

# Developing greener food value chains: environmentally friendly tomato post-harvest operations in four cities

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*The main aim of the study was to attempt to better understand environmentally friendly tomato post-harvest operations provided by micro- and small-scale farmers and traders in the context of bottom-of-the-pyramid (BOP) peri-urban and urban areas of four major cities: Dar es Salaam (Tanzania), Nairobi (Kenya), Tunis (Tunisia), and Cairo (Egypt). The study was initiated with an in-depth literature review and was followed by in-country, unstructured, informal, one-to-one interviews with a random number of micro- and small-scale farmers and traders and pictographic observations of table tomato post-harvest operations. The findings of the study provided a sample of practices and 'innovations' in post-harvest operations that used prevalently recycled post-harvest equipment, sparingly used natural resources, such as water, and powered operations using only energy of human origin. The findings ranged from the use of home-made sand filters for water purification, to large green leaves for 'refrigeration', to recycled paint buckets being used as 'solar ovens'. Waste was averted continually and if it did occur waste was recycled. The findings of the study contributed to increasing knowledge and consequently provided for a better understanding of practices that can potentially contribute to developing more environmentally friendly (greener) food value chains.*

**Keywords:** green, food, post-harvest, entrepreneurship, innovations

IN THE CONTEXT OF THE GREEN economy and green growth as applied to the agricultural and food industry there has been rising interest over the past few years in making food value chains more environmentally friendly (greener). There have already been some studies conducted on the subject, for example by geographic region (ESCWA, 2013), by type of food chain, horticulture and meat value chains (UNIDO, 2013, 2014), in attempts to ascertain and better understand what activities are carried out to develop greener food value chains. Many food value chain activities though occur in bottom-of-the-pyramid (BOP) informal settings, provided by food chain actors, whether farmers, traders, or retailers, who operate at this grass-roots level in peri-urban and urban areas. Thus an increased understanding of their practices as well as their know-how, for example, in dealing with the natural environment can contribute to providing relevant information, knowledge, and lessons in developing greener food value chains. A green food value chain can be defined as a food chain that provides value at each

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stage, proactively reducing the usage of the natural environment (natural resources, ecosystem services, biodiversity), so as to diminish or mitigate adverse impacts, or even have positive impacts, while considering disposal and recycling patterns of generated waste, to recapture value at each stage of the food value chain and thus further reduce environmental impact (FAO, 2014).

In this regard, a study was initiated with an in-depth literature review that was followed by in-country, field-level research. The empirical research was composed of unstructured, informal, one-to-one interviews with a random number of micro- and small-scale farmers and traders, and pictographic observations of table tomato post-harvest operations in four cities: Dar es Salaam (Tanzania), Nairobi (Kenya), Tunis (Tunisia), and Cairo (Egypt). The field study was conducted in full consideration of the limitations that such a field research methodology could provide for inferences of results to a wider population. The focus of the study was to attempt to ascertain possible environmentally friendly, grass-roots table tomato post-harvest operations that may be innovatively as carried out by micro-and small-scale farmers and traders in peri-urban and urban BOP settings of the identified cities.

### **The context: bottom of the pyramid and informal sector**

The BOP is a segment of the world population that represents multiple cultures, ethnicities, literacies, capabilities, and needs, and can be classified by social and economic factors (Prahalad, 2011). The BOP can be classified in a number of ways, for example, one common criterion used for BOP classification is income. The BOP population is the largest, but poorest, segment of the world population accounting for about 4 billion people earning between US\$1 and US\$5 per day (Rangan, 2011). About 1.4 billion live on US\$3 to US\$5 per day (low income); about 1.6 billion live on between US\$1 and US\$3 per day (subsistence); and about 1 billion live on US\$1 per day (extreme poverty) (Rangan, 2011). Many food value chain activities are thus conducted by food chain actors (farmers, traders, etc.) who work (and live) in BOP settings and as much as 80 to 90 per cent of smallholder markets (within the BOP) are informal (De Pozo-Vergnes, 2013). This informal food sector relates to activities of food production, transport, and retailing, for example, that are not under the direct purview of national governments (FAO, 2003). The main characteristics of the informal food sector are that it targets households with very small budgets and commonly provides food of low safety, hygiene, and quality. Further there are strong relationships between production and consumption, and the informal food sector relies on local sourcing of food, is vulnerable to seasonal changes, and seemingly has a poor environmental track record (FAO, 2003).

### **The bottom of the pyramid and the natural environment**

Food value chains that operate in BOP settings seemingly do not have a good natural environmental track record according to the common adage of the interface between poverty and the misuse of natural environmental assets. However this

is not really always the case as demonstrated in some studies (see Benson, 2014; Brown et al., 2014). For example, small-scale farmers and micro-scale traders are far more embedded within the natural environment (and its degradation) in many BOP settings, especially within peri-urban and urban areas, and consequently seem to be far more sensitive to environmental concerns. This seemingly creates a greater awareness for the natural environment and thus more motivation (and concern) to use natural environmental assets in a way that attempts to avert further degradation and harm to their work and livelihoods.

Many practices that are carried out in such BOP settings are undoubtedly carried out and motivated as a matter of need (poverty) and to earn whatever meagre living can be made. However, such practices can also potentially reduce the environmental impact of food chain operations. For example the reintroduction of recycled materials into food value chain activities, which many food value chain actors are involved in, causes a reduction in the emissions of pollutants generated during the production and marketing of food. These recycling activities reduce the quantity of waste that is destined for landfills and consequently reduces greenhouse gas emissions because a lower content of organic material goes into landfills (GIZ, 2011). Much of the organic matter that is recaptured is redirected to composting and/or animal feed markets and in some instances is transformed into biogas (GIZ, 2011). The reintroduction of these 'recycled materials' into food value chains uses less energy; this lower energy consumption results in reduced emissions and use of recycled materials reduces the use of primary raw materials (GIZ, 2011). Further, local peri-urban and urban food value chains have considerably less impact on the natural environment as they tend to work in 'closed systems' where resources are extracted, used, and recycled within such defined geographic localities. Natural resources, land, and safe water in particular, are used parsimoniously because of their scarcity and their value in peri-urban and urban areas. Marketing operations have a lower spatial dimension as such food distribution systems do not cover large distances, tend to be intensive in their coverage, and serve large numbers of customers that are concentrated in such areas.

## **Findings from the study: table tomato value chain and post-harvest operations in peri-urban and urban contexts**

### ***Table tomato value chain***

In BOP peri-urban and urban settings in the four cities, most of the table tomato value chains were found to be fairly simple and direct in nature, prevalently the system was from farmers' production sites to final consumers. There were cases found where farmers would play the role of traders, buying supplies from other farmers and then selling them to final consumers. Traders were also found in these types of food chains who would source tomatoes from farmers' production locations and then sell them to final consumers. Both farmers and traders would also sell table tomatoes to retailers in more established small-scale retail outlets as well as to roadside 'restaurants'. For example it was found in Cairo that traders who had

over-mature table tomatoes, and thus could not sell them as fresh, would sell the tomatoes to such restaurants who would use them for cooking. Most farmers found in Dar es Salaam would only be selling tomatoes when in season and would sell other mono crops when they were in season. Traders, still in Dar es Salaam, tended to sell a more varied set of produce, but still limited. For example one trader was found to be selling tomatoes, onions, and cucumbers. In Nairobi very much the same situation was found as in Dar es Salaam, but a few farmers found were also selling other produce in addition to tomatoes. In Cairo it was found that traders had a larger selection of produce, but still limited to possibly five to six different types of produce as well as tomatoes. In Tunis farmers were found selling tomatoes mainly when in season, but also sold 'processed' tomatoes, such as dried tomatoes. In all four cities the quantities being sold were small and would possibly account for approximately 4 kilos of produce on average, with some large variations, to fewer than 4 kilos being available for sale.

Marketing operations for table tomatoes specifically were seasonal and for traders in particular represented only one type of produce, among others that they sold. The quantities bought were small and would be added by traders to other horticultural produce. The small quantities bought by traders indicated the typical daily customer demand for fresh produce found in BOP markets. Consumers commonly would buy very small quantities of fresh produce, often on credit, but had a tendency to want to have a tasty meal as it could be the only meal in the day. This coincides with the findings of Banerjee and Duflo (2012) and Viswanathan et al. (2010) on consumer consumption patterns in BOP markets: eating possibly only once a day, BOP consumers want to ensure the food is nourishing and tasty.

For some of the farmers found in Nairobi, table tomatoes represented their entire meagre harvests, while for other farmers who also played the role of trader, table tomatoes were among their 'portfolio' of food produce being sold. Also in this case the quantities being sold were small, indicating a possible small harvest yield and a low capacity to invest money in buying quantities of differing produce from other farmers.

Such low demand for their produce may result in low incomes for these traders and farmers. Prices for produce in BOP markets were found to be slightly higher compared with more formal settings of table tomato distribution chains in all four cities in which the study was carried out. However along with these higher prices farmers and traders had to participate in extraneous price negotiations with customers as well as selling on credit to trusted customers. This also provided indications that income for both traders and farmers could be low.

Outlets for selling table tomatoes for both farmers and traders tended to be mainly located by the roadside, with improvised structures, ranging from a simple cloth laid on the ground, to buckets, to more 'formal structures', such as a simple table with overhead cover. These types of structures gave some indication of the differing abilities to invest in selling structures and consequently could provide some inference about incomes of the farmers and traders. However not all farmers and traders sold via stationary locations; some used various vehicles, mainly bicycles and hand-drawn carts, these being found mainly in Nairobi and

Dar es Salaam and to a lesser extent in Cairo and even lesser still in Tunis. In both Tunis and Cairo it was found that as well as animal-drawn one-axle carts, motorized vehicles were being used, small motorcycles, indicating a possible higher income because of the higher cost of investment in such vehicles.

The presentation of table tomatoes being sold within these outlets varied. Most of the arrangements found tended to provide for air passage and protection of the table tomatoes from direct sunlight and heat in an attempt to prevent increased ripening rates. In Dar es Salaam, in one instance, table tomatoes were found placed on large green leaves and also covered by large green leaves. The farmer selling the table tomatoes referred to this method as her own 'refrigerator'. It kept the table tomatoes out of direct sunlight and provided for some moisture (cooling), seemingly protected the tomatoes from dirt, dust, and insects, and was cost effective as there was no energy bill to pay and the large green leaves could be used over and over again.

### ***Table tomato post-harvest operations***

*Washing.* In Nairobi and Dar es Salaam washing operations after harvest and before transport for selling operations by farmers were conducted using a multitude of differing sources of water. It was noted that water was used very carefully, as it was seen as having high value. Commonly the water used in washing operations would be re-used for other purposes, such as watering crops. One notable water source for washing tomatoes was rain water found in holes alongside roads. The water was collected with recycled plastic bottles and the water would then be poured into a bucket. The bucket would be covered by a cloth bundle. The cloth bundle was composed of two layers of cloth with sand between the layers to act as a filter system for treating the water. Chlorine solutions were available at a price, but were not easy to find, and it meant farmers had to spend money on them. Moreover it was seen that chlorinated water could not be re-used for other operations and farmers would have to collect water again, for example, for watering crops. This would mean more time and labour and thus farmers would prefer not to chlorinate water and use the basic sand filtering system.

The problem with this system of washing tomatoes was the possible contamination of the tomatoes with water borne pathogens. The farmers were aware of this and their attempts to curtail this were obvious through the use of the sand filter. Tomatoes that had skin abrasions or punctures were of course more at risk of contamination than other tomatoes that had intact skins. Depending on the extent of the damage to the tomato skins, farmers would still present some tomatoes for sale. The more damaged tomatoes were usually set aside for family consumption, usually via cooking.

Some consumers buying table tomatoes would actually prefer slightly damaged tomatoes as they could negotiate on price more and thus spend less of their meagre earnings. Not many of the consumers were aware of the possible safety and hygiene risk from the table tomatoes they were buying as commonly they had a relational exchange with farmers (and consequently trusted them) and also sometimes could buy on credit. Most of the tomatoes were used by consumers for cooking and thus most of the possible contaminants would be rendered harmless.

*Sorting and grading.* While waiting for sorting in Dar es Salaam, table tomatoes were covered with large green leaves that provided not only protection from the sun, but also cooling. This was very interesting as the same method was used by another farmer at retail level, still in Dar es Salaam, who was selling table tomatoes and referred to this as her 'refrigerator'.

In Nairobi table tomatoes were found to be placed in plastic buckets and set in roadside potholes full of water to keep them cool prior to sorting operations. It was found that in this way tomatoes were less prone to heat stress and thus sorting operations could be done more at ease. The trader who was found using this method stated that he found it useful and cheap as it gave the tomatoes a longer shelf life.

*Storage.* In Dar es Salaam it was found that for storing tomatoes for the brief period prior to marketing and selling, large green leaves were used, both under and above the tomatoes, and water was passed over the green leaves occasionally to attempt to control temperature. This was found on more than one occasion, as mentioned previously, but interestingly adopted by farmers and traders alike who were selling their table tomatoes at the roadside. It was stated by traders that tomatoes would be stored like this for periods of up to eight to nine days, before the tomatoes started to wilt.

In Egypt it was found that clay pots were used to store tomatoes. The pots were placed in the ground and occasionally the lid of the pots were sprinkled with water. However because of the lack of air passage in the clay pots it was stated by two traders that the storage time was about four to five days and if the tomatoes had not been sold, when they started to wilt they would be sold to the typical local roadside food restaurants.

*Drying.* In Dar es Salaam it was found, on one occasion, that a farmer after washing, dried her tomatoes in an attempt to add value. She used a particularly interesting method. She used recycled plastic paint buckets to cover tomatoes for drying. Tomatoes were washed, cut up into slices and pulped. They were then salted sparingly and placed in the sun on the lid of the recycled paint bucket and then the paint bucket was placed on top of the lid. The heat generated by the sun would dry the tomatoes in this sun-powered 'oven'. The farmer dried the tomatoes in the hope of having a larger selling window for her produce, even though she admitted that selling dried tomatoes did not provide much extra income as consumers would buy very few and would buy by the number not by weight. However customers seemingly tended to trust her more as her drying operations were seen as taking good care of the tomatoes.

In Tunis it was also found that some traders would dry the table tomatoes to add value. Tomatoes would be cut, pulped, salted, and placed on racks and covered with a cloth that allowed for transpiration. The tomatoes were placed in direct sunlight for several hours. The tomatoes were then placed in recycled jars and sold. All these operations were done by hand in an attempt to not only earn more income, but also extend the shelf life of the tomatoes and thus have more opportunities to earn money. However referrals from some of the traders mentioned that rarely would consumers buy a full jar, but would ask for only a number of dried tomatoes.

*Packaging.* In Dar es Salaam and Nairobi table tomatoes were transported in traditionally woven baskets. These were preferred as they could be bought cheaply or were even made by the farmer or trader, they could be used over and over again, permitted a good capacity of loading per transport trip, and were also seemingly far more versatile in transport use as they could be fitted, for example, to the handlebars of bicycles. Even though these baskets provided air circulation, the inner surfaces were abrasive and did cause skin damage. When over full, they could also cause compression damage to the tomatoes at the bottom of the basket. The losses in transport, though, were not wasted as most traders stated that they either sold damaged tomatoes at very low prices or used them for their own food needs at home.

In Tunis, in one instance, it was found that tomatoes had been packed into a recycled plastic paint bucket. The bucket had been modified by the incision of small holes in the side of the bucket to allow for air passage. The buckets were placed on the side of the road, shaded from the sun, to take advantage of the air circulation created by passing vehicles.

## Conclusions

Overall it was found that most of the post-harvest methods and 'equipment' found were not only environmentally sensitive, with a reduced impact on the environment, but were also based on very low-cost 'adaptations' of post-harvest equipment and methods. The 'solar oven' found in Dar es Salaam was a most striking 'innovation' that replaced more formal solar drying equipment. The large green leaf 'sandwich' method was also an interesting 'innovation' as was the sand filter used in an attempt to sanitize water for washing table tomatoes. All these activities were done with little or no impact on the natural environment and actually tended to mitigate negative environmental impacts as equipment used was commonly recycled materials, for example paint buckets. These were used over and over again and there was no use of energy, apart from human energy. There was great attention on not wasting anything: for example damaged tomatoes were either sold at lower prices or used for farmers' and traders' household food uses. If tomatoes began to wilt, as in Cairo for example, they were sold on for cooking, thus averting losses and consequently saving the natural resources that would have been needed to produce more tomatoes. Further, the use of natural resources, such as water and large green leaves, had very little environmental impact as these too were used over and over again.

There is some clear evidence to show that some of the innovations found in this study were provided out of dire necessity because of a lack of money to buy more formal post-harvest equipment and pay for such things as chlorine. However from such practices it was also apparent that most of the farmers and traders did have knowledge about the natural environment and tried to look after it, even with the multitude of constraints they face.

These low environmental impact and nature-conserving practices do, though, cause concern in terms of tomato quality, safety, and hygiene. From the study it was

apparent that this could be a problem, but it seemed consumers trusted the sellers (farmer and traders) and thus were reassured. However the risks were apparent and cost-effective, adaptable, and easily replicable quality, safety, and hygiene practices are needed.

There was one notable factor that arose from this study and this was the (environmentally friendly) entrepreneurial drive behind these 'innovations'. Costs were very low for carrying out such post-harvest operations and using such equipment; the practices led to reduced usage of natural resources, while at the same time there were efforts to preserve the quality of tomatoes, in an attempt to achieve more stable prices that would render price negotiations more advantageous for the sellers over the buyers. Indeed some of the practices found and the seemingly environmentally friendly (green) entrepreneurial drive of farmers and traders are important lessons in terms of developing greener food value chains.

### The way forward

There is a clear need for further and more in-depth field level research in terms of environmentally friendly BOP practices and 'innovations' in food value chain activities all along the food chain. There is also a need for further research into upgrading activities in BOP food chains, which are cost effective and can be adapted and easily taken up by food value chain actors in terms of quality, safety, and hygiene. Moreover there is a need for further research at field level on BOP food value chains in terms of the conjugation between environmental sensitivity, entrepreneurial drive, and innovation (green entrepreneurship) in order to contribute further to the development of green food value chains.

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