchasing "loose" milk (unpasteurized).
- The Rwanda does not currently have a dairy policy, and private stakeholders in the dairy subsector are not organized or able to effectively advocate for needed regulations and investments.

A dairy subsector without National Dairy Strategy (NDS) would see production of 650,000 MT of milk, thus creating a surplus of 100,000 MT of milk in 2017 because of a projected population growth rate of 2.75 percent. The surplus is projected to increase to 200,000 MT in 2020. It is critical that the market, both informal and formal, absorb and monetize this production in order to drive the economic incentives that can pull the dairy industry to a scale sufficient to make it more cost competitive domestically and regionally. Without market incentives and profitability at the producer level, farmers may cut back on feeding their dairy animals, may choose not to milk their cows (evening milking), or sell their dairy cattle for slaughter because milk cannot be sold. The potential for milk production at scale and the economic promise of the dairy sector will be lost.

While demand for dairy and meat products is projected to increase naturally due to increasing population, urbanization, rising disposable incomes and changes in the demographic structure of the population, the rate of natural demand increase is not likely to be sufficient to absorb the approaching supply bulge. Currently 1/3 of Rwandan consumers consume no dairy products, as identified in the East African Dairy Development (EADD) consumer survey. To create the necessary market pull needed to reach scale, the NDS envisions targeted marketing interventions designed to increase the consumption of milk and milk products from its present level of 40 liters per person per year (l/p/yr) to approximately 80 l/p/yr in 2020, as well as to

reorient consumer demand toward processed, as opposed to raw, dairy production through promotion of its health and hygiene benefits.

On the supply side, the NDS envisions assisting the domestic industry to expand the number of improved dairy cows that are more productive (cross-bred cows) than local Ankole cattle, and cows have to be better fed and managed. Building on efforts to develop milk collection infrastructure and the cold chain, producers will have to become more market-oriented and commercialized, selling through their milk cooperative. Dairy product diversification (value addition) also will help absorb additional volumes of milk produced. Advertising campaigns for the latter will be required to stimulate consumer interest in what may be new product lines for many Rwandan consumers. As domestic demand and processing volumes grow, milk COP will fall, enabling processors to better tap export markets in countries in the region.

Strategic Dairy Development Programmes

The four strategic components and lines of action emphasized by NDS (2013) are summarized in Table 5.

Table 5. Strategic components and lines of action for dairy development

Components of Dairy Strategic Plan	Strategic Areas
Milk Production, Productivity, Quality and Standards	<ul style="list-style-type: none"> • Lead farmers and group activities • Input supply - advisory services • Seed multiplication & forage and hay businesses • Increase milk production on medium to large farms • Access to finance linking to milk sales revenues • Train dairy extension specialists for districts
Milk Collection, Processing, Trade and Consumption	<ul style="list-style-type: none"> • Improve efficiencies in milk collection • MCCs become consolidation points for all raw milk • Increase the utilization of plants' capacity • Diversification of product lines to increase sales • Increase cheese production and sales • Increased sales of safe dairy products

Policies, Institutions and Interventions to Improve Dairy Subsector	<ul style="list-style-type: none"> • Livestock productivity improvement • Enhance planning of feeder roads for milk collection • Improve access to electricity for dairy producers and MCCs • Market research to expand the markets for milk • Build capacity with skills in the dairy subsector • Create business environment conducive for dairy • Safe dairy products for domestic and regional markets • Promotion program on increasing milk consumption • Increasing regional exports of milk and dairy products • PP) for dairy subsector
Implementation and Coordination of the NDS	<ul style="list-style-type: none"> • Effective implementation and monitoring of the NDS

3.4 Poultry

Poultry industry in Rwanda is characterized by the coexistence of 2 systems: rudimentary village poultry and industrial poultry at its infancy, the 2 systems facing scarcity of inputs to fully exploit their potential. The poultry population amount for 4.08 Million and 26.4% of the total agricultural households kept poultry (Paul Heidloff, 2012).

The Rwandan poultry industry is limited by several general constraints viz.,

- Village poultry, which constitutes the majority of the national flock, is in poor condition;
- National supply of day-old chicks, which is poor
- Poor nutrition, related to the absence of the poultry feed industry, the scarcity and high prices of feed ingredients
- Poultry health constraints
- Absence of marketing strategies
- Financial constraints - low access to credit
- Institutional constraints.

The Strategy and Investment Plan to Strengthen the Poultry Industry in Rwanda (2012) set the following five objectives to establish poultry sector as one of the flagship industry.

- Maintaining domestic market and increasing market share

- Becoming regionally competitive
- Developing export opportunities and accessing foreign markets
- Increasing food security
- Increasing incomes of small-scale producers, emergence of major poultry business farmers.

The two strategic programmes and seven components in the Strategy and Investment Plan to Strengthen the Poultry Industry in Rwanda (2012) are summarized below.

Strategic Programmes

- Enhancing poultry meat and eggs production
- Marketing.

Components

- Poultry nutrition
- Supply of day-old chicks (Recovery and Implementation of hatcheries)
- Poultry Health and Biosecurity
- Development of village poultry
- Strengthening the institutional framework
- Mastery of sanitary quality
- Promotion of the poultry products.

Promoting private sector participation and commercial poultry value chain development through integration / contract farming will help poultry farmers with minimum investments.

3.5 Fisheries Sector

Rwanda has 1,390 sq.km as water surface (5.28% of total area) and 24 lakes including three shared lakes with Congo and Burundi. The national fish production is estimated at 13,000 tons of which capture fisheries contribute 9,000 tons and aquaculture 4,000 tons. Rwanda is currently by far a net importer of fish from neighboring Uganda and Tanzania. However, it is important to note that Rwanda also re-exports most of the imported fish to Congo. Fisheries and Aquaculture sectors provide about 200,000 jobs (both direct and downstream jobs) though it is not a traditional enterprise (Mwanja et al. 2011). According to the Vision 2020, Rwanda's human population is estimated to reach 16 million by 2020. Rwanda should strive to attain Sub-Saharan per capita fish supply of 6.6 kg by 2017 and thereafter build capacity for export. In order to attain Sub-Saharan fish consumption level, Rwanda will have to produce 112,000 tons per annum; an 8.5 fold increase

of the current production. Whereas this seems astronomical, it can be achieved with logical and guided private and public sector investment given the vast natural potential and prevailing socioeconomic policy environment.

The Government of Rwanda (GoR) laid out a New Fisheries and Aquaculture Policy in 1998 aimed at ensuring food security, poverty eradication, and natural resources/environmental protection. The policy called for improvement in aquaculture production, coordination of fisheries and aquaculture activities with water resources management, development of fisheries and aquaculture management capacity, and review of the attendant legislations. New fisheries law was enacted in 2008 to repeal the one which dated back in 1937. Along this was the establishment of a mega project, the Inland Lakes Integrated Development and Management Support Project (PAIGELAC) for development of fisheries and aquaculture funded by a loan facility from African Development Bank (ADB).



Fig.5. Fisher folks and craft on Lake Sake, Ngoma District

The Master Plan for Fisheries and Fish Farming in Rwanda (2011) has identified a number of constraints to the development of the sector. These include:

- Lack of a fish eating tradition that did not consider fish as a high value commodity.
- Poor regulatory framework of the fishing effort and fishing methods.
- Uncoordinated and unfocussed development projects leading to unsustainable outputs.
- Environmental pollution of water systems by excessive erosion of farmlands.
- Almost total depletion of natural fish stocks through overfishing.
- Fishing cooperatives that are geared towards harvesting with no inputs into the fisheries.
- Lack of private sector investments in the sub-sector.
- Lack of interest in fisheries and aquaculture at the district level hence low rating of the sector.
- There is very little local leadership support to fisheries and aquaculture development in almost all the districts.

- Lack of institutions for management of research and advisory services.
- There is no reliable data on the size of the fish stocks to guide management decisions.
- There are species introduction without adequate studies in contravention to CBD and FAO code for responsible fisheries.
- Lack of clear sector leadership and representation at national, regional bodies and international fora such as the CIFAA of FAO.
- Poor linkage of aquaculture and other agriculture production systems.
- Insufficient human resource to steer the sector.
- Significant high post harvest losses of the little fish harvested from the lakes.
- Lack of aquaculture technologies and innovations.
- Insufficient advisory services.
- Lack of fisheries and aquaculture inputs including seed, feed, gear, equipments and others on the local market.

Strategic Programmes for Fisheries Development

The strategic components and lines of action emphasized by Master Plan for Fisheries and Fish Farming in Rwanda (2011 -2020) are summarized in Table 6.

Table 6. Strategic components and lines of action for fisheries development

Thematic Area	Strategic Areas
Production systems, sport fishing, inputs, markets and product development	<ul style="list-style-type: none"> • Developing knowledge based aquaculture and fisheries systems <ul style="list-style-type: none"> ○ Cage production systems ○ Tanks based aquaculture ○ Aquaculture parks ○ Ornamental fish rearing ○ Development of sustainable capture fisheries ○ Sport fishing -Lake Muhazi • Input supply for commercial aquaculture <ul style="list-style-type: none"> ○ Seed ○ Feed • Input supply other than feed and seed • Fish marketing, processing and product development • Environmental health

Creating institutional capacity to manage and develop fisheries and aquaculture resources	<ul style="list-style-type: none"> • Fisheries and aquaculture management • Research and advisory services • Training
Creating enabling environment for the private sector to play a pivotal role in increased fish production	<ul style="list-style-type: none"> • Attracting the private sector in to fisheries and aquaculture

4. Present status and challenges in Agricultural Extension, Marketing, Insurance, Agriculture Mechanization, Food Processing, Infrastructure and any other relevant issues.

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 decentralised 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.

Achievements in these key areas include:

- Maize yields increased 4 times and wheat yields by 2.5 times between 2000 and 2010
- Hillside terraces increase potato yields 6 times
- Legume production increased by 73% from 2005 to 2010
- Through Girinka and small stock distribution 47% of farm households have at least one cow and 53% have at least one goat.
- Improving coffee quality and marketing have resulted in higher coffee prices

Acceleration of agricultural growth was driven largely by production for the domestic market, in staple crops, dairy and meat products. Coffee is an exception, as the primary export crop for international markets, and there are growing demands in regional markets, particularly Congo and Burundi, for dry beans, potatoes, maize, rice, cassava flour, maize flour, poultry products and live animals.

The annual agricultural growth target of 8.5% for the next five years is ambitious but achievable based on recent experiences. The major sources of growth will continue to be important, and new focus areas have also been added.

As per Strategic Plan (2013), agriculture growth will be driven by:

- Continued investment in land husbandry, irrigation and inputs
- Expanding productivity of staple crops
- Expanding the livestock sector, particularly small stock and fisheries
- Investing in mechanisation, processing and post-harvest facilities to modernise production
- Extension targeted at producers to develop a skill-based sector
- Research that responds to farmers' needs and identifies optimal crop varieties
- Aggregating smallholder production to provide sufficient quantities for markets
- Improving the quality of traditional export crops to generate higher premiums
- Increasing production of emerging export crops including horticulture
- Value chain development to strengthen supply and develop market demand
- Encouraging entrepreneurship through agricultural financing and insurance to reduce risk
- Attracting investment through soft and hard market infrastructure
- Building institutional capacity across the sector
- Facilitating a participatory approach, including women and youth, for inclusive growth
- Environmental sustainability and climate change adaptation for long term prosperity of the sector

High level sector outcomes focus on increased productivity of crops and livestock, improved households' food security, enhanced research and extension, improved value chain development and integration including private sector investment, better post harvest facilities and institutional development. Some of the key targets to achieve these outcomes include:

- 91% soil conservation (73% in 2012)
- 70,000 ha of irrigated land (25,000 ha in 2012)
- 25% mechanisation (13% in 2012)
- 90% of households with acceptable food consumption (79% in 2012)
- Improved ratio of extension workers per farmer household to 1/600 (1/839 in 2012)

- New financing and 18% of loans for agricultural activities (8% in 2012).

Agricultural transformation in Rwanda poses challenges that might be considered more typical of Asia than of Africa. One of the world's most densely populated countries – 416 persons per km at the last count – its population of 11.5 million was still growing at a vigorous 2.8% per year in 2012 despite falling fertility. The agricultural sector, including food-crop and export-crop production, livestock, forestry and fisheries, contributes 36% to GDP on average, but its contribution to employment is much higher, 73% overall and more for women, with food crops accounting for 85% of agricultural output (World Bank, 2013a: 44, 61 and World Development Indicators). Household production on micro-holdings has been overwhelmingly predominant, with average holdings of around 0.76 ha in about four separate plots. Productivity is well below potential, and income levels in agriculture remain extremely low (RADA, 2007).

A major ICT constraint for the Rwanda has been affordable, high-speed internet connectivity. Up until now, Rwanda has had to rely on satellite based data services, which are both slower and much more expensive than fiber based services. Consequently, there has been a great deal of demand for getting off of satellite and onto fiber. Under MINICT direction, the GOR just completed building a 2,600 km country-wide fiber optic backbone ring that connects all 30 Districts of the Country with the capital, Kigali. Extension should plan on leveraging these ICT infrastructural resources to the maximum extent possible, both for internal communication and training and for communicating with farmer audiences directly (Swanson et al., 2011).

Current extension advisory services focus on production agriculture, especially for the priority staple food crops. Little attention is being given to emerging high-value crop and livestock products that could increase farm income, especially for small-scale men and women farmers. Given that the agricultural production system in Rwanda is dominated by small-holder farmers with less than one ha of cultivable land (NAES, 2009) farmers need to maximize income from their small land holdings. They could greatly enhance their incomes by adding appropriate high-value crop and/or livestock in the process of intensifying and/or diversifying their respective farming systems. This would be sharply in line with the Strategic Plan for Transformation of Agriculture to maximize profits through agriculture and entrepreneurship development.

5. Status of Agricultural Extension and Research system

5.1 Agricultural Extension

The current pluralistic extension in Rwanda is one that is marked by a great deal of flux and change, and one in which a variety of different extension models are being experimented with and used. To provide clarity and focus, it will be important to refer often to the overall development strategy and the role that Extension is called to play within that strategy (Swanson et al., 2011).

National Agricultural Extension Strategy (NAES) document of Ministry of Agriculture and Animal Resources (MINAGRI) highlights the importance placed by the Government of Rwanda on developing a pluralistic agricultural extension system that captures the strengths of Top-Down approaches as well as the strengths of Bottom-Up approaches. As per the NAES, the extension must (National Agricultural Extension Strategy, 2009; Swanson et al., 2011):

- Be participatory
- Utilize multiple approaches and multiple methods
- Be farmer-led (i.e. demand-driven) and market-oriented
- Be process and results oriented
- Involve multiple actors in delivering extension education, information, and services
- Build on already existing initiatives

As per Swanson et al., (2011), the three core principles must inform all extension programs in order to be successful are:

1. Farmer -led
2. Market -driven, and
3. Decentralized

Rwanda's extension strategy aligns precisely with all the above core principles. The decentralization of the agricultural extension system in Rwanda was achieved through the 2004-5 administrative reform that transferred the delivery and supervision of extension services from MINAGRI to the Ministry of Local Government (MINILOC). As a result of this reorganization, MINAGRI is now responsible for coordination and planning of agricultural development programs; the agricultural sector information function; the monitoring and evaluation function; the regulation and control function; and the resources mobilization function. However, the direct delivery of public extension services, per se, is now being funded by and under the direct control of the Ministry of Local Government (MINALOC) at the district level.

5.1.1 Extension Methods Currently Being Pursued

Considerable attention and priority is being given by the MINAGRI to the Farmer Field School (FFS) methodology in Rwanda about using Integrated Pest Management (IPM) practices for selected crops. As reported in the Decentralized Agricultural Extension Road Map, since 2008 many farmer facilitators and co-facilitators have already been trained to use IPM for key crops including Irish potatoes (145 facilitators have trained 5,010 potato farmers), bananas (114 facilitators have trained 3,400 banana producers), tomatoes (60 facilitators have trained about 2,000 tomato farmers) and cassava (70 facilitators have trained about 2,100 cassava producers). It should be noted that most of this FFS training courses have been delivered by national level researchers and/or AAS teams at the zonal level.

However, it should be noted that these FFS training courses being implemented under MINAGRI generally bypass the front-line extension staff, especially at the zonal level. Therefore, It would be important in the future to involve these front-line extension workers (especially at the sector level) in the continuing FFS training courses being implemented by MINAGRI, so these front-line extension workers can help train and backstop these facilitators at the cell and village level.

In addition, many other extension methods can and should be used in training and supporting farmers, depending on the different crop, livestock, fisheries and other agricultural products (e.g. sericulture, bees, agro-forestry, etc.) being produced or processed (e.g. post-harvest handling or processing). Due to the topography of Rwanda, considerable attention must also be given to appropriate and needed soil and water management practices across Rwanda.

5.2 Research System

5.2.1 Overview of Research

Research Directorate in the Rwanda Agriculture Board (RAB) is responsible for overall coordination of countrywide agricultural research activities and driving science based technology generation for sustainable agriculture development. Agricultural research has been recognized as the engine driving agricultural growth in Rwanda and a critical tool in the fight against hunger and poverty. Prior to July 2011, The Rwanda Agricultural Research Institute (French acronym ISAR) was mandated with conducting scientific and technical development of agricultural and animal resources in Rwanda to improve the livelihoods of low income farmers. The institute

carried out research and promoted technologies in crop production, livestock, forestry, agro-forestry, post harvest management, land conservation and water management.

Research has made tremendous achievements overtime in contributing to the modernization of agriculture in Rwanda in line with agricultural development policies. Additionally, research activities have consistently aimed to contribute towards the improvement of food security. Combating malnutrition and improving livelihoods have also been a priority for agricultural research in response to national agricultural policies.

Agricultural research has undergone a radical paradigm shift over the years by moving away from a traditional research extension linear processes to Integrated Agricultural Research for Development (IAR4D) based on innovation platforms approach. In this system, the stakeholders (farmers, scientists, traders, local authorities, NGOs and the private sector) are becoming increasingly involved in the research process from priority setting and technology development to technology transfer.

5.2.2 Crop Research

Crop research is conducted through commodity programs, the range of which covers the key food and cash crops grown in Rwanda. Research covers different themes which are mostly aimed at improving crop productivity, considering that Rwanda's land constrained agricultural system.

In line with Crop Intensification Programme (CIP), research is being carried out on the development of improved varieties for different crops including beans, rice, wheat, maize, cassava, bananas, Irish potatoes, and sweet potatoes.

Qualities of interest include resistance against major pest and diseases, drought resistance, higher yields and early maturity. Combating malnutrition has also been a priority area for programmes and various nutrient rich crop varieties have been developed to combat malnutrition including Vitamin A Rich Cassava (Garukunsubire), High Quality Protein Maize (ISAR081), fortified Beans (rich in iron and zinc), orange Flesh Sweet Potatoes Rich in Vitamin A and Indigenous Vegetables.

5.2.3 Crop Protection

One of the major challenges facing agricultural production and productivity in Rwanda is the enormous crop losses caused by pests and diseases and crop protection research aims to generate technologies to counter this challenge. Strategies being used for pest and disease

management include testing new pesticides (Chemical and biological) for inclusion in IPM, testing varieties for their tolerance to pests and diseases, characterization of disease causing microorganisms and use of advanced diagnostic techniques among others.

5.2.4 Genetic Resource Conservation

This is another core area of interest for research, various programs including coffee and banana have field gene banks for conservation of material and also to serve as a source of planting material. Furthermore, to support conservation efforts, a state of the art national gene bank has been constructed at Rubona station for *ex-situ* conservation of plant and animal genetic resources.

5.2.5 Biotechnology

Biotechnology research aims to contribute to the national capacity to respond to the considerable demand in the country for quality planting material through mass propagation of disease free high yielding planting material using tissue culture technology. RAB currently has four fully operational tissue culture laboratories working on coffee, Irish potato, Banana, Pineapple, Tamarillo, Passion fruit and economically important trees. Furthermore, the biotechnology facilities have been vital in aiding scientists from different research programmes to conduct cutting-edge research in plant genotyping using molecular biology techniques and modern disease diagnostics using morphological, serological and molecular methods.

5.2.6 Post Harvest Handling and Management

Research in this area aims to achieve two objectives. The first is to broaden the utilization base of primary agricultural products through food processing and value addition techniques. To achieve this scientists work very closely with private sector processors. Examples of products under development include juices, jams and wines from fruits and bakery products from different composite flours. The second objective is to reduce post harvest losses through improving food handling and storage technologies after harvesting. Research efforts in this area mainly focus on fruits, vegetables, roots and tubers and cereals.

5.2.7 Livestock Production Research

The major constraints to livestock production in Rwanda are associated with low producing breeds; limited land for quality feed production; limited capacity for rational utilization of crop residues and agro-industrial by-products; and limited capacity of poor farmers to access cost effective disease control practices. Against this background the overall goal of the Animal Production Unit of Rwanda Agriculture Board (RAB) is to increase the contribution of livestock

sub-sector of agriculture through development and promotion of productivity enhancing technologies for animal production; and systematic crop-livestock integration for effective and efficient nutrient and sustainable land resource management.

The key livestock research objectives are :

- To develop high yielding livestock genotypes for meat and milk production on small-land holdings.
- To develop technologies for resilient feed resource base for smallholder livestock farmers.
- To develop affordable animal disease control tools for resource farmers
- To develop and promote innovations that promote crop-livestock integration and nutrient management for sustainable land use.

The expected outputs are:

- High yielding, and adapted ruminant and non-ruminant genotypes.
- High yielding and adapted forage germplasm species of the national feed resource based.
- Technology options for rational crop residue and agro-industrial material production, processing and utilization in the livestock production.
- Diagnostic tools and control methods for priority livestock disease in various agro ecological zones.

To address the above key objectives and obtain the desired outputs, the livestock research operates through commodity programs.

5.2.8 Fisheries

Management and implementation of fisheries policies and aquaculture is a mandate of Rwanda Animal Resources Development Authority (RARDA) which is one of the agencies of the MINAGRI. However, there is a conspicuously weak administrative structure for Fisheries and Aquaculture. The sector is managed by staff whose training is not directly related to fisheries discipline. Aquaculture is also a relatively new agricultural practice compared to crop and livestock husbandry. It remains unfamiliar to several stakeholders including advisory service providers. In many aspects, aquaculture is a technology-driven sector that requires farmer responsive research. Presently, there are no institutions mandated to undertake Fisheries and Aquaculture research and training in Rwanda. Limited research aspects of Fisheries and Aquaculture are undertaken by the National University of Rwanda (NUR) at Butare. NUR has one

of the well maintained aquaculture research stations at Rwasave used for training and teaching aquaculture.

Absence of research institutional capacity underlies the paucity of information on the water quality environment, ecology, fish stocks, reproductive and fish ecology, fish migrations, gear technology, aquaculture technologies such as induced spawning, feeding, genetics and selective breeding, production systems design, post harvest processing, value addition, product development, socio economics and others. Currently, most of the available information is from research components of some of the projects above that were undertaken by foreign experts with assistance from local team members over very limited periods. There is need for well planned research, focussed on addressing national challenges in Fisheries and Aquaculture.

6. Public and Private Institutions and their Relevance in Agricultural Development.

6.1 Public Institutions

The public sector institutions in agricultural development at the national level are coordinated by MINAGRI and regional field extension activities are being carried out by MINALOC extension workers at the district, sector and cell levels. A recent reorganization within MINAGRI consolidated various divisions under two specialized agencies: the Rwanda Agricultural Board (RAB) and the National Agricultural Export Board (NAEB). The goal was to effectively move extension and research activities into closer contact with each other (especially under RAB, but also through NAEB), since there have been continuing research-extension linkage problems within MINAGRI. This restructuring and re-alignment of resources appears to be headed in the right direction and has the advantage of moving subject-matter specialists closer to the end users, as they are deployed to four new zonal offices around the country (Swanson et al., 2011).

National Agriculture Extension Support Project (PASNVA - a French acronym that in English translates to) is a joint Extension strengthening project with two major components. The first was the establishment of the Center for Agricultural Information and Communication (CICA) to deliver 5 essential ICT services viz., (1) a documentation center and library; (2) a GIS lab; (3) a group for managing the MINAGRI website and the AMIS Portal (Agricultural Management and Information System); (4) staff to develop extension publications; and (5) staff to develop extension audio-visual materials. The second major component of PASNVA was to develop and pilot-test this new decentralized extension system.

The organization structure of Rwanda's public agriculture extension system is presented in Fig.6

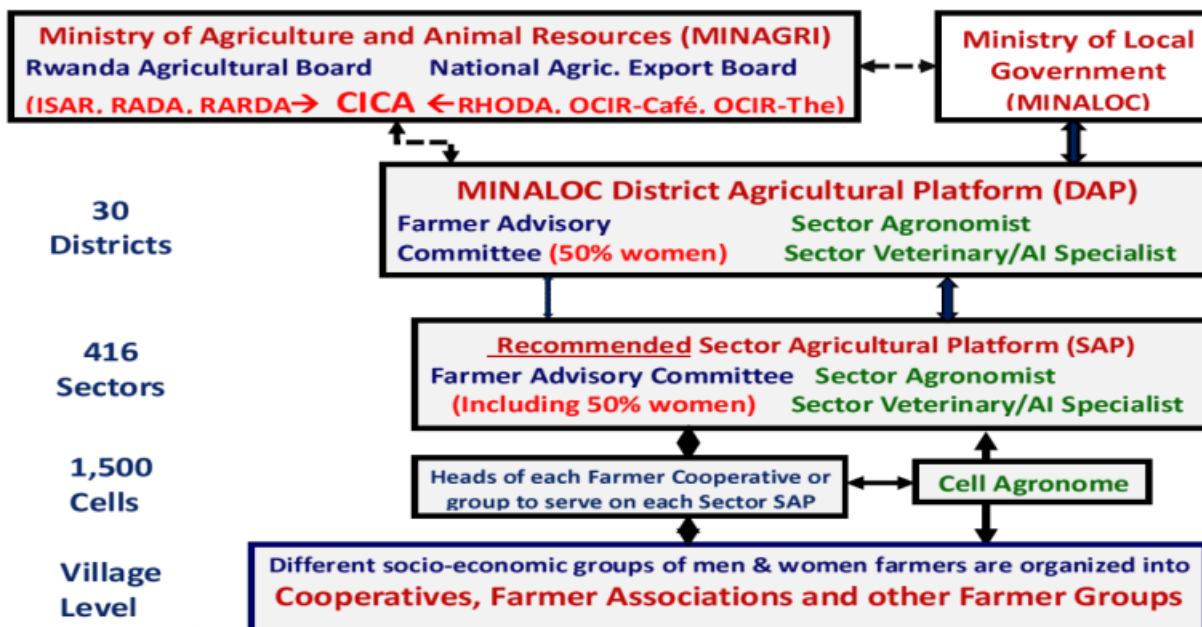


Fig.6 Public agricultural extension system in Rwanda

6.2 Private Institutions / NGOs

The Vision 2020 of Rwanda recognizes that the private sector will, over time assume the role of driver of the economy and the State's responsibility is stated as being to initiate, pilot, coordinate and monitor efforts. There are numerous international and local NGOs operating within the different districts across Rwanda, but most of these projects are focused on specific crop (e.g. rice, maize, beans, cassava, Irish potatoes, coffee, etc.) or livestock projects (e.g. one cow/one family). Most of these donor-funded projects last for only 3-4 years and then terminate. Therefore, most of these extension activities are not sustainable on a long-term basis, because most NGOs just move on to another project (i.e. with a different focus and/or in different districts) (Swanson et al., 2011).

There are two basic types of international NGOs active in agriculture in Rwanda. These are the multi-sector, mega-INGOs such as CARE, AFRICARE, World Vision International (WVI) and Catholic Relief Services (CRS) and the more Agriculture focused NGOs like Land-O'Lakes, Technoserve and Heifer Project International. Amongst the Mega INGOs, agriculture tends to not be a priority sector and is often included in an integrated livelihood or food security program that also includes health, water & sanitation, microfinance and education. However, they are only sustainable as long as there is international donor funding.

7. Present Capacity Building Programmes and Potential Areas

The recent restructuring that produced the Rwanda Agricultural Board (RAB) and the National Agricultural Export Board (NAEB) out of previously separate agencies within MINAGRI was a positive step in the right direction in terms of linking Extension and Research closer together. And, the related move of redeploying RAB subject matter specialists (SMSs) to the four new zonal offices, where they can be closer to the farmers and front-line extension workers they will work with and serve, is a positive development that needs to be built upon as RAB moves forward.

7.1 Pre-Service Capacity Building

The need in the Rwanda's field level is for general agriculture extension workers who have both technical and process skill training. As of now, universities only offer training in specialized agricultural fields like: crop production; horticulture; agro-forestry; animal production; veterinary medicine; soil science; soil and water management; irrigation and drainage management; agricultural mechanization; agricultural economics, and ; agribusiness. Therefore, there is practically no training in extension methods and management skills. Therefore, graduates with any of the above qualification are recruited as agronomists at districts (degree) and sector (diploma) levels. In addition, there was no evidence of demand-driven extension skills being taught in the current pre-service training programs.

7.2 In-service Capacity Building

There is no systematic training for district and sector agronomists to enable them provide advisory services across the board. It appears that in-service capacity building was curtailed by the placing of district and sector agronomists under MINALOC (Hakizimana 2007) and cell agronomists are almost barefoot extension workers.

7.3 Enhancing Extension Capacity Building

There is practically no training in extension methods despite the fact that NAES (2009) definition of extension recognizes the need for extension professionals with knowledge and skills in communication, adult education and facilitation methods. Appropriate faculty be strengthened to provide leadership in developing more effective extension training skills and knowledge (Swanson et al., 2011).

7.4 Extension Management Training

Extension management, including matrix management, is a technique of managing an organization through a series of dual reporting. It should be noted that the move of district agricultural staff to MINALOC in Rwanda has led to an absence of functional relationship between

MINAGRI and decentralized agriculture extension services – especially at district level and below (NAES, 2009). Training in matrix management for senior staff in MINAGRI and MINALOC could restore some functional relationship between the extension field staff and the MINAGRI. Hakizimana (2007) stressed the need for the MINAGRI to establish working relationship with local government authorities to ensure access to information to the farmers and also advise these farmers on the applied technologies. Therefore, there is a need to build capacities of relevant management staff within MINAGRI and the MINALOC in matrix management (Swanson et al., 2011).

7.5 Improving the Capacity of Key University Faculty

Agricultural training given at the Rwandan universities (ISAE, INATEC, NUR, and Umutara) is weak due to (a) critical shortage of qualified faculty, especially extension training faculty - on average, the universities have only a third of the critical faculty that they require, and (b) lack of equipment and facilities for practical training (Swanson et al., 2011). Also, the lack of M.Sc. training in the country (apart from Soil Science and Environmental Management) acts as a disincentive for B.Sc. holders in the extension system, like district-level agronomists. They do not see career advancement as a prospect for themselves. Therefore, there is a need for capacity development of appropriate faculty to provide quality training and to provide M.Sc. level training in order to address the current staff shortages and the need to improve career prospects for those already in the service (Swanson et al., 2011).

8. Training Priorities of the Country in Agriculture and Allied Sectors

The demand analysis on agriculture and allied sectors presented in the preceding sections disclose that knowledge and skills about high-value crops, as well as small-scale agro-processing and value addition is critical, given the Rwandan government's plan for modernization, value chain development and market orientation. Also current training at Rwandan universities and colleges primarily focuses on crop and/or livestock production practices. Therefore, field extension workers do not have the needed skills and knowledge about providing advice beyond the basic production practices (NAEP, 2009; Swanson et al., 2011).

Therefore based on demand analysis, following training programs are recommended.

8.1 Subject Matter Specific Training Priorities

1. Crop products processing (small scale processing, threshing, storage, transportation, grading, packaging, safety, quality assurance).

2. Animal products processing (small scale processing, storage, transportation, grading, packaging, safety, quality assurance).
3. Fish products processing (small scale processing, storage, transportation, grading, packaging, safety, quality assurance).
4. Safe application of modern biotechnology tools in agriculture and allied sectors.
5. Farm Mechanization for Small Farmers
6. Green House Technology
7. Bee Keeping: Production processing and marketing
8. Post-Harvest Technology and Management
9. Modern Dairy Technology and Management
10. Modern Poultry Technology and Management
11. Management of Soil Testing Laboratories
12. Food Processing Technologies and Management
13. Advancement in Fisheries Technologies
14. Mushroom Production and Marketing.
15. Climate resilient agriculture and allied sectors.

8.2 Extension Specific Training Priorities

1. Agricultural value chains / integration / contract farming to involve private players in EAS and inputs delivery.
2. Marketing and market analysis (analysis of comparative advantages, organizing markets, negotiations, linkages, price factors, transportation).
3. Small agri-business management (financial management, value chain analysis, principles of value chain, cost of producing commodities and consumer products in value chains).
4. Agri-entrepreneurship development.
5. Extension methods including participatory extension methods and approaches
6. Extension program planning, execution, monitoring and evaluation.
7. Extension management including matrix management.
8. Training methods and audio visual techniques.
9. Group dynamics and problem solving, farmers institutional / cooperative development / farmers interests groups development and management of agriculture cooperatives

10. Information and communication technology (ICT) management and its application in agricultural extension
11. Gender and youth in agriculture.
12. Extension research and action research projects
13. Research priority setting
14. Agriculture extension management, including matrix management.
15. Public Private Partnership in Agricultural Extension Management.
16. FFS approach beyond IPM.
17. Pluralistic EAS delivery.

8.3 Number of Extension Functionaries to be trained in Priority Areas.

It is suggested to train about 20 extension functionaries from each of the agriculture and allied sectors following Training of Trainers (ToT) approach. So that they in turn impart training back home at Rwanda to the extension functionaries.

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