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FOOD PROCESSING PILOT CENTRES

An approach to productive capacity-building for trade and poverty alleviation in Africa

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

Food Processing Pilot Centres

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Contents

Background

Even if in developing countries 40-60 per cent of manufacturing value is generated by agro-processing industries and these products represent the major export share, only 30 per cent of agricultural production undergoes industrial processing as compared to 98 per cent in high-income countries. Presently, agriculture employs about 80 per cent of the active population and about 90 per cent of the rural population. This makes agricultural development crucial, as the majority of people in developing countries rely and depend on it.

For various reasons related to government policy and strategy, infrastructure, technology and know-how, business management and marketing, the food industry and agriculture have limited integration and linkages in developing countries. The food industry has been encountering difficulties regarding the regular supply of raw materials of adequate quality, while the bulk of the agricultural production, due to the lack of strong outlets (markets or industry), has remained at subsistence levels, i.e. low yields, heavy post-harvest losses and unsafe and poor quality products. In sub-Saharan Africa, countries average post-harvest losses are estimated at over 40 per cent (up to 30 per cent in cereals and up to 70 per cent in fruits and vegetables).

This has hampered the growth of both the food industry and agriculture, and led to the spread of poverty and food insecurity, particularly among the rural population. Improved integration and strengthened linkages between agriculture, the agro industry and the market are prerequisites for better performing food value chains. They offer a sustainable remedial solution to the twin challenges of poverty and food insecurity and safety.

The food industries that have performed relatively well are those that rely exclusively or mostly on imported raw materials such as beverage industries using imported concentrates, the edible oil industry processing imported crude oil or the dairy industry relying mostly on imports of powdered milk. Given their limited linkages with local agricultural production, these industries have not been able to create any significant downstream or upstream impact. However, a food processing industry relying on local raw materials has the potential to induce the above linkages and would be the appropriate industrial development option in developing countries facing poverty and food security challenges.

Being a weak outlet for local agricultural products, the food industry has not been able to induce significant improvements in agricultural productivity or at the post-harvest level in most rural areas that suffer from a big technology gap. Therefore, most agricultural production remains of a subsistence nature.

The food processing pilot centre (FPPC) approach

The lessons learnt from past and ongoing projects/programmes show a big technology gap in the rural areas of developing countries in general and African countries in particular. It is currently the biggest challenge facing so-called rural entrepreneurs. Traditional technologies are no longer capable of producing tradable products. New (modern) technologies are required to address crucial production issues such as product design and development, product and technology innovation, implementation of appropriate product preservation and processing techniques as well as good manufacturing and food safety/quality practices that are required to meet changing market demands and stringent requirements. Education and vocational training have a crucial role to play in developing knowledgeable and qualified human resources capable of running food processing activities as a viable business.

The FPPC approach revealed itself to be an appropriate response and has played a dynamic role in terms of technology transfer and dissemination within the African environment and consequently in improving the revenues of the beneficiaries. Conceptually and practically, the FPPCs play a central role in the food industry value chain as they reinforce and manage the fundamental linkage between agriculture and the industry/market through technological upgrading, business networking and market access improvement, thus creating a more favorable environment for business development.

Each FPPC consists of food processing facilities managed by qualified people (from the technical and business management view points) linked to a certain number of farmers and market outlets. By linking the production to the market through processing facilities, each pilot centre represents in itself a micro food value chain.

The FPPCs assess market needs, decide on the products to be produced and produce them. They assist farmers (training and advisory services) to supply raw material that conforms to the specifications required. In most cases the farmers are shareholders in the related FPPC. Due to their small capacity, FPPCs organize themselves according to their joint commercial interests (trading company, export consortia or any other economic or commercial structure). Each FPPC established under UNIDO signs a 3-5 year Memorandum of Understanding (MOU), where it commits itself to function as a demonstration and training facility as required within the framework of the UNIDO project or within the activities of the main national counterpart of the project. The objectives sought through the FPPC are to:

- Support the transfer and dissemination of proven food technologies, in particular to micro- and small-scale enterprises, and their adaptation to local agro-ecological and social conditions.
- Create the basic foundations for product development and innovation through technological improvements including processing, preservation, packaging, safety/quality, etc.
- Develop qualified human resources in the fields of food processing technology, business management and marketing through vocational and in-plant training based on the concept of "learning by doing";
- Promote (internally and externally) business partnerships for joint management of technical and common trade issues;
- Establish credible and sustainable food processing operation networks and strengthen the priority segments of the value chain and their linkages from production to the market.

The rural FPPCs have been at the core of the Integrated Programme (IP) in several African countries such as Burkina Faso, Cameroon, Kenya, Madagascar, Mali, Morocco, Senegal, Uganda and United Republic of Tanzania. See the table below for the full list of existing pilot centres.

FPPCs have a direct impact on the beneficiaries involved along the food chain and have outcomes such as:

- Increased value added of local agricultural products;
- Post-harvest losses reduced;
- Increased employment and incomes;
- Reduced poverty and food insecurity.

The FPPC approach has been attracting the interest of governments and the private sector in recipient countries as well as among donors.

In **Burkina Faso,** the four FPPCs established in the fruits/vegetables drying sector have led to an overall technology improvement in more than 25 drying units. Two additional FPPCs are being established for sheanuts and dairy processing.

In **Uganda** (with already 12 well established FPPCs), the demand from the private sector for the establishment of FPPCs has been increasing. In 2005, five new FPPCs have been established with self-financing for equipment and technical support from UNIDO and three additional FPPCs have been established in 2006 within the UIP. NORAD and WFP appraised the FPPC approach as the appropriate solution to support the WFP initiative "Food for Assets" in northern Uganda. A joint WFP-UNIDO programme is under preparation for the establishment of more than 40 FPPCs under NORAD funding.

In **Cameroon,** after the installation of the two first FPPCs, the government has owned the approach and is about to ask for UNIDO assistance in the establishment of 50 FPPCs throughout the country.

In **Morocco,** the counterpart appraised the approach applied through the establishment of three FPPCs (a fourth FPPC will soon start operation). The Ministry of Industry expressed its willingness to further refine the approach and use it extensively within phase II of the IP to support the National Initiative for Human Development aiming at increasing the living conditions of rural populations through employment and income generation.

In **Mali,** where three FPPCs are being established, requests for further FPPCs have been received from associations of rural entrepreneurs and donor interest in the approach has been expressed.

In **Madagascar,** where at least five FPPCs will be established within the next two years, the counterparts/beneficiaries see this approach as a means to develop agro-based commercial activities in rural areas to fight poverty and food insecurity.

The FPPC approach revealed itself to be appropriate in the rural African environment. Based on the lessons learnt, there is great scope and potential for refining and establishing the foundations of rural professional excellence. The best FPPCs will have to be identified and assisted to function as real "Centres of Rural Vocational Excellence" and play a major role in technology dissemination. While the best FPPCs are developing their consulting and support services in post-harvest technology and know-how, there is, however, a need for support from governments and technical assistance agencies to accelerate the process and to help ensure its sustainability.

Food processing pilot centres established so far

Country	Food processing pilot centres	Activities	Production capacity/month	Market targeted	People directly involved[1]	Farmers involved	Observations
UGANDA	1. Masaka Organic Producers (MOP) Established in 2000	Processing of organic dried fruits (pineapples, papaya, mangoes, jack fruit, banana) and vegetables (tomatoes, cabbages, amaranthus, solanum sp) Fresh fruits and vegetables Training of processors and farmers	1.5 MT of dried products 24 MT of fresh fruits & vegetables 64 trained	Domestic Export: EU	10	175	Member of UCOFPA, NAPU and NOGAMU
	2. Tropical Ecological Foods Uganda Limited (TEFU) (est. 2000)	Processing of organic solar dried fruits (pineapples, papaya, mangoes, jack fruit, bananas)	2.5 MT	Domestic and export	7	84	Member of UCOFPA, NAPU and NOGAMU
	3. KOKA Women Group (est. 1992)	Processing of cassava products, sunflower oil Training of processors and farmers	Oil 100 litres	Domestic	4	1.500	Member of UCOFPA
	4. Kabale United Food Processors (est. 2003)	Processing organic solar dried fruits (pineapples, papaya, mangoes, jack fruit, bananas) Dairy processing (yoghurt production) Training of processors and farmers	300 litres of milk 1 MT of dried products	Domestic and export	6	1 for milk 12 for fruits	Member of UCOFPA[2]
	5. Hometech Food Processors (est. 2000)	Processing of fruit juices, tomato ketchup, baking cakes Training of processors	500 litres	Domestic	3	3	Member of UCOFPA
	6. Medi & Sons (est. 1994)	Maize milling and rice milling Advising of processors	Maize: 140 MT Rice: 70 MT	Domestic	5	22	Member of UCOFPA

[1]Personnel and members of entrepreneurs groupings (cooperatives, associations, etc.) and shareholders of small companies.

[2]Three farmers have established an FPPC to process their own production and use the facilities for training.

	7. Karambi Women Associates (est. 1991)	Processing of fruit juices, pineapple syrup, banana wine, textile weaving, tailoring Training	100 litres per month of syrups/juices 150 litres of banana wine Trained: 265	Domestic	19	120	Member of UCOFPA and DENIVA
	8. Kasper Foods Enterprises (est. 1996)	Processing of passion fruit concentrate, wine, vegetable processing, tomato and chili sauces Consultancy in food processing	Wine: 150 litres Passion fruit concentrate: 35 litres Sauces 0.8 MT Trained: 561	Domestic	5	4	Member of UCOFPA
	9. Envalert Uganda (est. 2004)	Processing organic solar dried fruits (pineapples, papaya, mangoes, jack fruit, bananas) Training and consultancy work: Carrying out studies for organizations	4 MT Trained 3	Domestic and export	8	3	Member of NAPU Direct integration with farmers required
	10. IKN Enterprises (est. 1999)	Processing organic solar dried fruits (pineapples, papaya, mangoes, jack fruit, bananas) Consultancy Business/financial management	0.25 MT	Domestic and export	15	53	Member of NAPU
	11. Mubende Drying Centre (est. 2003)	Processing organic solar dried fruits (pineapples, papaya, mangoes, jack fruit, bananas) and fruit juice	0.5 MT Trained: 69	Domestic and export	7	42	Member of NAPU, NOGAMU and PELUM
	12. Flona Commodities Ltd (est. 1995)	Processing of dried fruits	New capacity to be established (has been sourcing dried fruits from other drying centres)	Domestic and export	6		Member of NAPU
Total UGANDA	**12 centres**		**Approximately 223 MT/month** **Trained 962**		**95**	**2,019**	

Food processing pilot centres established so far (*continued*)

Country	Food processing pilot centres	Activities	Production capacity/month	Market targeted	People directly involved[1]	Farmers involved	Observations
BURKINA FASO	13. "Coopérative de Transformation des Fruits et Légumes" COTRAPAL: Bobodioulasso (est. 1992)	Processing of dried fruits and vegetables, juice production and syrups, production of "soumbala"	2.5 MT	Domestic and export (fair trade)	97	10	Member of DOGORI and CDS
	14. ABELMA: Bobodioulasso (est. 1999)	Processing of dried fruits and vegetables, juice production and syrups, ginger processing	1.2 MT 10 trained	Domestic Regional export	25	10	Member of CDS
	15. BASNERE: Ouahigouya (est. 1986)	Processing of dried fruits and vegetables, juice and syrups production, ginger processing	2.5 MT	Domestic Regional export (fair trade)	55	10	Member of CDS
	16. CAS-BF: Ouagadougou (est. 1997)	Processing of dried fruits and vegetables, juices and syrups production, vinegar, dried meat Training and consultations	1.2 MT 380 trained	Domestic and export	16	74	Member of NAFA
Total BURKINA FASO	**Four centres**		**7.4 MT/month** **390 trained**		**193**	**104**	

MOROCCO	17. Jabriyne, Chefchaouen (est. 2003)	Olive oil processing	2 MT	Domestic and export	36	36	3 cooperatives member of NEFZI Association and FEDOLIVE
	18. Beni Rotten, Chefchaouen (est. 2002)	Olive oil processing	2 MT	Domestic and export	31	31	3 associations and 1 cooperative, member of FEDOLIVE
	19. Bouadel (est. 2004)	Processing of dried fruits (dried figs/prunes)	0.5 MT 150 trained	Domestic and export	100	150	
Total MOROCCO	**3 centres**		**4.5 MT/month** **150 trained**		**167**	**217**	
MALI	20. Dioila, Koulikouro: “Centre de transformation et de commercialisation de produits à base de karité” (est. end 2005)	Sheanuts (karité) processing: Shea butter and soap Training	5.0 MT (butter)	Domestic regional and export	20	1500	
	21. Sikasso: “Centre de production de sirop et boissons non gazeuses à base de fruits locaux” (est. 2005)	Syrup and juice production Dried fruits/vegetables Training	2.0 MT (2,000 litres of syrups/juices)	Domestic and export	6	280	
	22. Ségou: “Centre de production de fruits et légumes séchés” (est. 2005)	Fruits/vegetables drying	1.0 MT	Domestic and export	6	250	
Total MALI	**3 centres**		**8.0 MT/month**		**32**	**2,030**	

Food processing pilot centres established so far (*continued*)

Country	Food processing pilot centres	Activities	Production capacity/month	Market targeted	People directly involved[1]	Farmers involved	Observations
SENEGAL	23. Fish processing centre Yoff (est. 1998)	Fish salting and drying, smoking, fermenting, etc.	5.0 MT 80 trained	Domestic and export	20	150	
	24. Fruits/ vegetables drying in Ndam Lo (est. 1990)	Drying of fruits and vegetables	2.0 MT 300 trained	Domestic and export	8	120	
	25. Province: Centre de séchage de fruits et légumes (est. 2002)	Drying of fruits and vegetables	0.5 MT 380 trained	Domestic and export	30	80	
Total SENEGAL	**3 centres**		**8.0 MT/month** **380 trained**		**58**	**350**	
CAMEROON	26. Bamende, West Province: Milk collection and preservation centre (est. end 2006)	Milk collection and preservation	36 MT (36,000 litres)	Domestic	3	60	Member of Ayembe Bon Mbei Dairy Cooperative of Santa
	27. Bafoussam, West Province: “Centre de transformation du gingembre et autres épices moulus” (est. 2006)	Ginger processing Spice processing	15 MT	Domestic regional and export	24	100	
Total CAMEROON	**2 centres**		**51 MT**		**27**	**160**	
GRAND TOTAL	**27 centres**		**302.45 MT of various food products** **1,882 trained**		**627**	**4,880**	

Country case study

Example of technology transferred through FPPCs to enhance food security and alleviate poverty (Burkina Faso – Uganda)

Introduction

The choice and development of appropriate technology and methodologies for transfer depends on the products and markets targeted, the potential of rural entrepreneurs/beneficiaries to absorb the technology, the social and economic environment, the infrastructure level and the costs of production inputs (labour, raw material, fuel, power supply, processing and packaging, etc.). The present case study describes how UNIDO, through the transfer of appropriate fruit and vegetable drying technology, managed to increase the productivity of small-scale rural operations, targeting export markets and the income of rural entrepreneurs in the African social settings of Burkina Faso and Uganda.

Background and the technology problem to be addressed

In Burkina Faso about 45 per cent of the population live under the poverty line and cannot meet their basic needs. The majority of the population live in rural areas and depend on agriculture, which employs 90 per cent of the people, most of them in subsistence activities. Poverty is also linked to recurrent unemployment. The industrial sector is rudimentary and industrial growth has been low due to the small size of the domestic market and to the lack of capital investment and competencies. Industrial production is mainly carried out by the agro-industries and by industries where production aims at substituting some imported products.

Industrial food production has a high potential for value adding, in particular in the processing of fruits and vegetables (drying, syrups, jams and marmalades, vinegar, etc.). It provides an opportunity for job creation and income generation in rural areas. However, the food industry in Burkina Faso strongly depends on various inputs that have to be imported such as processing equipment/technology and packaging materials.

The drying of fruits and vegetables is a traditional activity in Burkina Faso. Attempts to improve the technology started in 1987, targeting the export market. By 2000 more than 20 small-scale enterprises were processing fruits and vegetables with a focus on drying. Dried products (in particular dried mango) were in demand in the export markets. The technologies developed were based on driers using solar energy directly or indirectly, gas and electricity.

The first solar dryer developed was very simple and cheap to construct and operate. However, it quickly proved to be unreliable (climatic variations and drying parameters being difficult to control) and unable to meet the quality requirements of the export market.

The gas dryer showed some improvements. Here drying is continuous and the drying parameters can be controlled. However, gas is very expensive in Burkina Faso and consequently production costs are very high. Moreover, as the products are dried directly by the flames, the product is rather cooked, which has a negative effect on its quality.

Electric drying is very expensive for the small quantities produced by micro and small-scale enterprises and rural areas are rarely connected to the grid.

UNIDO's programme in Burkina Faso aimed at providing technical assistance in the development of competitive technologies for the processing of fruits and vegetables with particular emphasis on drying. The targeted objectives were on the one hand the reduction of production costs and on the other, better control of the drying parameters to produce a product of good quality. The idea was to develop a hybrid dryer using solar energy as the main source of energy (very abundant and cheap) and a supplementary source (gas or diesel) replacing solar energy in evenings, at night and during cloudy weather. The project was implemented in three phases:

- Conception and construction of a prototype hybrid dryer including an indirect solar dryer and a supplementary heating system using gas or diesel;
- Installion of the dryer and testing it in a pilot unit to serve later for demonstration and training purposes;
- Training the personnel of the pilot unit and trainers from local support institutions for technology dissemination.

Technology development

Description of the hybrid dryer

The prototype of the hybrid dryer was designed and constructed by the Department of Agricultural Engineering of the University of Agriculture in Vienna in cooperation with UNIDO. The system consists of a solar air collector, two drying chambers with drying trays, a photovoltaic system, a DC radial fan and a supplementary heater.

The ***solar collector:*** The solar air collector consists of six wooden boxes with internal dimensions of 2.023m x 0.735m x 0.235m. Each box contains a blackened absorber and insulation material to minimize heat losses through the bottom. The absorber absorbs solar radiation and converts it into heat. It consists of two layers: an aluminium expanded-metal screen and a single piece of aluminium foil sheeting below. The latter absorbs the incoming radiation transmitted by the porous absorber (aluminium—expanded metal), and prevents the air from coming in contact with the glass wool insulation. The tops of the boxes are covered with

4 mm thick colourless glass covers. The seal between the glass cover and the wooden box is ensured using aluminium slides and silicone.

The ***drying chambers*** serve as the drying unit. They are fabricated from 20 mm-thick wood. The inner walls are insulated with aluminium foil to prevent the drying air from coming into contact with the wooden walls and to allow regular cleaning of the drying chambers. Each drying chamber contains nine drying trays of one square metre (1 m^2) each. They are made of wooden frames and aluminium mesh at the base. The heated air from the collector enters the chamber through an opening at the bottom and exits through holes at the top of the rear of the wall of the chambers after having passed through the drying products loaded on the trays. Air filters are placed at the air inlets and exhaust openings to protect the drying commodities against infestation by insects and contamination by dust and dirt.

Electric fan and photovoltaic system: A two-step radial fan is applied for air circulation in the air collector and drying chambers. It has a maximum airflow rate of 350 m^3/h (1. step) and 600 m^3/h (2. step) at free blowing operation (i.e. low pressure resistance). The power consumption of the 12V DC motor is in the range of 65 W and 145 W at step 1 and 2 respectively. The fan is placed in a box with three inlet openings at the front and two outlet openings at the back. The three inlet openings are connected to the air outlet of the air collector and the two outlets to the drying chambers. The fan pumps the outside air though the collector and the connecting pipes. The hot air is then forced through the connecting pipes to the drying chambers. The air ducts connecting the fan box to the drying chambers are provided with flap-valves for the regulation of the hot air entering the chambers.

The ***photovoltaic system*** consists of four PV-modules, two storage batteries and a charge regulator. The four modules (24V and 110 Wp each) are electrically connected in parallel to give a total performance of 440 Wp (4 x 110) (Wp = peak watt is the amount of power produced at standard reporting conditions (SRC), viz. receiver temperature of 25°C and 1 kW/m^2 solar irradiance). Two 12V lead-acid batteries with a storage capacity of 120 Ah (Ampere-hour) each are used to store the voltage generated by the PV-modules. The batteries are connected in series. The power generated by the PV-array is used to charge the batteries during periods of high insulation. At night and during periods of low solar radiation, the batteries are charged with an electrical battery charger. The charge regulator regulates the array output in order to prevent battery overcharge, overheating and the resulting decrease in battery life.

The ***supplementary heating system*** uses a diesel-fuelled indirect heater to heat the drying air at night and/or during bad weather conditions (cloudy days). The temperature of the drying air is controlled with a thermostat. The technical data of the air heater is as follows:

Voltage	24 V
Power consumption	36 W
Fuel consumption	0,46 l/h
Heating capacity	3,5 kW
Air flow rate of the fan	180 m^3/h

Operating principle of the hybrid dryer

The hybrid dryer uses an indirect air collector to heat the ambient air during periods of high insulation. The incoming solar radiation (direct and diffuse components) incident on the collector surface is transmitted by the 4 mm thick glass cover and absorbed by the blackened aluminium expanded-metal screens, which are thereby heated. The heat gained is transferred to the air pumped in by the fan and transported to the drying particle in the drying chambers. The moist air exits through the exhaust opening on the top of the back wall.

The diesel (or gas)-fuelled warm indirect heater is used to heat the drying air at night and during periods of bad weather conditions. The supplementary heater uses a fan to pump the outside air into the burner, where it is heated up. The hot air is pumped into the fan box, where it is mixed with the additional air pumped in through the air collector by the radial fan. In order to avoid rapid discharge of the batteries, the system is connected in such a way that the supplementary air heater can be operated only in combination with the first step of the radial fan.

Results of operation on site in Burkina Faso

This hybrid dryer was installed at the facilities of three women's groups (including over 200 women entrepreneurs). The results of the economic evaluation are summarized in table 1. Production costs could be reduced by 40 per cent and product quality increased considerably. A local NGO, established with the assistance of Swiss cooperation, is continuously trying to improve this technology. In addition to the training of trainers, 25 trainers have been trained to support women's groups. This technology is being replicated in Senegal, Uganda and Morocco. Its dissemination to several other African countries is foreseen.

Table 1. Economic comparison of the two drying systems

Parameter	*Direct gas dryer*	*Hybrid dryer*
Energy consumption		
Source of energy	Gas	Solar/diesel
Capacity/drying cycle	20 kg	20/18 kg (dry/humid period)
Energy consumption/drying cycle	24/30 kg (dry/humid period)	3/5 l (dry/humid period)
Cost of energy/drying cycle	3500/4370 CFA	900/1500 CFA
Cost of energy/kg dried product	175/218 CFA	45/84 CFA
Quality of dried product		
Colour	Brown (dark)	Yellow
Flexibility	Less flexible (brittle)	More flexible (remark made by CDS quality control manager)
Taste	Part of the natural taste is lost	Natural taste is fully retained
Losses	High: 30 per cent	Low: 10 per cent
Monetary value	612 000 CFA (US$ 826)	63 000 CFA (US$ 85)
Production costs/kg of dried product	2 763 CFA (US$ 4)	1 870 CFA (US$ 2.50)

Application and results in Uganda

Based on the encouraging results obtained with the hybrid dryer in Burkina Faso, the technology was transferred to Uganda. Like in Burkina Faso, agriculture is the country's most important economic sector. Over 86 per cent of the population are engaged in agriculture. The major export crop is coffee, a world market commodity. However, world market prices for coffee and other agricultural produce have fallen drastically in the last few years leading to loss of income for the rural population. As a result farmers were assisted by several NGOs to switch from the conventional production of coffee to organic production of fruits (pineapples, apple bananas, paw paws, etc.) and vegetables for the local and export markets. However, they are lacking storage and transport facilities as well as preservation technologies and skills to avoid huge post-harvest losses.

In Uganda, several small-scale women's processing groups and companies are engaged in the processing of fruits for export using simple solar dryers. The climate of Uganda is characterized by low solar radiation and relatively high humidity all year round. This is a limitation for the use of the solar dryer.

UNIDO's programme in Uganda is aimed at contributing to poverty reduction through agro-processing and private sector development. Two companies, already engaged in the processing of dried fruits for export, were identified in the year 2002 for the installation of the pilot hybrid dryer. The major constraint of the companies was the low performance of the simple drying technology they were using. The long drying duration ranging from 2-3 days during the hot season and 4-5 days during the humid rainy season resulted in low capacity and poor product quality as well as considerable losses.

Technical concept for Uganda

The performance of solar drying systems is a function of available solar radiation, temperature and relative humidity of the ambient air. Average daily sunshine hours in Kampala are approximately six hours. The annual average ambient air temperature is about 26°C and relative humidity is above 85 per cent. The relative humidity and temperature of the air play an important role in the drying process. Humidity is the measure of the moisture content of the air. Very wet air (high humidity) will have less capacity to pick moisture from the drying particle. Increasing the temperature of the air reduces humidity and improves its capacity.

Based on this information, it was concluded that the hybrid dryer designed and tested in Burkina Faso had to be modified to adjust it to the prevailing weather conditions as well as to the poor infrastructure (frequent power interruption) in Uganda.

Description of the modified system

The plant consists of an indirect solar dryer and a supplementary heating system.

Indirect solar dryer: consists of a solar air collector with 12 m^2 total collecting surface, and of a drying chamber with 48 drying trays of 0.5 m^2 each. This is equivalent to a total drying area of 24 m^2.

Drying chamber: length 2.14 m, width 1.02 m. Sidewalls constructed of bricks, top covered with 20mm thick wooden board. The interior of the chamber is partitioned with wooden board into four compartments. The partition boards are provided with shelves for the 12 drying trays. The trays measuring 0.5 m x 1 m are made of wooden frames and aluminium mesh at the base.

Supplementary air heater: a normal warm air generator heater comprising a combustion head, a combustion chamber entirely in stainless steel, a ventilation and cooling unit, an air outlet, and fuel tank. The temperature of the air is regulated with a thermostat. A 315 mm-thick flexible hot air duct connects the air collector to the supplementary heater and the supplementary heater to the drying chamber. The technical data of the warm air generator is as follows:

Voltage	230 V/50Hz
Motor power	300 W
Fuel consumption at maximum operating capacity	2 l/h
Air flow rate of the fan	1900 m^3/h

Results of operation on site

Two units of the modified hybrid dryer were installed at the work sites of two processing enterprises. Both companies have over 100 registered farmers supplying them with fresh products and 30 employees. The drying duration could be reduced from several days to 12 hours (for apple bananas and mangoes) and 15 hours (for pineapples). Furthermore, the losses during processing were reduced considerably and the quality of the dried products improved (over 90 per cent of the dried product is of export quality). Over 20 artisans from all over the country have been trained in the fabrication, installation and maintenance of the system.

Conclusions

The case studies presented show that the application of appropriate food processing technology can help to generate income for the rural population in developing countries and to improve the competitiveness of the processing enterprises/companies. In Burkina Faso, production costs could be reduced by 40 per cent. Furthermore, the application of the hybrid dryer helped women entrepreneurs to diversify their production. In Uganda, where the prevailing weather conditions limit the use of simple solar dryers, production capacity and the quality of the dried products (pineapples, apple bananas and mangoes) could be improved considerably.

FPPC case study

Masaka Organic Producers (MOP) — Uganda

Masaka Organic Producers (MOP) is a private non-governmental organization (NGO) that deals in dried fruits. It was initiated by the late Aliddeki John and his wife Josephine in the year 2000. MOP deals in organic production and has established a network of farmers/suppliers and customers.

MOP before UNIDO intervention

MOP began as a family project with one staff member, using one local dryer for the processing of dried mangoes, pineapples and apple bananas with an output of 16 kg per month. With assistance from DANIDA, MOP acquired a tunnel dryer, which increased its production output to 160 kg per year. MOP started exporting dried fruits to Denmark (Urtekram) selling at US$ 2.5 per kg for dried pineapples and US$ 2 for apple bananas. Exports grew to 300 kg of dried pineapples per year.

MOP after UNIDO intervention

MOP was selected as a post-harvest pilot centre under the UNIDO capacity-building, technology and quality upgrading programme, and received a hybrid dryer with a minimum production of 340 kg per month and 90 per cent products of export quality. The introduction of the UNIDO hybrid dryer to MOP resulted in the following:

- Exports have grown to 2.5 tons of pineapples, one ton of apple bananas and half a ton of mangoes in 2003 and then to 4.5 tons of pineapples, three tons of apple bananas and three tons of mangoes in 2005;
- The number of farmers supplying MOP increased simultaneously from 37 to 70 certified farmers as well as 125 conversion farmers to be certified by Krav, Sweden;
- MOP purchased another UNIDO hybrid dryer with a PV system to cope with the increased demand and production of dried fruits;
- Markets expanded from Urtekram (Denmark) to Germany, UK, USA and Austria. Dried fruits are also sold to visitors and tourists who visit MOP;

- Export prices increased from US$ 2.5 per kg to US$ 7 per kg of pineapple and US$ 8 for mangoes and US$ 5 for papaya and jackfruit. The total value of sales increased from US$ 750 per year (before UNIDO intervention) to US$ 8,250 per year in 2003 and US$ 70,500 in 2005;
- Prices paid to out growers increased from USh 100 to 350 per kg for pineapples, apple bananas, jackfruits and papayas and USh 500 per kg of mangoes;
- MOP expanded to other districts of Masaka, Rakai, Sembabule and Mpigi;
- MOP is proposing to acquire two more hybrid dryers;
- The percentage of dried products of export quality increased from 60 to 90 per cent with minimal losses;
- Vacuum packing of export products added value;
- MOP has expanded from one acre of land to 10 acres;
- MOP has constructed a new modern processing building;
- It has expanded its local market outlets to supermarkets, hotels and restaurants;
- It has the increased number of certified out growers supplying the factory;
- Currently MOP sells to Amfri farms which exports to different parts of the world;
- MOP supplies local supermarkets such as Uchumi, Shoprite, NOGAMU.

Conclusion

UNIDO's intervention in technology transfer has greatly improved the production of solar dried fruits both in terms of quality and quantity and hence increased market opportunities in Uganda. MOP has become famous as a private enterprise due to its high commitment, interest and determination, particularly in technology transfer.

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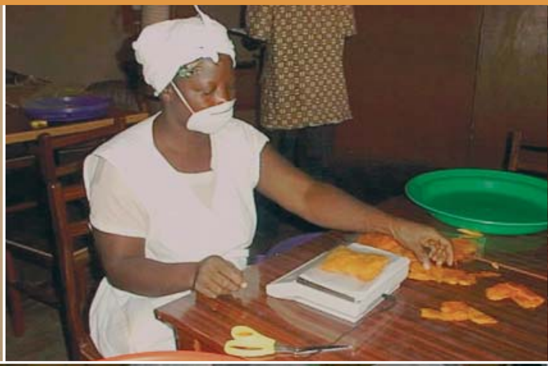

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