

# **Agricultural Analyses and Design** ***Analyses Agricoles et Conception***


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## **COLD CHAIN FOR AGRICULTURAL PRODUCTS IN RWANDA**

By

**Andrew Friend**  
**Ricardo Frohmader**

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## TABLE OF CONTENTS

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PREFACE.....	i
EXECUTIVE SUMMARY.....	ii
LE SOMMAIRE EXECUTIF.....	v
A. Introduction.....	1
B. The Cold Chain in Rwanda for Milk, Meat and Fish.....	1
1. The Airport Cold chain Facility: MAGERWA site.....	2
2. Chipped ice/ Ice blocks: The Bralirwa Ice factory.....	3
3. The Fish Cold Chain.....	3
C. Cold Chain For Fruits And Vegetables In Rwanda .....	4
1. Present State Of The Cold Chain for Horticultural Crops .....	5
2. Future Needs For A Developed Cold Chain .....	6
ANNEX A: COLD STORAGE FACILITIES FOR MEAT AND MILK.....	1

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## PREFACE

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The Agricultural Analyses and Design (AAD) activity is an eight-month design activity undertaken by the Chemonics International RAISE Consortium through funding supplied by USAID/Rwanda. USAID/Rwanda is using this study and design effort to support its Strategic Objective Number Three (SO3) *to increase the ability of rural families in targeted communities to improve household food security*. Specifically, USAID seeks to obtain information and proposed intervention strategies, approaches and activities suitable for USAID/Rwanda's support in achieving the second Intermediate Results under SO3 (IR3.2) of *creating and enhancing internal production / marketing chains that promote broad-based economic growth*. The purpose of AAD, therefore, is to provide USAID/Rwanda directions and information for their use in future development and eventual funding of a project that seeks to revitalize agribusiness in Rwanda and recreate links between the rural sector and private sector traders and processors. This USAID project will achieve its objective by addressing identified constraints and opportunities within the commodity chain for increasing economic growth via agricultural production and agribusiness. The principal task of AAD is to identify these constraints and opportunities.

The Agricultural Analyses and Design activity is divided into three phases. The first phase (two months) is to identify and recommend for in-depth study to USAID/Rwanda those commodity chains and interventions that have the most potential for creating increased economic growth, internal and external trade, opportunities for employment and increased income. The second phase (four months) will consist of a number of in-depth studies. Some studies will look at crosscutting issues such as transportation, finance and economic policy. An additional study will look at the creation of Agribusiness Support Centers. The remaining studies will be in-depth analysis of interventions related to commodity chains identified in phase one and selected for study by USAID/Rwanda. The results of these studies will provide the basis for phase three of the activity, the synthesis of the studies done in phase two and development of a technical proposal and supportive design components for USAID/Rwanda's use in developing a request for proposal (RFP) for a project to support IR3.2.

Dr. Andrew Friend and Mr. Ricardo Frohmader wrote this report as the result of two separate visits to the country. Dr. Friend was in Rwanda from 19 February to 4 March 2000 and Mr. Frohmader was in country from 25 February to 2 March 2000.

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## EXECUTIVE SUMMARY

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### **Cold Chain for Meat, Milk and Fish**

A cold chain is one of the most critical requirements to guarantee the quality of agricultural products as they move from the farm to the consumer. There are a number of obvious breaks and weaknesses in the present cold chain for milk, meat and fish products. During the war much of the refrigeration equipment for dairies, slaughterhouses, meat-processing facilities, fish storage and shop display was stolen or destroyed. The lack of trained engineers in refrigeration and electrical renovation, combined with a lack of investment and working capital, has resulted in many former operations still remaining out of action.

Aside from individual cooling units in some dairies and meat operations, there are only two cold chain facilities in the country. These are the airport cold chain facility run by MAGERWA and the Bralirwa ice making facility.

The MAGERWA facility is comprised of three positive temperature controlled refrigerated 40-foot containers and one flexible Positive and Negative temperature container. The 40-foot containers are able to hold 18- 20 tones of palletted de-boned, vacuum-packed meats. The refrigerated flexible temperature container may be hired with transport to collect meat orders from the slaughterhouse's cold stores and brought directly to the awaiting plane.

The Bralirwa ice unit is located at the site of the soft drink factory in Kicukiro. Currently about ninety-five percent of the ice is used for soft drink deliveries and soft drink cold storage at events such as weddings. The remaining five percent is used for cold transportation of fish to retail outlets. There was a second ice unit at Gisenye, but it is now out of use.

One of the more critical areas is the cold chain for fish. Fish farming in Rwanda is growing and has a bright future, but post harvest losses as a result of a poor cold chain are considerable. It is estimated that fifteen to twenty percent of fish is lost from the primary producer to the retail outlet. Fish processing and cold storage in Rwanda is minimal. Several projects tried to establish cold storage in the past, but they were not sustained after the closure of the projects.

### **Cold Chain for Fruits and Vegetables**

Rwanda is located nearly at the equator, with an elevation of 1,200 meters or higher. It has a climate that is sub-tropical rather than tropical. The country is mountainous and small, with ninety percent of the population living in rural areas. Most products are taken to market the day they are harvested, and because of the mild climate, appear to stand up fairly well. There is no cold chain, and one could not be easily justified for locally consumed fruits and vegetables.

Even though a cold chain is not a priority for local fruits and vegetables, it becomes a necessary adjunct to the development of horticultural exports. These crops must be cooled to the appropriate temperature and held in refrigeration at this same temperature from harvesting to departure. The cold chain has two main components, one for pre-cooling, and one for holding.

Pre-cooling must be accomplished for most export horticultural products soon after harvest. This can be done by means of forced air-cooling systems, hydrocooling, vacuum cooling or through the use of package ice. The method used depends on the crop, the volume being pre-cooled and costs.

Cold storage must be available while the product is awaiting transport. Complementary materials, such as insulated master packaging (e-containers) will be needed for certain of the exports (*e.g.* small fruits), to avoid heating of the product in transit. In this case, gel packs will be needed. These could also be used in the export of certain cut flowers.

At the time of the study, there are no pre-cooling or cooling facilities for fruits or vegetables in Rwanda. The sole flower producing and exporting company in Rwanda, does have a cold chain consisting of a fast cooling and a cold holding room. As noted above, MAGERWA has some refrigerated containers at the airport, but they are not well suited to the needs of perishable horticultural exports.

A cold chain does not appear to be critical for Rwanda's other current horticultural exports. These include bananas picked green and ripened in Belgium, passion fruit picked before abscission of the fruit from the stem, and physalis. These products are moderately hardy, and Kigali temperatures in the shade and at night are not extreme. In any case, these fruits are picked and packed the day before shipment, or on that very day. They also arrive at their destination no more than 48 hours after picking

The expansion of Rwanda's horticultural exports will require the development and expansion of a cold chain. The likelihood is that this cold chain will be enterprise based and will consist of pre-cooling and cold storage facilities such as those that are in place at the present flower exporter. In addition to these facilities, it will also be necessary for exporters to have a refrigerated means of conveying their products to the airport.

As exports develop, it may be useful to build an appropriate refrigerated storage system at the airport to accommodate the different types of product being shipped from Rwanda. In designing and building such a facility, care will need to be taken to ensure that the various temperature requirements of different products are accommodated. It will also be necessary to separate ethylene generation from ethylene sensitive products. Such a system could be developed through an exporter's association, or as a private venture.

There appears to be little call for Rwandan cold storage networks to be built at public for locally consumed crops, since there is very little demand for cold storage of these perishables. Many vegetables and root crops, such as cassava and sweet potato, appear to be in continual supply.

Potatoes might be the one crop in which cold storage could be economically justified. There is considerable price fluctuation between harvest and non-harvest times. These price differentials may eventually stimulate the construction of private sector or cooperative owned storage for the express purpose of capitalizing on these seasonal price variations. If a garlic or storage onion industry develops, storage could also be of use in the keeping of these products.

There appears to be substantial promise of Rwanda becoming a supplier of certain highland vegetables and fruits to the lowland and coastal areas of East Africa. If this is undertaken, there will be a need to develop the cold chain for the assembly, grading, packing, cooling and storage of products that then could be transported by refrigerated truck to market destinations like Nairobi, Mombassa, and Dar es Salaam. This development could also create a demand for refrigerated trucks. Currently, the tendency in the region is to buy used equipment in Europe and ship it to East Africa. This is questionable, given the lack of adequate maintenance services for these refrigeration units.

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## LE SOMMAIRE EXECUTIF

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Une conservation frigorifique sûre est essentielle à la sécurité et la qualité de la viande et des produits laitiers, du poisson et d'autres produits horticoles.

### **Conservation frigorifique de la viande, des produits laitiers et du poisson**

La conservation frigorifique est une des premières nécessités qui garantissent la qualité des produits agricoles dans leur transport à partir de la ferme vers le consommateur. Il existe un nombre de rupture et de défaillance évidentes dans la chaîne de conservation frigorifique pour le lait, la viande et le poisson. Pendant la guerre, la plupart des équipements frigorifiques des fermes, abattoirs, facilités de transformation de la viande, conservation du poisson ainsi que ceux destinés à l'échelonnage des produits ont été détruits. Le manque d'ingénieurs de formation dans les domaines de réhabilitation électrique ajouté au manque d'investissement et des capitaux de fonctionnement a eu pour conséquence l'arrêt complet de plusieurs anciennes opérations.

A part les unités individuelles de conservation frigorifique dans certaines fermes et boucheries, il n'y a que deux facilités de chaîne de conservation frigorifique dans tout le pays, celle de l'aéroport gérée par MAGERWA et l'unité de fabrication de la glace gérée par la BRALIRWA.

L'unité de MAGERWA est composé de trois conteneurs frigorifiques de 40 pieds (12 m) sous une température positive, et un autre pouvant fonctionner sous température négative et positive. Les conteneurs de 40 pieds sont capables de contenir 18 à 20 tonnes de viande, tandis que le conteneur à température positive et négative peut être loué pour le transport de la viande à partir des chambres froides des abattoirs jusqu'à l'avion devant transporter la viande.

L'unité frigorifique gérée par BRALIRWA est située sur l'emplacement de la limonaderie à Kicukiro. Actuellement, environ 95% de la glace produite est utilisée pour les livraisons des boissons sucrées et lors des cérémonies telles que les fêtes de mariage pour garder au frais les boissons. Les 5 % qui restent sont utilisés pour garder au frais les poissons lors de leur livraison aux petits vendeurs.

La préparation du poisson et sa conservation frigorifique au Rwanda constituent des activités secondaires. Plusieurs projets ont essayé dans le passé de mettre en place des chambres froides mais ses dernières n'ont pas pu se maintenir après la fin des projets.

### **Conservation frigorifique pour les fruits et les végétaux**

Le Rwanda se situe aux environs de l'équateur à une altitude de 1.200 m. Il jouit d'un climat sous tropical au lieu du climat tropical. Le pays est montagneux et petit, et 90% de sa population vit dans les zones rurales. Ainsi, la plus grande partie des produits est acheminée vers les marchés le même jour que leur récolte et, à cause du climat doux, ces produits semblent se conserver plus ou moins bien. Il n'y a pas de chambre froide, et on ne peut justifier l'existence d'une chambre froide pour les fruits et les légumes pour la consommation locale.

Même si, l'existence d'une facilité frigorifique n'est pas une priorité pour la production locale des fruits et des légumes, cela devient une nécessité secondaire au développement des exportations de produits horticoles. Ces produits doivent être gardés au frais à une température adéquate et conservés dans des chambres froides à cette même température à partir du moment de leur récolte jusqu'à leur livraison. La chaîne de conservation frigorifique a deux composantes importantes, l'une est l'avant conservation l'autre est la conservation proprement dit. L'avant conservation doit être effectuée pour la plupart des produits horticoles à exporter immédiatement après la récolte. Ceci peut être effectué selon différents moyens qui comprennent entre autres ; l'usage des systèmes de passage de l'air froid, refroidissement à l'eau, refroidissement à vide d'air ou par l'usage des blocs de glace. La méthode utilisée dépend de la nature du produit, de la quantité destinée à l'opération de pré-conservation et du coût de l'opération.

Les chambres froides doivent être disponibles pendant que le produit attend d'être transporté. Le matériel complémentaire tel que les conteneurs à parois isolés seront nécessaires pour certaines exportations telles que les petits fruits, pour éviter l'échauffement du produit en transit. Dans ce cas, des paquets de gel seront nécessaires et pourront même s'avérer utile pour l'exportation des fleurs.

Au cours de l'étude sur la conservation frigorifique, il n'y avait pas de facilité de pré-conservation ou de conservation frigorifique des fruits et des légumes. La seule société de production et d'exportation de fleurs au Rwanda a une unité de conservation frigorifique qui est constituée d'une chambre de refroidissement accéléré et d'une chambre froide à température ambiante. Comme cela a été mentionné précédemment, MAGERWA dispose de conteneurs frigorifiques à l'aéroport mais ils ne sont pas bien équipés pour accueillir les produits horticoles périssables destinés à l'exportation.

Une chaîne de conservation frigorifique semble ne pas être importante pour les autres produits horticoles d'exportation. Ceux-ci comprennent notamment, les bananes vertes qui sont mûries en Belgique, les fruits de la passion qui sont cueillis avant que le fruit ne se sépare de la tige mère, et les physalis. Ces produits sont plus ou moins durs et les niveaux de température (à Kigali) à l'ombre et pendant la nuit ne sont pas extrêmes. De toute façon, ces fruits sont cueillis et emballés la veille ou le jour même de leur transport, et arrivent à destination pas plus tard que 48 heures après leur cueillette.

L'expansion des exportations horticoles au Rwanda nécessitera le développement et l'expansion d'une chaîne de conservation frigorifique. Il est probable que cette chaîne soit sous forme d'entreprise et consiste des facilités de pré-conservation (pre-cooling) et de chambre froides telles que celles qui sont en place à l'entreprise d'exportation de fleurs. En plus de ces facilités, il sera nécessaire que les exportateurs disposent également des facilités frigorifiques pour transporter leurs produits vers l'aéroport.

Comme le secteur d'exportation se développe, il serait utile de mettre en place un système approprié de stockage frigorifique à l'aéroport, qui puisse accueillir les différents types de produits transportés à partir du Rwanda. Au moment de l'étude et de la construction d'une telle facilité, l'attention devra être mise sur le fait que les températures diverses requises pour

différents produits sont tenues en considération, et sur le fait que les produits générateurs de l'éthylène sont séparés de ceux qui lui sont sensibles. Ceci peut être développé par le biais d'une association des exportateurs, au une compagnie privée.

Il semble qu'il y ait peu d'enthousiasme pour la construction des facilités de conservation frigorifique au Rwanda pour des produits de consommation locale puisqu'il y a très peu de demande pour ce genre de conservation de produits périssables. Beaucoup de légumes semblent être approvisionnés sur les marchés d'une façon continue. C'est aussi le même cas pour les tuberculeux tels que le manioc et la patate douce.

La pomme de terre pourrait être le seul produit pour lequel la conservation frigorifique pourrait être économiquement justifiable. Il y a une fluctuation considérable des prix entre les périodes de la récolte et de la non récolte. Ces écarts entre les prix peuvent éventuellement servir de stimulant pour la construction des facilités de conservation appartement au secteur privé ou à une coopérative, et ceci dans le seul but de profiter des variations de ces prix saisonniers. Si l'industrie de culture de l'ail ou de conservation de l'oignon se développeraient, les chambres froides pourraient également être d'une grande utilité dans la conservation de ces produits.

Il semble qu'il y ait des promesses substantielles selon lesquelles le Rwanda deviendrait un fournisseur de légumes et de fruits des régions de haute altitude, aux régions de basse altitude et celles des côtes de l'Afrique de l'Est. Si ce projet se réalisait, il y aurait un besoin urgent de développer des chaînes de conservation frigorifique pour la collection, la classification, l'emballage, la conservation et l'entreposage de ces produits, qui pourraient de ce fait être transportés par les camions frigorifiques vers les marchés de destination comme Nairobi, Mombasa et Dar es Salaam. Ce développement pourrait également susciter la demande pour les camions frigorifiques. Actuellement, la tendance dans la région est d'acheter des équipements usagés en Europe et les transporter en Afrique de l'Est. Ceci est incompréhensible vu qu'il n'y a pas de services appropriés pour l'entretien de ces unités frigorifiques.

## **A. Introduction**

Cold chains are an essential part of modern agricultural marketing. They consist of a series of refrigerated or ice-based equipment and procedures to maintain food product at the desired temperature to prevent spoilage and maintain quality of the product. The establishment of an appropriate and cost effective cold chain is not yet wide spread in Rwanda. A few establishments have their own private systems but other than that there is very little in place. Several donor-funded projects have tried to put an effective cold chain into place but these have all failed.

This brief study looks first at the present situation for cold chains for meat, milk and fish products and then horticultural products.

## **B. The Cold Chain in Rwanda for Milk, Meat and Fish**

A cold chain is one of the most critical requirements to guarantee the quality of the processed product from the farm to the consumer. There are a number of obvious breaks and weaknesses in the present cold chain for milk, meat and fish products. During the war much of the refrigeration equipment for dairies, slaughterhouses, meat- processing facilities, fish storage and shop display was stolen or destroyed. The lack of trained engineers in refrigeration and electrical renovation, combined with a lack of investment and working capital has resulted in many former operations still out of action.

Some of these facilities are being partially restored in a phased approach. Unfortunately, many of these facilities have their priorities directed towards production and processing for direct sales to the market without attention to the quality and shelf life of the product.

This has led to:

- ! Lack of husbandry and good hygienic practices at the producer level
- ! Poor quality products
- ! Low hygiene standards of production process and final product
- ! Poor cold storage at processing factory/premises
- ! Poor delivery of product to retailer or trader: lack of refrigerated vans and lorries
- ! Poor display refrigeration cabinets- leading to a short shelf life
- ! Short expiry period in the home of the end user/consumer
- ! In turn, there is a poor feed- back of recommendations for the farmer/producer
- ! Limited export opportunity for sale of red meat/fish/dairy produce: therefore minimum facility available for cold storage at the Airport

The national cold storage capacity for milk, meat and fish products is summarized in the Annex A

The requirements of a good cold chain for meat and milk products is summarized as follows:

- ! Positive Cold rooms for 3, 6, 12 and 16 degrees Centigrade
- ! Negative cold room freezers: + 5- Minus 18 degrees Centigrade
- ! Refrigerated milk tankers- 3000-6000 liters
- ! Insolated Aluminum 1000 Liter milk tanks for Pick up trucks
- ! Refrigerated delivery 2-ton vans/camionettes.
- ! Refrigerated cutting rooms/ processing operations
- ! Refrigerated shop/supermarket display cabinets.
- ! Availability of Ice production and crushing for layered cold storage
- ! Availability of modern techniques for cold storage: Dry ice et al

### **1. The Airport Cold chain Facility: MAGERWA site**

Aside from the individual cooling units in some dairies and meat operations, there are only two cold chain facilities in the country: the airport cold chain facility run by MAGERWA and the Bralirwa ice making facility at Kicukiro. The consultants made a visit to the container go-down area of MAGERWA and to the Airport cold storage facilities. The current situation and future developments were outline by Mr Willy Makelberge, the Director General and Nr Thomas Niyongira, the Assistant General Manager. The duty manager Mr Medard Ruzundana demonstrated the cold storage capability.

The basic facility is comprised of three positive temperature controlled refrigerated 40 foot containers and one flexible Positive and Negative temperature container:

- ! X3 for 0, +6 and +14 for fruit, vegetables and flower export holding.
- ! X1 for -5 degrees C to -20 degrees C negative temperature for chilled and frozen meat and fish.
- ! X1 currently on loan to a dairy
- ! X1 planned to be added in the year 2000 (40 foot flexible temperature controlled)

The 40-foot container can hold 18-20 tones of palletted de-boned, vacuum packed meats. This could be possibly used for the beef and goat exports for the proposed contracts to the Middle East. JAMA Marketing and Trading with Managing Director Mr. Mahmoud Salem are currently exporting meats from Uganda to Egypt at \$1.45 per Kg Airfreight in 10 ton consignments. The Egypt Air tariff from Kigali is quoted as \$1.60 per Kg delivered to Cairo, which makes the finished Kg price competitive.

The refrigerated flexible temperature container may be hired with transport to collect meat orders from such places as the Nyagugogo Slaughterhouse cold stores and brought directly to the awaiting plane. The price renting the MAGERWA containers run from \$250 per month for the 20-foot container non refrigerated to \$400 per week for the 40-foot container refrigerated (flexible). These prices are also negotiable on a daily rate. MAGERWA has indicated that it is open to expansion plans for cold storage with growing exports of meat, fish, fruit, vegetable and exotic plants.

## **2. Chipped ice/ Ice blocks: The Bralirwa Ice factory**

The ice factory is on the site of the Primus Beer and soft drinks factory in Kicukiro. At the present time about ninety-five percent of the ice is used for soft drinks deliveries and to cool soft drinks at events such as weddings. The remaining five percent is used for cold transportation of fish to retail outlets. There was a second ice factory at Gisenye but it is now out of use.

The production capacity of the Bralirwa factory is 200 x 25 kg blocks per day from 2 shifts. 3 shifts could be used when the demand is high to produce 7000 + Kg per day. The compressor, water ice bank and refrigeration line, processed half metre 25 kg block conveyor are well maintained and hygienic. There is a shortage of ice chip making equipment that is vital if the cold chain improvement standards for milk, meat and fish are enforced within the country in the next 2 years.

There is no current experimentation with ice chips, the efficiency of layering techniques and the recommendations for ice per Kg transported per hour within Kigali/Rwanda.

The ice factory could be expanded at low capital cost and provides a vital low cost link in raw and processed product collection and delivery.

## **3. The Fish Cold Chain**

Fish farming in Rwanda is growing and has a bright future. The sector has all the natural advantages of inland lakes, easy transportation distances and cheap labor required for development and expansion of the sector.

The Fisheries Industry report for 1999(FAO) outlines the constraints and opportunities for the future and cites the expansion of community-based fisheries development. The constraints are summarized as:

- ! Institutional and Organizational Capacity
- ! Scientific and Technical constraints
- ! Human Resource constraints
- ! Economic constraints
- ! Training constraints

One of the most significant constraints is the high level of post harvest losses. Post harvest losses as a result of a poor cold chain implementation in the industry are cited fifteen to twenty percent from the primary producer to retail outlet.

Data from the analysis of national fish production in 1992 and the National Fisheries Strategy of 1998, estimates a potential increase in 4,700 tonnes of fish production from new sources including flood plains. Fish consumption per head in Rwanda is currently low at 1 Kg per person per year but is predicted to grow in the future. The international average for fish consumption is 13.0 Kg per head/year- if half this average were achieved then demand for some 48,750 tons of fish would be required per year.

At the present time, however, fish processing and cold storage in Rwanda is still minimal. Apart from evisceration, few fish are processed in Rwanda at the present time. With local fish production at low levels, most fish are sold fresh as there is not enough to commercially process. But as noted above this could change.

A typical regular buyer at Lake Nasho can be used as an example of how the present cold chain system for fish works. The buyer arrives late afternoon at the Associations' weighing station. By the time he gets there some of the fish are already of poor quality, having been caught hours before in the morning. The buyer is equipped with a small pick up truck loaded with a large insulated cooler of ice. The buyer brings in all ice got packing himself for the return trip to the urban centers, mainly Kigali, as no ice-producing units are available on site at any of the lakes. The fish are layered with the ice in the cooler for transport to market.

Several projects have tried to establish cold storage facilities in the past, but they were not sustained after the closure of the projects. With difficulties in maintaining electrical or gasoline driven freezing units on the lakes, it may be possible to consider transporting blocks of ice to the lakes for holding fish in insulated storage units. Such ice could be transported packed in sawdust and the sawdust could later be used for smoking the fish. This would ensure wood conservation and increase efficiency in processing.

### **C. Cold Chain For Fruits And Vegetables In Rwanda**

While Rwanda is located on the equator, most of the inhabited areas are 1,500 meters or higher in elevation. The climate is sub-tropical rather than tropical. The country is mountainous and small. Ninety percent of the population is rural. Most products appear to be taken to market the day they are harvested, and because of the mild climate appear to stand up fairly well. There is no cold chain, nor could one easily justify one for fruits and vegetables for local consumption.

Even though cold chain is not a priority for local production of fruits and vegetables, it becomes a necessary adjunct to the development of horticultural exports. These must be cooled to the appropriate temperature and held in refrigeration at this same temperature prior to departure. The cold chain for fruits and vegetable usually has two main components, one for pre-cooling, and one for holding.

A cold chain must be available for pre-cooling exports horticultural products soon after harvest. Usually this is done by means of forced air cooling systems, in which rapidly flowing cold air is moved through the product. It is important that the air be very moist, so as to minimize dehydration of the product. This system is most commonly used with flowers and berries, as well as with products that do not adapt to immersion in water.

Another way of rapid cooling some fruits and vegetables is by hydrocooling. In this case cold water is used to remove field heat from the product. This system requires clean water and great care to maintain the purity of the water. Dirty water can become a means of spreading disease and consequently ruining the product. It is commonly used in melons, in peas and in beans in some countries such as the United States and Mexico.

There are a couple of other ways of reaching desired temperature rapidly- one involves vacuum cooling which is often used on leafy crops and vegetables without a cavity. It is in wide use in the United States, requires considerable volumes, and is expensive.

Another system also used with crops such as broccoli and leafy vegetables like salad onions involves the use of package ice. Ice is mixed with water and injected throughout the already packed parafinated carton, filling up all the air spaces with ice granules. Again this is a system used in combination with truck shipment of vegetables, and is not recommended for Rwanda.

Cold storage must be available while the product is awaiting transport. Complementary materials, such as insulated master packaging (e-containers) will be needed on certain of the exports (*e.g.* small fruits) to avoid heating of the product in transit. In this case gel packs will be needed, which will also be of use in the export of certain cut flowers.

### **1. Present State Of The Cold Chain for Horticultural Crops**

As of this writing, there are no pre-cooling or cooling facilities for fruits or vegetables in Rwanda. Highland Flowers, the sole flower producing and exporting company in Rwanda, does have a cold chain consisting of a fast cooling and a cold holding room, as well as a second-hand refrigerated truck used to carry the packed flowers to the airport. This is adequate for their operation

As nearly as we can ascertain, the remainder of the available cold chain for fruits and vegetables in Rwanda consists of five venerable 20 foot containers that are the property of MAGERWA, a parastatal company that acts as the freight forwarder and customs agent for all Rwandan imports and exports. Four of these containers are located at the Kigali airport airfreight yard. Two are used for the storage of veterinary products and vaccines, as well as for dairy products and other fresh products requiring refrigeration. These operate at a temperature set at 10C, we were told, but during our visit we observed frequent entry and exit by stevedores and other people, which makes it likely that the temperature was higher. Another of the containers is used for the storage of frozen merchandise, while a fourth is also suited to frozen cargo but is in disuse due to low import volumes of frozen goods. This unit could be made available on a lease basis we were told. A fifth unit is currently leased, but is being used as a dry container.

Weekly rental fees for the MAGERWA containers are expensive- we were quoted a rate of Rwf 150,000 per week for the rental of a 20 foot refrigerated container. This rate is in excess of \$400.00 per week at the official exchange rate, somewhat less at black market rates. An annual rental would amount to \$20,800, an exorbitant fee considering that used equipment of this sort can often be bought for \$3,000.00 and less.

Cold chain does not appear to be critical for Rwanda's other current horticultural exports, which are bananas picked green and ripened in Belgium, passion fruit picked before abscission of the fruit from the stem, and physalis. These products are moderately hardy, and Kigali temperatures in the shade and at night are not extreme. In any case fruit is picked and packed the day before shipment, or that very day, and arrives at destination no more than 48 hours after picking, and

sometimes quite a bit less. Highland Flower's roses picked Saturday and Monday leave on the same day they were picked, and arrive in Europe less than 24 hours after picking

## **2. Future Needs For A Developed Cold Chain**

The expansion of Rwanda's horticultural exports will require the development and expansion of a cold chain. The likelihood is that this cold chain will be enterprise based, and will consist of pre-cooling and cold storage facilities such as those that are in place at Highland Flowers. In addition to these facilities, it will be necessary for exporters to also have a refrigerated means of conveying their product to the airport.

As exports develop, it may be useful to build a refrigerated storage system at the airport to accommodate the different types of product being shipped from Rwanda. In designing and building such a facility, care will need to be taken to ensure that the various temperature requirements of different products are accommodated, as well as to separate the ethylene generating from the ethylene sensitive products. There have been successful cases in Central America in which the horticultural exporter's federation took over the operation of these refrigerated warehouses to ensure that product handling was optimal for the products being exported. (Guatemala and Nicaragua) These operations also become a source of income and sustainability to these federations. There is no reason why this could not be done also in Rwanda at some point in the future.

There appears to be little call for cold storage networks to be built at public expense in Rwanda, since there is very little demand for crop storage of perishables. Many vegetables appear to be in continual supply. This appears to be true of root crops such as cassava and sweet potato as well.

Potatoes might be the one crop in which cold storage could be economically justified. There is considerable price fluctuation between harvest and non-harvest times. The authors' position is that these price differentials of themselves may eventually stimulate the construction of private sector or cooperative owned storage for the express purpose of capitalizing on these seasonal price differentials. If a garlic or storage onion industry developed, storage could also be of use in the keeping of these products.

There appears to be substantial promise of Rwanda's becoming a supplier of certain highland vegetables and fruit to the lowland and coastal areas of East Africa. Elsewhere the authors have recommended that attention be paid to discovering and defining Rwanda's competitive advantage in these areas. As these advantages become clear, and the opportunities are defined, there will be a need to develop the cold chain for the assembly, grading, packing, cooling and storage of products that then will be transported by refrigerated truck to market destinations like Nairobi, Mombassa, and Dar es Salaam. In the consultants' opinions this could begin to happen in 2-3 years time, with potatoes being the likeliest product to move in volume at the outset.

This development will also create a demand for refrigerated trucks. Currently the tendency in the Region is to buy used equipment in Europe and ship it to East Africa. This is acceptable provided there are adequate maintenance services for the refrigeration unit. It may make more sense to

have new refrigerated equipment installed on a second hand truck in Europe before exporting it to Africa, since refrigeration supply and maintenance is not good in some parts of East Africa.

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**ANNEX A: COLD STORAGE FACILITIES FOR MEAT AND MILK**

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<b>Location</b>	<b>Reception tanks/ litres</b>	<b>Fridge</b>	<b>Chest Freezer</b>	<b>Display 5° C</b>	<b>Cold storage +</b>	<b>Cold Storage -</b>	<b>Reefer containers</b>	<b>Reefer Van truck</b>	<b>Generator</b>
Nyange Dairy	2000 x 5	X2	X1	None	32 CM at + 20 for yoghurt	32 CM at - 5	none	X1 reefer milk lorry 6000 L; x2 delivery reefer vans: 24 CM	X1 25 KVA
Rubirizi Dairy	3200x1 1500x1 1000x2	X1	None	In town shop 5 CM	Small yoghurt culture box	X1 20 ft container Out of use	X 40 ft Reefer container: 38 CM	X2 reefer vans on order	X1 15 KVA
Nyabasindu Dairy	3000 x1 2500 x1 5000 x2 500L butter churn	X1	X1	None	none	2 -ve - 5° C cold rooms: 64 Cubic Metres	X3 1000 L insulated collection tanks for pick ups	X 2 Pick ups for delivery	X1 25 KVA
Ntebe Dairy	2500 x 1 1200 x 1	X1	X1	X4 8 ft Display cabinets for shop	None	None	None	X2 pick ups for fresh milk to dairy	X 1 15 KVA
Nyagatare Gouda cheese Dairy	500 x 1 on order	X1	none	None	None	None	None	Use of dairy x2 Camionet tes	None

Umutara Dairy	2500 x 1 1500 x 2 1000 x1 Out of use	X1 Out of use	X1 Out of use	None	None	2 –ve –5° C Cold rooms: 64 CM: Out of use	None: currently only churns ( 100)	X2 Camionet tes. Use of 6000 L refer Lorry	X 25 KVA out of use
Umutara milk collection Centres	X4 3000 L tanks	None	None	None	None	None	Churns	Use of x3 Camionet tes	X 15 KVA for total daily use
Byumba Dairy	500 x 2 (out of use) Plan to restart in 2000	X1	None	None	None	X1 18 CM (out of use)	Churns	None	None
Giswati Dairy	Destroyed- for private sale: 10,000 L	None	None	None	None	X1 18 (out of use)	None	None	None
Kararanga Goat Dairy	X1(500 L planned for year 2000.	X1	None	None (delivered freshly made to Hotels)	None	None	Churns	Local transport	None
Kigali milk sale tanks	2800 x1 2000 x5 1200 x4 1000 x3 750 x2 500 x3 inc private farmers on farm sites. <b>21,200 L</b> total. 16 tanks at average 1500 L planned for year 2000= <b>24000 L</b>								

Nyabugogo Slaughterhouse	None	None	None	None	+ve None	Chilling – 5°C: 180 Carcasses (65 Tons) 240 CM capacity	Freezing room: 144 CM capacity (to be repaired in year 2000)	New Reefer truck 5 tons meat delivery – 5°C. Cattle truck for cattle collection : 10 tonnes	25 KVA generator.  5 ton capacity Incinerator
Byumba Slaughterhouse	None	X1 (out of use)	X1 (out of use)	None	None	Chilling room for 10 beef carcasses: 27 CM capacity	None	None (local transport hire)	None
BCK meat processing plant/shop	None	X 4	X4	X 6 x 2.5 Metre display Cabinets	Chilling room: 0-5°C: 32 CM	- ve to –6 and freezer rooms: 64 CM	Access to reefer delivery truck: Nyabugogo	Use of 2 1.5 ton pick up vans	
Butare University Fishery	To be documented in processing report	All ice transport							
Gone Fishing Fish Farms	To be documented in processing report	All ice transport							
Lake Kivu Fish storage	To be documented in the processing report	All ice transport							

Kigali Airport. Magerwa Cold Storage	None	None	None	None	X 3 +ve 40 ft reefer containers. 0°C to + 15° C	X1 -ve 40 ft reefer container.+ 15°C to – 20 ° C.	All 4 refer containers at the Airport site but can be mobilised/hir ed on weekly basis.	Can mobilise reefer containers for	X2 24 KVA on airport site
Lake Muhasi Fish Storage	To be documented in the processing report	All ice transport							