

Micro- enterprises in Solar Food Processing Technology - Case Study

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Abstract

With the development of commercial technology in cabinet dryers, a new economic social activity emerged out in the rural areas in the field of agri-horticulture through processing of fruits, vegetables, spices, medicinal plants on micro level. Fifty food products of fruit and vegetables are processed in SEED commercial dryer on pilot scale by the application of food science and technology techniques for long shelf life and preservation.

The technology is successfully commercialized through establishing the rural micro-enterprises in 13 states in the country, starting from Ladak in North to Trivandrum in South. These enterprises not only generate the income and job opportunities to rural women and unemployed youth but also process the products with zero energy costs and with clean green energy. This obtained recognition from Ministry of New & Renewable Energy, Government of India and obtained a sanction of 50% subsidy on the cost of dryers. The importance, strategies and the promotional methods of solar food processing products in the domestic and export markets are discussed in this paper.

Introduction

The newly emerging solar food processing technology is an important Socio-economic activity in the country especially in rural areas. It has become an interdisciplinary technology with a multiphase character in rural set up.

The Solar Powered Solar Air Dryer designed and developed by “Society for Energy, Environment and Development” enabled the food processing technology to get a significant boost.

The two important constraints that come in the way for the rapid growth of food processing industry in India until today are that it is capital intensive and energy intensive. The innovation of new cabinet solar dryer by utilizing the solar photovoltaic and solar thermal energy have offered a good and apt solution to the above mentioned drawback on micro level.

It is not only the invention of new technology, but also the wide application to dehydration of fruits, vegetables, forest produce, medicinal and herbal products etc. it has contributed for wide popularization and usefulness of solar food processing technology. Fifty varieties of food products were successfully dehydrated by following the good food processing practices on pilot scale.

Since these dryers operate at zero energy cost, the cost economics of food processing is very favorable for small industry. Since the dryers are modular in nature, the capacity of systems can be varied depending on the market demand of products and capacity of capital investment. Thus a large number of entrepreneurs from the villages, semi urban and urban areas can participate and involve in starting the process industry.

Since this technology satisfies the requirements of international standards of cleanliness and hygiene, a small entrepreneur can export the produce through proper net working mechanism. This also will have enormous impact and influence on healthy living in rural areas.

This technology is based entirely on inexhaustible and non polluting solar energy and it protects the present and future generations from the carbon emission gases of harmful nature.

Besides promoting the growth of food industry, a larger section of women and youth in rural areas can earn good income and create employment potential for them. Lastly, we confidently say that it will revolutionize the food industry in the coming years both in India and in all developing countries on micro level.

In this paper, we describe the ground breaking innovation in solar dryer technology and its application to solar food processing of horticultural products. The successful development of these interlinked technologies resulted in commercialization through micro enterprises in rural areas. SEED has patented the solar dryer (Patent No: 211911).

PRINCIPLE OF SOLAR DRYER

Solar radiation passes through a transparent glass window located on the top of the cabinet, which is oriented to the South with a tilt equal to latitude to collect maximum solar radiation. The cabinet is made of anti corrosive material of Aluminum and Stainless steel and is of modular nature to meet the varying sizes.

The ambient air enters from the bottom of the cabinet from three sides & gets heated up with solar radiation incident from the top window. The heat energy is trapped in the cabinet and heats up the air. As a result the wavelength of solar radiation shifts to infra red region, causing green house effect. The hot air passes through the trays, carries the moisture from the product to the space above the trays and below the glass. Then it is exhausted by three Solar Photo Voltaic (SPV) Fans arranged on the top of the cabinet. The forced circulation of the air is achieved through these solar fans. Electrical heaters are provided as standby to meet any exigencies on non-sunny days.

The solar powered solar air dryer has capacity to evaporate 15kg of water per day from the processing of food and the loading capacity of 50kg of maximum of wet products. The loading capacities of food products in solar drying range from small scale to commercial scale depend on the size and number of dryers.

TECHNICAL SPECIFICATIONS OF SOLAR DRYER SDM-50

DRYING CAPACITY (WET PRODUCT)	:	Max 50 Kg.
DRYING TEMPERATURE	:	40°C - 65°C
AMBIENT TEMPERATURE	:	(25°C - 40°C)
SOLAR WINDOW AREA	:	2 .23 Sq.mts
TOTAL DRYING AREA	:	3.60 Sq.mts
TOTAL NO.OF TRAYS (MESH OR CLOSED) (MATERIAL 304 STAINLESS STEEL)	:	12 Nos
CABINET MATERIAL	:	ALUMINIUM WITH

		HIGH TEMPERATURE POWDER COATED, STAINLESS STEEL & BRASS HARDWARE		
EACH TRAY SIZE	:	L	W	H
		1100 mm x 260 mm x 20 mm		
SOLAR PHOTOVOLTAIC PANEL RATING	:	12V D.C.– 21 Watts		
SOLAR FANS	:	3 Nos		
BACK UP HEATERS RATING	:	AC 220 V, 3.6 KW		
ORIENTATION	:	20°South Tilt		

SPECIAL FEATURES OF THE SOLAR CABINET DRYER:

- The temperatures achieved in the cabinet are in the range of 35-70 ° C on clear Sunny days.
- The temperature difference between the ambient & inside the cabinet is 15-30 ° C on bright sunny days.
- Solar Photo Voltaic (SPV) fans are provided for air circulation as a means of forced circulation.
- A temperature control is provided to operate at the desired temperature in solar – electrical mode.
- A special glass filter is provided to cut off UV radiation & reduce solar intensity for special applications to simulate shade drying.
- Clean and hygienically prepared products meeting the cleanliness specification of ASTA of USA and others countries, is processed in these dryers.
- These dryers are modular, easily transportable/ portable and configured according to the availability of open space in user’s premises.
- The scalability of the design to any size on demand.

The solar drying process is an eco-friendly technology with the following characteristics:

- Zero Energy cost, pollution free energy
- Results in clean and uncontaminated products
- Meets International cleanliness standards
- Moisture control
- Finished products of Export quality
- Supports for self employment schemes and thereby income generation
- Sizes from small size to commercial production
- Ensures quality and value added products.

These dryers are multi-purpose, applicable to multi-crops and works for more than 300 days in a year.

ADVANTAGES OF ‘SEED’ SOLAR CABINET DRYER

‘SEED’ Solar dryer is very high efficient dryer and superior to other solar dryers. The reasons are:

- Basing on 25 years of Indian experience in Solar drying technologies, **SEED** advocates smaller systems for drying of horticultural and marine products. The smaller systems are easily manageable, maintenance minimal, suitable for smaller

group, efficient management, investment small, and volume of processed food controllable on the basis of market demand. The 'SEED' drying chambers (Modular structure) arranged together in series or parallel rows according to the space availability. Each bank operates jointly or severally in the given space as per the requirement of group of beneficiaries and also, on the market demand.

- They are suitable to small group activity and independently operated and maintained by women entrepreneur & youth in hilly areas.
- **They entirely run on Solar Energy. It does not require conventional electricity for blowers and fans like in Flat Air collector system and it runs on solar photovoltaic fans with variable voltage.**
- They are direct cabinet type dryers of high efficiency as the solar radiation directly enters and heats the air entering into the drying chambers unlike the air collector, which is indirectly heating the air, and is a low efficient system.
- They conserve Photovoltaic electrical energy also as the moisture evolution from the product is the function of solar radiation and, the same radiation induces the variable voltage and speed, unlike the air collector system depending partially on electricity.
- Instrument measuring system indicates cabinet and ambient temperatures on digital display or liquid thermometer.
- The special U.V. reduction glass filter simulates shade drying for the product, in case this is required for special purposes.
- The operation of this drying system does not pollute the environment and based on eco-friendly technology and Renewable Energy.

This dryer is far superior to indirect air collectors.



Fig: 1 SEED - SOLAR CABINET DRYER - Model - SDM 50

FOOD PROCESSING TECHNOLOGY – IMPORTANT APPLICATIONS

The application of Solar Dryer for Processing Fruits, Vegetables, Herbs, Forest Produce, Chemicals etc. has been studied extensively and the findings are indicated in the following table:

Solar Food Processing is a novel and unique technology developed by Society for Energy, Environment & Development (SEED) for dehydration of fruits, vegetables, forest produce, spices, sea-food etc. to the permissible moisture limits for better preservation, long shelf life and to the international cleanliness standards. These processes can be accomplished with

zero energy cost unlike the electrical drying in solar powered solar air dryers. The important nutrient facts are mostly preserved in this process.

The data compiled in this paper is collected from our application laboratory from 1998 in Hyderabad.

These items are pretreated with processes, preservatives, chemicals, additives with established food practices in food technology. The procedures are tested and compared with other procedures and finally arrived at the methods most suitable at operational levels and economically cost effective.

The laboratory has successfully processed 50 items, belonging to Agri-Horticultural products. They are classified into 8 categories, viz., fruits, vegetables, green leafy vegetables, spices, forest produce, medicinal and herbal products, food items and chemical powders. We update this data from time to time with new products and new drying technology.

TECHNICAL DATA ON SOLAR DEHYDRATION OF FRUITS, VEGETABLES, GREEN LEAFY VEGETABLES, FOREST PRODUCE, SPICES, FOOD ITEMS

S.N	Product	Drying Conditions				Finished product Moisture %
		Load kg/m ²	Cabinet Temp. °C	Time in Sunny hours	Yield (%) of product	
1	2	3	4	5	6	7
FRUITS						
1	Mango Bar (10mm thickness)	34.	50-65	20	45	12
2	Guava Bar (10mm thickness)	34.	33-48	20	45	12
3	Grapes	7.0	38-53	25	20	4
4	Sapota Slices	3.5	34-49	8	27	
5	Sapota Bar (10mm thickness)	34.	27-42	20	36	12
VEGETABLES						
6	Potatoes	5.0	35-50	4	30	5.0
7	Donda	5.0	36-51	19	30	5.0
8	Carrot	4.5	36-51	10	15	6.0
9	Tomato	4.2	45-60	10	10	5.0
10	Mushrooms	4.0	35-50	12	15	5.0
11	Bitter gourd	4.0	27-42	6	11	4.0
12	Onion		36-51	18	17	4.0
13	Amchur slices	5.0	45-60	7	10	4.0
14	Coconut	2.5	35-50	5	50	4.0
GREEN LEAFY VEGETABLES						
15	Curry leaves	1.5	40-55	8	35	4.0
16	Spinach leaves	2.0	40-55	15	8	4.0
17	Fenugreek leaves	2.0	25-40	6	13	4.0
18	Tamarind leaves	2.0	40-55	12	11	4.0
19	Gogu leaves	2.0	40-55	15	16	4.0
20	Mint leaves	1.5	40-55	5	17	4.0
21	Drumstick leaves	2.0	40-55	5.5	15	4.0
22	Corriander leaves	2.0	36-51	6	12	4.0
SPICES						

23	Ginger powder	5.0	35-50	20	15	4.0
24	Mango Ginger	8.0	25-40	10	16	4.0
25	Garlic Powder		30-45	4	33	4.0
26	Red Chillies	5.0	41-56	15	34	4.0
27	Green chillies	8.0	30-45	6	12	4.0
28	Pepper		40-55	8	34	
F O R E S T P R O D U C E						
29	Karaya Gum	2.0	43-58	19	30	-
30	Karakkaya	2.0	35-44	44.5	47	-
31	Sugandapala(Budipalagadda)	4.0	47-62	26	26.5	-
32	Alovera	5.0	34-49	9	2.8	-
33	Amla	5.0	35-50	6.5	32	-
34	Honey	2.0	45-65	5.5	91.5	-
M E D I C I N A L & H E R B A L P R O D U C T S						
35	Rosemary	4.0	40-58	15	30	
36	Spirulina Powder	4.0	45-60	6	18	4.0
37	Tulasi leaves	2.0	40-50	6	12	4.0
F O O D I T E M S						
38	Maida	4.0	35-56	4	96	4
39	Vermicelli	6.0	30-44	4	35	4
40	Noodles	7.0	25-44	4	77	5
41	Pickled Chillies	3.5	30-49	24	25	4
42	Fish	6.5	35-52	8	40	11
C H E M I C A L P O W D E R						
43	Silicon Carbide	2.0	45-60	3	80	4
44	Cellulose	3.5	40-60	7	50	4



COMMERCIALISATION OF SOLAR DRYERS

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Fig2: Vegetables, Fruits & Forest produce

SEED has commercialized the solar powered dryer very successfully. The price of Commercial dryer is Rs.85,000/-. The efficiency of dryer is 80%. It has 2.2 sq.mts solar window and 3.6 sq.mts drying area in the cabinet. About 150 dryers have been sold and installed by SEED at 80 locations in Andhra Pradesh, Tamil Nadu, Kerala, Karnataka, Delhi, Orissa, Andaman, West Bengal, Jammu & Kashmi, Himalchal Pradesh etc.

COMMERCIALISATION OF PROCESSED FOOD PRODUCTS

The projects yielded fruitful results in dehydration of several types of vegetables & Herbs, medicinal plants, forest produce etc. on pilot plant scale.

The technical know how of the processes are released to solar dryer entrepreneurs in the training programmes. Among these products Mango bar (Aampapad), prepared in clean and hygienic environment with a special recipe, has acclaimed as the best product and high quality in the country.

In the SEED Food Laboratory, senior scientists and technologists of national reputation along with qualified project assistants are managing the application laboratory.



Fig: 3 SOLAR DRIED FRUIT BARS

QUALITY OF THE SOLAR DRIED FOOD PRODUCTS

The Food Processing laboratory of 'SEED' has been conducting research and development on dehydration of Horticulture produce from the grants sanctioned by Department of Science & Technology (DST), Government of India and from own resources of 'SEED' since last five years.

The 'SEED' has started an Analytical laboratory with all facilities and to guide the establishment of rural test laboratories. The Physico-chemical properties such as moisture, pH & Acidity, Brix, Browning Index, Sulphur dioxide, Total Sugar, Reducing sugar, Protein & Fat, Total Ash, Minerals & Vitamins and Microbiological tests such as Total plate count, Yeast & Mould count, E.coli, Staphylococci, Salmonella and sensory evaluation properties such as color, texture, flavour, appearance etc.

The quality criteria is reproducibility and repeatability of the product in the production line as per the original recipe characteristic properties.

These laboratories aim at producing the export quality food products to cater to international markets to compete with the products from countries like Thailand, Philippines and China.

These laboratories not only assure high quality products but also create employment opportunities for highly skilled technicians in rural areas.





Fig: 4 SEED - LAB PHOTOS

SOLAR FRUIT BARS

I) MANGO BAR MARKET

The Mango bar, mentioned above is being introduced in U.S.A, Middle East and African countries this year. Hence many other superior quality products processed in solar dryers can be exported to USA, Middle East, African countries thru cooperatives and sale net works. The first consignments of Mango bar is already dispatched and repeated orders for export are continuing. The solar processed products will have edge over products from other countries in several respects where the processed foods are based on utilization of conventional electricity for the process. Hence we can compete in the international market.

II) OTHER FRUIT BARS (Guava, Chikku, Mixed Fruits, Khatta- Meeta) & AMLA

With the experience gained by SEED in processing the Mango bar, it developed many other fruit bars such as Guava, Chikku, Sapota, Mixed fruits & Khattha-Meeta bars and also Amla Supari with its special techniques and recipes. They are dried and processed in 'SEED' solar dryers.

INSTALLATION OF SOLAR DRYERS

'SEED' installed 150 solar dryers, both demonstration and commercial models in 13 states including Andhra Pradesh and other states in India, starting from Kashmir to Trivandrum and Gujarat to West Bengal. Out of these, more than 80 commercial models were installed and some of them are run on commercial lines and they proved as successful enterprises. These entrepreneurs, fall into the three categories viz., individual Government sponsored and social entrepreneurs, NGO based enterprises and professional institutions such as Arithika Samatha Mandal Plan, Suryapet, Swamy Ramananda Thirtha Rural Institute, Nalgonda, Ajoy Foods, Nellore, Youth for Action, Kothakota, Mahaboobngar, Dangoria Charitable Trust, Narspur, Magan Sanghralaya Samithi, Wardha, All India Women's Conference, New Delhi, Stree Sangkshema Trust, Penukonda, Roopak Overseas Pvt. Ltd, New Delhi, Ladakh Ecological Development Group, Leh, RCL Products, Chennai and others.

Out of these three categories, the last category has proved very successful as social enterprises. Their experience is a role model for promotion of the technology as well as creation of job opportunities for rural women.

Training Programmes:

Training programmes were conducted for women for upgradation of skills and know-how of processing of food products for the last 4 years. 1,000 women entrepreneurs were trained in variety of foods in dehydration process. The trainees are Self Help Groups (SHGs), Non-Governmental Organizations (NGOs), entrepreneurs and the programmes were conducted in a number of places throughout the country.

Successful Micro-enterprises:

To prove the value addition and commercial viability of the above dryers, field tests have been carried out for Mango bar processing for the last six years for test market development and the cost economic analysis of Mango bar. Starting from 10 kgs of production per month, SEED has scaled up the production to 1 ton of Mango bar and fruit bars per month in a short period. This created new marketing outlets in twin cities of Hyderabad.

The other entrepreneurs had developed the new products like Ragi sprouted flour, Soya flour, dried Apricots on commercial scale in different parts of the country on their own initiative.

On recognizing the successful implementation of SEED dryer technology, the Ministry of New and Renewable Energy (MNRE) has sanctioned 50% subsidy on the cost of solar dryer

system during October, 2008. This augmented the widespread activity of solar food processing technology among the micro-enterprises to start food-processing unit with 10 dryers system as a unit for operation. The new solar micro enterprises expanded the product range from green leafy vegetables to marine food.

Cost Economics:

Cost Economics, of solar micro-enterprises are worked out for fruits and vegetables with an investment of Rs. 1 Million for one unit of 10 dryers. It can transact 10 tons of fruits or fruit bars in dehydrated form. The value addition is two and two-and-half times the raw material and the profit is Rs. 0.45 million per annum. This is an excellent income and profitable venture in rural India. The cost benefit analysis of our dryers indicates that a commercial venture of a project with 10 solar dryers will give the pay back period of 2 - 2½ years with 50% subsidy of MNRE as announced to SEED patented dryer.

The profitability of the technology in terms of employment potential and income generation is established and acceptability of the product in the market is evaluated from the proven market demand. Our expectation about the feasibility of the technology for rural employment has been realized.

The reasons for the success are:

1. The grass root level Non Government and voluntary organizations have devotion for service to rural people and have the ability to capacity building and skill development among rural women.
2. Solar food dehydration process is the integration of food science and technology and solar drying technology disciplines. So the practice followed in solar food processing is based on these two techniques. To make the solar food processing products, one needs rigorous training in this technology by well qualified persons, close monitoring and supervision of the operations and following the food safety, clean & hygienic practices, quality consciousness and assurance in day to day production. The social entrepreneurs have proved very successful in this respect.
3. SEED provided the training to the workers in the processing techniques, based on the outcome of R & D, testing the production samples periodically, correcting the procedures for high quality products.
4. SEED provided valuable marketing support. Initially SEED has arrangements with these NGOs to buy back the processed products (raw-material supplied by SEED and paying the processing charges only) to market by the SEED and in the later stage to train them to start marketing by themselves in their own localities.

The above mentioned methodology has given us the confidence in taking up a big project which can be of national programme in many states.

As we create a good market for one popular product, the diversification to other products is a smooth transition and gives the stability to the enterprise.

Acknowledgement:

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