POSTHARVEST INSTITUTE FOR PERISHABLES

Burundi
Training Program
in
Food Preservation By Solar Drying
with
Supplemental Heat

Kenneth D. Hoyt

and

Marilyn A. Swanson

Report No.

PIP/Burundi/Nov 84/No. 56

University of Idaho

in cooperation with

United States Agency for
International Development

Training Program in
Food Preservation by Solar Drying with Supplemental Heat

Presented by

Kenneth D. Hoyt

Marilyn A. Swanson

for the

Postharvest Institute for Perishables

University of Idaho

Moscow, Idaho 83843

U.S.A.

in collaboration with the

University of Burundi

November, 1984

The USAID Mission in Burundi, Africa, received a brochure from the Postharvest Institute for Perishables, College of Agriculture, University of Idaho, that outlined a short course that could be presented in-country on solar dehydration of food. The course and its objectives were found opportune by the USAID Mission and the University of Burundi as they were cooperating on a solar dryer (improved farm technology) project. The University of Burundi was organizing a three-month international training program starting in September 1984 for participants from seven African countries as well as other interested organizational participants from the commercial, private and governmental sectors in Burundi.

USAID/Burundi requested that the University of Idaho conduct a short course on Food Preservation by Solar Drying with Supplemental Heat as part of the extended training. As a result of the cable traffic between the USAID/Burundi and the University of Idaho, Mr. Kenneth D. Hoyt and Ms. Marilyn A. Swanson, were designated as resource personnel from the College of Agriculture, University of Idaho.

The purpose of the program was to train participants in the construction and operation of a solar dryer with a supplemental heat source, and in drying, packaging, storing, reconstitution and use of dried foods. There were three main objectives:

1. To train participants in the construction and operation of a solar dryer with a supplemental heat source in the drying of:
   a. Root or tuber crops
   b. Tropical fruits
   c. Vegetable crops
2. To train participants in packaging, storage, and reconstitution of dried foods for human consumption.
3. To train participants in the pedagogical methodology of extension training.

Hoyt and Swanson implemented a training course with a training manual on solar drying and food preservation of tropical crops at the University of Burundi, Bujumbura, Africa during the period November 12 to 28, 1984. There were sixteen participants from seven countries (Zaire, Madagascar, Mali, Chad,

Togo, Senegal, and Burundi). Several of the lectures, discussions, and work laboratory sessions were attended by other interested individuals from the University of Burundi.

The training program had two major emphases: the construction and use of a solar dryer with a supplemental heat source, and the methodologies and practice of preservation of food by drying. After an initial introduction and overview, the participants were divided into two groups, each taught simultaneously by one of the instructors. One group learned solar drying principles, applications, evaluation of existing solar dryers, the availability of supplemental heat, construction and operation of various heat collectors and drying chambers. Simultaneously this group constructed a solar dryer. The other group learned food selection, principles, food preservation methodologies, specific food drying techniques, nutritional contributions of dried food, packaging, storage, and the use of dried foods. At the midpoint of the day the two groups were rotated and the training sessions were repeated. Thus both groups received the entire training. Upon completion of the solar dryer by the two groups, all of the participants were divided into five teams of three persons each. Each team designed two experimental drying trials incorporating the principles presented, selecting their own commodities to dry, and individual preparation and pretreatment methods. After the drying trials, the groups reported on their results and conclusions.

Before the first drying trial, the participants were not enthusiastic about the need for supplemental heat for the dehydration of food. During the first drying trial, the weather was inclement and, consequently, the insolation rate of the sun was insufficient for high-quality drying. The prepared foods remained in the dryer for two and one-half days. Although certain drying and experimental parameters were intuitively discovered, two of the products became moldy.

For the second drying trial, the teams selected different commodities, pretreatments and preparation techniques. Supplemental heat in the form of charcoal was used throughout the drying trial. An attempt was made to generate biogas for supplemental heat in the solar dryer, however a delay in mixing the slurry negated the incorporation of biogas in the program.

As a result of using supplemental heat provided by the charcoal, food dried quickly and participants were able to observe the difference between lack of heat and proper use of heat in air flow and drying to obtain high quality dried foods.

In summary, the training course was considered very successful both by the instructors and by the participants as indicated by the course evaluation. During the training, participants were able to apply the principles of construction and use of a solar dryer with supplemental heat. Guided discussions and result-demonstrations were the primary pedagogical methods used throughout the training. The primary use of English as a major language did not appear to hinder the training since several of the participants could understand and speak English. Through their translations, excellent discussions and the formulation of participants' ideas were readily achieved.

Due to the need to reduce the loss of perishable crops at the farm level through farmer education, and to upgrade extension personnel in methods of preserving foods, solar drying, packaging, storage and reconstitution, it is felt that the technology presented in the class was appropriate for the village level and could be well accepted by rural individuals. Solar food drying is in evidence in Gitega, the second largest city in Burundi, where there is an FAO-organized solar dryer project. In addition, there are solar drying projects underway at the University of Burundi.

The University of Burundi has indicated that it will build solar dryers and dry tropical crops both at the FAO-Gitega project and at the USAID Expermental Farm utilizing the knowledge obtained in the training.

The cost to construct a solar dryer in Bujumbura is expensive. During the class, participants were asked to provide suggestions for alternative types of materials which could reduce the initial cost. Some of the suggestions included bamboo, clay bricks chinked with clay or cow dung and rocks used in place of metal in the collector. However, no substitute for plastic used as glazing could be found. The cost of glass is prohibitive and plastic is extremely expensive.

It is recommended that collaboration with the University of Burundi and the University of Idaho be continued. Burundi is a very poor country. The population pressure has reached a point where a family's holdings provide only

marginal support. More than 90% of the population of Burundi are subsistence farmers. The risk of famine is a real threat if the weather is bad during the growing season. Soil exhaustion and severe erosion also hamper production. As a result the per capita food production has stagnated or declined in recent years. Only massive efforts will be able to reverse this trend.

A large percentage of food stuffs and other commodities are imported. The tax on these items make them extremely expensive and almost prohibitive for the rural people. Efforts directed towards such technology as food drying, the development of cottage industries and the utilization of indigenous materials to construct food dryers will greatly enhance the availability of food stuffs, reduce the postharvest losses of crops and the economic stress placed on the rural Burundians.

The team from the University of Idaho wishes to thank the training course participants for their knowledge, interest and cooperation during the training program. The team also wishes to thank particularly the faculty of the University of Burundi for their cooperation and assistance.

The team especially wishes to thank Mr. Dennis Baker, USAID/Burundi for his constant concern for the team's health and welfare. Mr. Baker singularly made our stay at Burundi pleasant and successful for which we owe many thanks. We would like to invite those individuals connected with the USAID and USA Embassy to collaborate with the University of Idaho again on any project they think appropriate.

COURSE OUTLINE

FOOD PRESERVATION-SOLAR DRYING WITH SUPPLEMENTAL HEAT

I. Overview of Course

A. Methods of Food Preparation
B. Solar Drying

II. Drying as a Preservation Method

A. Methodology of Food Drying
B. Fundamentals of Drying
C. Food Properties and Moisture Extraction

III. Preparation of Foods for Drying

A. Preparation and Procedures for Dried Fruits
B. Preparation and Procedures for Dried Vegetables
C. Preparation and Procedures for Other Food Commodities

IV. Evaluation of Dried Foods

A. Nutritional Values of Dried Foods
B. Use of Dried Foods

V. Packaging and Storage of Dried Foods

A. Evaluation of Previous Storage Procedures
B. Evaluation of New and Innovative Storage Procedures

VI. Experimental Design and Selection of Food and Dryer Parameters for Drying Trials

A. Food Parameters
B. Dryer Parameters
C. Preparation of Foods for Drying Trials

VII. Solar Dryer Design and Considerations

A. Material
B. Size
C. Temperature
D. Relative Humidity
E. Air Flow
F. Orientation for Maximum Efficiency

VIII. Supplemental Heat Sources

A. Design
B. Heating Medium
C. Efficiency

IX. Solar Dryer Construction

A. Cabinet
B. Solar Collector
C. Firebox

X. Evaluation of Existing Solar Dryers

XI. Technology Transfer and Outreach

TRAINING AGENDA

FOOD PRESERVATION - SOLAR DRYING WITH SUPPLEMENTAL HEAT

DAY 1	8:30 AM	1. Overview of course Hoyt & Swanson
Lecture-Discussion Sessions		2. Methods of Food Preservation -An Overview Swanson
		3. Drying as a Preservation Method Swanson
		4. Solar Drying - An Overview Hoyt
	1:30 PM	1. Methodology of Food Drying Swanson
Lab Sessions		2. Dryer Cabinet Construction Hoyt
		Both groups rotate at midpoint of sessions
DAY 2	8:30 AM	1. Fundamentals of Drying Hoyt
Lecture-Discussion Sessions		2. Food Properties and Moisture Extraction Swanson
	1:30 PM	1. Evaluation of Dried Foods Swanson
Lab Sessions		2. Complete Cabinet and Firebox Hoyt
		Both groups rotate at midpoint of sessions
DAY 3	8:30 AM	1. Solar Collector Principles Hoyt
Lecture-Discussion Sessions		2. Preparation of Foods for Drying Swanson

	1:30 PM	1. Preparation of Dried Fruits Swanson
Lab Sessions		2. Solar Collector Construction Hoyt
		Both groups rotate at midpoint of sessions
DAY 4	8:30 AM	1. Evaluation of Some Existing Solar Dryers Hoyt
Lecture-Discussion Sessions		2. Packaging and Storage of Dried Foods Swanson
		3. Orientation of Solar Dryer for Maximum Efficiency Hoyt
	1:30 PM	1. Preparation of Dried Vegetables Swanson
Lab Sessions		2. Complete Dryer Construction Hoyt
		Both groups rotate at midpoint of sessions
DAY 5	8:30 AM	1. Use of Dried Foods Swanson
Lecture-Discussion Sessions		2. Supplemental Heat Sources Hoyt
		3. Summary and Evaluation of Week's Activities
	1:30 PM	1. Labs Open for Individual Instruction
Lab Sessions		2. Evaluation of Dried Fruits and Vegetables
		3. Complete Solar Dryer Details

DAY 6	8:30 AM	1. Nutritional Values of Dried Foods Swanson
Lecture-Discussion Sessions		2. Experimental Design of Drying Trials a. Food parameters b. Dryer parameters Swanson & Hoyt
	1:30 PM	1. Total group divided into 3 representative subgroups
Lab Sessions		2. Selection of Food and Dryer Parameters for Drying Trials Swanson & Hoyt
DAY 7	8:30 AM	1. Preparation of Foods for Drying Trials
Lab Sessions All Day Same grouping as preceding day		2. Initiate Trials
		3. Conducting Trials
DAY 8	8:30 AM	1. Drying Procedures Specific to Fruits and Vegetables Swanson
Lecture-Discussion Sessions		2. Drying Procedures Specific to other Food Commodities Swanson
Lab Session Previous three goups		1. Evaluation of Drying Trial 1
	1:30 PM	2. Initiate Drying Trial 2
Lab Session		
DAY 9	8:30 AM	1. Technology Transfer and Outreach Hoyt
Lecture-Discussion Sessions		

	1:30 PM	1. Evaluation of Previous Storage Procedures Swanson
Lab Sessions		2. Evaluate Drying Trial 2
DAY 10	9:00 AM	1. Summary of Course a. Food Technology Swanson b. Dryer Technology Hoyt
Lecture-Discussion Sessions		2. Course Evaluation by Participants

COURSE PARTICIPANTS

	NAME	ADDRESS	POSITION/JOB MAJOR RESPONSABILITY
1.	MUMBWA MOKONGO	Université de Kinshasa Faculté des Sciences B.P. 190 Kinshasa XI ZAIRE	Assistant au Département de Chimie
2.	YENGULA MAKTUMY HASSAN	Université de Kinshasa Faculté des Sciences B.P. 190 KINSHASA XI - ZAIRE C/O LUNGELE MASTAAJABU B.P. 1183 KINSHASA - ZAIRE	Assistant au Département de Chimie
3.	RAKOTONDRAVELO J. Chrysotome	Département Agriculture de l'Etablissement d'Enseignement Supérieur des Sciences Agronomiques B.P. 1175 101 Antananarivo - MADAGASCAR.	Assistant au Départment Agriculture
4.	Mme BIRIHANYUMA Capitoline	ISABU B.P. 795 BUJUMBURA	Laboratoire de Chimie Agricole
5.	KERIM Bangana	Laboratoire de Recherche sur l'Energie Solaire INSE Université du Benin B.P. 1515 Lomé - TOGO	Technicien Supérieur Biochimie - Laboratorie
6.	Yolla AGUENADE ZONGRE	Direction du Pétrole des Energies Nouvelles et Renouvelables B.P. 94 N'DJAMENA (TCHAD)	Ingénieur Chimiste Technologue
7.	LAMINE DIOP	Centre d'Etudes et de Recherches sur les Energies Renouvelables CERER B.P. 476 DAKAR - SENEGAL	Chercheur responsable de programme (bio-conversion) impr. stave Projet
8.	Ibrahima LO	Centre d'études et de recherche sur les Energies Renouvelable CERER B.P. 476 - DAKAR-SENEGAL	Chercheur responsable du programme Sechage Solaire

NAME	ADDRESS	POSITION/JOB MAJOR RESPONSABILITY
9.NIBIGIRA Remy	Département de l'Agronomie (Projet Maraicher) B.P. 1185 BUJUMBURA	Chef du Service HORTICOLE
10. Andace NDAYIZEYE	Direction Générale de l'Energie B.P. 745 - BUJUMBURA	Conseiller Advisor in the ministry of public works, Energy and mines solar Energy section.
11. MINANI Longin	B.P. 1168 BUJUMBURA BURUNDI	Professor of Heat Transfer, Thermodynamics Fluid Mechanics in both University of BURUNDI and ISCAM.
12. MPFIZI Leonidas	Département de l'Agronomie Projet Semences Selectionnees B.P. 1185 BUJUMBURA	Chef du Service Semences Sélectionnées
13. GATONGA Jules	MINISTERE DES TRAVAUX PUBLICS ENERGIE ET MINES DIRECTION GENERALE DE L'ENERGIE C.E.B.E.A. B.P. 255 BUJUMBURA	HOMOLOGUE DU CHEF DE PROJET - CEBEA
14. Oscar SINDAYIGAYA	Université de Burundi Faculté des Sciences Département de Physique B.P. 2700 BUJUMBURA	Assistant et: Chef de Projet Séchage Solaire
15. Sidibe Fatoumata	Laboratoire Energie Solaire B.P. 134 Bamako, Mali	Engineur en Industrie Alimentaire
16. Hilde BAERT	Projet Nutrition Musage B.P. 2351 Bujumbura, Burundi	Ing. agro