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On-farm cellar storage managed by cooperatives (Source: Padam Bahadur Subedi, Nepal).

FEED THE FUTURE
BUSINESS DRIVERS FOR FOOD SAFETY

Cooperative Agreement No. 720BFS19CA00001

COLD CHAIN MANAGEMENT AND FOOD SAFETY IN ETHIOPIA, RWANDA, SENEGAL, AND NEPAL

Technical Learning Note

January 2021

www.feedthefuture.gov

USAID FROM THE AMERICAN PEOPLE

MarGEn

Food Enterprise Solutions

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Recommended Citation
Ahmed, M.R., Kitinoja, L., & Tokala, V.Y. (2021). *Cold Chain Management and Food Safety in Ethiopia, Rwanda, Senegal, and Nepal.* A report produced for Feed the Future Business Drivers for Food Safety, funded by USAID and implemented by Food Enterprise Solutions. Arlington, Virginia, USA.

Acknowledgements
The authors would like to acknowledge the following people for their contributions to this work:

- Rwubatse Bernard, Local Consultant, Rwanda
- Dieng Elhadji Omar, Local Consultant, Senegal
- Sefu Gerefa Edo, Local Consultant, Ethiopia
- Subedi Padam Bahadur, Local Consultant, Nepal

Disclaimer: This publication is made possible by the generous support of the American people through the United States Agency for International Development (USAID). The contents are the responsibility of the authors and do not necessarily reflect the views of USAID or the United States Government.

Upper Left: On-farm cellar storage managed by cooperaties; Upper Right: Low-cost shade structure, made using indigenous materials; Lower Center: Zero Energy Cool Chamber made with bricks and sand (Source: Padam Bahadur Subedi, Jumla, Nepal).

Introduction

Based upon the immediate necessity for interventions to reduce food losses and ensure food safety, Feed the Future Business Drivers for Food Safety (BD4FS), funded by USAID and implemented by Food Enterprise Solutions (FES), initiated research focused on Senegal, Nepal, Rwanda, and Ethiopia to be conducted by MARGEN. Considering the importance of crops with respect to consumption status, nutritional aspects, degree of postharvest loss, food safety issue and scope to the business opportunities, each country selected two important horticultural crops: Rwanda (Banana and Tomato), Ethiopia (Tomato and Mango), Nepal (Tomato and Apple), and Senegal (Tomato and Mango). Postharvest assessments of these value chains using Commodity Systems Assessment Methodology during October- November 2020 revealed that these crops suffer high levels of losses. The cold chain is the series of actions and equipment applied to maintain the product or commodity within a specified range of low temperature during the steps of supply chain. A reliable, integrated and efficient cold chain can not only contribute to reducing losses and waste in the quantity and quality of food, but can also improve the efficiency of food supply chains and compliance with food safety and quality standards, thus also reducing health problems and costs associated with the consumption of unsafe food. In this article the status of the cold chain in the four selected countries have been presented and possible solutions to overcome the gaps in cold chain are discussed.

Status of the Cold Chain and Associated Food Safety Issues

All the countries studied lacked essential infrastructure such as proper roads and reliable electricity grids, which present significant challenges for investment in the cold chain, especially in rural areas. In Rwanda, the majority of the handlers and marketers are not using cold chain infrastructure, while precooling and cooling process are rarely being performed for fresh tomatoes. Harvested tomatoes are typically exposed to direct sun (20 to 35°C) with little or no shading. Only a few local processors have refrigeration units to handle small quantities of tomato. Similarly, for bananas which come from all corners of the country to Kigali, Rwanda markets there is no proper cold chain. Refrigerated trucks are very limited in number and the transport of horticultural crops in these open trucks is still a challenge. Wholesalers sometimes wait for 2 days and retailers for 4 days to sell the fruits, with no temperature or relative humidity management.

In Senegal, the horticultural crops are mostly produced in rural areas or outside cities, while the cold chain infrastructure is more often concentrated in or around urban areas. The handling, storage, transport, sale, and consumption of perishable food commodities in rural areas often takes place entirely outside of temperature controlled environments. The stakeholders are unaware of the importance of temperature control or report that they cannot afford it. Handlers have pointed out the lack of cold storage equipment is the reason why mangoes are being handled by wholesalers and retailers in ambient atmospheric conditions, which causes significant losses due to exposure to heat. Logistic suppliers found the market demand too narrow as mango handling in local markets remains traditional, but there are opportunities for developing the market.

In Ethiopia, there are no cooling or storage facilities for mango fruit for small-scale producers. However large-scale producers (exporters) have refrigerated transport and storage facilities. The precooling is done at wholesaler's level, but they pre-cool by using ambient temperature water and can remove only about 50% of field heat. This is still too warm compared to the standard of removing 7/8th of field heat before the product packaging or storage, to increase shelf life, reduce losses, ensure quality and food safety.

In Nepal, apple is a high value crop and the fruit losses can be minimized by proper precooling and cold storage with temperatures below 0°C. In general, the ripe fruits are picked and stored in the on-farm cellar storage and then packed (Figure 1). The precooling and cold chain systems are not well developed in Nepal for apple storage. The cold storage facilities are far away from popular apple growing regions and do not have sufficient electricity supply. In the case of tomato, precooling chambers and cold chain systems are not common. Community precooling collection centers and grading systems are seen as big opportunities for investment and business ventures.

Possible Solutions and Opportunities

The effective cold chain management from farm to retail is essential to reduce postharvest losses and ensure food safety. There are several techniques available for temperature management and the method used depends on the crop requirements and the local costs. Strategies for cold chain development should be adapted to specific commodity groups, and to geographic and socioeconomic conditions. Good management of the integrated steps, including maintenance, is needed. Collaboration among multiple stakeholders involved in the unbroken cold chain of a particular commodity is vital for success. Governments can provide key services, such as roads, electricity, public infrastructure and legislation which can facilitate cold chain development. Education, awareness, and capacity building are also critical services which governments can provide.

The cold chain begins on the farm. Fresh produce is best harvested during the cooler times of the day and bins of produce should be placed in the shade. Keeping produce in the shade can help to reduce pulp temperature by 10 to 15°C. For small

scale farmers, a shade structure (Figure 1) is a simple and affordable technology which can return its cost after only a few uses. Wrapping a bin or covering it with a tarpaulin and leaving it in the sun is not nearly as effective as putting the bin in the shade.

Pre-cooling can be done by different methods including hydro-cooling, room cooling, top icing, forced air-cooling, or vacuum cooling. Hydro cooling suits crops such as fruits, melons, and leafy vegetables but only when microbiologically safe water is available to minimize cross contamination. Mangoes and tomatoes can be pre-cooled using hydro-cooling, but the water should not be too cold. The lowest safe temperature for tropical and sub-tropical crops is generally 13 to 15°C. Considering the sustainable and economic aspects, community-based precooling facilities are a good option for the four countries.

Transport is an important link in the cold chain as temperature maintenance is critical in this link in order to preserve the quality, safety, and shelf life of perishable food. Therefore, cost, productivity and efficiency are three factors that need to be taken into account in the design of the refrigerated vehicle. To enable the vehicle to operate with fuel economy and have more capacity, aluminum or other light weight material is used instead of steel. Dual tires are replaced by wide base single tires in order to save fuel and thermal insulation is designed according to the application requirement (Gelinas, 2007). A cold plate is a phase change material that can help to maintain the product inside the insulated transport vehicle within a specified temperature range. An advanced cold plate system is powered by electricity and can be recharged at night. A 6 to 8 hour charge powers the cold plate for more than 12 hours. If the unit is not opened during transport, the charge can provide up to 48 hours of product protection time.

There is a possibility to promote improved on-farm cellar storage in Nepal in high altitude areas to store apples for short periods (Figure 2). Night air ventilation at high altitudes, where the ambient air temperature is naturally cold, can be used to keep the storage room cold. It is also essential to ensure that apple should not be stored with other commodities. Scaling up the zero energy cool chamber (ZECC) with proper humidity and temperature maintenance can be utilized for storing tomatoes, mangoes, and green bananas (Figure 3). Wholesalers and retailers can come together to create new improved low-cost community based cool chambers or cold storage facilities to reduce losses during storage. If electricity is available, a CoolBot™ equipped cold storage unit can be utilized for storage of produce for short periods of time. Major improvements are also needed to establish better technology transfer techniques, with adequately planned curriculum, training and extension of cold chain handling practices, and management. As per the respondents in Ethiopia, where handlers and marketers have access to credit from various micro finance, unions, and cooperates, it may be possible to construct these types of low-cost precooling chambers and cold storage units.

Conclusions

The essential points for addressing proper cold chain management and thereby ensure food safety in the countries studied includes training programs to teach the importance of cold chain management and transfer low-cost technologies, using clean and microbiologically safe water, proper temperature and humidity management, community precooling, and storage facilities. Local advocacy is required for obtaining government support to develop any missing essential infrastructure. A list of low-cost tools and technologies for improved postharvest handling, cold storage management, and food safety are provided in Teutsch and Kitinoja (2019).

References

Gelinas, T. (2007). Cooling Cost Control. Fleet Equipment, 33(2), 22-21.

Teutsch B. and Kitinoja L. (2019). 100 under $100: Tools for Reducing Postharvest losses. The Postharvest Education Foundation, Oregon, USA. http://postharvest.org/100_under_100.aspx.