

Saving Tomatoes for the Sauce



Tomatoes are among the most popular and widely used vegetables around the world, but probably nowhere more so than in Nigeria, where they constitute 18% of the diet. From omelets and soups to banana and rice dishes, no meal is complete in this West African nation without this fleshy fruit.

Nigeria is the largest producer of tomatoes in sub-Saharan Africa, with an average annual yield of 1.8 million metric tons, grown mostly in the northern part of the country, yet 1.3 million metric tons of tomatoes and tomato paste are imported each year.

Unfortunately, more than 40 per cent of tomatoes grown locally is lost every year between farm and table.

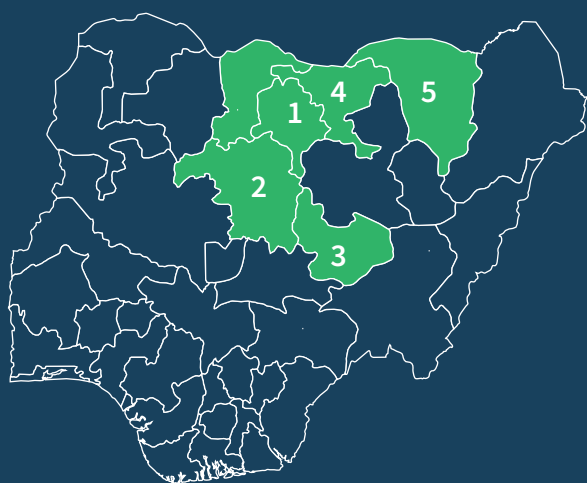
In 2016, the Rockefeller Foundation launched its multi year initiative to raise awareness about and find ways of reducing post-harvest loss in Africa, where more than 40 per cent of fruits and vegetables spoil before they can be consumed, reducing incomes of small-holder farmers by upto 15 per cent. Food loss impacts food security and food production in Africa and across the world, with 30 per cent of all food produced for human consumption being lost before it reaches consumers, and 40 per cent of that which does reach them going to waste. The YieldWise Initiative focused on four crops – tomatoes and cassava in Nigeria, mangoes in

Kenya and maize in Tanzania – in its search for solutions to post-harvest loss in Africa.

For the tomato value chain, the Rockefeller Foundation partnered with PYXERA Global and TechnoServe as implementing partners. PYXERA Global began work on YieldWise in 2016, partnering with the Dangote Group, a leading manufacturer in Nigeria, to establish an outgrower scheme for the Dangote tomato processing plant in Kano State. The aim of the arrangement was to provide small-holder farmers in the region with a ready, year-round market, which would greatly reduce the perennial losses that happened during the peak harvest season due to an influx of produce. In turn, the steady supply of tomatoes would keep the factory operational all year round. By 2018 PYXERA had facilitated training of farmers on efficient production practices, connecting them to fresh markets as well as the Dangote factory, and increasing their access to financing and innovative technologies for better storage and handling of tomatoes.

In the first year, Dangote issued contracts to 33 Farmer Associations which enabled them to get inputs on credit. With this promising start, a season of learning began. At the end of the 2016 season, only a fraction of the farmers were able to supply the contracted amounts to Dangote for several reasons, including operational glitches at the factory

States in the YieldWise - TechnoServe Tomato program



- 1. Kano
- 2. Kaduna
- 3. Plateau
- 4. Katsina
- 5. Jigawa

and competition from other markets, notably the fresh market. Moreover, there were not enough tomatoes to keep the factory running during the wet season (April to October), when yields were typically low.

To compound it all, the invasion of a deadly moth, *Tuta absoluta*, in 2016 caused losses of over 80% of tomatoes produced in northern Nigeria, driving prices astronomically high, and leading to closure of several factories. So devastating was the moth attack that the Government declared a state of emergency. Nigerian farmers nicknamed it “Tomato Ebola” due to its similarity to the deadly virus that swept across West Africa in 2014, killing over 11,000 people.

The moth destroyed over 80% of tomato farms in the state of Kaduna and more than 90% in neighboring Kano alone. Prices for raffia baskets shot up from N1,500 (US\$7.50) per raffia basket before the outbreak to N42,000 (US\$212), affecting the livelihoods of thousands of farmers. The shortfall in supply led to the shutting down of the new Dangote tomato processing plant.

The following year heralded some improvement. Unlike 2016, when they were caught unawares, farmers had been trained and were prepared to combat the spread of the moth. They used the credit they received to expand their operations and applied techniques they had learnt of growing suitable tomato varieties and managing post-harvest loss. **In 2017, yield among farmers who had been trained by YieldWise was 23 metric tons per hectare, compared with a national average of 10**

metric tons per hectare. Average post-harvest loss per farmer decreased from 6.8 metric tons in 2016 to 4.3 metric tons in 2017.

TechnoServe came on board at the end of 2017 with a target of increasing the number of small-holder farmers reached to 35,000 in the northern Nigeria states of Kano, Kaduna, Plateau, Katsina, and Jigawa. Prior to YieldWise, TechnoServe had worked in the tomato value chain with 3,000 farmers in Katsina and Kano to increase yields by linking them to sources of quality inputs. From that experience, TechnoServe had established two key truths: The first was that because of their high consumption levels, households were the leading subsistence level ‘processors’ of tomatoes in Nigeria, using produce from farms or the fresh market for immediate cooking, or for turning into pastes and sauces that could be stored for longer. The second was that cottage industries played a significant role in processing tomatoes which might otherwise have gone to waste, and consequently were important actors for reducing post-harvest loss.

TechnoServe continued to build farmers’ capacities for tomato production in the dry (November to March) and wet (April to October) seasons. Tomatoes in the north are primarily produced in the dry season, when farmers have better control of the factors of production, especially water, which comes from rivers, streams and wells. Since most tomato farmers plant at the same time, they end up flooding the market with produce at harvest. The market has a cap, and when it can take no more, prices plummet and the farmers lose both produce, which is highly perishable, and income. On the other hand, not many farmers produce tomatoes in the wet season because it is difficult to control the amount of water in the fields, and the crop is more prone to diseases because of the moist conditions. However, because of this strain on supply, tomato prices are much higher during this season.

To help stabilize the market and optimize opportunities for farmers, the YieldWise team trained them on techniques and technologies to reap maximum benefits from each season. Those who farmed in the dry season were encouraged to stagger their planting times so that they did not flood the market by bringing in produce at the same time. This meant that a farmer would plant only a portion of land at a time and harvest several times, or that farmers in one community would plant at different times so that they did not all harvest together. Those who planted in the wet season were taught how to get the most out of their farms by controlling the water and potential for diseases, and how to maximize production to take advantage of the prevailing high prices. Both sets of farmers were trained on



Time for change: Tomato Traders Union officials Emenike Anekwe (right) and Ndubuisi Enehe plan to set up a crate depot at the Onitsha tomato market so that traders stop using raffia baskets. Tomatoes ready for market stacked in a Reusable Plastic Crate sold through Yieldwise RPCs are now in common use.

post-harvest loss management and varieties of seeds suitable for various conditions so that they could quickly adapt when necessary.

Hand in hand with the training, farmers were encouraged to consolidate their produce so that they could engage off-takers as groups, but it soon became clear that this would not be necessary. Because of the perishable nature of the tomatoes, it was a natural process for farmers to aggregate their produce, and there were many such centers where they would go and sell their harvest. Armed with this information, TechnoServe instead focused on strengthening the market associations and expanding the networks of the aggregators by linking them to more farmers and buyers. In this way, farmers have been able to access new markets, sell more produce and make more income. TechnoServe encouraged farmers to work through associations, and to save and pool their resources to purchase quality inputs in bulk at a discount. While farmers were at first reluctant to save individually, this cost-share model with the promise of affordable inputs proved quite popular.

Another aggregation model that worked well was with buyers – off-takers, processors, hotels or wholesale outlets – who invested in smallholder farmers by providing inputs at the beginning of the season, and once the produce was ready, they bought the produce, paid the farmers and provided input for the next season. These groups of farmers

naturally aggregated and developed a relationship among themselves and with the buyers, viewing themselves as producers for those concerns.

Turning to Technology

In its search for suitable technologies to reduce post-harvest loss, the Rockefeller Foundation commissioned a report in 2016 to identify manufacturers and suppliers of returnable plastic crates (RPCs) in Nigeria, including their production capacities, crate dimensions and contact details. The aim of the report, produced by the Post-harvest Alliance for Nutrition (PLAN) under the Global Alliance for Improved Nutrition, was to support adoption of crates for packaging of fresh fruit and vegetables in order to reduce losses, improve efficiency, value and profitability. A database of manufacturers and suppliers of RPCs for fresh fruit and vegetables in Nigeria was developed to provide information and link manufacturers to potential buyers and users.

Compared with the traditional raffia baskets, RPCs are stackable and therefore do not damage the produce during storage and transportation; they are cleanable, thus improving food safety; and they are durable and reusable multiple times, making them more economical in the long run. Traditionally, however, tomato transporters have used raffia baskets to transport tomatoes, but research has shown that about 40-50% of the produce gets spoilt in the baskets by the time it gets to the final consumer. This is

because the tomatoes are packed tight in the baskets, causing them to get crushed, and they also tend to go bad faster in the heat. Tomatoes that are transported in the stackable plastic crates, on the other hand, are less likely to get crushed.

In 2018, TechnoServe carried out an experiment to evaluate how packaging materials contributed to post-harvest loss. Tomatoes were transported over a distance of 700km from Kaduna in Northern Nigeria to Onitsha tomato market in Anambra State, South-Eastern Nigeria, in raffia baskets and in plastic reusable crates over the course of two days. The major parameters used in monitoring loss were the condition of the tomatoes at the point of loading and at the point of offloading in terms of color, firmness and weight. The findings were that there was no significant change in color or firmness in the tomatoes packed in reusable plastic crates, and weight lost was 2% of the initial one. But for those transported in the baskets, there was reduced firmness and color change. The tomatoes had been harvested at the turning stage, but they were ripe by the time they got to the market, and their weight had decreased by 14%.

Despite their numerous benefits, the use of RPCs is very low among small-holder farmers and other value chain actors in Nigeria due to a number of factors, lack of awareness being a major one as well as the cost of the crates – ₦1000 (\$3.50) per crate with a holding volume of 20kg-25kg compared with raffia baskets at ₦500 with a 45-60kg capacity. Another prominent challenge militating against the large-scale use of RPCs in the country is the inefficient reverse logistics – high transaction cost of returning empty crates from southern Nigeria (where they are transported to) to lender hubs in northern Nigeria (where they were borrowed from). Indeed, YieldWise found that about 96 per cent of small-holder tomato farmers and local produce aggregators use the pointy raffia basket to pack and transport their tomatoes, and that the total number of RPCs commercially circulated in Nigeria was less than 100,000.

To resolve this challenge, TechnoServe has adopted direct and market facilitation approaches to promote the use of crates in the tomato value chain. In 2019, YieldWise facilitated the formation of an RPC Association based in Danja, Katsina State, with the aim of promoting the use of the crates among local produce aggregators and small-holder farmers, and to address the challenge of reverse logistics of empty RPCs from the south to the north. The association comprises RPC service providers, raffia basket weavers who are interested in transitioning into RPC vendors, produce aggregators and new investors.

Operating with a target of purchasing 60,000 units of RPCs in 2020, the association purchased 30,000 units in 2019 valued at ₦60,000.000 (US\$166,666) on an incentive-based arrangement with a Lagos-based RPC manufacturer. In addition, YieldWise has supported the association with 5,000 crates. Under the incentivized purchase arrangement, the RPC manufacturer gives the association a commission of ₦200 (\$0.55) on every unit bought, and this will be aggregated and used to purchase a truck to return empty RPCs from markets in the south to the association's hub (in the north). The association is expected to procure the truck in the third quarter of 2020.

In 2019, the Nigerian Incentive-Based Risk Sharing System for Agricultural Lending financed a program for small-holder tomato farmers and aggregators in Kano State under which each farmer received 30 reusable plastic crates, as well as crop protection and insurance services, seeds and fertilizers. TechnoServe enrolled YieldWise farmers in the program and is training the participating farmers on techniques for effectively managing the RPCs to minimize breakage.

PLAN also identified lack of cold chain storage and logistics as a key factor contributing to the huge post-harvest loss in fresh fruits, vegetables and other perishable produce in Nigeria. The International Institute of Refrigeration estimated that improving access to refrigeration could prevent the spoilage of up to 23% of perishable foods currently produced in developing countries. To reduce post-harvest loss, perishable commodities need to be pre-cooled, chilled or frozen as close to the point of harvest as possible in order to retain nutrients and add shelf life. Cold storage and refrigerated transport should also be available at every stage of the value chain, but lack of electricity has made it difficult to implement such modern solutions in developing countries like Nigeria. Innovative companies, however, have developed solutions to work within such infrastructural constraints, such as Nigeria's Cold Hubs and i-Farm, who rent storage space in solar-powered cold rooms in Owerri and Jos respectively.

In September 2017, PLAN organized a National Cold Chain Summit in Lagos, where over 50 private and public sector stakeholders agreed that the cold chain sector in Nigeria needed to be developed to effectively reduce post-harvest loss and to improve food security and nutrition. Following the summit, the Organisation for Technology Advancement of Cold Chain in West Africa (OTACCWA) was formed to advance development of the cold chain sector. The main benefit of being a cold chain association member would be the opportunity to grow one's business, building of capacity



Left: Loaders pack the stackable crates neatly onto the lorry. Right: A truck is loaded with crates of tomatoes in Danja, Katsina, for transporting to Lagos. Photos: Adedotun Adedoyin

within the industry and creation of partnerships along the supply chain.

Despite the logistical hurdles, YieldWise successfully introduced technologies that helped farmers to increase their yields and reduce post-harvest loss. One such technology was a zero-energy cooling chamber in which farmers could store their harvest for up to 21 days at a temperature of 10-14 degrees Celsius, increasing the shelf life of the tomatoes as they waited for prices to improve. Another technology to preserve tomatoes was a locally crafted solar dryer, on which farmers could dry excess tomatoes for sale later. The dried tomatoes are popular with consumers and fetch a good price when there is limited

fresh produce on the market. Without the solar dryers, farmers would dry their tomatoes on the bare tarmac, without tarpaulins, which was a food safety risk.

Building Markets

Through PYXERA, YieldWise model began establishing and strengthening formal market linkages. For tomatoes in Nigeria, markets mostly occur naturally, and they absorb most of the crop produced in the country. As the initiative began to take hold, the main concern was to ensure farmers got premium prices for their tomatoes and both implementing partners began to link farmers with high-end market actors, such as processing companies. Most of the



A Zero Energy Cooling Chamber (ZECC)

work on this component revolved around helping farmers to plan market entry; creating awareness of market forces at different points of the year in order to optimize production and get the best prices; and advising farmers on tomatoes required by different market actors. Additionally, there were a host of alternative buyers who purchased produce from farmers. The initiative was able to establish several trade arrangements between processors and groups of farmers, such as Captain Foods in Lagos, which buys tomatoes from farmers' groups in Kano, and Smiley's Kitchen, a cottage processor in Kaduna who purchases 12.5 metric tons of tomatoes a month from a local farmers' group.

While the cottage industries are thriving, there are also several huge plants that process tomato products in Nigeria, but only a few of these actually crush fresh tomatoes for paste or sauce. TechnoServe's Program Manager in Nigeria, Mr. Femi Oloruntoyin, observes that most of these factories don't buy fresh tomatoes at all from the market, but instead import cheap concentrate from China which is diluted to make tomato paste. And so over 85% of tomatoes produced by Nigeria's small-holder farmers ends up in the fresh produce market, creating a glut. This means that, until steady markets are created for the fresh produce, farmers will continue to struggle to sell their tomatoes or to get good prices for them. But there is hope in the horizon. A federal state government ban on importation of tomato concentrate that was to be introduced in 2019 has yet to be enforced, but some local companies such as Dangote are positioning themselves to enter that market using fresh, local tomatoes. Through its convenings of stakeholders, TechnoServe has been drumming up support for the ban to be effected, as it would have a significant positive impact on players in the value chain, while greatly reducing post-harvest loss. Encouraging investment in tomato processing, especially at cottage industry level, because of its potential to minimize post-harvest loss, was particularly significant.

Smart Farming

For small-holder farmers to access markets in processing industries, they would need to produce quality tomatoes to meet the standards of that market. However, YieldWise discovered that many farmers had for years been using recycled seeds obtained from drying the larger tomatoes from their last harvest, while others were using generic open-pollinated varieties, resulting in low yields – about 8 to 12 metric tons per hectare. YieldWise implementers encouraged the farmers to buy hybrid seed and fertilizer from certified agro-dealers, and used demonstration farms to illustrate the difference this made. **The high yield from**

the hybrid seeds – 35 metric tons per hectare – convinced many farmers to change to quality inputs and to employ methods like crop rotation to get maximise their yields.

During harvest, TechnoServe encouraged farmers to harvest their crop at the turning stage, when the tomatoes were still partly green, instead of when they were completely ripe as they tended to spoil quickly. At the aggregation centers, the trading happened in open fields, putting the tomatoes under direct sunlight and at risk of spoilage, so farmers were encouraged and buyers to build sheds at the centers to shelter produce awaiting purchase.

Getting quality input and adapting technologies to help them increase their yield requires that farmers have access to finance, one of the areas that YieldWise set out to address. In the beginning, some financial institutions were identified as potential partners, but it was quickly discovered that these institutions were not too keen to work with farmers because of the inherent risks in production – such as the risk of natural events and the fact that some small-holder farmers have a tendency to default on repayment. The government had introduced programs to encourage financial institutions to lend to small-holder farmers, while TechnoServe resorted to working with two crowdfunding organizations – Thrive Agric and efarms. Farmers were encouraged to save in order to get access to finance for inputs from the crowdfunding partners.

The model worked like an out-grower scheme, where farmers provided the farmland and the labor, while investors provided the inputs. After the harvest, the farmers paid the investors back with their produce. A total of 550 farmers benefited from the arrangement in the wet season of 2018, and 300 in 2019. YieldWise encouraged the financing of wet season farmers because their earnings were much higher than those of dry season farmers, who were likely to struggle to repay their loans. Flooding in 2018 caused some farmers to default on their loans, and so in 2019, TechnoServe encouraged eFarms to take out a small insurance cover for the farmers to mitigate against a similar occurrence. The cost of the insurance was also deducted from the harvest.

The quest to reduce post-harvest loss was hampered by the fact that the recommended technologies and inputs were beyond the financial reach of most farmers. TechnoServe studied the dynamics of who shouldered the post-harvest loss at each stage of the value chain and discovered that this was dependent on the transaction dynamics. If the tomatoes were transported before the farmers were paid,



Home-made: Cottage industries are becoming significant players in tomato processing. Right: Tomato sauce ready for sale.

they incurred the post-harvest losses, but if they were paid at point of purchase, the buyer incurred the loss. In the same vein, the cost of buying or hiring crates would fall on the value chain actors, who would benefit most from the crates. If the farmers were paid before the tomatoes were transported, then the buyers would be keen to ensure they were packed in crates to preserve as many as possible. But if they were to be paid once the tomatoes got to the market, then the farmers would be more inclined to use crates.

What About The Ecosystem?

Policy influencing is a challenge for the TechnoServe team, especially because YieldWise was implemented at a time when Nigeria was transiting politically, so officials who had worked with the initiative when it began were moved. Nevertheless, government officials in all five states have been receptive to and appreciative of the issues around post-harvest loss, and even took part in training activities to

build their skills and knowledge. In addition, desk officers in the Ministry of Agriculture were appointed as point persons and it is their responsibility to foster ownership and sustainability of the work in post-harvest loss.

The Yieldwise Initiative played a critical role in bringing together stakeholders from various sectors in the tomato value chain to discuss and agree on how to work together. In October 2018, PYXERA Global convened 250 delegates from the private and public sectors in Kano with the objective of fostering collaboration to strengthen the tomato value chain and reduce post-harvest loss. The meeting resulted in formation of a Tomato Triangle secretariat to manage the tomato value chain across states. Though initiated by PYXERA in 2016 the convening is now an annual event led by the Government of Nigeria. Similarly a round a round-table meeting was set to be convened in 2020 by the Deputy Governor of Kano targetting high-level stakeholders and decision-makers to discuss issues dogging post-harvest



Kaduna Commissioner of Agriculture, Mrs Halima Lawal

In Kaduna, the Commissioner of Agriculture, Mrs. Halima Lawal, keeps a keen eye on activities in the tomato sector, which she describes as the most important agricultural product in the state. Kaduna is a leading grower of tomatoes in Nigeria, producing over one million metric tons annually. According to the Commissioner, the state has the highest number of tomato farmers in the country, and thanks to the efforts of partners like TechnoServe and the YieldWise Initiative, farmers in Kaduna have higher average yields per hectare than many other parts of the country. The number of cottage industries processing tomatoes continues to increase, and several large processors have recently ventured into the fresh tomato processing industry.

loss, identify solutions and make commitments on the way forward. With the process being led by the government, sustainability and high-level interest are guaranteed at state level, and can then be escalated to federal government level.

The non-farm sector, too, has responded positively to the YieldWise interventions. An unexpected outcome was the formation of a National Reusable Plastic Crate Association to promote the use of crates for transporting tomatoes and other produce. The association created a company that bought crates from manufacturers at a discounted rate, saving ₦2 million (US\$5,550) that in turn was used to buy a vehicle for transporting crates. Another positive externality was the emergence of cottage processing industries as significant players in the tomato value chain and management of post-harvest loss.

In the end, as YieldWise unfolded many lessons were learnt and presumptions clarified. An initial target of 40 per cent female inclusion was in the initiative design, but tomato production is a male-dominated venture in northern Nigeria and this target proved unreachable as women made up only 12 per cent. Women in the tomato value chain are more likely to be found in the cottage processing industry.

The results of the mid-term evaluation conducted by Evalreach Limited, a Nigeria-based external evaluation firm indicated that **YieldWise surpassed its targets in transforming the tomato value chain, training 35,000 farmers, reducing post-harvest loss from an average of 36.6% to 17% at the mid-point of implementation and increasing farmers' income by 33% in the five implementation states.** As awareness and management of post-harvest loss grows, as the number of cottage industries and their capacities increase, and as more large investors venture into processing produce from the fresh

market, more of the tomatoes grown by hard-working small-holder farmers in Nigeria will certainly end up on tables across the country.

Going forward, the crating and cold storage technologies hold great promise for significant reduction of post-harvest loss of tomatoes and other fresh fruit and vegetables in Nigeria. However, the level of awareness, acceptance, accessibility and particularly value perception by primary producers may still be a major challenge to the widespread use of returnable plastic crates. This needs to be addressed by widespread advocacy, business support, training and use of pilots, and may stimulate the creation of more organized small-holder producers for linkages with improved post-harvest technologies. To this end, the Post-harvest Loss Alliance for Nutrition created an online information portal to improve collaboration and communication, and to increase access to information, including crating company contacts and best practices around post-harvest loss.

For cold storage facilities, there is huge potential for development of efficient systems, use of renewable energy and building of local capacity in cold chain system management and practice. Opportunities exist in rural areas for construction of cold aggregation centers close to the farm gates to reduce loss, and for third party cold chain logistics service provision. The high cost of energy remains a major concern in Nigeria, as well as lack of trained personnel, outdated technology and poor infrastructure. The formation of an association of cold sector players and RPC producers and users are expected to result in focused development of the cold chain and RPC sectors, and ultimately to minimal post-harvest loss of tomatoes in Nigeria, ensuring more tomatoes end up in the proverbial sauce.

Rockefeller Foundation's YieldWise initiative was launched in 2016 with the goal of reducing post-harvest loss in select countries and value chains by up to 50 percent. More than 40 percent of fruits and vegetables in developing regions spoil before they can be consumed.

Using a multi-pronged strategy, YieldWise sought to improve millions of rural lives by increasing incomes, increasing the availability of food and protecting finite environmental resources.

The initiative targeted tomato and cassava production in Nigeria, mangoes in Kenya and maize in Tanzania.

YieldWise Initiative in the tomato value chain in Nigeria was implemented by TechnoServe and Pyxera Global.