

**Final Report**  
Study on Marketing, Post Harvest, and Trade  
Opportunities for Fruit and Vegetables in Rwanda

***Submitted by:***  
***J. E. Austin Associates, Inc.***

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Study on Marketing, Post Harvest, and Trade Opportunities for Fruit and Vegetables in  
Rwanda

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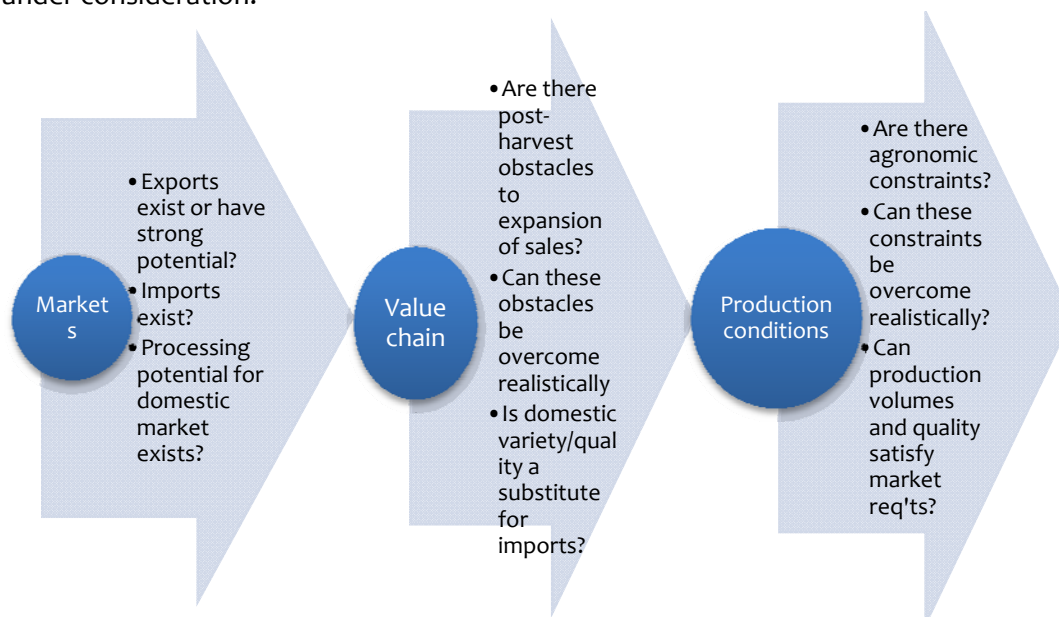
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## EXECUTIVE SUMMARY

The principal objective of this study was to identify appropriate crops for planting in the areas developed under the Land Husbandry, Water Harvesting and Hillside Irrigation (LWH) project. In addition, critical factors and constraints for success in growing, managing in the post-harvest stage and marketing those crops were identified so that activities designed to overcome the constraints can be included in the implementation plan for the LWH project.

The study was limited to tea, coffee and horticultural crops (fruits and vegetables) as these are the highest value crops that would repay the investment on irrigation development and watershed conservation. The initial list of crops recommended in the LWH project design (plantain, mango, pineapple, avocado, coffee and tea), together with other potential crops were reviewed, using a value chain analysis, to come up with a prioritized list of crops for inclusion in the LWH project.

Quantitative as well as qualitative data were combined in the form of a series of filters that a crop must pass through before it can be recommended for inclusion in the LWH project, including considerations and criteria such as the comparative advantages under Rwanda's climatic conditions, geographical location, producer knowledge, the potential for import substitution as well as export markets, costs of production, risks of pests and diseases, links in the value chain which could constrain market potential, and requirements to achieve product quality (e.g. via intensive farmer training). Since value chains begin with the market or demand, three filters (shown below) were applied in a sequential manner to each crop under consideration:



Analysis of the domestic demand for fruits and vegetables was somewhat constrained by lack of disaggregated data (with almost all products being lumped together into either “fruits” or “vegetables”), however, a look at behavioral parameters for demand confirmed

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that the domestic market for fruit and vegetables will continue to respond strongly to national economic growth. While domestic demand for horticultural products will grow, it will be important to avoid over-supplying the market at any point in time, and outlets such as processing, regional and international exports should be taken into consideration.

Crosscutting issues for the crops under consideration were examined; with respect to regional trade and prices, some crops were found to have greater potential on both domestic and regional markets than others. The issue of quality, with the exception of tea, was found to be a major constraint for the potential of Rwanda's high value crops to meet market requirements (domestic, regional and international). An examination of the country's processing industry confirmed that its capacity is significantly underutilized, but there is scope for boosting supplies of raw materials with respect to a number of high value crops. The existing infrastructure (cold storage facilities, transportation and farm investments) was examined to determine which interventions are needed and where in the short as well as long term to alleviate constraints posed to horticulture crops as well as the tea and coffee subsectors. The need for an expansion of the varieties of horticultural crops cultivated in Rwanda, together with provision of more intensive, well trained extension services, was identified as areas which should be given high priority by the government as well as private investors and NGOs. Examination of alliances in value chains led to the general conclusion is that every effort should be made to coordinate planting programs in the watersheds with commercially solid buyers, whether they are wholesalers for supermarkets, processors or exporters.

Applying the above series of filters to each crop, along with cross cutting issues, the study came up with recommendations for crops which should be included in the LWH project. It should be noted, however, that many of the recommendations have to be qualified. Some crops can be recommended only for certain areas of the country; others can be recommended only if certain cultural practices are followed at the field level; others can be recommended only up to a certain volume owing to market restrictions, or only when there are commitments from processors or exporters to buy them; and so forth. Accordingly, it can be misleading to simply say a crop is or is not recommended. With these caveats in mind, the first table presents a summary of the recommendations by crop according to the scale of their planting, with detailed explanations given in the main report as to a crop is placed in one category rather than another. "Large scale" means 1,000 hectares or more and "small scale" means probably no more than 100 hectares, in some cases less. "Moderate" is between those two magnitudes. The second table presents the irrigation recommendations for the selected crops so that the LWH project can best allocate the irrigated areas according to each crop's requirements.

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**Recommended Crops for Watersheds according to Scale of Planting**

Recommended				Not recommended
Large scale	Moderate scale	Small scale	For trials	
Tea Cooking banana Hass avocado	Apple banana Passion fruit Tree tomato French beans Pineapple Carrots Tomatoes Irish Potato Leeks	Habanero/Scotch Bonnet chili Organic Bird's eye chili (dried) Coffee Strawberry (local variety) Gooseberries Mango Onions Cabbage	Macadamia Strawberry (imp. variety) Sugar snap peas Mange tout peas Baby carrots Cherry tomato Other vegetables (See text)	Plantain Citrus Papaya

**Irrigation Requirements for Recommended Crops**

<p><b>Irrigation recommended for:</b></p> <ul style="list-style-type: none"> <li>• Passion fruit</li> <li>• Tea (mountain/hill, and perhaps only in dry season/periods of drought)</li> <li>• French beans and all other vegetables destined for export markets (cherry tomato, mange tout and sugar snap peas, baby carrot, Habanero/Scotch Bonnet chili pepper)</li> <li>• Tomato</li> <li>• Imported/improved varieties of strawberry</li> <li>• Organic Birds Eye Chili</li> <li>• Gooseberry (destined for export markets only)</li> <li>• Cooking banana (during dry season)</li> <li>• Apple banana destined for exports (organic, organic dried) – but must be applied judiciously as <i>Fusarium</i> development is favored by wet soils</li> <li>• Hass avocado (during establishment period only, ca. 1 – 2 years)</li> <li>• Macadamia (during establishment period only, ca. 1 – 2 years)</li> </ul>
<p><b>Irrigation not needed for:</b></p> <ul style="list-style-type: none"> <li>• Pineapple</li> <li>• Coffee</li> <li>• Irish potato, leeks, carrots, cabbages, onions grown during the rainy season and in areas not prone to drought, e.g., western and northwestern watersheds</li> </ul>
<p><b>Irrigation not essential but would be beneficial for:</b></p> <ul style="list-style-type: none"> <li>• Tree tomato (certified organic/GlobalGAP destined for export markets)</li> <li>• Local strawberry varieties</li> <li>• Vegetables (carrots, cabbage, onions, leeks, Irish potato) grown for local/regional markets in drought prone areas or during the dry season</li> <li>• Mango, except for improved (grafted) varieties and during establishment phase mainly</li> <li>• Valley/swamp tea during dry season</li> </ul>

In conclusion, both Rwanda's natural environment and demand conditions are conducive to substantial increases in the acreage and volumes harvested of a number of crops, primarily fruits and vegetables, tea and Irish potatoes, and coffee as well in a longer-term perspective. Additionally, Rwanda has a regional comparative advantage in several crops and therefore there are possibilities for regional exports and import substitution and the option of extra-regional exports is a very real one for a number of production lines.

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As the study highlights, however, a number of investments and complementary programs will be needed in order to ensure that the newly planted crops represent profitable and sustainable options for Rwandan farmers. These are summarized as follows:

- Quality is the single most pervasive concern for development of the recommended crops. This embraces production methods including approaches to disease control, post-harvest handling procedures, the use of cold chain facilities, product and process certifications, and even the type of packaging. To improve quality as well as yields at the farm level a complementary program of intensive, hands-on technical assistance will be needed for several years.
- Critical infrastructure needs include coolers and dryers at the field level, cold chain facilities, greenhouses or tunnels, and improved rural access roads. In addition, it is vital to improve the management of the cold store at the international airport by putting its management in private hands.
- Financial and technical assistance for obtaining organic and other certifications will be needed for groups of small farmers.
- In many cases, financial and technical assistance will be needed for market exploration including sample shipments.
- In general, alliances between buyers (or processors) and producers need to be strengthened and made into multi-faceted relationships. Positive examples are found in the operating modes of East African Growers, SORWATHÉ and Inyange Dairy, but the approaches of these enterprises need to be spread more widely. The BTC CTB sponsored initiative to organize and sustain an umbrella organization comprised of producers, transporters, marketers and other actors in the horticulture value chain should be encouraged and supported. Market linkages are very important for small farmers.
- A continuous program of trials of new products and new varieties should be made into an integral part of the LWH projects, and those trials should be carried out in a participatory manner with farmers. There are a number of products that could become significant lines of export for Rwanda, but trials are needed to determine their feasibility in Rwandan conditions and the best ways of managing those products.

The keys to success for Rwandan agriculture will include promoting crops that have a comparative advantage in the country, producing high quality products, and becoming known as a reliable, steady supplier of those products. Modern agriculture, especially for high value crops, is a knowledge-intensive business, and Rwandan farmers will need links not only with markets but also with the requisite kinds of private technical information and expertise on a continuing basis. The LWH projects and related activities in Program 1 of the PSTA provide opportunities to make that kind of expertise available to farmers.

## **ACKNOWLEDGEMENTS**

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## LIST OF ACRONYMS AND ABBREVIATIONS

ADAR	Assistance for the Development of Agribusiness in Rwanda
BEC	Birdseye Chilies
BNR	<i>Banque Nationale du Rwanda</i> (National Bank of Rwanda)
CIALCA	Consortium for Improving Agriculture-based Livelihoods in Central Africa
CTC	Cut Tear and Curl (system of production of standard made tea)
DRC	Democratic Republic of Congo
EAC	East African Community
EAG	East African Growers (private company based in Kenya)
EICV2	<i>Enquête Intégrale sure les Conditions de Vie des Ménages II</i> (Integrated Living Conditions Survey II)
FPEAK	Fresh Produce Exporters Association of Kenya
IFPRI	International Food Policy Research Institute
IITA	International Institute of Tropical Agriculture
ISAR	<i>Institut des Sciences Agronomiques du Rwanda</i> (Rwanda Agricultural Research Institute)
ISO	International Organization for Standardization
LWH	Land Husbandry, Water Harvesting and Hillside Irrigation
MINAGRI	Ministry of Agriculture and Livestock (Republic of Rwanda)
MINICOFIN	Ministry of Finance and Economic Planning (Republic of Rwanda)
MINICOM	Ministry of Commerce (Republic of Rwanda)
MOU	Memorandum of Understanding
OCIR-Café	<i>Office des Cultures Industrielles au Rwanda – Café</i> (Rwanda national coffee board)
OCIR-The	<i>Office des Cultures Industrielles au Rwanda – The</i> (Rwanda national tea board)
OTF	On The Frontier group
PSTA	<i>Plan Stratégique pour la Transformation de l’Agriculture</i> (Strategic Plan for the Transformation of Agriculture)
RHESI	Rwanda Horticulture Export Standards Initiative
RHODA	Rwanda Horticulture Development Agency
RWF	Rwandan Franc
USAID	United States Agency for International Development
USD	United States Dollar

## Objectives and Context

The principal objective of this study is, on the basis of agronomic suitability and market analysis; identify appropriate crops for planting in the areas developed under the Land Husbandry, Water Harvesting and Hillside Irrigation (LWH) project. In addition, critical factors and constraints for success in growing, managing in the post-harvest stage and marketing those crops should be identified so that activities designed to overcome the constraints can be included in the implementation plan for the LWH project. A value chain approach has been taken for each crop.

The study is limited to horticulture crops and tea and coffee, for the reason that these are generally the highest value crops and hence would repay the substantial investment required for irrigation development on hillsides and watershed conservation. Feasibility studies have been carried out for the LWH project in each of the areas in which it will be implemented. They emphasize engineering design considerations and also recommend 2-3 crops per watershed, but the recommendations lack thorough market analyses. The terms of reference for this study indicated that the crops to be reviewed could include plantain, mango, pineapple, avocado and coffee. While some of these crops should be included in the watershed developments, market and agronomic research carried under this activity suggests that not all of them may be among the most appropriate, and that others may have higher priority.

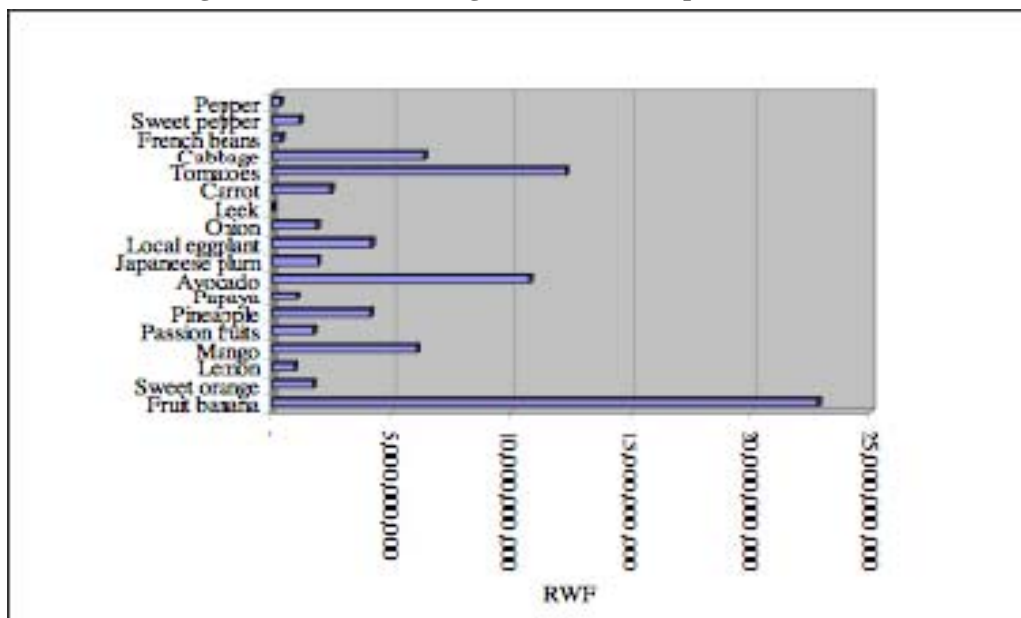
## High Value Crops in Rwanda

This section of the report will contain an overview of the horticulture sector and tea and coffee in current conditions in Rwanda, covering areas planted, production and prices obtained by farmers. As well as producing high-quality tea and specialty coffees, Rwanda produces a wide variety of fruit and vegetable crops, for both the domestic market and export markets. Although trade in fruits and vegetables is not as well documented as for grains, legumes and root crops, and production estimates are not available for the more minor but numerous fruits and vegetables, these crops represent a very important part of the sector. Also, they are quite labor-intensive to produce and these crops along with tea and coffee generate well over half of the employment in the sector.

On a per hectare basis horticulture crops give high returns to farmers. RHODA estimates that 1 million persons are involved in horticulture, either in production or the value chain. For the farmers who grow horticultural crops, on average they gain 45 percent of their income from those crops while dedicating only 12 percent of their land area to them.

Figure 1 below shows the relative importance of the leading horticulture crops. The annexes to the report contain a number of tables with information on production, value and trade of these products and others.

Figure 1: Value of Leading Horticulture Crops Produced in Rwanda



Source: S. Masimbe, F. Gahizi, B. Musana and J. Sangano (G&N Consultants, Ltd.), A Survey Report on the Status of Horticulture in Rwanda, prepared for the Rwanda Horticulture Development Agency (RHODA), October 2008.

## Key Considerations and Criteria

The key considerations and criteria for selecting crops for the newly developed watershed areas include the following:

- Crops in which Rwanda has a **comparative advantage** in terms of climate, soils, producer knowledge, nearness to regional markets and other factors.
- Potential for competitive **import substitution**, which would imply that additional production would not affect prices received by producers.
- Existence of **export markets** in which Rwandan products can be or are competitive.
- Factors that may influence the **cost of production** to Rwanda's disadvantage, e.g., cost of importing packing materials.
- Agronomic considerations, particularly the incidence of **plant diseases and pests** and the crops' degree of resistance to them.
- **Links in the value chain** that may constrain the possibilities for increasing exports, e.g., the way in which the cold store at the airport is managed. Here emphasis has been placed on identifying needed actions and investments in the post-harvest stage.

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- Requirements for ensuring the needed levels of **product quality**, such as intensive, **hands-on training of farmers**.

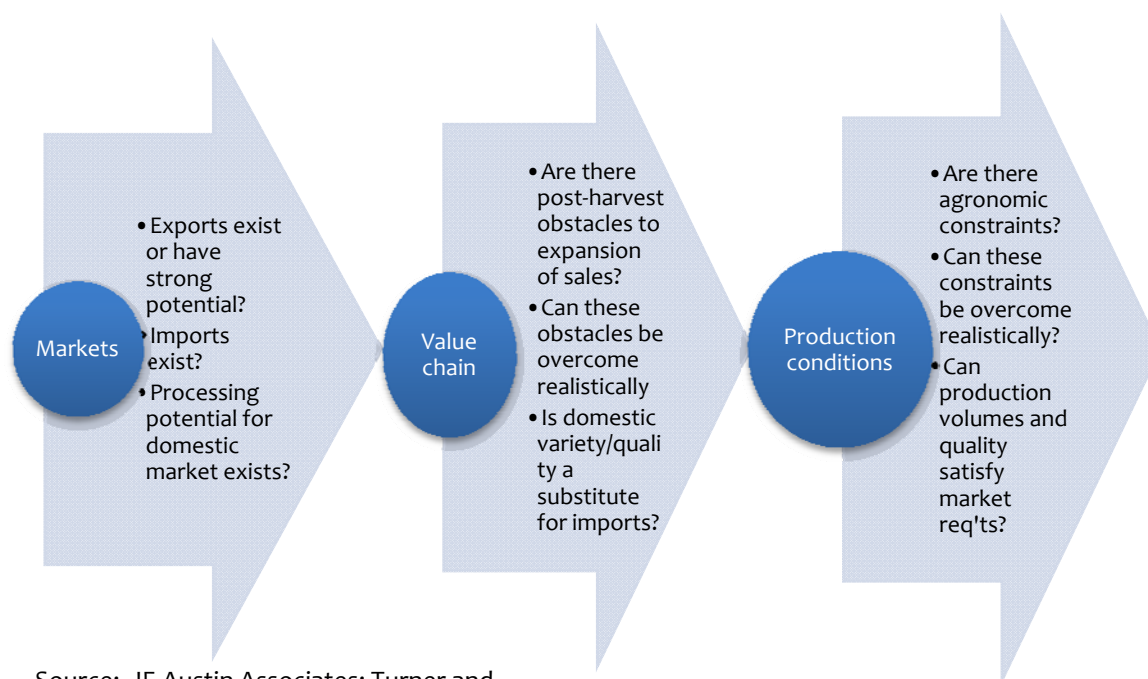
### Methodology

The methodology for the study is based on both quantitative and qualitative approaches. The study team encountered useful data on variables such as production, trade and prices, but there are severe limitations on data availability and quality for these products. In general, the standard agricultural data sets are compiled for what are regarded as “principal” crops (and principal livestock products) but in those compilations, fruits and vegetables are always treated in aggregate form although they are an important part of the sector. Nevertheless, some more disaggregated information has been found in specialized studies and this report makes extensive use of it.

The qualitative data come from detailed interviews with sector experts and persons involved in processing and trade of fruits and vegetables. These interviews have proven invaluable because they fill gaps in the quantitative information and in addition, they provide dimensions to the analysis that would not be available in quantifiable form.

The two tracks of the study, quantitative and qualitative, are combined in the form of a series of filters that a crop must pass through before it is recommended for inclusion in the LWH project. They include the considerations and criteria mentioned above. Those filters and the sequence in which they are applied are the heart of the methodology of this study and they are summarized in the graph in Figure 2. Because agricultural development must be market-driven, the filters begin at the market end of the value chain and terminate with production considerations.

**Figure 2: Sequence of Filters Applied for Selecting Products**



Source: JE Austin Associates; Turner and

## Demand for Fruits and Vegetables

According to the most recent survey of living standards (EICV2), vegetables, bananas and other fruits account for about 17 percent of food expenditures for the average household, and 10 percent of total expenditures.<sup>1</sup> In rural areas, these products represent a much greater share of the average household food budget, about 35 percent. The difference is mainly attributable to the fact that urban consumers spend proportionately more on processed food, meat products and rice.

As income levels rise, consumers tend to decrease the share of their household budget that is devoted to food. At the same time, they increase their consumption of some classes of food items relative to others. This is true in Rwanda and everywhere else. Although cross-sectional survey data are not strictly applicable to changes experienced over time, information from the EICV surveys show how food consumption patterns change as households move up to higher income strata. The products for which they tend to decrease their consumption shares by the greatest amounts include maize, sorghum, cassava and other root crops, pulses, potatoes and sweet potatoes. The items that increase in relative terms include rice, vegetables, fruit, vegetable oils, meat products and processed foods. Table 1 presents estimates of income elasticities of demand that support these trends.

**Table 1: Income Elasticities of Demand from the Living Standards Surveys**

	2001-2002 Survey			2005-2006 Survey		
	Rural	Urban	National	Rural	Urban	National
Maize	0.4	0.4	0.4	0.7	1.2	0.8
Rice	4.1	0.9	2.6	2.9	1.2	2.1
Sorghum	0.5	0.6	0.6	0.5	1.0	0.6
Wheat	4.7	1.1	2.6	0.6	1.0	0.7
Cassava	0.5	0.5	0.5	0.3	0.4	0.4
Potatoes	0.7	0.6	0.8	0.6	0.8	0.7
Sweet potatoes	0.1	-0.3	0.2	0.2	1.0	0.3
Other roots	0.3	0.5	0.4	0.3	1.0	0.4
Pulses	0.3	0.4	0.4	0.3	0.9	0.4
Bananas	1.0	1.1	1.1	0.7	1.4	0.9
Vegetables	0.7	0.7	0.8	1.1	1.0	1.1
Fruits	0.6	0.8	0.6	1.3	1.1	1.3
Oil crops	1.7	0.9	1.6	1.2	1.0	1.2
Other crops	3.4	0.9	2.3	3.1	1.1	2.1
Livestock	3.0	1.1	2.2	3.0	1.4	2.3
Processed food	1.1	1.1	1.2	1.3	1.2	1.3
Nonfood	1.5	1.1	1.2	1.3	0.9	1.1

These parameters confirm that growth of domestic demand for fruits and vegetables will continue to be robust for the foreseeable future. When the parameters are calculated for individual income strata, additional insights become available. While the overall income elasticity of demand for rice, for example, is high, it is much lower for upper income groups. In the latest EICV survey, in highest of five income strata in urban areas, this parameter has a calculated value of 0.9, vs. 5.8 for the lowest of the five urban income strata. In rural areas, the difference was even more striking in the case of rice: 1.5 for the highest stratum vs. 9.6 in rural areas. This suggests that, for example,

<sup>1</sup> These and other data on demand parameters are taken from an ongoing model-based analysis of the role of agriculture in Rwandan development by Xinshen Diao of the International Food Policy Research Institute (IFPRI).

expenditures on rice consumption will respond less than proportionately to additional income perceived by the highest urban income group, and much more than proportionately for the lowest group. Hence, future growth in rice consumption will be supported mainly by income increases for households that are in the lower income strata.

For vegetables and fruit, the picture is quite different. To illustrate, in EICV2 in urban areas, the income elasticity of demand for vegetables is a uniform 0.9 across all five-income strata. I.e., an extra 10 percent of spending power results in an extra 9 percent of expenditures on vegetables at all income levels. For fruit other than bananas, the urban income elasticities vary from 1.4 for the lowest income group to 0.9 for the highest: a difference but much less marked than the one for rice. And for bananas the respective elasticities are 2.1 for the lowest urban stratum and 1.1 for the highest, again a smaller variation than in the case of rice.

Thus, a more disaggregated look at behavioral parameters for demand confirms that the domestic market for fruit and vegetables will continue to respond strongly to national economic growth.

Unfortunately, the survey data do not disaggregate consumption of fruits and vegetables by individual products. Time series data on prices are not available for the calculation of price elasticities of demand but international experience shows that the price elasticity of demand for individual horticulture products is almost invariably greater than one in absolute value (less than -1.0). Therefore a basic criterion for selection of crops for the LWH areas is that they can either: 1) be exported, 2) substitute for imports, or 3) fill unused processing capacity on the domestic market. (For the aggregate of fruits and vegetables the price elasticity of demand is typically in the range -0.6 to -0.9, but since households may substitute among fruits and among vegetables in response to price variations, the individual products are more price sensitive.)

Therefore, while domestic demand for horticultural products will grow, it will be important to avoid over-supplying the market at any point in time. The consequence could be a significant drop in the domestic price. This points to the importance of three outlets for mentioned above for additional production. Regarding the third outlet of the processing section, the income elasticities of demand for processed foods are high so that market can be expected to expand more rapidly than the market for fresh products.

In regard to exports, it should be noted that, worldwide, exports of fruits and vegetables from developing countries have grown rapidly in recent decades. In the 1990s, European imports of fruits and vegetables surpassed all other types of agricultural imports.

## **Crosscutting Issues for High-Value Crops**

This section introduces a number of issues that are relevant to most crops in the sub-sector. More detailed comments on some of these issues are found in the crop-by-crop discussions below and also in the concluding section.

## Regional trade and prices

Coffee and tea of course have large export markets throughout the world. For fruits and vegetables, the regional export markets have special importance. A considerable amount of informal trade in fruits and vegetables takes place across the borders in the region, often by boat, bicycle and foot as well as by vehicle. The documentation is imprecise but it is clear that these products move fairly freely between Rwanda on the one hand and Uganda, Congo, Burundi and Tanzania on the other, and to and from Kenya as well. As would be expected when trade is fluid, prices tend to converge except for transport margins. However, in some cases substantial price differentials have remained, beyond what is explained by transportation costs, and those differences tend to indicate where comparative advantage lies.

Table 2 compares supermarket prices in Nairobi, Kampala and Kigali for selected fruits and vegetables, as of May 2009. Those products for which Rwanda's price is higher than in both the other countries are highlighted in yellow. Products for which Rwanda has a favorable growing environment stand out for having relatively low prices

	Rwanda	Kenya	Uganda
Avocados	0.26	0.20	0.26
Carrots	0.86	1.05	1.29
Cabbages	0.43	0.43	0.40
Mangos, ngowe	4.32	1.32	2.00
Green bell pepper (capsicum)	0.60	1.72	1.49
Red onions	1.04	1.45	1.47
Pineapple	0.86	0.92	0.70
Tomatoes	2.42	1.19	1.29
Courgettes	1.04	1.32	1.29
Eggplant	1.29	1.19	1.29
Lemon, local	1.24	0.92	0.60
Lettuce	0.43	0.60	1.00
Passion fruit, black <sup>1</sup>	1.29	1.72	1.82
Banana, long (gros michel variety)	1.21	0.92	0.84
Broccoli	0.78	2.52	3.09
Pumpkin, yellow	2.59	0.79	0.51

<sup>1</sup>Purple passion fruit.

Sources: Sundip Jethalal, General Mgr., Fresh An Juici, Nairobi; Nakumatt Supermarket management, Kigali.

in the country; examples include carrots, passion fruit, red onions, green bell peppers and broccoli. Rwanda appears to be a net exporter to the region of some of these crops<sup>2</sup> (see Annex Tables).

On the other hand, by regional standards, prices in Rwanda appear to be fairly high for some other fruits and vegetables, at least in the dry season, and Rwanda imports more of these products than it exports. The high prices tend to indicate less favorable growing conditions than in neighboring countries and hence lack of comparative advantage. Examples include lemons, pumpkins and mangoes. These are generalizations and it is important to be aware that there are significant geographical variations within Rwanda. For example, carrots enjoy a suitable climate in the north but not in the east or south central parts of the country. Mangoes, though generally a more appropriate crop for the hotter climates of Uganda, Congo, Burundi and Tanzania, can be grown reasonably well in Bugesera and to some extent in other areas, though perhaps not with the same quality and yields as in other countries of the region.

Another indicator that suggests some prices tend to be relatively high is the fact that many processing facilities have considerable unused capacity; in some cases they have difficulties in

<sup>2</sup> There is a lack of reliable regional trade data that this report was not able to overcome.

competing with prices paid by local traders for supplies and still operate profitably, and this has been stated explicitly by some facility managers.

Reasons for the high prices include, in addition to the climate, the scarcity of land and the low yields. Rwanda can most readily export, and compete with imports, in those crops for which the climate helps confer special quality characteristics. If yields can be raised and quality improved with irrigation and intensive technical assistance, then the range of competitive crops can be widened, as this report indicates.

The data in Table 2 do not imply that Rwanda cannot grow more of the higher-priced items, but it does suggest that crop husbandry and yields should be improved in those items and that more production would be expected to lead to lower prices. An example could be tomatoes for processing.

If additional production from the LWH areas were to result in somewhat reduced prices for a few crops, producers would be compensated by the higher yields that would result from irrigation and improved cultivation practices, and more income and employment would be generated in the processing industries, which then would source more of their raw materials domestically. Thus for tomatoes, for example, a slight decline in prices may benefit the sector as well as improve the welfare of consumers. However, in other cases where the market is saturated and there is little or no room for import substitution, then additional production would significantly affect prices and the products would not pass the first filter and therefore would not be recommended for the LWH projects.

### **The quality issue**

For the domestic market, a pervasive issue is lack of sufficient quality in fresh fruits and vegetables. A major buyer for supermarkets stated he would purchase more products locally, rather than importing them, if quality were higher. This and other evidence indicate the need for intensive, on-farm technical assistance in association with all the watershed development projects. It has been estimated that only 10 percent of horticulture producers have received technical assistance, and even that has not always been of a continuing, hands-on variety. As commented below for the case of apple bananas, even when farmers are aware that better cultivation practices will improve yields and reduce disease incidence, they do not always apply the lessons. The technical assistance should cover harvest and post-harvest operations also. The post-harvest phase is equally important for ensuring product quality. An obvious example of the need for improvements in this area is the practice of tossing tomatoes together into rustic baskets that were designed to carry harvested potatoes. The result is an inferior product when it reaches the buyer's hands, no matter how good it was when picked from the plants.

Quality is even more important for export markets. In addition to meeting consumer expectations regarding taste, appearance, consistency, packaging and other characteristics, obtaining certifications is increasingly important for penetrating export markets. These can include organic, Fair Trade and other types of certification at the farm level and HACCP and ISO, as well as organic and Fair Trade, certifications at the processing level. Rwanda has advantages for organic production because of the traditionally low use of agro-chemical inputs. However, this advantage has not always been well exploited. For example, a sample of tree tomato fruit shipped to the UK was rejected because of pesticide residues in excess of the limits.

In view of the potential role that organic products can play in Rwandan agricultural exports, the government may wish to support this aspect of the LWH project by reaching a consensus with farmers and decreeing organic production zones, in which only organic production will be carried out. Clearly, a farmer cannot earn organic certification if the neighboring farm is using pesticides that could be carried across farm boundaries by the wind, so usually zones that embrace multiple farms have to go the organic route together. Perhaps more importantly, certifying all the farmers in a given geographical area vastly increases the ease of setting up an Internal Control System that is by far the most cost effective way of certifying numerous small-scale farmers.

The quality issue is more important and more widespread in fruits, vegetables, tea and coffee than in, say, grains and legumes. Hence, quality has to be given priority in the development of this sub-sector. In overall terms, Rwanda's climate and small farm size (high ratio of labor to land) lends in a comparative advantage in fruits, vegetables, tea and coffee, which are high-value products, vis-à-vis many other kinds of crops, but to fully realize this comparative advantage it will be necessary to pay close attention to quality concerns.

### **An overview of the processing industry**

The tea and coffee processing industries are well developed in Rwanda, although improvements are being implemented as a result of the privatization program for tea factories and the technical assistance provided to coffee washing stations. New types of processed products have been developed for tea recently: bagged tea and "orthodox" (rolled leaf) tea. The tea factories and their production levels are listed in section 7. For fruits and vegetables, there are seven major processors in the country along with more than a dozen smaller processors (see Table 12 in Annex Tables A). They produce a range of fruit pulp, juices, concentrates, sauces, fruit wines, and jams, some of which are exported, but as yet they do not have capabilities for producing the dried and fresh frozen fruits that have good markets in developed countries. A couple of entrepreneurs have carried out experiments for drying fruit but so far, they can be only considered to be artisanal.

The above-mentioned underutilization of capacity in fruit and vegetable processing is a general characteristic of the sector. Overall, the unused capacity in processing facilities was 85 percent last year, a very high figure. The price question for one or two products explains part of this phenomenon. A bigger reason undoubtedly was the high tax of 39 percent levied on sugar inputs to fruit processing. This tax rate was revised downward to 5 percent in the past few months (while remaining at 39 percent for retail consumers of sugar) and it is expected that processing activity will pick up as a consequence. In some cases, another factor causing the underutilization of capacity is the lack of a solid, long-term relationship between producers and processors –the lack of a true alliance in the value chain. This issue is central to the development of high-value crops and is discussed more fully below. In other instances, capacity simply may have been constructed without a proper assessment of the market.

### **Infrastructure: transportation, cold stores and farm investments**

In the international context, Rwanda is at a disadvantage with respect to transportation since it is landlocked with only three direct flights a week to Europe. However, the considerable volumes of cross-border trade attest to the viability of trade routes with neighboring countries, informal as they may be in some instances. There also have been regular air shipments of fresh produce to Brussels. New transport options are being opened to the Middle East by air and plans are underway for a railway to Isaka in Tanzania, both of which will facilitate export possibilities. In addition, the planned new airport for Rwanda, located outside of Kigali, may open up other direct routes to Europe and

other international destinations. Clearly, air shipment is viable only for the highest value products in relation to their weight, but there are products in Rwanda that meet that requirement. It should be noted, however, that the PSTA suggests that the Government of Rwanda provide guarantees of air cargo space for a transitional period of a few years, to induce cargo airlines to provide additional service to Europe and the Middle East. The Government appears to be seriously considering this option, which could significantly alleviate the current constraints posed by limited and expensive air freight.

Transportation within the country is a frequent bottleneck in spite of the small geographical extent of Rwanda. Farm access roads are generally unpaved and their condition extracts a heavy toll from vehicles and the perishable produce carried. They often can be impassable during parts of the rainy seasons. Therefore improving rural roads, preferably laying down tarmac, is a priority for principal producing areas for perishable products.

The cold chain for Rwandan agriculture is still underdeveloped. The only existing infrastructure is a new cold store facility which has been constructed at the international airport, but shippers have commented that its management is not adequate for the needs of the sector. Too often, a consignment of fruit or vegetables has to sit in the sun for an hour or more until the facility is opened, and when there is an electricity outage the backup generator is not always turned on promptly. Adequate separation is not always provided between organic products and non-organic products, which can jeopardize organic certifications. In brief, the management of this cold store needs to be put in private hands rather than being left with a parastatal.

Some producing areas have sufficiently rapid road access to the airport that local cold store facilities are not needed. However, the study team estimates that, depending on the crops grown and the markets for which they are destined<sup>3</sup>, up to six cold stores should be planned for major fruit and vegetable zones, starting with Kirehe, Bugesera, plus a selected site in the western or northwestern part of the country for crops like tree tomato, carrots and gooseberries. The other three facilities should be planned in relation to the accessibility of the watersheds being developed. In all cases, the management of these cold stores should be private.

In cases in which the selected crops lend themselves to fairly frequent and continuous harvesting throughout the year, an economical alternative to cold stores is refrigerated trucks of a size appropriate to the volumes harvested. The decision between fixed facilities and trucks cannot be made in the abstract but rather depends on the harvesting program that emerges from the planting decisions.

It will be equally important to facilitate, through the LWH project, the installation of evaporative coolers and other simple cooling devices at the farm level, or for groups of farms. It is important to take the “field heat” out of perishable products before they begin their journey up the value chain.

Apart from irrigation itself, which is a powerful instrument for increasing farm productivity, another important piece of infrastructure is greenhouses or, in their simplest form, plastic tunnels. Their use

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<sup>3</sup> For example, sites where significant production of perishable vegetables and fruits for export (e.g. French beans, edible podded peas, passion fruit) is undertaken would definitely benefit from having cold storage facilities in place, whereas others producing less perishable products and/or for local markets (local eggplant, chillis, Irish potato) may not need such cold storage facilities.

for vegetable cultivation is growing rapidly throughout the developing world. It is recommended that small numbers of them be installed on an experimental basis in watersheds with crops for which they can be useful, and that farmers work with technical experts in a participatory manner to develop the best cultivation practices for tunnels. When their successful use has been demonstrated, they can be installed on more farms. The potential for productivity gains is very high with these structures; the yield increases often can be from two- to five-fold or more.

Finally, as stressed throughout this report, harvest and post-harvest **techniques** can be equally or more important than **infrastructure**. For that reason, the report concludes that intensive and sustained technical assistance to farmers will be one of the keys to success of the watershed projects.

### Varietal development and extension

Rwandan horticultural exports are still in their infancy as compared to those in Kenya and Uganda and even in Ethiopia. Therefore, it is likely that new export products will emerge in coming years, and some of those with very small export volumes at present may grow to become more significant foreign exchange earners. One of the recommendations of this study is that in each project watershed a small area be set aside, typically no more than one to three hectares, for varietal trials of newer products and for testing different techniques of production. The farmers whose land is being used for this purpose should be compensated by the project for the foregone annual crop harvests and local farmers, particularly women farmers, should be invited to participate in the trials.

These trials should be part of a program of participatory research and extension, in which technical experts work side-by-side with farmers, playing the role of facilitators of the learning process as much as sources of technical information. For small farmers, participatory approaches have proven to be more effective ways to raise the technical level of farming and farm productivity, as compared to the traditional top-down approach of “delivering” technical messages to farmers. Agriculture is increasingly a knowledge-intensive sector with numerous areas of specialization, especially in regard to cultivating high-value products. Facilitating processes of acquiring knowledge, and incorporating farmer know-how into those processes, empowers farmers to continue learning on their own and gives them a sense of ownership over the varieties and practices that are developed.

Sometimes the solutions are relatively simple and involve harvest and post-harvest practices. Many farmers in Rwanda have a tendency to harvest crops too early because they are eager for cash, which sometimes reduces the weight of the harvest and in all cases reduces quality and shelf life. This problem is common in passion fruit, sweet peppers, potatoes, tree tomatoes and coffee, for example. If the project can develop support mechanisms to overcome this problem, it will already be contributing significantly to raising farm incomes.

The participatory approach can be fruitfully extended to the selection of crops to be grown in the newly irrigated watershed areas. Although this report suggests a number of alternative crops that can be considered, and some of the relevant factors for their success, farmers should be consulted closely in the decisions about which crops to grow in a given locality. Among other advantages, this will help ensure a greater commitment to proper cultivation of those crops on the part of the farmers. It is suggested that for each watershed a list of at six to eight crops be presented to the farmers, with the aim of their selecting four to five of them. A reasonable degree of crop diversity is important for soil management and controlling crop diseases. It also helps reduce market risk, which always is present although this report has tried to identify crops with the most promising markets.

### Alliances in value chains

Another general conclusion is that every effort should be made to coordinate planting programs in the watersheds with commercially solid buyers, whether they be wholesalers for supermarkets, processors or exporters. They are stakeholders in agriculture also. As illustrated below for the cases of French beans and avocados, buyers can indicate the number of hectares that should be planted for their needs and may be willing to enter into contracts with producers in some instances. Buyers can also indicate their standards for product quality and packing (inappropriate harvesting and post harvest handling practices, including packaging, are a widespread deficiency in horticulture production in Rwanda at the present). In some cases, it can be important for buyers to make partial payment for the crop even before the harvest, to dissuade farmers from harvesting prematurely out of need for cash, which is a common practice that affects the quality of the product. This kind of relationship within the value chain will be very important for the economic success of the watershed development projects.

The project should attempt to facilitate the formation of alliances between groups of farmers and the next links in the value chain. As long as the relationship between the seller (the farmer) and the buyer is based only on negotiating a spot price it will be a fragile relationship because price is the one issue for which the two sides are adversaries. A more enduring relationship also includes provision of inputs and technical assistance that demonstrably raises farmers' incomes, and collaboration in solving quality issues. Farm gate prices also can be negotiated for the longer term, including clauses for changing them in light of changes in export prices. An umbrella organization of coffee cooperatives in Rwanda already has applied this formula successfully, providing a second payment to coffee farmers whose amount depends on the price received at the time of export of the processed coffee. If similar approaches could be applied to producers and buyers of horticultural produce, it could reduce the risk of "side selling" on the part of the producers who have been provided inputs on credit by the buyer, and the relationship between the two parties less prone to breaking down.

SORWATHE's approach is an example of fostering long-term, multi-dimensional relationships with growers, giving a deeper stake in cooperating with the processor. The factory has set up healthcare clinics in growing areas and has donated sewing machines (among other things) to local women to give them another source of income. The project can take a leadership role in encouraging longer-term relationships between farmers and buyers of their crops. This approach of contract farming has many variants but all the successful ones go beyond the question of negotiating a spot price for sales. In the fruit sector, Inyange Dairy stands out for having made strides in forging closer and more enduring relations with producers of passion fruit.

As another example of a functioning alliance between growers and exports, for its French beans operation East African Growers provides all inputs on a credit basis (paid back by farmers when the crop is harvested) and has an excellent repayment rate; not only do farmers benefit from having the assistance in procurement of these otherwise hard to access inputs, but EAG has an MOU with RHODA whereby all contracts with farmers are witnessed and monitored by RHODA. This reinforces the farmers' respect for the contract with EAG.

The role of the private sector in developing Rwanda's horticulture industry is crucial; much of the success of Kenya's horticulture industry can be attributed to the efforts of the Fresh Produce Exporters' Association of Kenya (FPEAK) and its members. We therefore advocate a larger role for

the private sector through strengthened alliances in the value chain, and for putting management of the airport cold store in private hands, as occurred through FPEAK intervention in Kenya.

Given the importance of intensive technical assistance for these crops, coordination will be equally important with RHODA (and its equivalent in the new MINAGRI structure) and the soon-to-be-organized umbrella organization for the producers, transporters, marketers and all other players in the horticulture value chain, which is being developed by the Belgian BTC CTB Horticulture Support program housed in RHODA. RHODA, with the assistance of BTC CTB, has developed a sound strategy for the sector and it provides much of the basis for continuing actions to support growers and processors. The driving force should be the needs of the private sector, with RHODA/MINAGRI responding by providing appropriate support when and as needed.

In light of the economic importance of the horticulture sector in Rwanda, it also merits consideration for a higher priority in government and international support programs. By contrast, the coffee sector has received several times the project funding that horticulture has. Coffee is indeed a valuable sector for the economy but employs about half the people that horticulture does.<sup>4</sup>

Relatively recent initiatives, both by MINAGRI and non-governmental actors, have been launched to support the horticulture sector. At the time of writing<sup>5</sup>, the Rwanda Horticulture Export Standards Initiative (RHESI) program, housed in MINAGRI, provides training in sanitary and phytosanitary issues so that exported produce meets international requirements and is IPPC compliant. They are encountering difficulties in achieving their goal of complete provision of all necessary SPS services. The Rwanda Bureau of Standards (RBS) believes all certification activities belong as part of their mandate; the head of RHESI expressed concern that RBS lacks the agricultural expertise needed to fulfill this role, and that it should be clearly under the jurisdiction of the MINAGRI RHESI program. For organic certification, the office set up in Rwanda by the NGO Ceres in 2007 is providing technical assistance to Rwandan producers seeking organic certification, primarily on the side of inspection and certification. They will most likely work in conjunction with the Ugandan based Agro Eco Louis Bolk Institute, which has worked in Rwanda on an intermittent basis for many years, and which is called upon throughout the East African region for provision of assistance in training in organic production, and linking producers to markets.

Other conclusions of a crosscutting nature are discussed in the following sections.

## Application of the Filters to Crops

Rwanda possesses many viable options for cropping in the new watershed developments. If tree species suitable for wood, forage and soil retention were included in the analysis, the range of options would be even greater. Professionals in the value chain are convinced of the potential for growing more fruit and vegetables. One chairman of a large food enterprise in Kenya stated he believes the regional potential for fresh produce (onions, cabbage, tomatoes, etc.) is enormous and

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<sup>4</sup> It is estimated that about 500,000 farmers are at least partially engaged in coffee production. See: Republic of Rwanda, Ministry of Agriculture and Livestock Resources, *Strategic Plan for the Transformation of Agriculture in Rwanda – Phase II*, Kigali, December 2008, p. 30.

<sup>5</sup> Since the time of writing, two other government agencies may be assuming responsibility for dealing with issues of SPS. The Rwanda Agriculture Development Board will be responsible for National Plant Protection Services while the National Export Board will handle private standards.

would be interesting once transport routes are improved. While not being a guarantee that a regional market exists, this is an indication that the region may well serve as a viable outlet for increased volumes of Rwandan fruits and vegetables.

Nevertheless, in light of the evidence summarized by crop in this section, which facilitates the application of the three filters, many of the recommendations have to be qualified. Some crops can be recommended only for certain areas of the country; others can be recommended only if certain cultural practices are followed at the field level; others can be recommended only up to a certain volume owing to market restrictions, or only when there are commitments from processors or exporters to buy them; and so forth.

Accordingly, it can be misleading to simply say a crop is or is not recommended. The text of this section tries to provide insights into the conditions that would make each crop a viable option or, in a few cases, rule it out entirely. With these caveats in mind, Table 3a presents a summary of the recommendations by crop according to the scale of their planting, and the reader is urged to consult the remainder of this section to see why a crop is placed in one category rather than another. “Large scale” means 1,000 hectares or more and “small scale” means probably no more than 100 hectares, in some cases less. “Moderate” is between those two magnitudes. Table 3b presents the irrigation recommendations for the selected crops. The discussion after Tables 3a and 3b is organized by crop.

**Table 3: Recommended Crops for Watersheds according to Scale of Planting**

Recommended				Not recommended
Large scale	Moderate scale	Small scale	For trials	
Tea	Apple banana	Habanero/Scotch	Macadamia	Plantain Citrus Papaya
Cooking banana	Passion fruit	Bonnet chili <sup>6</sup>	Strawberry	
Hass avocado	Tree tomato	Organic Bird’s	(imp. variety)	
	French beans	eye chili (dried)	Sugar snap peas	
	Pineapple	Coffee	Mange tout	
	Carrots	Strawberry	Baby carrots	
	Tomatoes	(local variety)	Cherry tomato	
	Leeks	Gooseberries	Other vegetables	
	Irish potatoes	Mango	(see text)	
		Onions	Essential oils (esp.	
		Cabbage	geranium)	

<sup>6</sup> Known more in Rwanda as *piment lantern*.

**Table 4: Irrigation Requirements for Recommended Crops**

<p><b>Irrigation recommended for:</b></p> <ul style="list-style-type: none"> <li>• Passion fruit*</li> <li>• Tea (mountain/hill, and perhaps only in dry season/periods of drought)</li> <li>• French beans and all other vegetables destined for export markets (cherry tomato*, mange tout and sugar snap peas, baby carrot, Habanero/Scotch Bonnet)</li> <li>• Tomato*</li> <li>• Imported/improved varieties of strawberry</li> <li>• Organic Birds Eye Chili*</li> <li>• Gooseberry* (destined for export markets only)</li> <li>• Cooking banana (during dry season)</li> <li>• Apple banana destined for exports (organic, organic dried) – but must be applied judiciously as <i>Fusarium</i> development is favored by wet soils</li> <li>• Hass avocado (during establishment period only, ca. 1 – 2 years)</li> <li>• Macadamia (during establishment period only, ca. 1 – 2 years)</li> </ul>
<p><b>Irrigation not needed for:</b></p> <ul style="list-style-type: none"> <li>• Pineapple</li> <li>• Coffee</li> <li>• Irish potato, leeks, carrots, cabbages, onions grown during the rainy season and in areas not prone to drought, e.g., western and northwestern watersheds</li> </ul>
<p><b>Irrigation not essential but would be beneficial for:</b></p> <ul style="list-style-type: none"> <li>• Tree tomato* (certified organic/GlobalGAP destined for export markets)</li> <li>• Local strawberry varieties</li> <li>• Vegetables (carrots, cabbage, onions, leeks, Irish potato) grown for local/regional markets in drought prone areas or during the dry season</li> <li>• Mango, except for improved (grafted) varieties and during establishment phase mainly</li> <li>• Valley/swamp tea during dry season</li> </ul>

\* Overhead (sprinkler) irrigation is NOT advisable as it favors development of diseases in these crops; drip or other soil irrigation systems should be used.

## Tea

Tea is a product in which Rwanda has a comparative advantage because of altitude and climate. It is Rwandan agriculture’s largest export earner after coffee, and its prices have held up better during the recent world economic downturn than those of specialty coffee. From 2004 to 2008, tea exports earned an average of about US\$ 37 million each year. Between 1998 and 2007, export prices received fluctuated between US\$1.49 and US\$1.97 per kg. and then reached US\$2.27 in 2008. Total production of made tea was about 20,000 tons in each of 2007 and 2008. The Government has been privatizing tea factories and the output of private factories has increased substantially this decade. According to statistics of OCIR-Thé, the industry is a source of income for more than 60,000 households and employs more than 35,000 workers.

Rwanda produces some of the highest-quality tea in the world and its markets continue to expand. Its tea is consistently ranked first in the Mombasa auctions. Currently 97 percent of domestic production is exported and tea factories have said they can process and export all the additional tea that can be produced in the country without affecting prices received because Rwanda’s share of the world market is very small. Traditionally Rwanda exported all its tea via the Mombasa auctions, where it consistently obtained the highest prices, but some factories are increasingly making direct exports to foreign buyers in the United Kingdom, Pakistan, Afghanistan, Yemen, Egypt and South

Africa. Efforts are also underway to open up new markets in the United States and Middle East as well as the Far East.

Tea is cultivated mainly on large plantations, which are owned and managed by about a dozen tea “factories” that process green leaves into made tea. The factories supplement the tea cultivated on their own land with relatively small amounts of tea produced by tea cooperatives and private growers, although out growers provide about 75 percent of the leaves in the case of SORWATHE. For Rwanda Mountain Tea they provide about 30 percent of the leaves. The majority of tea growers (farmers) are organized in *Coopthes* and *Villageois*<sup>7</sup>, brought together by a single umbrella federation (Ferwacothé) at the national level. Ferwacothé comprises 15 cooperatives of various sizes with about 30,797 members, and 14 of these cooperatives are actively engaged in tea production. The federation controls a total of 2,972 hectares of tea in marshlands (valleys) and 4,845 of tea hectares on hillsides. Tea plantations are concentrated in the southern, western and northern provinces of the country, and the largest concentration is around the Nyungwe forest ring.

Table 5 shows the production trends in made tea, disaggregated by factory, illustrating the growing importance of the private factories (highlighted in red in the table).

**Figure 3: Tea Growing Locations in Rwanda**



Source: OCIR-Thé (the figure was not available on a map of current Districts).

<sup>7</sup> *Coopthes* constitute growers on scattered small plots, while *villageois* are relatively bigger units and possess land that was formerly owned by government.

The marketing chain for tea is necessarily short, reflecting the extreme perishability of fresh tea leaves, which must be delivered to the factory within hours of being picked so as not to suffer a significant loss in quality. Tea leaves usually are picked early in the early morning, when temperatures are cool, and they are transported in baskets to local collection points that are typically within 3 km (Rwanda Mountain Tea) or 5 km of all growers (OCIR-Thé). After being weighed, they are loaded onto trucks for delivery to the factory. Following a brief withering period, they are chopped, fermented, dried down, cut, and packaged for export. Tea exported from Rwanda is mostly transported by road to Mombasa for the auctions. Private factories however increasingly sell tea directly to niche buyers and blenders in, for example, the USA.<sup>8</sup>

The LWH project presents a special opportunity for tea production because almost all of it is presently cultivated without irrigation. In the dry season the tea plants become stressed hence, yields are affected, and some of them die. It is estimated that on average irrigating tea would raise its yields by 50 percent over the dry season. It would be particularly important to expand the production of hill tea (mountain tea), which is the higher-quality variant, and the LWH project is well suited to that purpose. Tea plantation cover, besides its ability to thrive on acid and aluminum toxic soil, can also act as an effective rehabilitation crop for exhausted land. It therefore, remains an option for effective soil conservation measures, especially on small farms. Tea has high value added per hectare, and its productivity can be improved by mulching as well as irrigation.

**Table 5: Production of Made Tea by Factory and Total Exports**  
(Production in '000 kg. exports in '000 US\$)

Factory	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Mulindi	1,914.8	1,971.3	3,173.4	2,290.8	2,121.7	1,990.8	2,618.8	2,607.2	3,261.4	3,212.6
Shagasha	1,485.6	1,593.1	1,928.6	1,749.5	1,887.3	1,628.3	2,009.7	2,015.2	1,996.0	1,453.6
Gisakura	1,468.5	1,582.5	1,796.7	1,648.5	1,750.2	1,574.5	1,910.2	1,794.6	2,080.9	2,312.2
Mata & Nshili	1,173.5	1,008.8	1,298.7	1,242.1	1,401.8	1,171.2	1,144.3	1,461.0	2,105.1	1,794.4
Kitabi	1,194.8	1,216.7	1,611.1	1,255.4	1,435.7	1,244.4	945.5	1,397.8	1,760.1	1,876.5
Rubaya	1,169.5	1,110.5	1,292.2	1,033.7	1,368.7	1,337.6	1,615.2	908.5	0.0	0.0
Nyabihu	460.7	642.4	760.4	611.0	609.3	681.5	708.0	526.8	0.0	0.0
Pfunda	1,040.4	948.1	1,203.0	1,022.8	1,179.8	919.9	0.0	0.0	0.0	0.0
Gisovu	800.2	786.3	1,195.3	1,090.2	1,205.0	1,107.9	1,240.3	1,219.1	1,716.5	1,791.0
<b>Total OCIR-Thé</b>	10,708.	10,859.	14,259.	11,943.	12,959.	11,656.1	12,192.0	11,930.3	12,920.1	12,440.3
<b>SORWATHE</b>	2,261.8	3,531.8	3,549.4	3,004.1	2,524.0	2,342.6	3,020.6	2,799.2	3,661.6	2,923.3
<b>Pfunda T.C.</b>	0.0	0.0	0.0	0.0	0.0	179.7	1,245.0	1,330.0	1,441.1	1,787.0
<b>Rubaya priv.</b>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	577.0	1,209.7	1,195.5
<b>Nyabihu priv.</b>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	339.4	1,241.5	1,203.3
<b>Nshili</b>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	415.8
<b>Total Private</b>	2,261.8	3,531.8	3,549.4	3,004.1	2,524.0	2,522.3	4,265.6	5,045.6	7,553.8	7,524.9
<b>Total National</b>	12,969.	14,391.	17,808.	14,948.	15,483.	14,178.4	16,457.6	16,975.9	20,473.9	19,965.2
<b>Exports</b>	19,254	22,648	25,743	22,176	22,602	53,515	20,342	32,613	34,777	44,950

Source: OCIR-Thé.

Another factor that makes tea especially suitable for watershed development is that approximately one-third of the area of a tea estate has to be planted in fuelwood for the factory. There are stages

<sup>8</sup> Republic of Rwanda, Ministry of Agriculture and Livestock, December 2008.

in tea processing that cannot be economically powered by electricity. Tree planting is part of the design of the LWH project but the area devoted to trees, and the species, should be coordinated with the tea factories when tea is part of the new watershed-planting program.

The elements of the value chain for tea (the second filter of this study) are in place, with the restriction that tea factories prefer not to purchase tea produced farther away than a given radius (typically 15 km) from the factory because of the above-mentioned freshness constraints. Hence planting decisions should be coordinated with the nearest factories if they fall within that radius. In regard to location of production, it should be noted that the higher-quality mountain tea is not defined by altitude but rather by slope and other conditions that make it grow more slowly, and so it can be produced in many locations in Rwanda. However, its volumes of production are lower than those of valley tea. For example, at present only 6 percent of SORWATHE's tea production is mountain tea. Nationally, not more than 10 percent is classified mountain tea. Cultivation of tea is an intensive occupation and higher yields result from the timing and manner of pruning, and the frequency and method of fertilizer application. For organic teas rock phosphate and manure are applied instead of chemical fertilizers.

The main value added options for tea are organic and fair-trade certification. The recent implementation of price differentiation and improvement in tea transport has helped increase the quality of Rwandan tea quality. The private tea factory SORWATHE has gained Fair Trade certification for its products and now has ISO 22000 certification as well. Rwanda Mountain Tea, which owns two factories (Rubaya and Nyabihu), is in the process of obtaining ISO 22000 certification.

OCIR-Thé recently developed a bagged tea product, and the facility for producing it is running over capacity. The target markets for this product are East Africa and Dubai. This value added operation appears quite profitable. A rough indicator of the profitability is that a kilo of the better grade of bulk CTC<sup>9</sup> tea may fetch a price up to US\$3-4, whereas the bagged tea earns US\$14/kg., and the cost of bagging is estimated at US\$7-8 per kg. However, there may be limitations to the amount of tea that can be exported in bagged form because it would begin to compete with the products of the very agents who buy bulk made tea from Rwanda, and the market links to them could be prejudiced by such competition. In another value added initiative, SORWATHÉ has recently invested in a facility for producing "orthodox" tea (rolled leaf tea), for which only some of the harvested leaves are suitable. This is a high value product but not all the tea factories can afford to make that kind of investment.

Subject to the 15-km. radius limitation and coordination with tea factories, there is no upper bound on the amount of new tea that can be planted in the watersheds under out grower schemes. The project will need to support farmers for the first 3 to 4 years or more after planting tea, until harvests become significant. After that, it is a very worthwhile crop for smallholders. Tea also is an excellent crop for soil conservation. Care needs to be taken about mining activities in tea growing areas because they diminish water quality. In some areas such as Karenda, the mining is informal but no less injurious to tea production. Another area in which the government can assist tea production is paving rural roads. Rwanda Mountain Tea, for example, has a problem with 8 km of poor dirt road

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<sup>9</sup> CTC refers to the process of producing made tea: cut, tear and curl.

linking the Rubaya factory up with main roads. They have discussed this issue with the government and are hopeful the road will be paved.

## Coffee

The *Strategic Plan for the Transformation of Agriculture* comments that:

*Coffee production in Rwanda declined in the latter half of the 1990s up to 2001, as a consequence of fluctuating and declining world prices, and by the end of that period many producers were uprooting their coffee trees. The amount of effort devoted to tending coffee trees declined, and crop losses were high from the fungal infection leaf rust and from the insect antestia. Concomitantly the quality declined. In 1987, 40% of Rwandan coffee was classified as “standard grade” and 60% as the lower “ordinary grade.” By 2000, 90% of production was of ordinary grade.*

*During this period of unfavourable price trends for commercial-grade coffee, prices for higher grades (fine and specialty) increasingly diverged from the former. In light of this development in world markets, in 2002 Rwanda began to put into action a strategy for enhancing the quality of its production so that it could be sold at the higher prices. One of the keys to producing the higher grades is fully washing the coffee.<sup>10</sup>*

In 2002 there were only 2 washing stations in the country, and a goal was established to increase their number drastically, a goal that has been largely achieved. Now there are 130 coffee washing stations in the country. In addition, an intensive effort was implemented to develop specialty coffees in Rwanda and market them effectively.

The PSTA II also observes that international campaigns were launched for Rwandan coffee, millions of new trees were planted to replace aging existing trees, and programs were undertaken to increase the use of fertilizers, fungicides and insecticides on coffee.

Progress in transforming the coffee sector has been significant but somewhat slower than expected (Table 6). At the beginning of this decade a specialty coffee sector did not exist in Rwanda, so the development of this high value product is a signal achievement in itself. Between 2003 and the first half of 2008 farmer prices for cherry coffee more than doubled, from RWF 60/kg. to RWF 130/kg. and higher in some instances. Then the world economic crisis caused a fall in prices of the better grades of coffee in late 2008, farmer prices for fully washed coffee in Rwanda declined, and some washing stations closed as a consequence. Nevertheless, prices of fully washed and specialty coffees are expected to recover within a year or two at most, and the long-term prospects of the sector in Rwanda are bright.

The *Rwanda National Coffee Strategy* for the period 2009-2012 recognizes that although progress has been made, it has been difficult on some fronts, particularly in improving the quality of the cherries harvested and turning around the coffee washing stations.<sup>11</sup> Although export prices increased for Rwandan coffee up to mid-2008, and Rwanda gained international recognition for the quality of its coffee world prices for specialty coffees actually increased more rapidly. The pricing structure within

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<sup>10</sup> Government of Rwanda, Ministry of Agriculture and Animal Resources, *Strategic Plan for the Transformation of Agriculture, Phase II*, Kigali, December 2008, pp. 30-31.

<sup>11</sup> Ministry of Agriculture and Animal Resources and Ministry of Commerce and Industry, *Rwanda National Coffee Strategy 2009-2012*, Kigali, July 2008.

Rwanda has been such that most farmers have had no incentives to produce better quality harvests, and input use and husbandry of coffee trees remained below what was hoped to be achieved.

**Table 6: Production and Exports of Coffee, 1995-2008**

	1995	1996	1997	1998
Production MT	21,829	15,239	15,000	14,268
Exports USD	38.2	43.0	45.3	25.9

1999	2000	2001	2002	2003
18,250	16,098	18,267	19,796	14,175
30.6	22.4	19.4	19.2	15.0

2004	2005	2006	2007	2008
28,858	18,609	26,291	14,826	21,000
32.3	39.0	54.0	30.2	46.7

Consequently, for the medium term the coffee strategy concentrates on five pillars related to improving quality at the same time that rehabilitation of the plantations can produce higher yields and hence greater volumes of coffee:

- Improve monitoring and distribution of seedlings, fertilizers and pesticides.
- Encourage a voluntary turnaround program for the coffee washing stations.
- Improve international sales and distribution mechanisms.
- Implement a census and GIS study of all coffee producing regions.
- Implement value addition activities including toll roasting abroad and partnerships with international retailers.<sup>12</sup>

PSTA II also notes the importance of shading coffee trees as part of the improvements in farm-level management, implementing a program to control coffee leaf rust, and carrying out systematic fertilizer trials to have greater certainty regarding what kinds of input mixes would be productive. It also comments that it is necessary to:

*Identify the cause of the "potato taste" that is a major constraint to getting greater prices for Rwandan coffees and **implement as an urgent matter a programme to correct it.** Nearly 25% of all Rwandan specialty coffees in 2008 revealed significant levels of this defect. This percentage is higher than last year. The specialty coffee industry realizes now that Rwandan coffees will continue to be infected with this defect unless remedial actions are taken. Already, Rwanda is losing income due to this problem. Several higher end buyers have even refused to continue to buy Rwandan coffee because of it. Larger roasters selling to big buyers like Wal-Mart and Target are also refusing to buy Rwandan coffee in large quantities for these markets due to the defect.<sup>13</sup>*

<sup>12</sup> Rwanda National Coffee Strategy, 2009-2012, pp. 33-37.

<sup>13</sup> Strategic Plan for the Transformation of Agriculture, Phase II, Kigali, December 2008, p 81.

The source of this odd taste in the coffee has been identified as the *antestia* bug, and it is urgent to find ways to control it because it is jeopardizing Rwanda's gains in international marketing of high quality coffee.

In conclusion, in spite of the short-term downturn in world prices for specialty coffees, it is clear that coffee can continue to be a substantial income earner for Rwandan farmers over the medium and longer term and increase its export earnings. Therefore it passes the first filter of markets. However, it is also clear that efforts to improve quality, at the levels of production, harvesting, and processing, have to take precedence over acreage expansion at the present time. In effect, there are important issues in regard to the second and third filters, the value chain and on-farm management of the crop. It is recommended that caution be exercised in planting new coffee trees in the watershed development projects until more progress is made in resolving these issues. Specifically in the case of coffee this study recommends:

- a) If coffee plantations exist in some of the watershed development areas, work with the national coffee program to help intensify the efforts to improve cultivation and harvesting practices and post-harvest management for those farmers, and to accelerate the rate of improvement of the washing stations.
- b) Plant new coffee trees only where improved washing stations exist that are willing to process higher volumes of cherries, and implement intensive programs of farmer training for the newly planted areas.

Coffee washing stations are widespread throughout most of the country, except for the far north and northeast. In the project areas it will be important to involve any stations that exist there in decisions concerning coffee plantings, and ascertain whether they would prefer to see the emphasis placed on improving the quality of harvested coffee in their areas. Therefore the amount of coffee planted in the new project areas could turn out to be even less than that indicated in Table 3.

### The banana family

Banana is by far the dominant fruit crop in Rwanda in terms of value of production. Four members of the banana family are consumed or produced in Rwanda: cooking bananas, beer bananas<sup>14</sup>, apple bananas and plantains. Although some commentaries treat plantain and cooking bananas as interchangeable terms, they are genetically different and are prepared differently in households.

Apple bananas<sup>15</sup> are of the highest unit value and are being exported successfully in organic form to Europe. The elements of the value chain are largely in place though one link in particular needs to be improved (the management of the airport cold store). In addition, there is a large export market for organic dried apple bananas. For example, representatives from the Belgian Technical Cooperation and RHODA attended the European trade fair Biofach 2009 and found that one importer was interested in 8 containers of organic dried apple banana per year from Rwanda, a volume which the country is currently in no position to supply. An OTF survey found that dried organic apple bananas and dried organic pineapple were Rwanda's two main opportunities for the dried fruit market.<sup>16</sup>

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<sup>14</sup> Sometimes referred to as wine bananas.

<sup>15</sup> Also known as baby bananas, dessert bananas or sweet bananas.

<sup>16</sup> OTF, Dried Fruit Survey Analysis, February 1 2006.

Given the high ratio of fresh to dry weight of these fruits<sup>17</sup>, along with Rwanda's relatively small size compared to other producers of organic dried tropical fruit, significant increases in areas planted to organic apple banana (and probably pineapple) in Rwanda could easily be absorbed by the international market for these products. The fact that dried produce can be sent via the less expensive surface shipping route adds to the attractiveness of the organic dried fruit sector,

Another factor in favor of apple bananas is that recently market tests have been carried out in Germany for a Rwandan liquor based on these bananas, and the results were very favorable. However, this product is the most vulnerable of the banana family to *Fusarium* wilt disease (*Fusarium oxysporum f.sp. cubense*), and that disease has been debilitating its production. It is present in all producing areas of the country. To date researchers have not developed an effective approach for controlling this disease or moderating its effects. Judicious irrigation and mulching to reduce drought stress on the plants helps defend them against *Fusarium* wilt to a degree, and accordingly IPM techniques have been developed to mitigate somewhat the effects of this fungus on all bananas including apple bananas.

Recent findings of banana researchers include the following:<sup>18</sup>

- Survey results from 5 sites in Rwanda show that 85% of farmers reported drought stress and 74% poor soil fertility as being major constraints to production and researchers estimated drought stress losses to correspond to farmers' perceptions.
- *Fusarium* wilt is a major constraint for apple banana and "exotic" beer banana as well.
- Although yield was positively correlated with amount of mulch applied, very few farmers applied external mulch and even fewer manure.

Provision of irrigation together with improved crop husbandry (proper mat spacing, composting, mulching, applying manure) would have far greater impact than irrigation alone, but evidently, continuous on-farm technical assistance will be necessary to ensure it is practiced. There are examples in Kirehe of properly managed apple bananas in this sense.

Apple bananas definitely have good market prospects, both domestically and externally, and so they must be considered as a major option for selected zones in the watersheds. However, in light of this disease issue apple bananas pass the third filter (production filter) with the caveat that intensive technical assistance must be provided on a continuous basis to growers, and cultivation practices must be monitored for a few years until farmers can clearly see the benefits of better crop husbandry. It is already a tradition to interplant apple bananas with cooking bananas and/or beer bananas, which are more resistant to *Fusarium*, and this tradition should be followed in the newly developed watershed areas.

Regarding the second filter for dried organic apple bananas, the cited OTF survey of dried fruit markets points out that having cold storage facilities is a critical need, along with organic certification and preferably Fair Trade certification. That study also underscores the need for a

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<sup>17</sup> For pineapple, one kg of dried fruit is derived from 14.81 kg fresh, and for banana, the ratio is 1 kg dried: 8.24 kg fresh (N. Monkam, 2004, *Projet Pilote Fruits Seches au Rwanda*, ADAR Project/Chemonics International Inc.)

<sup>18</sup> C. Murekezi and P. J. A. Van Asten, "Farm Banana Constraints in Rwanda: A farmer's perspective," *Banana and plantain in Africa: Harnessing international partnerships to increase research impact*, Conference book of abstracts, 5-9 October 2008.

product testing capability. The conclusion is that it is difficult to break into the markets for dried tropical fruit but that once in, they are lucrative.

Another critical aspect of the value chain for dried sweet bananas (apple bananas) is the packaging. And the packaging method is important: “Fully half (50%) of respondents prefer Nitrogen Flushed packaging, followed by vacuum packed. The Vacuum-packed process removes oxygen from the packs, causing oxidization. The result is bumpy looking packaging, molded to the internal shape. Vacuum packing is relatively expensive. ‘Nitrogen Flushing’ forces inert gas into the bag, which pushes out the oxygen. The equipment required for nitrogen flushing tends to be less expensive than vacuum packed.”<sup>19</sup>

According to that study, the main markets are seen to be Germany, Denmark, Switzerland, the UK and Oman.

With appropriate varietal trials, the FHIA 01 variety of bananas may be planted in place of Rwandan apple bananas if they would be destined for use in the production of banana chips. Tests of consumer preferences in Europe showed that chips produced from the FHIA 01 variety were preferred to all other options, including apple bananas.<sup>20</sup> However, until a processor confirms interest in making chips from this banana for export, and the capacity to do so, this variety would not pass the second (value chain) filter. It appears that for Rwandan consumers the taste of FHIA 01 does not match that of apple bananas.

Rwanda imports plantain, chiefly from the Congo (DRC), and produces a small amount, but in general, climatic conditions in Rwanda will not permit an acceptable import substitute to be grown locally, so it doesn’t pass the production filter. On the other hand, for cooking bananas domestic supply falls considerably short of demand and there are substantial imports that could be replaced. They come mainly from the DRC and secondarily from Uganda. If production were to increase sufficiently it would even be possible to engage in some exports since the prices of cooking bananas are higher in Burundi than in Rwanda, at both farm gate and retail levels. This type of banana is more resistant to *Fusarium* wilt, especially when it is irrigated and farmers practice mulching.

Cooking bananas pass through all the filters and in addition are excellent for soil retention on slopes and terraces. Approximate calculations of the market indicate that about 1,500 additional hectares of cooking bananas could be planted without affecting prices in a downward direction. Over the longer run the consumption budget share devoted to bananas declines as incomes rise (Table 1 above), but banana consumption still will rise in absolute terms for quite a long time, and the current volumes of imports provide ample space for import substitution by additional domestic output. Cooking bananas benefit more from irrigation (suffer more from drought) than apple bananas do. An indication of the importance of cultivating cooking bananas under irrigation is the fact that their price rises much more in the dry season than in neighboring countries, which receive more rainfall throughout the year. Irrigation extends the length of the harvest and thus would give farmers opportunities to sell at prices that are higher than the ones they receive now. (The seasonal

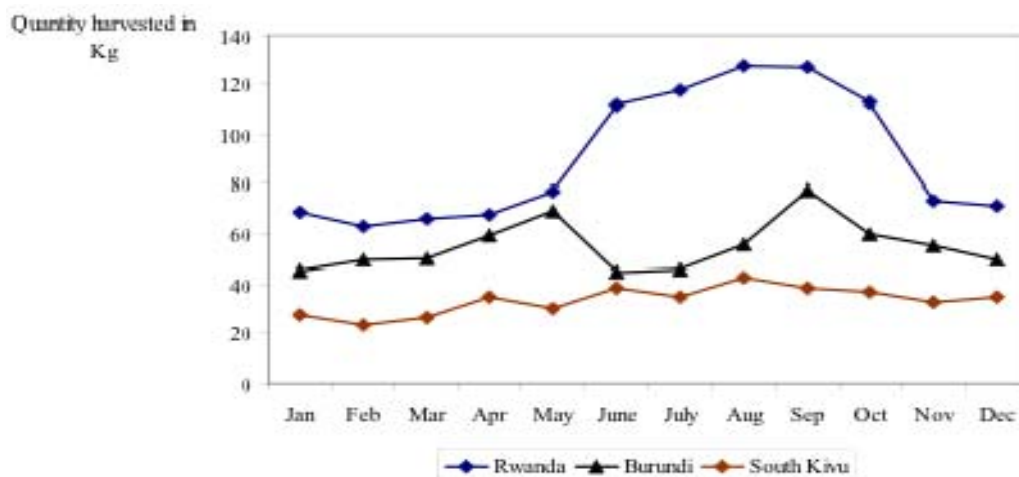
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<sup>19</sup> OTF, Dried Fruit Survey Analysis, February 1 2006.

<sup>20</sup> P. J. A. Van Asten, D. Florent and S. Apio, “Opportunities and constraints for dried dessert bananas export in Uganda,” *Banana and plantain in Africa: Harnessing international partnerships to increase research impact*, Conference book of abstracts, 5-9 October 2008.

shortages are the main reason for imports of this product.) Figure 4 shows the greater seasonality of cooking banana harvests in Rwanda than in neighboring countries.

**Figure 4: Seasonal Price Movements of Cooking Bananas in East Africa**



Source:  
John  
Jagwe,  
Emily  
Ouma,  
Piet  
van  
Asten  
and  
Steffen  
Abele,  
Banana

Marketing in Rwanda, Burundi and South Kivu: CIALCA Project Survey Report, 2008 p. 18.

In addition to monoculture plantings of cooking bananas, small areas in the watersheds could be devoted to evaluating intercrop systems with this kind of banana. Research in Uganda has shown that intercropping with coffee benefits both crops, and similarly intercropping with beans appears to be a productive combination provided the beans are managed in a no-till way. Also, as noted, intercropping can be implemented with apple bananas with irrigation and appropriate cultivation techniques. To illustrate the very substantial gains that may be had from intercropping bananas with coffee, in Arabica coffee growing areas of Uganda, annual returns/ha were USD 3,421, USD 2,092 and USD 1,552 for intercropped banana-coffee, mono-cropped banana and mono-cropped coffee, respectively.<sup>21</sup>

Exporters have also expressed interest in red bananas but the issue that remains to be clarified for this variety is whether there would be a domestic market for the rejects –the fruit that does not meet export quality standards. As of this writing, this issue is being investigated.

Finally, the importance of organic and fair-trade certifications should not be overlooked. The apple bananas that Rwanda is currently exporting are certified as organic, and this has helped them secure a consistent market in Europe.

### Avocado

Rwanda has inherent advantages in the production of avocado. Studies in Cameroon have shown for a range of varieties of avocado that quality characteristics (taste, percentage of oil) improve as altitude in which the crop is grown increases (which lowers temperatures).<sup>22</sup> In addition, the crop's

<sup>21</sup> P. J. A. Van Asten, D. Mukasa and N.O. Uringi, "Farmers earn more money when banana and coffee are intercropped", *Banana and plantain in Africa: Harnessing international partnerships to increase research impact*, Conference book of abstracts, 5-9 October 2008.

<sup>22</sup> Ministère des Affaires Etrangères, France, "Memento de l'agronome," CIRED – GRET, 2002.

water requirements are 1200 – 1600 mm of rainfall per year, well distributed through the seasons, and that characterizes the rainfall in most of Rwanda.

The local variety of avocado in Rwanda is superior in taste and consistency but the international market prefers the Hass variety, which also has good taste and in addition has a tougher rind and therefore is not as perishable and is easier to ship long distances without damaging the fruit. If someone were to make a sample shipment of Rwandan local avocados to Europe by air, carefully packed, and carry out market trials, demand for that avocado might well be created given its special qualities. Currently one Rwanda exporter is shipping to Germany very small quantities of organic apple bananas, passion fruit and both local and Hass avocados (the latter growing near Butare), but it is not yet clear whether a larger export market for local avocados exists. In the meantime, any export of avocado would have to be of the Hass variety.

The domestic market for the local variety appears to be in balance regarding supply and demand. Therefore, plans for expansion of the areas planted in avocado would have to concentrate on Hass avocados. It is a variety from California that derives from a species that originated in Guatemala, and it does best at higher elevations, at altitudes of 900 – 2400 m.a.s.l.<sup>23</sup> Avocado is a crop whose prospects are closely tied to plans for improvements in the transportation network in East Africa. More than one entrepreneur has commented that avocado exports (Hass) would be a viable proposition via the proposed railway to Isaka, Tanzania, and from there by sea to Europe. In fact, there appears to be interest in planting Hass avocados in the next year or two given that the trees would begin to yield when the railway is scheduled for completion, in 2014.

Specifically, the Managing Director of East African Growers, which already has invested in Rwanda vegetables for export, came to Rwanda to explore the possibility of setting up production of Hass avocados (up to a total of 1,000 ha), which they would hope to ship via the new railway link. Trees would come into productivity in 3 – 5 years time. The Managing Director said the company would even be willing to invest in installation of irrigation facilities, provided they were done correctly. He also insisted on improvements to management of the airport cold storage facilities, and improvement in air cargo services. If this project were to go ahead, EAG would set up an avocado conditioning and packing facility in Kigali, similar to one they have in Nairobi, and would provide all the expertise to enable farmers to correctly produce and harvest the crop. The packing and conditioning facility would wax and pack the fruit so that they could be shipped in containers via the railway to Tanzania (estimated transit time of 3 days), and from there uploaded onto ships. Hass plantlets would be provided by EAG, and distributed by MINAGRI to selected growers who are geographically clustered.

Avocado trees could be expected to start yielding about 0.9 tons/ha after three years and 21 tons/ha from year seven onward. As soon steps are taken to resolve the cold storage deficiencies and MINAGRI agrees to collaborate with extension services to farmers, EAG is willing to initiate the project by investing in a nursery for avocado plants.

## Pineapple

Pineapple is a significant horticultural crop in Rwanda, grown mainly in the eastern and southern parts of the country. It is not as vulnerable to infestations as crops such as passion fruit, tree tomato

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<sup>23</sup> R.C. Ploetz, G.A. Zentmyer, W.T. Nishijima, K.G. Rohrbach and H.D. Ohr, eds., *Compendium of Tropical Fruit Diseases*, 1994, published by The American Phytopathological Society.

and apple bananas, so from a viewpoint of the production filter it is a worthwhile crop. On the surface it would appear that there are possibilities for increasing production to substitute for the rather substantial amount of pineapple imports that flow into the country, mainly from Uganda, DR Congo and Burundi. According to the admittedly imprecise cross-border survey, in 2007 Rwanda imported more pineapple (about 43 thousand tons) than it produced (about 31 thousand tons). Some estimates of imports are higher. However, exports of fresh pineapple to other countries of the region would not be viable: “Fresh pineapples are not adapted to export. The transport cost is high . . . On a sub-regional basis the demand for fresh pineapple does not exist. Kenya, Uganda and Tanzania are important production areas and cater to the home market.”<sup>24</sup>

In addition to some import substitution, there is a market for pineapple juice, pulp and jam as well. The Entreprise Urwibutso, among others, produces pineapple juice and Shema Fruits is exporting 100 jerry cans (29 kg/jerry can) of fruit jam by surface to France per week. Pineapple jam, which is perceived by the importer to possess unique taste characteristic, comprises about half these exports, and guava and mixed fruit jam the rest. The above-mentioned study by FACE recommends developing a pineapple concentrate industry aimed at supplying regional markets and the EU and the Middle East. However, it cautions that some of the processing capacity should be used for passion fruit concentrate, which it claims would be much more profitable.

In spite of these opportunities, doubts have been expressed about the extent to which additional pineapple should be promoted, concerning both markets and the value chain, i.e., from the perspectives of the first and second filters of this study. The first doubt arises from the fact that extensive additional areas of pineapple have been planted in the last two years, and it is not yet known how much additional production will be brought onto the market from those areas. The second issue is that farm-to-market transportation of pineapples is still carried out in rudimentary fashion in most cases and, together with the lack of a cold chain, this results in considerable losses of fruit and lowering of its average quality when it reaches markets. At least one person involved in the trade in a managerial capacity said pineapple supplies are insufficient because the production areas are far from Kigali and the fruit arrive in the capital in very poor condition.

Because of the state of rural access roads, in some cases pineapple can be obtained in better condition from Uganda, and also from DR Congo, for parts of the country located closer to those borders. Effectively, transportation conditions have created a market for pineapple that is semi-segmented spatially. In addition, these circumstances create a relatively large amount of fruit suitable only for processing as opposed to consumption in fresh form, so in relation to demand there can be a surplus of pineapple juice and jam on the local market while fresh supplies are in balance with demand.

From a broader international viewpoint, horticulture experts point out that owing to Rwanda’s climate and the particular variety of pineapple that is produced in the country, it is at a comparative disadvantage with respect to major pineapple producers in countries such as Ghana, Ivory Coast, Cameroon, Southeast Asia and even Costa Rica and Panama, where the MD2 variety, which is preferred in industrialized countries, is planted and exported by boats on a considerable scale. In addition to the varietal factor, Rwandan pineapple exports to countries outside the region currently

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<sup>24</sup> Jean Marechal, Jean Ferdinand Schrurs and Alfonse Nkeshimana, Feasibility Study for the Development of the Pineapple Growing Sector in Rwanda (Eastern Province, Districts of Kirehe and Bugesera), Executive Summary, Food and Agriculture Consulting Engineering (FACE), June 4, 2008, p. 5.

have to go by air, and the relatively low value-weight ratio of pineapple (in relation to many other fruits and vegetables) means that the airfreight costs constitute another barrier to being competitive. Finally, it should be noted that because of climate the pineapples from Uganda and Burundi are considered to be of high quality.

Having said this, it remains true that Rwanda exports small quantities of certified organic pineapple by air to Europe, and that it possesses a pineapple processing industry. On the other side of the ledger, this exporter is not planning to increase the volumes of organic pineapple shipped by air. In a longer term perspective, one manager of a major fruit and vegetable operation in the region believes large potential markets exist in the Middle East and recommends looking for gaps in Asian production of tropical fruit including pineapple, as well as markets in the Middle East and EU for certified organic dried tropical fruit.

There may be other sources of export demand. Entrepise Urwibutso has found importers interested in “pineapple concentrate” (which is the syrup with water content further reduced) in Switzerland and Singapore. To produce the concentrate he needs first to invest in new equipment, which he is in the process of doing. The owner of the company said to meet the future demands for pineapple concentrate, the area planted in pineapple would need to increase by 1,700 ha. He would be interested in working with the LWH program to increase his pineapple supplies.

Among agriculturalists there is not a consensus about the supply-demand balance for pineapple but the viewpoint of this study is that currently there is room for additional expansion of pineapple plantings of the existing variety for the domestic fresh market and for processing, particularly if cold stores are built in the producing areas and road transport conditions are improved. Transportation and handling costs would absorb a good part of the price differential with respect to pineapples in Uganda (Table 1), so a modest increase in additional supply to the capital city area should not affect prices appreciably, and the quality differences vis-à-vis fruit from neighboring countries are not very great. It is recommended that any increase in pineapple acreage under the watershed projects be limited to about 500 hectares (which should yield about 8,000 tons of fruit under optimal production conditions and probably less) until the effects on the market of the recent plantings can be properly assessed. If processors begin to produce and export dried organic pineapple or pineapple concentrate, and arrangements for supplying fresh fruit can be made with them as suggested above, then the demand could rise significantly and the additional hectares under pineapple might rise to 1,000 or more. (World markets are saturated by conventional dried pineapple, much from Asian countries such as Thailand and the Philippines, and therefore Rwanda would only find a market for certified organic dried pineapple.)

In brief, the main issues concerning pineapple are in Filter 2, specifically in packaging, transportation and cold storage. On the production side, pineapple is a profitable crop for producers and relatively easy to manage. Table 6 shows that the profit margin for producers is sufficient that modest declines in prices, if they were to occur, could be absorbed. A kilogram of fresh pineapple sells for RWF 100 at the farm level and the cost of production is about RWF 70 per kilogram, assuming yields are relatively low at about 3.6 tons per hectare, which may characterize many farms.

Baby pineapples have been mentioned in some of the literature on Rwandan horticulture but in recent years, this product has been supplanted in international markets by the MD2 variety of pineapple and other full-sized varieties.

**Table 7: Farm Costs and Returns to Pineapple Production (2009, RWF/ha.)**

<b>Revenue</b>	<b>360,000</b>
<b>Costs</b>	
Labor	108,000
Fertilizers	72,000
Herbicides and pesticides	-
Others	72,000
<b>Total costs</b>	<b>252,000</b>
<b>Margin</b>	<b>30%</b>

### Passion fruit

Passion fruit is the fruit of choice for juices in the domestic market, as confirmed by processors such as Inyange Dairy and Urwibutso. Rwandan passion fruit also has a superior flavor that is well received in the European market and the regional market. A manager of Inyange Dairy said expressions of interest for pure (no sugar or added preservatives) pasteurized passion fruit juice had come from Oman and Dar es Salaam, but that unless they can guarantee the consistency of both the quantities and quality they can provide to importers, there is no point in trying to develop an export market. Their factory would have to be certified before attempting to sell on the international markets.

With its new UHT processing facility, Inyange Dairy estimates that from July onward it will need 63 tons of passion fruit daily, an amount the sector will be hard pressed to provide. As another indication of the market's preference for Rwandan passion fruit juice, trucks arrive regularly from Uganda to purchase passion fruit grown in the northern part of Rwanda. Entrepreneurs claim to have found additional markets for Rwandan passion fruit juice in Canada, the United States and elsewhere. In addition to its flavor, passion fruit juice has a longer shelf life than pineapple juice. The above-mentioned FACE study for pineapple strongly recommends developing a passion fruit concentrate industry for export.

Although passion fruit passes the first filter easily, to date the volumes of juice exported to the extra-regional market have been small. The limiting factors are production, which has been devastated in some areas by diseases, and post-harvest handling. The main enemies of the plant are passion fruit woodiness virus (PWV) and the *Septoria* spot fungus. The plant is also vulnerable to the less serious diseases anthracnose (*Colletotrichum gloeosporioides*), brown spot (*Alternaria spp.*) and the cucumber mosaic virus.

These diseases represent very serious threats to the passion fruit sector in Rwanda and because of their greater presence in northern parts of the country it is not recommended that the crop be planted in new watershed developments in those areas. Given the overarching importance of the disease issue for passion fruit, it is worthwhile to review how they affect the plant and what the appropriate responses are, which must be adopted in the LWH projects. Persons in the industry feel these disease issues may not yet received the priority they warrant in MINAGRI. Research by one of the present team members reached the following conclusions regarding PWV:

This disease was first identified in Rulindo in 2002 and has since become widespread in Kigali-Ngali and has been observed from Ruhengeri to Cyangugu. The primary symptom of this deadly viral disease is a thickening and hardening of the fruit's skin and the fruit are smaller in size and juice content is greatly reduced. The foliage is affected and plant growth is stunted. Depending on the age of the plant when it is infected, the onset of the viral infection may mean no marketable fruit is produced. The virus is transmitted by insects and by mechanical means such as cultivation tools. As long as the plant is not stressed it can be infected and show no symptoms, but once the growing conditions become less than optimal owing to drought, insufficient plant nutrition, cool temperatures and other conditions, then the virus manifests its symptoms and there is no remedy save uprooting the plant and burning it or otherwise destroying it completely. It is important to note that PWV has seriously affected passion fruit plantations in Kenya, to the extent that many producers there have abandoned the crop. Researchers around the world have not found a PWV-resistant variety of passion fruit so the only course of action is to prevent it.

Regarding the *Septoria* spot fungal disease, it is found throughout Rwanda's passion fruit growing areas. The pathogen attacks both leaves and the fruit, producing brown spots that remain small (ca. 2 mm) on the leaves and stems but which can coalesce to cover large areas of the fruit. Affected fruit ripen unevenly and sometimes rot entirely, and the juice can become unacceptable for processing. Even a light infection can reduce the value of the crop sharply or render it useless. *Septoria*, like other fungi, is favored by high humidity and therefore occurs when the plant is not properly pruned and trellised. What makes this infection especially troublesome is that it can be transmitted by seeds. Given that the infection begins early in the plant's life through the seeds and spreads quickly throughout nurseries by water-borne dispersal (and failure of most producers to remove infected seeds), use of a fungicide, if a registered one existed for passion fruit in Rwanda, would not be effective. Again, the best approach is prevention: careful selection of the fruit from which seeds are to be extracted and proper inspection and hygiene in nurseries and in the field.

Disease management techniques for passion fruit are centered on the following measures aimed at prevention:

- 1) **Selection of the growing environment to minimize stress.** Passion fruit should be grown at altitudes of 1200 to 1700 meters. Higher elevations up to 1900 meters can be tolerated only if soil fertility is high, drought stress can be avoided and careful crop management is employed. Passion fruit requires well-drained soils and therefore valley bottoms, which are humid most of the time, should be avoided.
- 2) **Seed selection and extraction.** Only seed of known origin should be used. Seeds should be selected from plants that show no symptoms of disease, grow vigorously and produce purple fruit. It is preferable to let the fruit mature fully on the plant before using it for seed. If a producer has no access to passion fruit other than that found in the market then only fruit with absolutely no disease symptoms should be used. Before extracting the seed, the fruit should be dipped in a sodium chloride solution to kill surface pathogens. Technical assistance can guide the farmers in seed selection procedures.
- 3) **Nursery hygiene.** Nurseries should be located far from passion fruit fields and their location should be rotated. Seeds should be planted at least 1 cm apart and seedbeds should be separated by at least 10 cm. Closer spacing favors the propagation of diseases. The nursery should be inspected **daily** and any plants showing signs of disease should be uprooted and destroyed.
- 4) **Hygiene at the field level.** Plant rotation and separation are essential. New plantings should be located at least 50 meters and upwind from existing ones. Once plants cease to be

productive, they should be uprooted and burned. Land on which passion fruit has been grown must be devoted to other crops for at least three years before being returned to passion fruit.

- 5) **Pruning and other practices.** One of the factors that predispose Rwanda's passion fruit to disease is that producers do not practice regular pruning. Without pruning, the plant develops a dense canopy that favors the emergence of fungal infections. It is helpful to keep the soil covered with straw or other organic material, weed regularly (and avoid injuring the plant during weeding), and ensure proper fertilization.

More detailed prescriptions of measures to reduce the incidence of passion fruit diseases can be provided to farmers by technical experts, but these comments are sufficient to show the nature of the requirements for a sustainable passion fruit sector in Rwanda that will capitalize on the country's comparative advantage in this valuable crop.

Inyange Dairy's experiences provide good illustrations of how to develop alliances between growers and the processing industry. The firm, which first provided technical and material aid to selected groups of passion fruit growers, has continued to provide seedlings and technical assistance to growers, but now only in southern regions of Rwanda (Ruzizi, Nyamasheke and Gikongoro) due to the high levels of passion fruit disease in northern Rwanda. The company believes it is important to build up trust amongst the farmers so as to be assured they will sell their product to Inyange. Ugandan traders do represent competition for procurement of passion fruit, but because the Ugandans do not adhere to an agreed upon price, instead dropping their offer as soon as other buyers have left the scene, the Rwandan farmers are beginning to appreciate the loyalty of (as well as technical assistance provided by) the likes of Inyange, and are increasingly willing to sign long term contracts with the company. They negotiate a margin of minimum/maximum price they will pay for the fruit, according to seasonality of production. The company would be willing to invest up to FRW 100,000 million/year in technical and other assistance to passion fruit producers, such is the importance of this crop.

In sum, systematic and continuous efforts at disease management and sound alliances between producers and processors are the keys to sustaining and developing the passion fruit sector in Rwanda.

### Tree tomato

Tree tomato or tamarillo<sup>25</sup> (*Cyphomadra Betacea*) is grown mostly in the northwestern and western parts of the country. It is a member of the family of *Solanaceaes*, which also include potatoes, aubergine and sweet peppers. Tree tomato is a perennial bush with a woody trunk that grows to heights between 2 and 5 meters in favorable conditions, and it requires a cool climate and optimal temperatures for this plant are in the range 14°C to 20°C. It is susceptible to wind damage because of its shallow root system but adapts well to a variety of soil types, preferring those of medium texture with good drainage and considerable organic material. It does not require irrigation but availability of water can extend its productive period, which typically lasts up to three years for most of the plants, and improve yields and resistance to viruses.

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<sup>25</sup> This crop is also referred to as Japanese plum, and internationally it is known as tamarillo.

Although it is a relatively new product on international markets, there is strong demand for tree tomato in fresh form in those markets, particularly in the UK, Germany, the Netherlands and Spain, and especially if it is organic. Fair Trade certification also helps open markets for it. After being imported, it is processed into juices, concentrates, jams, gelatins and sweets. If processing facilities and adequate transport were available, it could be exported also in the form of fruit pulp or concentrate. Other principal exporters of tree tomato include Kenya, Zambia and New Zealand.

Some of the actors in the value chain believe MINAGRI is advising farmers to spray this crop as a routine production technique, which results in high pesticide residues. As alluded to above, those residues were found in a sample of tree tomatoes sent by East African Growers to the UK, and the shipment was declared unacceptable. For organic tree tomato to succeed, the government would have to delineate zones for organic production –which would be the case for other products as well. Research has found that tree tomato responds well to organic pesticides, so reduction of agrochemical use need not have deleterious effects on production levels.

The Rwandan horticulture strategy developed by OTF<sup>26</sup> emphasizes that success in exporting tree tomatoes will depend on installing a cold chain, developing professional relationships with buyers, becoming a reliable supplier, and complying with export certification requirements as well as obtaining organic certification, implementing a traceability system, and giving attention to the quality of packaging.

Another challenge is imparting appropriate practices for post-harvest handling. After being harvested, the fruit should be washed, disinfected and waxed, but producers usually are not accustomed to doing that. For transportation, the fruit should be placed in containers that are rigid with separations inside, and plastic boxes are the international standard for that purpose. These containers also should be washed and disinfected after every use. For international shipments, rigid cardboard boxes typically are used with a capacity of 2 to 2.5 kg. each.

After the unfortunate experience with the trial shipment to the UK, East African Growers has sent additional samples to Dubai, and more to the UK, and is awaiting the response of the importers. EAG believes Rwanda tree tomatoes to be of superior quality and potentially capable of finding an export market. However, it should be noted that diseases (especially viral) usually destroy the crop after two to three years. If it were grown for export, a careful IPM program would have to be put in place, windbreaks installed and a rotation program followed. But none of these problems are insurmountable.

## Mango

The world's largest producer of mango is India, followed by China, Thailand, Pakistan and Mexico. However, Mexico is the largest exporter, followed by India, Brazil, Pakistan and Peru. The U. S. is the largest importer and the European Union is the second largest. Saudi Arabia, the U. A. E. and Malaysia also are important markets, and now Australia has emerged as a significant buyer of mango also.

It is shipped fresh (subject to certifications that it has been produced in zones free of Mediterranean fruit fly or given hot water treatments), as pulp and juice, and in dried form. It has a wide variety of uses in consumption, including in fresh and canned forms, in dried strips or chunks, in frozen chunks,

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<sup>26</sup> OTF Group, *National Strategy for Rwandan Horticulture, Strategy Development Overview*, Kigali, June 2006.

as juice, and in ice cream, desserts and jams. It is also sold to consumers as frozen mango pulp from which juice is made in the household.

Modern varieties of mango are derived from two sources: monoembryonic varieties, which originate from what is now India, and polyembryonic varieties from an area now comprising part of Myanmar and Thailand. Both environments are characterized by hot weather (significantly higher temperatures than are found in most of Rwanda) and the former by a dry season of two to three months or longer, and the latter by a monsoon rainfall pattern.

Mango varieties sought on export markets (e.g. Keitt, Kent, Haden, Tommy Atkins and, recently, Ataulfo exclusively from Mexico) are all derived from the Indian monoembryonic varieties of mango. In this group, a dry period (as in no measurable rainfall) of two to three months is necessary to stimulate flowering, and high temperatures during this period favor a higher proportion of hermaphroditic or perfect flowers, from which fruit are set (lower temperatures result in a higher proportion of male flowers, from which no fruit are set).

For all mango varieties, rainfall during flowering is highly detrimental as it interferes with pollination and tends to result high levels of the fungal disease anthracnose, which both reduces fruit production and quality. All mango varieties perform best at a temperature range of 20 – 27 degrees C and warm temperatures (25 - 30 degrees C) during fruit development; high temperatures result in higher fruit quality.<sup>27</sup>

Very few areas in Rwanda, if any, have the prolonged period of no measurable rainfall which is required for good flowering and fruit set of mango, especially for those varieties sought on export markets. Even some of the driest and warmest sites proposed for inclusion in the LWH project do not have the rainfall and temperature conditions that are necessary for good mango yields and quality. In the Bugesera District, probably the most favorable for mango, there is on average measurable rainfall during every month of the year, and the temperatures are below the optimum for mango production, with average monthly lows of 16°C or 17°C in all month and average monthly highs from 27°C to 29°C.

For these reasons, international experts agree that mangoes cannot be competitive in Rwanda in comparison with mangoes grown in warmer climates in Burundi, Tanzania and Uganda. This does not mean they cannot be grown in Rwanda; indeed, in value mango is the third most important fruit produced in the country, after sweet bananas and avocados (Annex 9 in Annex Tables A). There is some scope for further production in areas like Bugesera (including grafted varieties) for substituting the small amount of imports from the DR Congo, but the potential for expansion is limited.

Given that most of the areas proposed for development under the LWH project do not have conditions conducive to production of either high yields or good quality mango, this crop can not be recommended for inclusion in the LWH project, with the exception of relatively small areas in selected sites in the lower rainfall-higher temperature zones.

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<sup>27</sup> Sources: Compendium of Tropical Fruit Diseases, 1994, published by The American Phytopathological Society and Edited by R.C. Ploetz, G.A. Zentmyer, W.T. Nishijima, K.G. Rohrbach and H.D. Ohr; *Memonto de l'agronome*, 2002, CIRAD-GRET-MAE (France), *Mango Production in Malawi* (Anon.).

## Tomato

Tomato is Rwanda's second largest vegetable in volume produced and area cultivated (after cabbage), and is the largest in value. It is sold on the domestic market fresh and in processed form. Rwanda is a net importer of tomatoes, mainly from the DR Congo and Burundi, although it also exports some to those countries and others in the region. There appears to be excess demand on the domestic market since some processors are anxious to obtain greater supplies of fresh tomatoes for conversion into tomato paste. Hence, tomatoes pass the first filter easily, with the domestic market constituting the main potential outlet for additional production.

Processors, specifically SORWATOM, still suffer from the competition with imported tomato paste subsidized by the Italian Government, but they feel that if they could produce sufficient volumes of processed tomatoes they would be competitive. It is believed that eastern DR Congo is a large potential market for Rwandan tomato paste since it is a common ingredient in Congolese cuisine. There is also some potential for exporting tomato paste to Burundi.

However, it should be pointed out that there are significant concerns about the quality of the tomatoes produced, at least as they are received at processing plants and supermarkets. This concern is attributable to both production practices (mainly disease control) and post-harvest handling, so there are issues for both the second and third filters.

At the field level, tomatoes suffer drought stress during the dry season, and pests and diseases pose a serious constraint to production. Insects destroy young seedlings on a large scale in some fields; and *Phytophthora* (late blight) is particularly severe during the rainy season and when overhead irrigation is used. There are also viral diseases that can seriously reduce production; apparently one is tomato yellow leaf curl virus from a description of the symptoms. ISAR has been carrying out tests on 40 varieties of tomatoes so it is possible that some of these problems can be reduced through research efforts. Irrigation can ameliorate the impact of the dry season on production but it should not be sprinkler irrigation because that method tends to propagate diseases more rapidly in tomato fields (see below).

In regard to the second filter, a problem that has to be overcome for tomatoes is the lack of strong, functional alliances between producers on the one hand and processors and other buyers on the other hand. SORWATOM, for example, is concerned about side selling of the fruit by the cooperatives with which the company works. SORWATOM provides inputs (seeds, fertilizers, pesticides) on credit as the producers cannot access credit themselves, in the expectation producers will repay at the time of sale. But many traders arrive at the farmers' fields at harvest (which occurs over one month) and offer a higher price than the company (which cannot raise its prices without seriously reducing its profit margins). Evidently, contract farming has not taken root for this crop. However, to complete the picture it must be said that processors need to ensure timely purchases from farmers, so that the crops do not get damaged sitting in the sun after the harvest awaiting transportation. In addition, as noted earlier, it would be worthwhile to explore the option of making some payments to farmers prior to harvest, so they do not harvest prematurely for need of cash. RHODA can play a role in helping broker alliances and monitoring their performance to see where problems emerge and devise solutions.

SORWATOM has been working with a MINAGRI-sponsored project to produce tomatoes under sprinkler irrigation at the LUX-Development irrigation scheme in Gashora (Bugesera). However, the overhead irrigation proved detrimental to production during the last rainy season when it, combined

with the rain, resulted in extremely high levels of late blight infection. The company would prefer gravity fed irrigation and is hoping such a system can be set up at the Gashora scheme.

In conclusion, Rwanda has potential to increase the production of tomatoes but important issues at the farm level and in the value chain need to be resolved before that can happen. Also, increases in production volumes are likely to be accompanied by somewhat of a decline in prices, as noted earlier in this study, but improved productivity at the farm level and more stable selling arrangements could compensate for that trend.

Another product that is worth exploring on a pilot scale is cherry tomatoes. They would have a secure market within the country, in the supermarkets.

### French beans and peas

In the East African context Kenya is a significant producer and exporter of French beans and peas. However, there is a seasonal window from January to March when, due to its being drought prone, Kenyan production of vegetables often falls short of demand. Not long ago persons who trade in these products estimated that Rwanda could probably export the following products and volumes over this period: French beans 5 tons/week (delivered two times per week) and the same volumes and frequencies for sugar snap peas and mange tout peas. All crops would have to be GlobalGAP certified, and would have to put into and maintained in cooled facilities (i.e., a cold chain) right after harvest, and delivered to Nairobi not more than two days after harvest. The ideal arrangement would be to harvest in the morning and ship to Nairobi in the afternoon, they said.

The role of airfreight costs had not yet been properly analyzed, but the buyers said if such an arrangement were found to be commercially profitable and feasible, at least one company would provide the bulk shipping containers to the Rwandan producers (at cost) and expect them to conduct an initial grading on farm so as to reduce transport costs.

This potential has now been more than fulfilled for the case of French beans, and by another company. On May 8 2009 *The New Times* wrote:

“East African Growers (EAG) Rwanda has exported about 50 tons of French beans to Belgium in a period of six months. The company, which was targeting five tons per week, has doubled the volume to 10 tons per week. East African Growers Rwanda’s main customers are Star Fruit.

“ ‘With no doubt it’s a success story because it was our target for the first six months and we are on track,’ Aimable Gakirage, Director General of EAG said in an exclusive interview.

“According to Gakirage, currently the firm manages to utilize only 10 hectares of the total 50 hectares it owns. He said they intend to expand their capacity but it depends on the cargo space, which is their biggest challenge.

“ ‘We are constrained by direct cargo space from Kigali otherwise we have a wide range of products that can be exported to the United Kingdom,’ Gakirage said.

“Recently President Paul Kagame visited the Gasabo-based site and he hailed the initiative where he urged local leaders to learn from EAG and use cooperatives for developmental activities.

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“Among the challenges addressed to the president include expensive cargo space and cold room charges. The president urged the Ministry of Agriculture to look into the issue and ensure the problem is solved. Kagame suggested that the project should be expanded to other areas.

Gakirage said that the company pays \$2.2 per kilogram [for transportation to Europe] yet these are not direct flights compared to Kenya where the same amount is paid to direct flights.

“ ‘We can not compete with people from Kenya or other places with direct flights; it is expensive and inconvenient because it also involves reloading,’ Gakirage emphasized.

Gakirage is a Rwandan who worked in the horticulture sector in Kenya for many years before returning to Rwanda. He therefore had significant experience in the export horticulture industry; this, together with his Rwandan roots has been key to the success of this venture, which is an illuminating experience for the potential for other horticulture crops.

Initially EAG tried producing mange tout and sugar snap peas in addition to beans. However, heavy rainfall destroyed the pea crops. The varieties grown would have to be produced under tunnels to avoid damage from heavy rainfall, but then could encounter problems of high temperatures and increased incidence of diseases. Those in charge of the experiment would like to have first conducted more varietal trials to determine those best suited to Rwanda, but they felt working with cooperatives that farmed land communally was an obstacle. Now that EAG has succeeded with the bean exports, the Rwandan Government is providing more support and they may go ahead with more extensive varietal trials. The Government is also very interested in promoting GlobalGAP certification of Rwandan horticultural producers.

EAG exports all packaging materials and most inputs (seeds especially) to Rwanda from Kenya. The biggest constraints are lack of irrigation (resulting in seasonal gaps in production), lack of awareness on the part of farmers of market standards and food safety which result in a very high percentage of rejects in the beans they produce, and a lack of a business orientation in some of the public sector support programs. EAG would be interested in renting a packhouse if one existed, which they believe (together with training of farmers in quality issues and standards) could enable them to expand their exports. They insist the packhouse would have to be under their own management rather than being a government-controlled enterprise.

A big advantage Rwanda has over Kenya for these crops is that there are no “brief-case brokers” who manage to purchase the produce from the farmers by offering higher prices, or other incentives, which then leaves the exporting company short in its supply along with the loss in its investment in provision of inputs (a big problem in Kenya).

EAG does not feel the airfreight costs – direct from Kigali to Brussels – are too expensive. He cited \$1.30/kg. because for the moment outgoing costs are lower than incoming owing to empty space on the planes. An additional advantage with Rwandan exports is that there is little competition for cargo space on the Kigali to Brussels route and therefore little danger of “offloading” fresh produce, which frequently occurs with exports from Nairobi.

EAG has a client in Belgium interested in importing 30 t/week of French beans, provided they are GlobalGAP certified, meet market and food safety standards (e.g. HACCP certification of packhouse). Their current exports from Rwanda (about 10 t/week) make it into the Belgian market only because

EAG has convinced the produce meets GlobalGAP and other requirements, given that they are following the same procedures used by their certified producers in Kenya.

One factor which has made EAG's French bean export venture in Rwanda a success is that they are able to sell the non-export grades on local markets at a profitable price, given that green beans are already a common food in the Rwandan diet. If edible, podded pea production were to take off, its success would in part be dependent on whether or not a local market could be found for non-export grade, perhaps in the hotel and restaurant industry.

This experience also underscores the importance of a strong alliance between the exporter and the producers (filter 2), and that such an alliance can help deal with production issues as well (filter 3).

### Chilies

International buyers expressed interest to the members of this study team in purchasing chilies from Rwanda. There is good potential for certified organic chilies, fresh and dried, on international markets. In dried form, for example Bird's Eye chilies, they would have the obvious advantage of going by surface freight. In fresh form local demand exists for good quality *Capsicum chinense* (Habanero type), which is currently imported by Nakumatt from Uganda.

Various types of chili peppers are commonly found growing throughout Rwanda, albeit cultivated only on a small scale for the most part, and in many instances, isolated plants have sprouted spontaneously from seed dispersed by birds and other animals. Given the suitable climate for *Capsicum* production, the abundance of labor and its relatively non-perishable nature, dried Bird's Eye Chili (*Capsicum frutescens*) was identified as a potential export from Rwanda during the USAID-funded ADAR project. This crop, if managed properly, can produce fruit over a two-year period of time; moreover, harvesting the chilies requires a large pool of labor, which makes its production comparatively less competitive in countries such as South Africa and Zambia, where labor costs are much higher than in Rwanda. The high levels of solar radiation (due to proximity to the equator) and the right temperature conditions are conducive to the production of a fruit with excellent color and high levels of capsaicin, the chemical which gives chilies their pungency.

Several entrepreneurs and two cooperatives received assistance from the USAID-funded ADAR project over 2004- 2006 for production and export of organically certified Bird's Eye chili (BEC). A small, land locked country such as Rwanda must make use of its advantages if agricultural exports are to profitably sold on international markets; in the case of BEC, the low use of chemicals, and reliance on organic fertilizers and cultural practices for soil fertility maintenance impart an advantage for producers seeking organic certification, and the value added conferred by certification helps to compensate for Rwanda's high transport costs. The large supply of low cost labor in Rwanda also favors production of crops such as BEC that require large numbers of workers who do not necessarily have many skills or much expertise; extra efforts must be made at the managerial level, however, to ensure control of product quality.

Samples of the organic BEC produced by the ADAR assisted entrepreneurs/cooperatives were sent to importers in Germany and the USA in 2005; their evaluation was that the crop was of high quality, and two expressed an interest in importing at least one container load of certified organic BEC every couple of months from Rwanda. Unfortunately, budget cuts resulted in early termination of the ADAR project and with the lack of adequate technical and financial assistance, all producers eventually let their organic certification lapse and ceased to pursue exporting their product.

Given that high quality organic BEC can be produced in Rwanda, and in view of the continued interest on the part of European and North American importers in procuring this product from Rwanda, this is a crop that can be recommended for inclusion in the LWH project. In addition to close, hands-on technical assistance, and financial support for organic certification and purchase of solar tunnel driers (required for production of aflatoxin-free high quality dried fruit) would be required for successful production of an export quality crop.

Other types of chilies, e.g. *Capsicum chinense* (referred to as Habanero and Scotch Bonnet in English and “piment lantern” in French) have also been observed to grow well under Rwanda’s climatic conditions. In the case of *C. Chinense*, demand exists for the fresh fruit both on the local market and for processing. Nakumatt-Kigali currently imports pre-packaged *C. Chinense* from Uganda, although it could be produced locally, citing the higher quality and better presentation of the Ugandan product as reason for importing the fruit. Yet, with simple plastic “greenhouses” or “tunnels”, the same product could readily be produced in Rwanda.<sup>28</sup> Fruit of lower quality would find a ready market in the processing sector. Sina Gerard is already producing an oil (sauce) from *C. Chinense*, which he sells on both local, and export markets (albeit in small quantities for the exported product). A bottled *C. Chinense* sauce is made in Burundi and imported to Rwanda; the same sauce could be produced locally, if volumes of production were increased, and an interested entrepreneur identified.

Fresh habanero peppers also have export potential that is worth exploring but are more demanding than the dried version in post-harvest handling.

In sum, the main requirements for success with chili exports are sustained hands-on technical assistance to farmers and attention to two particular issues in the value chain: installation of solar tunnel dryers at the farm level and obtaining and maintaining organic certification.

## Carrots

In the tropics, carrots are usually grown at higher altitudes. Lower temperatures, especially at night, are more favorable to both yield and quality of carrots. One study found that growing the ‘Chantenay’ variety of carrot at a temperature regime of 35°C day/17°C night yielded 15.4 tons/ha, compared with 6.8 tons/ha under conditions of 35°C day/22°C night. Size under the cooler night temperature regime was on average 10.3 cm in length (and 4.1 cm maximum diameter), compared to 6.2 cm length (and 3.2 cm maximum diameter) with warmer nights.<sup>29</sup> The color of carrot roots is also better under lower temperature growth conditions, and the development of the pigment lycopene is inhibited by high temperatures. Thus Rwanda’s relatively cooler climate (compared to Uganda and Burundi) is favorable to both higher yields and better quality of carrots, which make this crop an interesting candidate for some of the higher altitude LWH project sites.

The quality of Rwanda’s carrots compared to those of immediately surrounding countries already has been recognized in the marketplace, and Rwanda exports a considerable amount of carrots to

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<sup>28</sup> Production under plastic may not be necessary; this is the method employed in Uganda, so trials would need to be conducted to determine whether or not such infrastructure is required to achieve the same quality for *C. Chinense* production in Rwanda.

<sup>29</sup> Williams, Uzo and Peregrine, *Vegetable Production in the Tropics*, Longman Group UK Limited, 1991.

Burundi and the DR Congo. This regional market should continue to grow and represents a significant outlet for additional production.

Baby carrots are an option for the future if well handled. Kenya, Tanzania and South Africa are among the countries exporting this crop. The most critical requirement for entering this competitive market is adequate post-harvest handling (filter 2). In particular, baby carrots require a cold chain and preferably are exported in frozen form. At present Rwanda does not have the facilities required to enter the frozen produce export market, but this is an option that merits exploration. It could apply to other crops also, including French beans and peas.

As in the case of other crops, organic certification for baby carrots would give Rwanda a more significant entry point into international markets. It is not suggested that baby carrots be cultivated in the LWH projects in the near future, but if entrepreneurs invest in the appropriate infrastructure then this crop could become a fairly important one.

### Macadamia

Macadamia is a tree that originated in Australia. It was discovered by the German botanist Ferdinand von Müeller in 1848 and commercial exploitation of the tree began shortly after that. The first macadamia tree planted on purpose is still yielding nuts because its productive period can exceed 200 years. Macadamia nuts are the highest valued nuts in the world.

They are produced commercially primarily in Australia, Hawaii, South Africa, Kenya, Malawi, Colombia, Costa Rica, Guatemala and Brazil. To date the United States, Australia and Japan are the principal consuming nations for macadamia nuts, but European and Asian demand for them is increasing. Taiwan consumes more macadamia nuts and oil per capita than any other country. The nut is appreciated not only for its taste and the possibilities of its use in cooking, but it also is a star ingredient in anti-aging creams produced by leading brands such as Lancôme. In addition, more than 40% of its composition is oleic acid, a substance similar to olive oil that helps reduce cholesterol. More than 80 % of the fatty acids in macadamia nuts are monosaturated. All these factors contribute to increasing and sustaining international demand for the crop.

The possibility of planting macadamia has been mentioned by ISAR in its *Participatory Diagnostic Report for the Cyabayaga Watershed (2006)* and in the RHODA Business Plan, but in both cases without elaboration. Since the crop is not yet well known in Rwanda, a few comments are offered in this section about its cultivation.<sup>30</sup> Macadamia grows well with annual precipitation of 1500 mm to 3000 mm, well distributed throughout the year and with no more than two months of drought. Thus irrigation during the dry season can benefit this crop. Its preferred temperature range is 18°C to 29°C. Normally these conditions are found at altitudes of 400 to 1000 meters above sea level but the crop can be cultivated up to 1200 meters.

Establishing nurseries is important for macadamia production, and grafting rather than propagation by seeds is recommended. The trees begin producing in the fifth year and yields continue to increase until the fiftieth year.

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<sup>30</sup> The material in this section is based in large part on personal communications from Hector Rodriguez.

The nuts that have fallen should be collected at least once every two weeks, and then they are carefully dried until the humidity drops to 3.5%. The commercial product is toasted and vacuum-packed nuts.

Macadamia trees benefit watersheds by helping conserve sources of water. They are also favored hosts for bees.

Macadamia has significant long-term potential for Rwanda. Among other considerations, its high unit value reduces the importance of transport costs. However, commercial-scale production would require an investor in the processing industry and a program of training and supervision of producers. The government, through RHODA, may wish to try to interest investors in this crop, and in the meantime it is listed as one of the crops for which it would be worth carrying out trials.

### Citrus

Rwanda is a net importer of citrus from other countries in the region. Although oranges and limes can be grown in Rwanda, the country does not have a comparative advantage in any citrus product for the following reasons:

- Floral induction is favored by a period of cool (less than 13°C) temperatures, or a prolonged dry period – neither of which is found in Rwanda.
- Two serious citrus diseases exist at high levels in Rwanda, and neither can be managed profitably with technologies available:
  1. Citrus canker, caused by a bacterium and favored by humid conditions and spread by rainfall, wind, mechanical means (tools); in eastern DR Congo and Rwanda, high levels of the insect “life miner” serve to further spread the disease. Once canker levels reach a certain threshold (not measured but observed to exist, at least in the former Cyangugu region), the disease can neither be eliminated nor controlled, and it has devastating impact on fruit production.
  2. Citrus greening disease: caused by an intracellular bacterium and vectored (disseminated from one plant to another) by the insect “psylla,” which is only found above certain altitudes (i.e., those prevailing in much of western and northern Rwanda). This disease completely destroyed production of oranges in the Mazowe Valley of Zimbabwe in the 1990s, resulting in production being shifted to the lower elevation southern part of the country. In Rwanda, most farmers are unaware of the disease and how it is spread. Fruit produced from greening-infected trees never develop color (hence the name “greening”), have poor flavor and low yields.

### Irish potato

Rwanda is a major net exporter of Irish potato, mainly to the DR Congo and Burundi. The crop is widely grown throughout the country, and within Rwanda it is consumed entirely in fresh form. It is a major staple in the diet of Rwandans. While the high levels of rainfall in Rwanda favor development of potato disease (especially late blight (*Phytophthora infestans*), Rwanda’s relatively cooler climate (compared to the DRC and Burundi) give it a regional comparative advantage in the production of this crop, for agronomic reasons as explained in the following comments. High temperatures are not conducive to good tuber formation due to excessive rates of respiration (thus reduction in assimilate available for tuber development) and inhibition of tuberization in some cultivars. Early growth is favored by temperatures around 22°C and later growth by temperatures in

the region of 18°C. The best tuber production is achieved where day temperatures are warm (not hot) and night temperatures are cool.

Optimum soil temperature for tuberization is in the range of 15-20°C. Rainfall in the range of 500 – 700 mm evenly distributed over the growth period is optimal precipitation. Altitudes over 1000 m.a.s.l. are normally required for successful growth and economic yields are usually obtained only at elevations above 1000 m.a.s.l. (although cultivars have been developed for production at lower altitudes). High light intensity, such as is found in Rwanda (given its altitude and proximity to the equator) favors tuber formation, and low light intensity has the reverse effect (inhibition of tuber production).<sup>31</sup>

Thus, the prevailing conditions in the higher altitudes (cool temperatures, high light intensity, even distribution of rainfall over the rainy period) found in much of northern and western Rwanda correspond to a good production environment for Irish Potato. Although the product is bulky, if harvested at the mature stage, after suberization of the outer skin has taken place, the tubers are not highly perishable (relative to vegetables such as tomato and fruits like banana), and therefore they are suited for being stored for as long as several months time, provided they are not exposed to high temperatures or moist conditions.

Irish potato, while considered a staple crop, enjoys a higher status in consumer preferences than most other root and tuber crops (cassava, sweet potato), and consequently it is much more commonly featured on hotel and restaurant menus than the latter two crops. Hence we can assume that increased production of potato in Rwanda would find a market, both domestically and regionally.

Irish potato therefore passes the first two filters of the crop selection procedure. With respect to the third filter, caution is advised insofar as following strict crop rotations with non-solanaceous crops. It is recommended to crop the same land in potatoes (together with all other solanaceous crops) only one time every three years to avoid high levels of diseases such as late blight (*Phytophthora infestans*) and nematodes (e.g., *Meloidogyne* species), especially in areas such as Ruhengeri and Gisenyi that have a tradition of growing the crop. Irish potato can be grown in with crops such as beans, cereals and cassava. Expansion of Irish potato production is therefore recommended but only on a moderate scale under the LWH.

### Other crops

- **Gooseberries (physallis):** This crop already has a small domestic market in Rwanda, particularly for jam and pastries. Internationally, Europe imports significant amounts of gooseberries, especially from Colombia and mostly for consumption in Germany. These berries are appreciated for their health benefits. In order to compete with Colombia Rwanda would have to export organic gooseberries; the Colombian product has been subject to criticism for high doses of pesticides, and this leaves an opening for an organic competitor.
- **Imported strawberry varieties:** Rwanda has good growing conditions for strawberries but the local varieties are small and often have poor color, to the point of sometimes being

unacceptable for jams. California produces excellent varieties of strawberries and it worth making trials of them in Rwandan conditions.

- **Asian eggplants (long/slender and small), Asian (small) cucumbers, Asian (mild, long) pepper :** These crops can be grown in Rwanda and would have buyers in the supermarkets. The main issue is product quality, and dealing with that issue would require intensive technical assistance much as EAG has provided for French bean growers.
- **Baby corn:** This is a product with good export markets and production could begin on the basis of the domestic market, both for supermarkets and restaurants. Exports would require construction of appropriate packing facilities.
- **Cabbage:** Rwanda has better growing conditions for this principal vegetable than surrounding countries do, and production could be expanded for exports to the regional market. However, planting decisions should be made in close coordination with marketing agents who have firm links to regional markets.
- **Onions, leeks:** As in the case of cabbage, Rwanda has a favorable climate for growing these crops, in comparison with surrounding countries. Production could be expanded for both the domestic market and the regional market, in coordination with marketing agents.
- **Essential oils:** Organic certified essential oils like geranium (more than patchouli) are very profitable for farmers and have an assured international market. It would be well worth essaying plantings of these crops on a small scale and in coordination with buyers.

## Conclusions and Recommended Actions

Rwanda is blessed with a good climate for many crops. Both the natural environment and demand conditions are conducive to substantial increases in the acreage and volumes harvested of a number of crops, primarily fruits and vegetables, tea and Irish potatoes, and coffee as well in a longer-term perspective. Consumer demand parameters, for example, suggest that domestic demand for fruits and vegetables will continue to expand rapidly over the coming years. Equally, Rwanda has a regional comparative advantage in several crops and therefore there are possibilities for regional exports and import substitution. In addition, the option of extra-regional exports is a very real one for a number of production lines, and small quantities are already being shipped out on a regular basis. The crops in which Rwanda has a comparative advantage are labor-intensive (as well as high value per hectare), and Rwanda is well endowed with rural labor. Its high labor-to-land ratio favors intensive crops.

On the basis of analysis of markets, value chains and production conditions, this report has identified the crops which are primary candidates for expanded acreage under a project such as the LWH project, along with indications of which ones can be grown in rainfed conditions and which require irrigation. If Rwanda can achieve “take-off” in the area of high value crops, it is likely that the list of successful export crops will be rather long, at least up to a dozen crops if not more. This has been the case for countries like Kenya and South Africa and others as far away as Peru.

The report also underscores the fact that a number of investments and complementary programs will be needed in order to ensure that the newly planted crops represent profitable and sustainable

options for Rwandan farmers. Given the importance of these recommended actions, they are reiterated here in summary form as follows:

- Quality is the single most pervasive concern for development of the recommended crops. This embraces production methods including approaches to disease control, post-harvest handling procedures, the use of cold chain facilities, product and process certifications, and even the type of packaging. To improve quality as well as yields at the farm level a complementary program of intensive, hands-on technical assistance will be needed for several years. The model of the East African Growers for working with French bean producers is illuminating in this regard. Advisory assistance in the value chain will also be needed for the crops that are less well known, although the country has processing facilities for products like juices and jams that are technically advanced.
- Critical infrastructure needs include coolers and dryers at the field level, cold chain facilities, greenhouses or tunnels, and improved rural access roads. In addition, it is vital to improve the management of the cold store at the international airport by putting its management in private hands. Up to six strategically located cold store facilities will be needed.
- Financial and technical assistance for obtaining organic and other certifications will be needed for groups of small farmers.
- In many cases financial and technical assistance will be needed for market exploration including sample shipments.
- In general, alliances between buyers (or processors) and producers need to be strengthened and made into multi-faceted relationships. Positive examples are found in the operating modes of East African Growers, SORWATHÉ and Inyange Dairy, but the approaches of these enterprises need to be spread more widely. The BTC CTB sponsored initiative to organize and sustain an umbrella organization comprised of producers, transporters, marketers and other actors in the horticulture value chain should be encouraged and supported. Market linkages are very important for small farmers.
- A continuous program of trials of new products and new varieties should be made into an integral part of the LWH projects, and those trials should be carried out in a participatory manner with farmers. There are a number of products that could become significant lines of export for Rwanda, but trials are needed to determine their feasibility in Rwandan conditions and the best ways of managing those products.

The keys to success for Rwandan agriculture will include promoting crops that have a comparative advantage in the country, producing high quality products, and becoming known as a reliable, steady supplier of those products. Modern agriculture, especially for high value crops, is a knowledge-intensive business, and Rwandan farmers will need links not only with markets but also with the requisite kinds of private technical information and expertise on a continuing basis. The LWH projects and related activities in Program 1 of the PSTA provide opportunities to make that kind of expertise available to farmers.

## Annexes

### Annex 1: Fruit and Vegetable Production, Quantities and Value<sup>32</sup>

Province	District	Total Production (t)				
		Bananas	Fruit (bananas)	Pineapple	Vegetables	Processed
<b>City of Kigali</b>	(AGASH)	319	234	17%	129	11
<b>City of Kigali Province Total</b>		<b>319</b>	<b>234</b>	<b>16%</b>	<b>129</b>	<b>11</b>
<b>Eastern</b>	ISHERE	2 711	424	1	993	-
	ISHERE	2 676	1 251	17	622	17
	ISHERE	379	1 192	-	34	-
	ISHERE	666	737	3 210	119	4
	ISHERE	1 993	1 487	17%	2 271	-
	ISHERE	181	77	19	173	-
	ISHERE	317	5 029	1%	113	17
<b>Eastern Province Total</b>		<b>16 782</b>	<b>21 767</b>	<b>33%</b>	<b>4 646</b>	<b>29</b>
<b>Western</b>	UBUYUMU	1 611	62	-	-	10
	UBUYUMU	489	1 172	14,7%	-	-
	UBUYUMU	647	641	-	-	426
	UBUYUMU	2 489	1 102	1	-	232
	UBUYUMU	1 146	1 761	17	1 661	- 381
<b>Western Province Total</b>		<b>15 489</b>	<b>11 133</b>	<b>14,3%</b>	<b>2 893</b>	<b>2 349</b>
<b>Southern</b>	ISHERE	1 977	1 887	7,2%	712	4
	ISHERE	2 249	724	97	276	-
	ISHERE	477	561	16%	41	31
	ISHERE	7 611	2 267	2,2%	211	-
	ISHERE	188	78	-	-	239
	ISHERE	1 471	1 697	122	66	11
	ISHERE	2 997	1 17	-	-	79
	ISHERE	5 403	47	1,4%	-	48
<b>Southern Province Total</b>		<b>31 771</b>	<b>11 761</b>	<b>12,2%</b>	<b>1 394</b>	<b>141</b>
<b>Western</b>	ISHERE	2 574	1 11	17%	227	27
	ISHERE	1 111	1 78	18	11	287
	ISHERE	223	28	-	-	-
	ISHERE	7 911	21	11	187	-
	ISHERE	776	234	-	-	11
	ISHERE	1 625	925	-	429	69
	ISHERE	1 111	1 401	212	18	2 074
<b>Western Province Total</b>		<b>21 128</b>	<b>15 114</b>	<b>4%</b>	<b>1 899</b>	<b>2 344</b>
<b>National Total</b>		<b>81 297</b>	<b>69 231</b>	<b>21,1%</b>	<b>11 171</b>	<b>6 491</b>

Source: Survey data from 2008

<sup>32</sup> These annex data are from: S. Masimbe, F. Gahizi, B. Musana and J. Sangano (G&N Consultants, Ltd.), *A Survey Report on the Status of Horticulture in Rwanda*, prepared for the Rwanda Horticulture Development Agency (RHODA), October 2008.

## Annex 2: Total Production of Japanese plum, lemon, orange and papaya

Product	Country	Total Production (t)			
		Japan (t)	USA	Orange	Papaya
<b>Crystallized</b>	<b>ORANGE</b>	0	-	-	-
<b>Crystallized Apples Total</b>		0	-	-	-
<b>Others</b>	APPLES	0	0	0	0
	APPLE	0	-	-	0
	APPLE	0	-	-	0
	APPLE	0	0	0	0
	APPLE	0	0	0	0
	APPLE	0	0	0	0
<b>Others Apples Total</b>		0	0	0	0
<b>Others</b>	APPLE	0	0	0	0
	APPLE	0	-	0	0
	APPLE	0	-	-	0
	APPLE	0	-	0	0
	APPLE	0	0	-	0
<b>Others Apples Total</b>		0	0	0	0
<b>Others</b>	ORANGE	0	0	0	0
	ORANGE	0	0	-	0
	ORANGE	0	0	0	0
	ORANGE	0	0	0	0
	ORANGE	0	0	-	-
	ORANGE	0	0	0	0
	ORANGE	0	-	-	-
	ORANGE	-	0	0	-
<b>Others Oranges Total</b>		0	0	0	0
<b>Others</b>	PAPAYA	0	-	0	0
	PAPAYA	0	0	-	0
	PAPAYA	0	0	0	0
	PAPAYA	0	0	-	-
	PAPAYA	0	0	0	0
	PAPAYA	0	-	-	-
	PAPAYA	-	0	0	-
<b>Others Papayas Total</b>		0	0	0	0
<b>Others</b>	LEMON	0	-	0	0
	LEMON	0	0	0	0
	LEMON	0	0	-	0
	LEMON	0	0	0	0
	LEMON	0	0	0	0
	LEMON	0	0	-	0
<b>Others Lemons Total</b>		0	0	0	0
<b>National Total</b>		0	0	0	0

\*All values are in metric tons

Annex 3: Total area under avocado, fruit banana, pineapple, mango and passion fruit

Province	District	Total Area (Ha)				
		Avocado	Fruit Banana	Pineapple	Mango	Passion Fruit
<b>City of Sigatoka</b>	<b>042420</b>	16837	6368	4884	21425	6282
<b>Eastern</b>	<b>030000</b>	69378	33337	6388	147518	
	<b>030001</b>	38730	48330	830	3441	130
	<b>030002</b>	8738	34111	-	114	-
	<b>030003</b>	24378	48748	7118	8488	1487
	<b>030004</b>	11300	10000	8180	3000	
	<b>030005</b>	8138	1083	1000	2843	
	<b>030006</b>	13727	3000	888	1111	1187
<b>Eastern Province Total</b>		1366	100000	88888	28888	88888
<b>Western</b>	<b>030007</b>	11000	11000			
	<b>030008</b>	11000	11000	11000	-	11000
	<b>030009</b>	11000	11000	-	-	11000
	<b>030010</b>	11000	11000	11000	-	11000
	<b>030011</b>	11000	11000	11000	11000	11000
<b>Western Province Total</b>		6387	88888	28888	88888	88888
<b>Southern</b>	<b>030012</b>	28138	11000	88888	7878	1387
	<b>030013</b>	11000	11000	1111	11000	-
	<b>030014</b>	11000	11000	11000	11000	11000
	<b>030015</b>	11000	11000	11000	11000	11000
	<b>030016</b>	11000	11000	11000	11000	11000
	<b>030017</b>	11000	11000	11000	11000	11000
	<b>030018</b>	11000	11000	11000	11000	11000
<b>Southern Province Total</b>		11000	110000	88888	110000	110000
<b>Western</b>	<b>030019</b>	11000	110000	11000	11000	110000
	<b>030020</b>	11000	11000	11000	11000	11000
	<b>030021</b>	11000	11000	-	-	-
	<b>030022</b>	11000	11000	11000	11000	-
	<b>030023</b>	11000	11000	-	-	11000
	<b>030024</b>	11000	110000	11000	11000	11000
	<b>030025</b>	11000	11000	11000	11000	110000
<b>Western Province Total</b>		11000	88888	88888	88888	88888
<b>National Total</b>		110000	1100000	888888	1100000	888888

\*All figures are in hectares

### Annex 4: Total production for cabbage, tomato, local eggplant and carrot

Province	District	Total Production (kg)			
		Cabbage	Tomato	Local eggplant	Carrot
<b>City of Sijil</b>	GHANSA	100	400	1	100
<b>Eastern Province</b>	ආරාධනා	110	110	7	-
	ආරාධනා	633	1,333	1,000	-
	ආරාධනා	1,1	200	0	20
	ආරාධනා	110	110	0	-
	ආරාධනා	70	600	0	-
	ආරාධනා	-	200	0	-
<b>Eastern Province Total</b>	<b>ආරාධනා</b>	<b>2,200</b>	<b>4,000</b>	<b>1,000</b>	<b>20</b>
<b>Western Province</b>	ආරාධනා	1100	-	70	-
	ආරාධනා	2,100	20	2,700	-
	ආරාධනා	700	200	0	10
	ආරාධනා	1,000	1,100	100	2
<b>Western Province Total</b>	<b>ආරාධනා</b>	<b>1,800</b>	<b>1,300</b>	<b>100</b>	<b>60</b>
<b>Southern Province</b>	GHANSA	100	400	2,000	70
	ආරාධනා	2,100	20	10	20
	GHANSA	1,100	1,100	2,000	20
	ආරාධනා	1,100	2,000	7,000	10
	ආරාධනා	20	1,100	100	-
	ආරාධනා	1,100	0	0	10
	ආරාධනා	1,100	10	1,100	2,000
<b>Southern Province Total</b>	<b>GHANSA</b>	<b>11,200</b>	<b>10,000</b>	<b>2,100</b>	<b>1,000</b>
<b>Western Province</b>	GHANSA	2,100	0	2,100	100
	GHANSA	1,000	0	100	100
	GHANSA	1,100	-	-	1,100
	GHANSA	1,100	200	100	20
	GHANSA	2,100	20	0	2,100
	GHANSA	1,100	1,000	2,000	20
<b>Western Province Total</b>	<b>GHANSA</b>	<b>10,000</b>	<b>1,200</b>	<b>11,000</b>	<b>10,000</b>
<b>National Total</b>	<b>GHANSA</b>	<b>70,000</b>	<b>60,000</b>	<b>20,000</b>	<b>10,000</b>

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Annex 5: Total Area under cabbage, tomato, local eggplant and carrot

Province	District	Total Area (ha)			
		Cabbage	Tomatoes	Local eggplant	Carrot
City of Sijak	001420	15 162	31 768	9 111	3 371
<b>City of Sijak Province Total</b>		15 162	31 768	9 111	3 371
Flores	001001A	47 000	41 000	15 000	-
	001002	17 000	100 000	17 000	-
	001003A	112 000	11 000	29 700	3 000
	001004	21 000	1 700	7 000	-
	001005A	4 000	41 000	-	-
	001006A	-	100 000	9 700	-
	001007A	-	200 000	100 000	1 000 000
<b>Eastern Province Total</b>		196 000	606 700	166 400	1 004 000
Maluku	001001A	100 000	-	10 000	-
	001002	100 000	1 000	10 000	-
	001003	1 771 000	11 000	10 000	20 000
	001004	100 000	20 000	1 000	3 000
	001005	200 000	2 112 000	70 000	10 000
<b>Maluku Province Total</b>		1 501 000	2 144 000	101 000	33 000
Sulawesi	001001A	10 000	2 000	100 000	5 700
	001002	100 000	10 000	10 000	100 000
	001003	100 000	10 000	10 000	10 000
	001004	10 000	10 000	10 000	10 000
	001005	1 000	10 000	10 000	-
	001006	7 000	100 000	10 000	-
	001007	10 000	-	10 000	1 000
<b>Sulawesi Province Total</b>		230 000	2 120 000	150 000	127 700
Sulawesi	001001A	100 000	1 000	100 000	100 000
	001002	10 000	1 000	10 000	1 000
	001003	100 000	-	-	100 000
	001004	10 000	2 000	10 000	1 000
	001005	200 000	1 000	10 000	200 000
	001006	100 000	100 000	100 000	1 000
	001007	10 000	10 000	10 000	10 000
<b>Sulawesi Province Total</b>		540 000	2 112 000	250 000	503 000
<b>Indonesia Total</b>		1 847 162	7 000 000	1 000 000	1 500 000

000 - 10-digit provincial survey

Annex 6: Total area under onion, French beans, sweet pepper, pepper and leak

Province	Region	Onion	French beans	Sweet pepper	Pepper	Leak
City of Ngazun	GAZARD	21 995	20 714	1 076		
<b>City of Ngazun Province Total</b>		21 995	20 714	1 076	1 076	
Eastern	BURKINA	.. 00	-	-	-	-
	C. & S.	4 249	-	-	1 200	-
	SAO-POLA	-	-	-	-	-
	MOU-D	-	-	-	0 200	-
	BOUSS	-	-	-	-	-
	SAO-POLA	-	-	-	22 200	-
	SAO-POLA	-	-	1 00 000	0 200	-
<b>Eastern Province Total</b>		4 249	20 714	1 076	23 600	12 700
Northern	BURKINA	11 871	202 000		0 200	
	GAZARD	4 204	-	-	4 200	-
	C. & S.	-	200 000	0 200	200 000	1 200
	Mou-D	1 200	0 200		0 200	
	P. J. & S.	20 000	0 200	0 200	20 000	
<b>Northern Province Total</b>		37 275	202 400	0 600	24 600	24 700
Southern	GAZARD	20 000	10 000	0 200	20 000	-
	P. J.	1 000	10 000	-	-	-
	SAO-POLA	200 000		0 200		
	SAO-POLA	20 000		0 200	20 000	10 000
	SAO-POLA	-	-	-	-	-
	SAO-POLA	-	-	-	20 000	-
	P. J. & S.	1 000	20 000		10 000	
<b>Southern Province Total</b>		22 000	30 000	0 600	40 000	24 700
Western	SAO-POLA	1 200	200	-	4 200	-
	SAO-POLA	200	-	-	0 200	-
	SAO-POLA	1 200				
	SAO-POLA	0 200				
	P. J. & S.	20 000	10 000	-	-	-
	P. J.	200	-	-	-	-
<b>Western Province Total</b>		22 800	30 000	1 000	4 400	4 700
<b>National Total</b>		100 000	11 2 000	10 000	200 000	1 000

\*00 - ...

## Annex 7: Value of the major fruits and vegetables

Crop	National Production (kg)	National Average Price/kg (TRY)	Total Value (TRY)
Seedless banana	19,886,558	0.88	17,500,168.44
Seedling orange	3,143,548	1.28	4,023,741.44
Lemon	4,388,800	1.28	5,617,664.00
Mango	9,178,918	1.18	10,831,103.24
Pineapple	6,482,378	0.78	5,056,254.84
Pawpaw	11,389,148	0.88	10,022,450.24
Passion fruit	3,104,720	3.08	9,562,547.60
Papaya	61,887,181	0.31	19,185,026.11
Avocado	6,332,378	0.78	4,949,254.84
Japanese plum	88,287,138	0.08	7,062,969.04
Local eggplant	8,231,887	1.28	10,536,813.36
Corn	-	-	-
Leek	251,584	68	17,107.63
Carrot	8,298,498	0.22	1,825,669.56
Tomato	68,742,171	0.18	12,373,590.78
Cabbage	13,518,488	68	9,192,571.36
French onion	6,178,111	1.4	8,649,355.40
Seed pepper	1,727,308	688	1,187,367.90
Pepper	238,880	1.28	305,747.20
<b>Total Value</b>			<b>79,792,822.662</b>

Yıl 2020 = 100 TL = 1 TL

## Annex 8: Estimate of average prices at farmgate

Crops	Unit Price (TRY/kg)
Seedless banana	0.88
Seedling orange	1.28
Lemon	1.28
Mango	0.88
Pineapple	0.78
Papaya	0.31
Avocado	0.78
Japanese plum	0.08
Local eggplant	1.28
Corn	1.13
Leek	16
Carrot	0.22
Tomato	0.18
Cabbage	16
French onion	1.4
Seed pepper	0.688
Pepper	1.28

## Annex 9: Tonnage processed by each major processor per year in Rwanda

Industry	Subsector	Type of processor	Quantity processed per year (t)	Maximum capacity per year (t)	Utilization rate (%)
INDUSTRIAL	Garbage	Wastewater treatment	100	100	100
Manufacturing	Food	Food processing	11	10	110
Textile	Textile	Textile processing	20	200	10
Chemical	Chemical	Chemical processing	10	100	10
Metals	Metals	Metals processing	100	100	100
Energy	Energy	Energy processing	10	100	10
Construction	Construction	Construction processing	10	100	10
Transport	Transport	Transport processing	10	100	10
Information	Information	Information processing	10	100	10
Health	Health	Health processing	10	100	10
Education	Education	Education processing	10	100	10
Other	Other	Other processing	10	100	10
TOTAL			1,000	1,000	100

## Annex 10: Fruit and Vegetable Imports 2006-2007 (kg.)

The data in these tables are from: National Institute of Statistics of Rwanda, Ministry of Finance and Economic Planning, and Planning, Policy and Capacity Building Unit, Ministry of Agriculture and Animal Resources, "Cross Border Trade Survey November – May 2007," Report No. 2, Kigali, July 2007. These data have not been validated by the Ministry of Agriculture and Livestock and should be viewed as rough approximations, but nevertheless they give an idea of relevant magnitudes.

IMPORTS					
	FROM DRC	FROM BURUNDI	FROM UG	FROM TZ	TOT.IMPORTS
SORGHUM	4054688	2041922	927664	611468	7635742
MAIZE	33488527	535239	31934737	921006	66879509
MAIZE FLOUR	40308513	13650387	24707193	1921963	80588056
WHEAT	1455517	240425	41661	1173336	2910939
WHEAT FLOUR	6760991	0	347652	6413254	13521897
					<b>171536143</b>
BEAN	5409127	3204546	1451240	466505	10531418
PEAS	5348921	131	194094	5147414	10690560
PEANUT	508179	127662	84630	295484	1015955
SUNFLOWER	6630	100	6418	97	13245
					<b>22251178</b>
CASSAVA	3881430	1276962	957338	112041	6227771
SWEET POTATO	17539618	10879295	6646345	3551	35068809
IRISH POTATO	3179831	725545	1702233	144519	5752128
					<b>47048708</b>
COOKING BANANA	40689712	33100	16923627	11713	57658152
BANANA FOR WINE	17585973	2885	366	90	17589314
APPLE BANANA	13223131	454480	48783	59	13726453
					<b>88973919</b>
CASSAVA FLOUR	9182000	8206121	669091	177568	18234780
SORGHUM FLOUR	305959	237429	2928	63330	609646
SUGARCANE	2237707	3030	34095	24000	2298832
PALM OIL	99273606	96874041	1552678	100163	197800488
TARO	684800	105	23323	123	708351
SOYA	230622	965	600	200391	432578
DRY CASSAVA	1728363	390	27	894	1729674
RICE	286700	0	2180	0	288880
MILLET	11117	0	10878	0	21995
SOSOMA	5100	0	5050	0	10150
VEGETABLE OIL	21	0	15	0	36
HONEY	0	0	0	0	0
PEANUT OIL	1055	0	5	0	1060
CABBAGE	202004	80856	12517	31050	326427
TOMATO	1296117	1175909	1051	47476	2520553
POIREAU	108623	12905	8456	1012	130996
CARROT	16578	0	3041	310	19929
ONIONS	1496428	726801	531796	2045	2757070
SPINACH	21032	20690	74	0	41796
EGG PLANT	1971196	1958565	4865	0	3934626
POIVREUX	39	0	31	0	70
CERELI	155	130	0	0	285
CASSAVA LEAVES	532255	450071	4440	2165	988931
					<b>10720683</b>
PINEAPPLE	25613984	17342112	3863	1076	42961035
MARACUJA	5572565	5138210	152	36079	10747006
AVOCADO	6060207	5226946	1236	98104	11386493
MANGO	176161	72990	0	2063	251214
IBINYOMORO	73	0	10	0	83
AMAPERERA	51201	50006	783	0	101990
CITRUS	1222373	1110475	48	0	2332896
PAPAYER	686357	525	120	0	687002
ORANGE	5914090	1126787	1	0	7040878
PEPPER	70415	70025	0	0	140440
					<b>75649037</b>
CATTLE	8454	480	1551	0	10485
GOAT	22817	1230	8253	460	32760
SHEEP	3466	90	48	0	3604
EGGS	15370	40	13085	40	28535
MILK	34841	560	2512	25090	63003
CHICKEN	44519958	44400952	12675	92030	89025615
RABBIT	83	0	22	0	105
PIG	2109	0	10	0	2119
FISH	17163898	159099945	75366	1178192	1363367
COW BUTTER	61174	0	5	61152	122331
BREAD	0	0	0	0	0
CAKES	95	0	0	0	95
FISH	16482139	15473040	3750	1005105	32964034
CANARD	20	0	0	20	40
TURKEY	0	0	0	0	0

## Annex 11: Fruit and Vegetable Exports 2006-2007 (kg.)

EXPORTS					
COMMODITIES	TO DRC	TO BU	TO UG	TO TZ	TOTAL EXPORTS
SORGHUM	4414627	3801890	39978	678	8257173
MAIZE	2491702	2356732	54787	6670	4909891
MAIZE FLOUR	7786109	1458115	221324	845	9466393
WHEAT	19159	16376	1753	100	37388
WHEAT FLOUR	318677	152	84	316040	634953
BEAN	63968640	62098868	24256	103170	126194934
PEAS	2201724	2018167	17061	154341	4391293
PEANUT	856301	700229	866	4789	1562185
SUNFLOWER	326	0	0	180	506
CASSAVA	2854181	2780631	304	655	5635771
SWEET POTATO	405098	178707	290	1001	585096
IRISH POTATO	50322580	48896713	67219	939256	100225768
COOKING BANANA	2144489	583749	1000730	307328	4036296
BANANA FOR WINE	354291	195	101	286	354873
APPLE BANANA	125443	1205	273	252	127173
CASSAVA FLOUR	1507275	922452	565	40	2430332
SORGHUM FLOUR	514343	10002	1870	600	526815
SUGARCANE	24093	10	11	142	24256
PALM OIL	793477	778830	0	124	1572431
TARO	301041	300000	0	265	601306
SOYA	2047713	1956661	2	807	4005183
DRY CASSAVA	34023	1495	2	78	35598
RICE	2087	0	222	1830	4139
MILLET	1356	450	183	20	2009
SOSOMA	9210	0	0	0	9210
VEGETABLE OIL	628911	50	0	0	628961
HONEY	79093	0	0	0	79093
PEANUT OIL	230	0	0	0	230
CABBAGE	276402	88928	12849	4420	382599
TOMATO	778555	259232	1609	132744	1172140
POIREAU	1688881	54170	435	2089	1745575
CARROT	1420015	1404270	1601	893	2826779
ONIONS	575932	563685	930	396	1140943
SPINACH	9522	20	10	0	9552
EGG PLANT	161664	35230	5003	0	201897
POIVREAUX	21899	0	0	0	21899
CERELI	8958	0	0	0	8958
CASSAVA LEAVES	12549	75	2	10	12636
					<b>7522978</b>
PINEAPPLE	6803	196	1	478	7478
MARACUJA	37974	8327	0	10254	56555
AVOCADO	47339	5926	885	810	54960
MANGO	10752	1100	0	2	11854
IBINYOMORO	11366	0	0	0	11366
AMAPERA	3920	0	0	0	3920
CITRUS	123524	100000	0	0	223524
PAPAYER	19120	70	0	0	19190
ORANGE	43419	140	70	0	43629
PEPPER	23063	40	0	0	23103
					<b>455579</b>
CATTLE	93289	25181	22	0	<b>118492</b>
GOAT	76500	4836	53	5	<b>81394</b>
SHEEP	22551	62	132	0	<b>22745</b>
EGGS	35460	0	15	0	<b>35475</b>
MILK	123998	16907	549	140	<b>141594</b>
CHICKEN	458262	381387	779	80	<b>840508</b>
RABBIT	29978	0	0	0	<b>29978</b>
PIG	7599	0	0	0	<b>7599</b>
FISH	203268	5704	0	11248	<b>220220</b>
COW BUTTER	71624	0	0	20	71644
BREAD	110	0	0	0	110
CAKES	445669	0	0	0	445669
FISH	86590	2852	0	5624	95066
CANARD	1	0	0	0	1
TURKEY	71	0	0	0	71
GOAT AND SHEEP SKIN		0	0	0	0

## Annex 12: List of Contacts Met Over the Course of the Study

### **Rwanda**

Loraine Ronchi, Economist, Agriculture and Rural Development, Rwanda Country Office, The World Bank (Tel. 591314, e mail [ironchi@worldbank.org](mailto:ironchi@worldbank.org))

Valens Mwumvaneza, Agriculture and Rural Development Specialist, Rwanda Country Office, The World Bank (Cell 0788464196, Tel. 591397, e mail [vmwumvaneza@worldbank.org](mailto:vmwumvaneza@worldbank.org))

Martha Byanyima, Project Director for the Rwanda Horticulture Export Standards Initiative (RHESI) (E-mail [marthb.rhesi@gmail.com](mailto:marthb.rhesi@gmail.com))

Janet Kangaho, Sales and Marketing Director, Rwanda Tea Authority OCIR THE (Tel 55100377, Mobile 0788305042, E mail [j.basiima@rwandatea.com](mailto:j.basiima@rwandatea.com), [basiima@rwandatea.com](mailto:basiima@rwandatea.com))

Wilfred Rwigamba, Planning Officer, OCIR THE (Mobile 0788528034)

G. Nihal Bopearatchy, Managing Director (Mobile 0788303101, e mail [rwdmountaintea@yahoo.com](mailto:rwdmountaintea@yahoo.com)), Rwanda Mountain Tea Rubaya – Nyabihu Tea Factories

Jolly Dusabe, Project Coordinator, Rural Sector Support Project, Republic of Rwanda Ministry of Agriculture and Animal Resources (Mobile 0788 301751, e mail [j.dusabe@rssp.gov.rw](mailto:j.dusabe@rssp.gov.rw))

Emmanuel Grosjean, Assistant Technique, Appui a la Filiere Horticole du Rwanda (Cell 0788564493, e mail [Emmanuel.grosjean@btcctb.org](mailto:Emmanuel.grosjean@btcctb.org)) and Eric Kabayiza, Head/Production Unit, RHODA (Cell 0788 53757, E mail [kabayeric@yahoo.fr](mailto:kabayeric@yahoo.fr))

Ephrem Niyonsaba, Stakeholders Manager, Technoserve, Rwanda (Cell 0788 303702, e mail [ephrem@tnsrwanda.org.rw](mailto:ephrem@tnsrwanda.org.rw))

Aime Gakirage, East African Growers (Mobile 0788303641, e mail [agakirage@yahoo.com](mailto:agakirage@yahoo.com))

Salim Abdulgani, Country Manager, Salute Rwanda Ltd.(Supplier of produce to Nakumatt-Kigali) (Mobile 0783215643, e mail [saluterwanda@yahoo.com](mailto:saluterwanda@yahoo.com))

Charles Murekezi, Ph.D., IITA Post-Doctoral fellow/Minagri Banana Researcher (Mobile 0783008453, e mail [charlesmurekezi@yahoo.co.uk](mailto:charlesmurekezi@yahoo.co.uk))

Rombe Salum, Technical Director, Shema Fruits (fruit processing factory in Butare), Mobile 0788503640, e mail [rombesam2@yahoo.fr](mailto:rombesam2@yahoo.fr))

J.C. Alles, Director General, SORWATHE S.A.R.L. (Mobile 0788306673, e mail [jcalles@rwanda1.com](mailto:jcalles@rwanda1.com))

Donatille Nibagwire, Director, Floris (exporter of organic fruit, trader in fruit and vegetables on local market and also flower boutique owner) (Tel. 250 5128734, Mobile 0788 534846, e mail [florisrwanda@yahoo.fr](mailto:florisrwanda@yahoo.fr))

Theonase Munana, Director of Production (Mobile 0788306334, e mail [tmunana@yahoo.fr](mailto:tmunana@yahoo.fr)) and Gloria Mukankuranga, Director General (Mobile 0788301836), SORWATOM

Janvier Gasasira, SPSPAT/KWAMP Coordinator in MINAGRI, (Tel 55116716) email: [papstacoordinator@minagri.gov.rw](mailto:papstacoordinator@minagri.gov.rw)

Ernest Ruzindaza, Director, Planning, Policies and Capacity Building, MINAGRI, Republic of Rwanda (E mail [ruzindazaernest@yahoo.fr](mailto:ruzindazaernest@yahoo.fr))

Agnes Kalibata, Minister of State, MINAGRI, Republic of Rwanda (E mail [kalibatts@yahoo.co.uk](mailto:kalibatts@yahoo.co.uk))

P.Damien Mbatezimana, Managing Director, Shekina Enterprises (Mobile 0788309009, e mail [shekio5@yahoo.fr](mailto:shekio5@yahoo.fr))

Gerard Sina, Owner and Director, Entreprise Urwibutso (Mobile 0788302999, e mail [sina@rwanda1.com](mailto:sina@rwanda1.com))

Nils Zirimwabagabo, Project Coordinator, Inyange Extension Project, Inyange Industries (Mobile 0788301451, e mail [nzirim@yahoo.com](mailto:nzirim@yahoo.com))

George Mashinkila, Agricultural Economist-Investment Officer, FAO Sub-regional Office for Eastern Africa (Mobile +251 911 509535, e mail [George.Mashinkila@fao.org](mailto:George.Mashinkila@fao.org))

Mr. Ndahiro, Head of Export Statistics, Rwanda Development Board (Mobile 0788747399)

Innocent Niyonsaba, Agricultural Statistics Specialist, National Institute of Statistics of Rwanda (Mobile 0788614610, e mail [amatus@rocketmail.com](mailto:amatus@rocketmail.com))

Viviane Mwitirehe, Director, Statistics Department, National Bank of Rwanda (BNR) (Mobile 0788309163)

Mr. Potien, Director of Planning, OCIR Café (Mobile 0788303709)

Emmanuel Uwemeyinkiko, Accountant, OCIR Café (Mobile 0788561511)

Robert Bayigamba, Chief of Board of Directors, Private Sector Federation (Mobile 0788301309, E mail [bayirob@yahoo.fr](mailto:bayirob@yahoo.fr))

Clementine Mukarukundo, Internal Trade Department, MINICOM (Mobile 0788878114)

Bisa Samali Octavien, Senior Investment Advisor, MINECOFIN (Mobile 0788303658, e mail [bias.octavien@minecofin.gov.rw](mailto:bias.octavien@minecofin.gov.rw))

**Traders and Farmers Interviewed by Sulaiman Kyambadde**

Issa Gihigi, Banana Transporter

Olive Kaneza, Retail Trader (Mobile 078894547)

Muhamud Kanyandekwe, Retail Trader

James Bugwiza, Transporter (Mobile 0788224992)

Idarus Nkusi, Retail Trader (0788581739)

Zainab Mukankusi, Dessert Banana Wholesaler (Mobile 0788764049)

Emmanuel Nyirindekwe, Cooking Banana Farmer

Innocent Uwamahoro, Pineapple Farmer (Mobile 0788873734)

Alex Kabagambe, Pineapple Farmer (Mobile 0788305735)

Desire Nvunabandi, Avocado Farmer

Laurent Twayigize, Cooking Banana Farmer (Mobile 0788570699)

J. Batiste Munyakyanza, Beer Banana Farmer

Dorosera Nyiransababera, Pineapple Farmer

Tharcisse Tugeregeze, Avocado Farmer

## **KENYA**

David Wakaba, Packhouse and Operations Manager, Greenland Agro-Producers Ltd., E mail [dwakaba@greenland.co.ke](mailto:dwakaba@greenland.co.ke)

Paresh Patel, Director, Fresh An Juici Ltd – suppliers of fresh produce to Kenya and Uganda Nakumatt Supermarkets (Tel. (254) 20 826090, Cell (254) 733 602455, E mail [paresh@freshanjuici.co.ke](mailto:paresh@freshanjuici.co.ke)) and Sundip Jethalal (Cell (254) 722 344743, E mail [sundip@freshanjuici.co.ke](mailto:sundip@freshanjuici.co.ke))

Henry Kinyua, Senior Business Manager/Team Leader – Horticulture, TechnoServe Kenya (Tel. (254) 20 375433, Cell (254) 733 812319, E mail [hkinyua@technoserve.or.ke](mailto:hkinyua@technoserve.or.ke))

Moses Ndirangu, Technical Manager, East African Growers Group, Tel. (254) 20 827485/827488/823539, Cell (254) 720 372015, E mail [mose@eaga.co.ke](mailto:mose@eaga.co.ke)

Hasit Shah (Tiku), Managing Director, Sunripe Ltd. And Chairman of FPEAK, Tel. (254) 20 827993/822518, Cell (254) 722 742244, E mail [tiku@sunripe.co.ke](mailto:tiku@sunripe.co.ke)

Hilary Kandi, Sales Manager, Bureau Veritas, Tel. +254 20 4450560-64, E mail [sales.nairobi@ke.bureauveritas.com](mailto:sales.nairobi@ke.bureauveritas.com)

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