

Solar drying in Uganda

From Appropedia

This article is based on an Ashden Awards case study of Fruits of the Nile, who won an Ashden Award (<http://www.ashdenawards.org/winners/nile08>) for their work in 2008.

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Summary

Southern Uganda has abundant sunshine and rainfall, and fruit like bananas, pineapple, and pawpaw grows well, as do other crops. Many smallholder farmers grow fruit as their main cash crop, but much of the fruit goes to waste, particularly during the months of peak production, because there is insufficient market within a reasonable transport distance.

Fruits of the Nile is a Ugandan dried fruit company which has helped to get the spare fruit production from rural growers to international markets, and in doing so brought skills and income all along the supply chain. The company buys fruit from 120 registered primary producer groups, which it has trained in organic farming, hygiene, fruit drying, and business management. They in turn buy fresh fruit from 840 other approved farmers, who have also been trained by Fruits of the Nile. Fruits of the Nile is a Fair Trade company, and the whole supply chain is in the third year of conversion to organic production.

Most producers use simple, timber-framed 'cabinet' driers, which are covered with UV-stabilised polythene, with mesh-covered vents at the base and top. Sliced

fruit is laid out on plastic mesh trays inside the drier, and dried by the sun. Each drier can produce between five and 12 kg of dried fruit every two days, in good sunshine.

The dried fruit is packed into polythene bags, and then into hessian sacks which are taken by van to the Fruits of the Nile factory in Njeru, where 37 people are employed in sorting, packing and administration. At the factory the fruit is inspected by the Quality Supervisor, and any substandard production is rejected. The fruit is re-sorted to remove any that is discoloured or dusty, or shows signs of insect damage. Fruit is re-packed in double-layered polythene bags, frozen down to -150C, then packed in boxes for export.

The company has a rigorous quality management system using paper and computer records. This contains cross-referenced records including every delivery, each day's sorting work, and every payment and deduction. To comply with organic certification requirements, complete traceability is needed, and records have to be retained for at least five years.

The primary producers earn on average about 3.8 million USh (£1,100) per year from selling dried fruit. Each producer in turn provides income to about three casual labourers and seven farmers. Allowing for these payments, the cost of the driers, and transport, the producers still keep about 50% of their earnings as profit. This represents a significant income for rural Uganda, greater than that of a primary school teacher.

Overall about 1,400 people receive income from the work of Fruits of the Nile, and at least 8,000 family members therefore benefit.

The move to organic production has improved the local environment on the farms, and saved workers from the hazards of pesticides. Solar drying is renewable, and does not produce any gaseous emissions. The whole supply process has been designed to minimise new environmental impacts, by drying fruit and retaining waste at the point where it is grown, and using bulk transport within Uganda. It is less energy intensive to ship dried fruit overseas than transport the same fruit when fresh, because it is lighter, and does not require chilled storage or air freight.

There is considerable potential for the Fruits of the Nile supply chain to grow. Most primary producers would like to increase their production capacity, and Fruits of the Nile has a waiting list of farmers who would like to become producers. The factory is currently operating at only 60% capacity, and could easily increase this to 100%. The constraint in growth is securing the markets for the dried fruit. Fruits of the Nile hopes that If the organic certification is finally approved later in 2008, this will greatly expand its export markets. Provided that the export markets are available, the business model could be replicated in many other places with plentiful sunshine, where agricultural products go to waste because there is insufficient local market for them. However, as Fruits of the Nile has found, it requires a significant commitment in training,

administration and quality control to be the bridge between rural farmers and international consumers.

The organisation

Fruits of the Nile Ltd is a commercial fruit-drying business exporting about 120 tonnes/year of solar-dried banana and pineapple to Europe. It was founded in 1991 by Angello Ndyaguma, Kate Sebag and Adam Brett, and currently employs 37 people at the fruit sorting and packing factory in Njeru, Uganda, and buys from 120 producer groups. Its turnover in 2007 was about £336,000.

Context

Southern Uganda has abundant sunshine and rainfall, and fruit like bananas, pineapple, and pawpaw grows well, as do other crops. Many smallholder farmers grow fruit as their main cash crop, transporting it by bicycle to local markets on the main roads, from where trucks buy it and transport it to the urban centres. This often involves considerable distances – for instance it is over 300 km from the main banana-producing area, west of Mbarara, to the capital, Kampala,

However, much of the fruit which is grown goes to waste, particularly during the months of peak production, because there is insufficient market within a

reasonable transport distance. With wasted food in some parts of the country, other people in Uganda go hungry, and about 19% of the population is classed as undernourished in official statistics.

The difficulty in finding markets makes farm incomes unreliable, with prices falling to almost nothing when there is a glut of fruit. Fruits of the Nile was set up in 1990 as a fruit-export business, with the aim of linking rural producers to export markets. Because of the cost and difficulty of transporting fresh produce, the company has focussed on dried fruit. Using simple, solar-heated driers means that no fuel or electricity is required, and drying can be carried out on the farms which grow the fruit.

Technology and use

Construction of the driers

Most of the driers used by Fruits of the Nile are simple, timber-framed cabinets, about 4 m long, 1.5 m wide and 0.5 m high, covered in plastic sheet. The cabinet is raised off the ground using wooden legs, which rest on stones for stability and to reduce insect attack. The plastic is standard UV-stabilised agricultural polythene. Inside the drier is a rack to support the plastic mesh trays on which the fruit is laid out.

Air enters through a mesh vent in the base of the drier and exits through vents at the top of the back or sides.

The upper surface of the polythene slopes up slightly from the front to the back, in order to direct the airflow. When sunlight falls on the drier the air inside heats up to a temperature of 50°C or more, and water evaporates from the fruit. The warm air expands and escapes through the top vents, taking water with it, and it is replaced with cooler, drier air drawn in through the bottom vents. This natural convection process is driven by very small differences in pressure, so it is important that the vents are clear, that the drying fruit is correctly spaced on the trays, and that the air does not 'short circuit' through holes in the cover. The polythene sheet must therefore be nailed down very carefully, and any tears must be taped over. This also prevents insects from getting in. To ensure quality, each drier is built on site by a Fruits of the Nile carpenter. Every two days

each drier is thoroughly cleaned and checked for holes.

The driers last for about five years if well maintained, although the polythene sheet has to be replaced every three to five seasons depending on how carefully it is looked after.

Fruits of the Nile has also constructed eight larger driers, built on the ground with a concrete slab base to store heat. These either have chimneys to increase the air flow by natural convection, or solar powered fans to force convection. Although these driers are more efficient, they cost about six times as much as a cabinet drier, and are too expensive for most producers.

Using the driers

The driers are used by 'primary producers', either individual families or groups. Some producers are in the South West of Uganda, in the main area for producing apple banana and bogoya-banana, other producers near Njeru work with pineapple. Fruit is collected from the producer's own land or bought from approved local farmers. When it has reached the appropriate ripeness, it is sliced by hand, and the slices are laid out on the plastic mesh trays. Each cabinet drier can accommodate four trays, sufficient for 20 to 30 kg of fresh fruit, which reduces in weight to five to 12 kg when dry. To test for completion of drying a slice is squeezed or torn, and a trained producer can judge from the feel of the fruit whether or not it is ready. On very sunny days, four full trays can be dried within two days. In cloudy weather the fruit dries more slowly, and

the number of trays may be reduced so that the rate of drying does not become too slow. If it takes more than five days for the fruit to dry, then it will be discoloured and unacceptable. Fortunately the main rainy season is a time when little fruit is harvested.

The dried fruit is packed into polythene bags, each containing about 7 kg. These are securely tied up, stacked on a shelf in a clean area, and stored for a maximum of three weeks until a producer has sufficient to take to the Fruits of the Nile factory in Njeru. When the bags are transported, they are placed inside double plastic sacks for the journey, which is usually by company vans. The journey from the banana-producing region to Njeru takes a full day, and some producers will transport fruit dried fruit from their friends as well

as their own.

Factory processing

At the Fruits of the Nile factory, the receiving staff remove the hessian sacks, and the Quality Supervisor inspects each plastic bag of fruit. Any bag in which the fruit is damp, damaged or the wrong colour is rejected. The accepted bags of fruit are put into fresh sacks and marked with the code number of the primary producer and the date. The fruit is weighed in the presence of the Quality Supervisor, who enters the weight in a ledger. The delivery sacks are washed and re-used if possible, or else returned to the bag manufacturer for recycling. The producers receive clean bags and sacks for their

next load.

The sorting room is the main area of the factory. Fruit-sorting staff work individually or in pairs at stainless steel tables. Each day, a particular table will be allocated to fruit from just one producer, to ensure that all production is traceable. Each plastic bag is opened and the fruit spread out on the table, so that any fruit which is discoloured or dusty, or shows signs of insect damage, can be removed. The good quality fruit is re-packed into new plastic bags containing just over 2 kg, and these are again labelled with the producer's code number and date.

Each new bag is sealed and put inside a second bag for protection. Twice weekly, all fruit is frozen down to -

150C to kill any possible moth eggs which may have been blown into the driers. Finally the bags are packed into cardboard boxes, which are labelled with the producer's code and packing date.

There is a growing shortage of electricity in Uganda, because of increased demand and the low water level in Lake Victoria which feeds the main source of power, at Owen Falls near the source of the Nile. The Njeru factory is in the industrial region of Uganda, which was deliberately sited close to Owen Falls. However, even here there are now frequent power cuts. The factory relies on electricity for lighting (to supplement the daylight in the sorting area, so that fruit colour can be judged accurately), sealing bags, computer systems and the freezer. A small battery-inverter backup system

is used to keep lighting going over the sorting area during power cuts, but other parts of the operation have to shut down.

How users pay

£1 = 3313 Uganda Shillings (USh) [April 2008]

A drier costs about 500,000 USh (£150). A producer will normally contribute about 330,000 USh (68%) by buying the timber, nails and some other materials locally. Fruits of the Nile supplies the UV protected polythene sheet, plastic mesh and the labour to construct the driers. This 170,000 USh contribution is provided to the producer as an interest-free loan.

Individual producers and producer groups own between two and ten driers each, with an average of five.

Producers are paid 2,500 USH/kg for dried banana and 5,000 USH/kg for dried pineapple. Each time a producer delivers dried fruit to the factory, payment is made for the weight of accepted fruit which has been delivered, less a deduction for any fruit from the previous delivery which was subsequently rejected during sorting. A repayment for any outstanding loan is also deducted. Fruits of the Nile never takes more that 20% of the fruit price as a loan repayment, and often allows producers to spread their payments over three years or more, if they have financial problems. Payments can be made in cash, but some producers have direct payments to their bank accounts.

Training, support and quality control

Maintaining quality has always been crucial to the viability and success of Fruits of the Nile. If the dried fruit was not of acceptable quality, then the business and its supply chain would not survive. Quality and record keeping have to be even more rigorous now, because Fruits of the Nile is in the process of converting the whole supply chain to organic certified standards.

Producers

Farmers who would like to join the Fruits of the Nile

producer network must initially fill in a questionnaire, to assess their capability for providing a sufficient quantity of clean, quality product. A Fruits of the Nile field officer comes to assess the cleanliness and size of their home, the availability of clean water, the supply of fruit and whether they are competent to manage a small business. If selected, the farmer has to purchase the materials for the agreed number of driers, and when these are available the Fruits of the Nile carpenters construct them. Over a three day period, the field officer trains new producers in organic production, hygiene, food preparation, packing and running a business. For fruit preparation, the primary producers and their staff must cover their hair, wash their hands, keep fingernails short and use utensils only for fruit preparation. Contamination during transport must also

be avoided if the food is to have the organic label.

The producers must purchase only from other farmers who are registered with Fruits of the Nile, and have been trained to produce to organic standards. They must also keep a record of all fruit purchases, and bring this with them to be checked by the Quality Supervisor when fruit is delivered to the factory. Producers and farmers are given regular refresher training and advice. The field officer makes regular unannounced checks as does the certification body (IMO-Switzerland).

If more than 10% of the fruit from a producer is regularly rejected, the field officer will work with the producer to sort this out. In a few cases, Fruits of the Nile has temporarily ceased purchasing from a producer

while the field officer, or a good producer, has trained them again. In this way, they have never had to reject a producer.

Factory

All the factory workers are trained 'on the job' in hygiene, sorting and packing. They are regularly monitored by an experienced sorter until they are competent. Strict hygiene rules are enforced, including wearing hairnets and overalls. A record sheet is completed for each sorting table each day which shows name of the sorter, the name of the producer, the weight of rejected fruit and why it was unacceptable. In this way, problems with both factory staff and

producers can be noticed and sorted out. Organic-in-conversion fruit is handled separately from normal production.

Fruits of the Nile has a rigorous quality management system using paper and computer records. This contains cross-referenced records including every delivery, each day's sorting work, every payment and deduction. Problems are automatically highlighted and then investigated. To comply with organic certification requirements, complete traceability is needed, and records have to be retained for at least five years.

Benefits

Economic and employment benefits

The work of Fruits of the Nile brings income and skills to all within the supply and production chain. This is one of the criteria for being approved as a Fair Trade certified business.

At present, 840 farmers supply fruit to 120 producer groups (70% female), which typically employ between one and five labourers. There are also 37 factory workers (55% female). This means that about 1,400 people directly earn an income from the work of Fruits of the Nile. An average Ugandan family has six to seven people, so at least 8,000 family members benefit from the business. However, some of the people who are earning care for many more people, including orphans,

so the benefits probably go much further.

During 2007, Fruits of the Nile bought 60 tonnes each of dried banana and pineapple from producers, at a price of about 450 million USh (£136,000). This is equivalent to an average income of about 3.8 million USh (£1,100) for each of the 120 producer groups. No detailed analysis has been undertaken of how this income moves further down the supply chain. However some estimates are:

- Each producer employs between one and five casual labourers to help with the fruit preparation and growing, at a typical rural rate of 1,000 USh (£0.30) or more per day.
- About 80% of the fresh fruit is bought from 840

approved farmers. Prices vary greatly depending on the season (typically from 200 to 350 USh per kg for fresh pineapple and 170 to 200 USh per kg for fresh banana). Using these rates, the average farmer probably earns about 160,000 USh (£48) per year, from selling fruit. This is over half the annual earnings of a day-labourer, and is earned from fruit which would otherwise have gone to waste.

- Angello Ndyaguma has worked through the accounts with some producers. Taking into account the cost of labour, fresh fruit, equipment and transport, he estimates that about 50% income to the producer (1.9 million USh per year) is profit. In rural areas, where opportunities for earning cash

are limited, this is significant. For comparison, the average salary of a primary school teacher is about 1.3 million to 1.7 million USh per year. For most producers, the main use of this new income has been to educate their children, paying secondary school fees and in some cases being able to put children through university. Producers also improve their homes, and may be able to afford more land or livestock.

Most producers set up as private enterprises. However, a small number of groups have been set up by NGOs. These include groups of people who are caring for orphans, who were brought together by the NGO Africare, which part-funded their driers. Many of these

carers look after four or more orphaned family members, in addition to their own children, and therefore have very limited opportunities for earn income. By working as a fruit producer group they earn income and also learn business skills.

The factory workers earn from 1.2 million to 2.2 million USh (£360 to £650) per year, depending on their level of responsibility and length of service. After three to five months service an additional 10% is paid into a compulsory savings account. Staff are provided with a cooked lunch and tea breaks. No sick pay is provided (though there is a provision for first aid) but management are sympathetic to the need for compassionate leave. Although the peak seasons for banana and pineapple are at different times of the year,

there are about two months per year when fruit production is low. Some staff who work at the factory between leaving school and starting university leave at this time. The permanent staff are still paid for these months, and will be used for maintenance work around the factory and allowed time off.

The increase of skills along the supply chain starts with the farmers, all of whom are trained in organic production. Primary producers also receive this training, but in addition learn about food processing and how to manage a small business. Factory workers learn food production skills, and some have been promoted to administrative positions within the company.

Environmental benefits

The move to organic production has improved the local environment on the farms, for both primary producers and farmers. Fruit waste and peelings from the processing are all composted or fed to cattle, goats and chickens. No chemical fertilisers or insecticides are used, which is particularly important for illiterate farmers who might make mistakes through not understanding the instructions. The whole farm converts to organic production, so the benefits go beyond just the fruit.

Solar drying is renewable, and does not produce any gaseous emissions or other environmental impacts. Because the fruit that is dried was previously going to waste, there is no direct saving of energy or avoidance of greenhouse gas emissions, and the whole supply

process has been designed to minimise new environmental impacts. The fruit is dried close to where it is grown, reducing transport costs and enabling the waste to be returned immediately to the land. Public transport is normally used for carrying the fruit within Uganda. Shipping dried fruit to overseas markets is less energy intensive than transporting the same fruit when fresh. It does not require chilled stores, or air freight, and the value of fruit that can be transported in one container is much higher.

Potential for growth and replication

There is considerable potential for the Fruits of the Nile supply chain to grow. Many primary producers have succeeded in running profitable solar-drying businesses. Most of them would like to buy more driers, so that they could increase their production capacity and sell more dried fruit. Neighbours see the success of the primary producers, and Fruits of the Nile has a waiting list of farmers who would like to become involved. The Fruits of the Nile factory is currently operating at only 60% capacity, and could easily increase this to 100%.

The constraint in growth is securing the markets for the dried fruit. Small quantities are sold locally but the price is low, and there is little interest in a dried product when there is so much fresh fruit available. The major

sales are for export, currently just to Fullwell Mill in the UK. Without more export contracts in place, Fruits of the Nile cannot risk a significant increase in production, despite the pressure from producers and would-be producers. It therefore limits the construction of new driers.

However, the market for dried fruit and other healthy snacks is growing. If the organic certification is finally approved later in 2008, Fruits of the Nile expects that this will greatly expand its export markets. It could easily bring 30 to 50 more producer groups (100 to 150 extra driers) into the supply chain each year, with equivalent increases in factory staff. Fruits of the Nile is also working with Mbarara University of Science and Technology on solar-drying of local medicinal plants.

This business model can be replicated in many other places with plentiful sunshine, where agricultural products go to waste because there is insufficient local market for them. Fruits of the Nile has advised producers in other countries, including mango producers from Burkina Faso, herbs and spices from Zanzibar, banana and pineapple from Tanzania, and mushrooms from elsewhere in Uganda. However, as Fruits of the Nile has found, it requires a significant effort in training, administration and quality control to be a long-term bridge between rural farmers and international consumers.

Management, finance and partnerships

Fruits of the Nile was founded in 1990 by Angello Ndyaguma, Kate Sebag and Adam Brett. Initially they tried exporting fresh fruit but that was unsuccessful. They therefore turned their attention to solar fruit drying, and designed the driers which were needed. From a small start, when it was a struggle to produce the minimum 500 kg for air-freighting for export, the business now exports 120 tonnes of fruit per year. During the last three years, Fruits of the Nile has scaled up significantly. Factory production has moved from Kampala to a new tailor made factory in Njeru. Training, monitoring and quality management systems have all been made more rigorous to meet the requirements of organic certification.

Grants from the Gatsby and Ashden Trusts helped

Fruits of the Nile to extend a credit facility to primary producers. A more recent grant from Shell Foundation is supporting the process of organic certification, including management and setting up systems. A commercial loan funded the expansion of the factory, additional containers for storage and a large plot of land which could be used for future expansion. Most of the funding for Fruits of the Nile comes from its sales of dried fruit, which were £336,000 in 2007. It is hoped that organic certification will both increase the price paid by about 15%, and also generate new export contracts.

The directors of Fruits of the Nile are Angello Ndyaguma, John Sebunza, Adam Brett and Kate Sebag. Key staff are Angello Ndyaguma, Managing Director;

John Kabyetsiza, Finance and Administration Systems Manager; John Sebunza, Drier Constructor / Maintenance Manager; James Babumba, Field Supervisor and Constance Tusime, Quality Supervisor.

Notes

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See also

- Ashden Awards
- Drying of foods (Practical Action Brief)

- Solar Drying in Morocco

External links

- Ashden awards write-up and video on the solar driers.
(<http://www.ashdenawards.org/winners/nile08>)
- Information on all Ashden Awards winners
(<http://www.ashdenawards.org/winners>)

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