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Postharvest physical risk factors along the tomato supply chain: a case study in Fiji

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ABSTRACT: Poor produce quality and inconsistent supply currently impede smallholder vegetable growers in Fiji from accessing high-value domestic markets. The available produce destined to go to the market is further lost through poor postharvest handling practices, road conditions and absence of a cool chain. The increasing importance of food and nutritional security in view of climate change factors affecting Pacific Islands Countries intensifies the need to reduce horticultural food loss. Postharvest losses were measured from harvest through to product arrival at the Suva municipal fruit and vegetable markets, with post-municipal market losses determined using simulated storage conditions. In this study, 32.9% of the harvested product was removed from the commercial supply chain. Poor temperature management during on-farm product ripening, and limited on-farm postharvest hygiene were key contributors to the observed loss. Contrary to expectations and comparable studies in other less developed countries, the losses due to transportation to municipal market were low (0.1%). While we found negligible in-transit physical damage to the product in the case study, this does not imply that existing road infrastructure is not an issue in Fiji, or that postharvest quality is not adversely influenced by in-transit conditions. A significant number of high intensity vibration events were recorded along the transport chain, most of which were restricted to a relatively small portion of the western bank Sigatoka Valley road. The small losses post-farm gate (in transport or at the market) are due to fast-to-market transport over relatively short distances and fast on-selling, involving few intermediaries, once at the market.

Keywords: tomato supply chain, temperature, vibration, Fiji

This presentation is from a research study conducted in Fiji, through the University of the South Pacific, with assistance from an ACIAR (Australian Centre for International Agricultural Research) project in collaboration with the University of Queensland and the University of the Sunshine Coast.

Our aim was to assess postharvest risk factors, and for a commodity we chose tomatoes. From talking to farmers in Fiji we see their problems are similar to those faced elsewhere: limited access to high value markets because they cannot achieve the required consistency in the supply and quality of products.

This is an edited transcript of the presentation, with some of the powerpoint slides shown. The paper was co-authored by Professor Steven Underhill (University of the Sunshine Coast) and Sunil Kumar.

Figure 1. The tomato growers use a range of production practices (4 images at left) and a range of situations on-farm for storing and ripening the crop postharvest (4 images at right).

Through the ACIAR project, we set up a 'participatory guarantee scheme' (PGS) between growers and hotels based on agreed quality and quantity demanded. We supported this relationship with 'grower collaborative network assistance' and protocols to improve postharvest handling. To study the postharvest handling aspects, we aimed to analyse the risk, quality and losses in pre-existing postharvest vegetable supply chains. Then we developed tailored low-cost technologies as solutions specific to the local conditions in Fiji.

To analyse the risks, we compared the different modes of transport, road conditions, time to market, packaging and the maturity of the product, as well as post-market shelf conditions, to see where problems were occurring.

There is a range of production practices (Figure 1). Growers use a rain-fed system; some grow the tomatoes on trellising; the crop is usually picked green, by hand, into a bucket or a bag. Tomatoes are ripened on the farm, laid out on a flat surface, such as on the house verandah. Some people when they have extra crop to harvest, lay them out on the floor of a bedroom. If the farm is away from the house, the grower may have a small on-farm shed for ripening the crop. Some farmers have a well set-up storage shed.

Growers also use a range of packaging and transport options that have evolved over the years, with ripened tomatoes variously packed into open drums, boxes, baskets or closed sacks, and transported in closed private cars or vans or in sacks loaded onto open trucks (Figure 2).

Postharvest handling project

Our project focused on Viti Levu, the largest island in Fiji, and on the Sigatoka Valley, where most of the horticultural produce is grown. We observed a range of growers, beginning our observations on Day 1 of the harvest. Ripening on-farm took several days (Figure 3), and then we observed the growers packing the produce, and loading it and transporting it to Suva (Day 6 in Figure 3), arriving in

Figure 2. The growers use various packaging options (4 images at left) and a range of vehicles to take the crop to market (4 images at right).

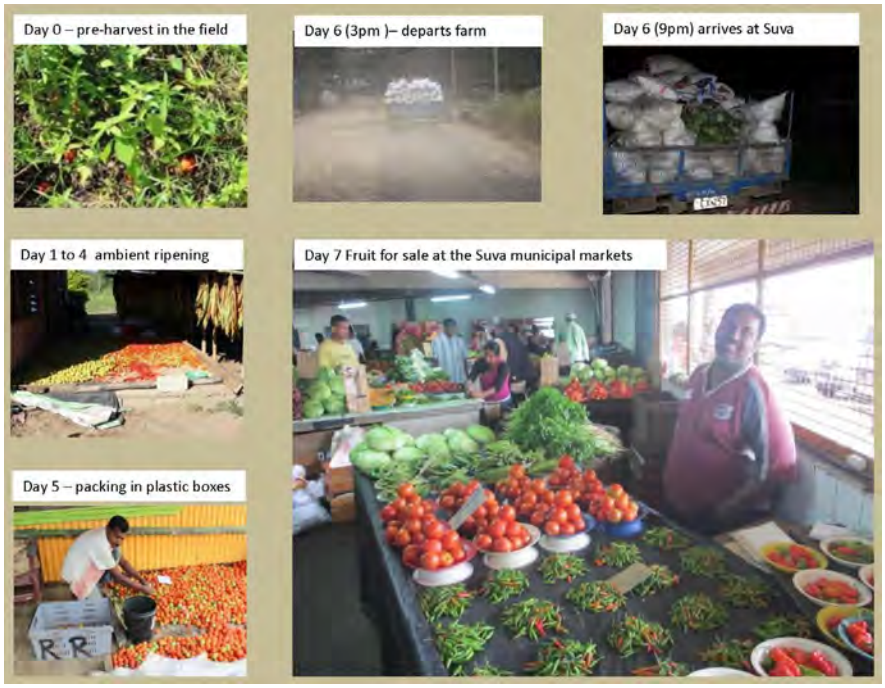

Figure 3. Some examples of the process from picking to marketing for several growers from the Sigatoka Valley who sell their produce at the market in Suva.

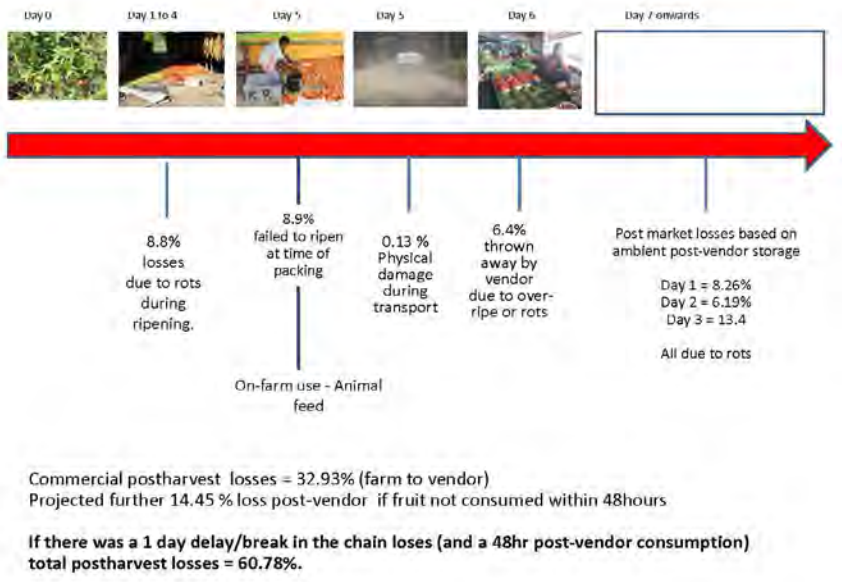

Figure 4. Analysis of typical losses along the observed supply chain.

the evening, around 6–9 pm. The next day (Day 7 in Figure 3) the tomatoes were on sale at the market.

We estimated and analysed the losses from Day 1 onwards: how they happened, and what happened. Figure 4 shows typical results: 8.8% losses due to rot during the ripening process; 8.9% failing to ripen (not a loss, because they were used on-farm for animal-feed); 0.13% physical damage during transportation; 6.4% thrown away by the market vendor because they were overripe. Then post-market over three days there were further losses from rotting because of storage conditions (Figure 4). We also simulated the effects of natural events such as flooding interrupting the process and preventing the produce reaching the market (Figure 4).

We measured the ambient temperature around the produce, from Day 1 of the harvest onwards. If tomatoes should be kept at around 25°C after harvest, the measurements (e.g. Figure 5) showed that during travel that was the case, but not during on-farm storage and ripening.

For the transportation stage, we fitted a Global Positioning System (GPS) and vibration recorders and data loggers onto the truck so we could see what was happening throughout the journey from the valley to the main municipal market in Suva. During transport, there were vibrations damaging to tomatoes on a particular section of the road to Suva (Figure 6), specifically 30 minutes and eight seconds after leaving the third farm in the pick up truck! The data-loggers showed when the truck stopped; the driver behaviour; all those details.

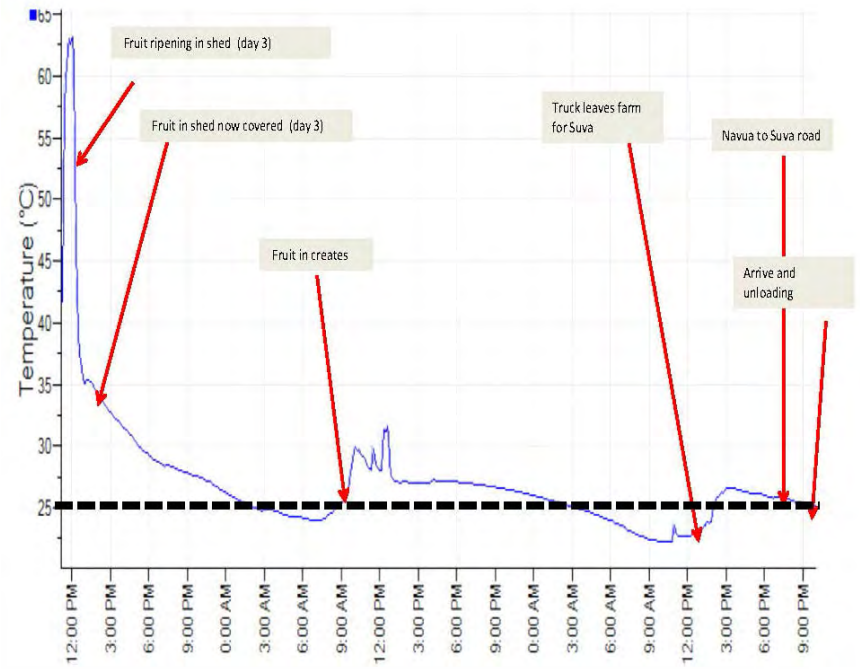

Figure 5. Tomato storage temperatures on-farm and during transport to Suva markets.

Findings

In this study, postharvest loss of tomatoes along supply chains was 32.9%. We found out that the road conditions are poor. Also, that the packaging was not ideal. However, the key postharvest challenge in terms of quality is on the farm, because of the on-farm ripening process.

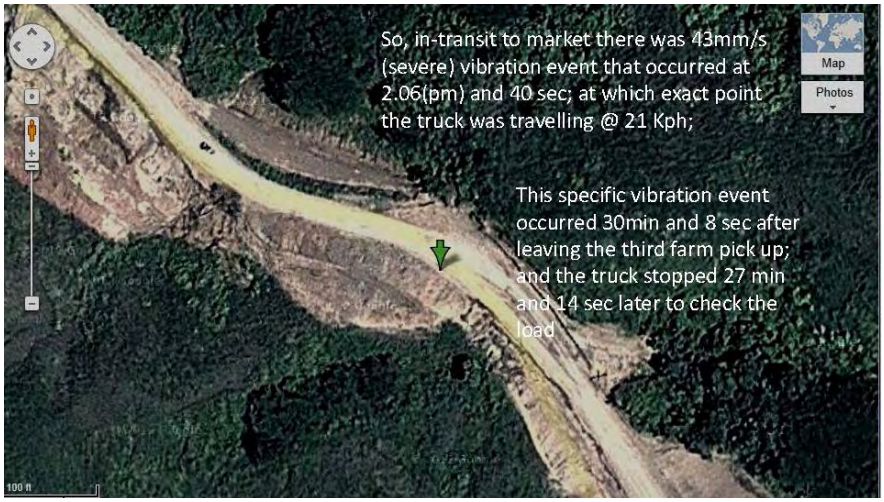

Figure 6. The exact spot where the vibrations were worst in one recorded journey!

Growers need to apply better ambient ripening practices on-farm, and better postharvest hygiene and packaging. Farmers are busy with many activities and are not necessarily harvesting the tomatoes at the best stage of ripening. They need to sort the picked fruit and remove tomatoes showing signs of rot, to reduce the build-up of pathogens in the rest of the harvest.

Postharvest and post-ripening, other factors can be modified to reduce losses. Plastic crates (recycled to save money) for packing give the tomatoes better protection than bags. Positioning on the truck is another factor. Putting the tomatoes at the front of the truck, with other vegetables further back, would reduce the impact of the vibrations on the tomatoes. The speed of the truck also matters – driving more slowly, especially in heavily loaded old vehicles, would reduce the effects of the vibrations. And on-farm ripened fruit is less prone to vibration stress.

Postharvest capacity-building

We aim to build postharvest capacity in Fiji and in Solomon Islands, by:

- helping growers gain knowledge to support better agribusiness decisions;
- exploring alternative postharvest strategies by providing simple low-cost tools to do that;
- using relatively high-tech equipment in a participatory learning environment to highlight relatively fundamental handling practices; and
- highly targeted remediation.

Salesh Kumar is a lecturer at the Fiji National University in the College of Agriculture, Fisheries and Forestry, based in Koronivia, Nausori, Fiji. He is undertaking his PhD at the University of the South Pacific under the University of the South Pacific–ACIAR Scholarship Program. His research focus is postharvest handling practices of high value horticultural crops along the value chains in Fiji, under the guidance of Professor Steven Underhill, University of the Sunshine Coast, Australia. Salesh has attended conferences and published articles originating from his ongoing postharvest research work. He has accumulated considerable experience in the agricultural sector having worked for the Fijian Ministry of Agriculture for over 15 years. He is currently involved in an ACIAR-funded tropical fruit project with postharvest work to commence in Fiji, Tonga and Samoa.