SOLAR APPLIANCES FOR TANZANIA

A paper prepared for the Workshop on
SOLAR OVEN TECHNOLOGIES
FOR EDUCATORS, POLICY MAKERS AND ENTREPRENEURS
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Preamble

• Availability of solar appliances is a motivation to use the abundant solar energy resource not only to combat poverty and sustained economic activity but also as an effort to achieve energy conservation in Tanzania where commercial energy is already a burden to the national budget.
• This paper focuses on the dissemination of solar thermal systems as one of the solar energy applications in promoting economic growth in agriculture and the food industry, the sector that may give a remarkable impact to the nation if well addressed.
• The technology to develop solar dryers is normally simple and understandable to the majority of least educated carpenters and artisans if trained to manufacture them under simple supervision.

INTRODUCTION

• Tanzania energy balance shows high dependence on fuel wood, charcoal and petroleum products which are very costly.
• Fuel wood is causing deforestation and petroleum products are causing high rates of environmental pollutions
• There is need to use clean cheap and environmental friendly energy resource.

SOLAR ENERGY

• In 40 minutes the sun bathes the earth with enough energy to meet its power needs for a year
• Tanzania laying on the equator is bestowed with abundant solar energy potential
• Receives sunlight for 4 to 9 hours a day 8 months during the year and energy potential of between 4.6 and 6.5 kWh/m²

SOLAR APPLICATIONS

• Drying of crops and other materials
• Water heaters
• Water distillers
• Cookers
• Electricity generation
• Solar evaporation ponds
• Passive solar heating and cooling

SOLAR THERMAL SYSTEMS

• Has high potential applications in Tanzania
• Does not require high technology to construct appliances to tap the energy resource
• Many collaborators are already disseminating the technology
SOLAR DRYING SYSTEMS
• The long wavelength solar radiation are absorbed by the material to be dried and converted to heat energy
• In traditional open air drying system, drying is done without cover or protection
• A Ultraviolet (UV) resistant plastic film or glass is used as a cover to trap the rays on modern dryer systems

SOLAR DRYERS
• Solar dryers are specialized devices that control the drying process and protect agricultural produce from damage by insects, dusts and rain. In comparison to drying product in the open, solar dryers generate higher temperatures and lower relative humidity, and increase flow of air across the produce, resulting in shorter drying periods, lower product moisture content and reduced spoilage during the drying process.

TYPES OF SOLAR DRYERS-1
• Traditional open air dryer: Produce placed in the open and exposed to both sun, wind and other undesired elements.
• Direct solar dryers (cabinet dryers): Enclosed, insulated structures inside which both solar collection and drying takes place. Radiation is collected through a transparent cover (glass or plastic) in the drying chamber, which is ventilated for improved airflow. Trays carrying produce to be dried are placed inside the chamber. (Fig. 1, 3, 4 and 5 on notes)

TYPES OF DRYERS-2
• Indirect solar dryers (thermosyphon dryers): these have a collector and a separate drying chamber. They operate more efficiently and allow more control over the drying. The collector heats up air, which then rises by convection, forcing its way through the racks of drying produce in the drying chamber. Such dryers may be with or without flow enhancement. Such dryers are best suited for high value commercial scale drying (Fig.2 on handouts).

DRYER LIMITATIONS-1
• Dryer Sizes: There is a limitation to the size of a dryer unit, especially those suitable for viable micro and small business. Larger units lead to construction, transportation, installation and operational constraints.
• Timing of drying process: Even with solar dryers, the drying process is considerably slowed down during cloudy or rainy season.

DRYER LIMITATIONS-2
• Quality control of the dried product: Quality of the dried produce has an influence on the marketing capability and the income, since higher prices can be achieved by higher quality. For products to compete in international and local markets, a very strict quality control regime must be maintained.
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<th>DRYSER TECHNICAL ISSUES-1</th>
<th>DRYSER TECHNICAL ISSUES -2</th>
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| • Type of produce to be dried, the timing of harvest and possible pre-treatment.  
  • Quality and quantity of produce, It is important to consider that quality deterioration occurring during pre-drying cannot be eliminated in the course of the drying process. | • Seasonal variation in solar radiation.  
  • Drying process and drying schedule to be realised.  
  • Investment costs. |

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<th>ADVANTAGES OF SOLAR DRYERS-1</th>
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| • Increased household food security  
  • Dried products improve family nutrition because fruit and vegetables contain high quantities of vitamins, minerals and fibre.  
  • For diabetics dried fruit prepared without adding sugar is a healthy choice instead of desserts.  
  • Dried fruit can be used in stews, soups and casseroles or enjoyed as snacks. It can also be added to cereals for breakfast or used in making ice cream and baked products. | • It improves the bargaining position of farmers. Sometimes farmers sell at very low prices during the harvest season because they cannot store or preserve their surplus products.  
  • It encourages people to establish their own gardens.  
  • Creates employment opportunities and a sustainable income. |

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<th>RULES AND REGULATIONS</th>
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| • Cleanliness and care must be observed in the processing of dried fruits and vegetables.  
  • Register with Tanzania Food and Security Authority (TFDA) and the Tanzania Bureau of Standards (TBS) | • Packaging should be carried out immediately after unloading and cooling because the dried slices will reabsorb moisture and be susceptible to attack by insects and other pests. Proper storage should take place in the absence of moisture, light and air |
TIRDO EXPERIENCES

- TIRDO recognizes the efforts to disseminate solar drying technologies provided by other collaborators such as University of Dar es Salaam, SIDO, AMKA, TaTEDO, PRIDE, SUA, the Government Ministries and other donor agencies; and assures them continual support and information sharing to make their mission a success.

TIRDO FIELD SURVEYS OBJECTIVES-1

- To establish the common post harvest drying systems and the drying efficiency to meet standards particularly for fruits and vegetables.
- To identify the agro products which can be improved by solar drying systems.
- To carry out a critical analysis of the crop drying process in the survey regions and to study the constraints experienced by the farmers and processors of agro products.

TIRDO FIELD SURVEY OBJECTIVES-2

- To evaluate the currently available drying systems with the view to determine the solar drying technologies and processes that can be operated viably and efficiently.
- To design and fabricate solar dryers suitable for drying the agro products commonly available in the region.
- To perform dryer efficiency tests to justify their capacity for quality production.
- Sensitize and train the entrepreneurs to effectively use the dryers.

SURVEY FINDINGS-1

- Products to be dried in these areas were identified as fruits, vegetables, mushroom, fish and herbs, all of which required quality drying for hygienic and competitive market.
- Many farmers were using the traditional open air drying systems.
- Awareness of the solar drying technology is very limited to a few people mostly in urban areas.

SURVEY FINDINGS-2

- Few entrepreneurs had acquired solar dryers supplied by AMKA and SIDO, but there was little or no follow up on training, repair and maintenance programs; as a result many of the dryers were abandoned or left unattended.
- Marketing of dried fruits is not very open to many people, again rural population are more ignorant of such markets.
- Abundant fruits were left to rot or sold at a ‘throw away’ price during harvest season due to transport problems.

SURVEY FINDINGS-3

- Lack of financial capacity to acquire alternative technologies among the entrepreneurs.
- Fish was abundant in the lake zones and the demand for simple and cost effective technology was needed.
- There is urgent need to develop and supply solar dryers for the different produce.
- Many people were organized in registered production groups.
TIRDO INTERVENTIONS-1

• To increase awareness, TIRDO organized stakeholders meetings in the surveyed areas by engaging the local governments, cooperative groups, farmers and traders.
• Introduced an incentive to supply solar dryers (Appendix 1) at 50% discount to registered groups engaged in the solar drying programs. The package includes free training, free stationary and meals during the three day training at their site. The training involve introduction to food drying technology, dryer construction and use.

TIRDO INTERVENTIONS-2

• A dryer operating manual in form of a brochure is issued with each dryer.
• Introduction to regulations to acquire food processing license.
• Marketing strategies and contacts for their products
• Modifications and improvements are done as it deem necessary
• After sells service of the dryers is offered free

ACHIEVEMENTS-1

• Forty stakeholders attended a one day workshop at TIRDO as a first step in creating awareness. Similar stakeholders meetings were held in all surveyed areas in collaboration with the local government authorities.
• Brochures and posters were distributed at Saba Saba exhibitions. Solar dryers and dried products were also displayed as a gesture of awareness and marketing.

ACHIEVEMENTS-2

• Four direct dryers (Fig.1) have been distributed to registered groups in Newala, Kibaha and Dar es Salaam. Training was also given to the groups each with about 12 members
• Six indirect dryers (Fig. 2) have been constructed and distributed to Kibaha, Kisarawe and Dar es Salaam. 4 groups have already been trained.
• Four carpenters have been trained to construct solar dryers

ACHIEVEMENTS-3

• Fifty seven fish dryers have been constructed and distributed to the lake zones of Mwanza, Mbambabay, Mwar and Dar es salaam. One hundred and twenty fish processors and eight carpenters have been trained in this field
• Dryer performance tests were also done using standard instruments at TIRDO and on sites

DRYER PERFORMANCE TESTS-1

• For fish drying it has been observed that an average drying air temperature of 44°C is maintained during the day in the dryers, which is sufficient to ensure a reasonably fast drying, and to
• The moisture removal was about 60% weight loss was observed for solar dried fish and moisture content determination of the dried fish found that they had only 11.38%.
DRYER PERFORMANCE TESTS-

- For vegetable drying, the dryer temperatures were maintained at to about 54°C (130°F), fruits should be kept at 57°C (135°F) and moisture content to be 12% and 16% respectively. These controls are done by opening the bottom and top air vents accordingly.

RECOMMENDATIONS-1

- There is need to encourage creation of co-operations, in which rural farmers are organized, such as SACCOS for easy funding.
- These co-operations should build central food-processing plants which are organized under an umbrella organization that has contacts with the foreign markets.

RECOMMENDATIONS-2

- To create a product with a high quality, not only good machinery is required but elaborate training is demanded with sufficient practical training, at least creating a few batches of dried fruit when supervised by a professional trainer.

RECOMMENDATIONS-3

- The produced should be of a constant quality, implying that drying chamber conditions should be constant and therefore controlled this in combination with the CAC recommendations that state that the process has to be done in a controlled environment (a building), creates the recommendation that an indirect solar dryer constructed within a building is a possible solution.

RECOMMENDATIONS-4

- Because of the lack of good accessible infrastructure in Tanzania it is essential that the plant is strategically placed, meaning that the plant has to be centrally placed regarding the rural farmers, but also has to be placed close to a tarmac connecting road, to secure supply to the umbrella organization and so the buyer.

- The presence of various drying technologies in Tanzania is a good development. The knowledge about how to build proper food processing facilities is also there. On the other hand, in practice the drying of fruit and vegetables still takes place with inadequate drying machines and at locations in which the environment is not controlled. This also influences the quality of the products negatively.
RECOMMENDATIONS-5

- The availability of education in food processing is good. The theoretical and practical training, however, lacks behind. A lot of people in the field are still poorly trained in food processing and the practical training of rural farmers is hardly done.

RECOMMENDATION-6

- More research work is needed to come up with viable back-up system that can provide drying on cloudy or rainy days
- Serious marketing has to be done to convince funding institutions to give loans.