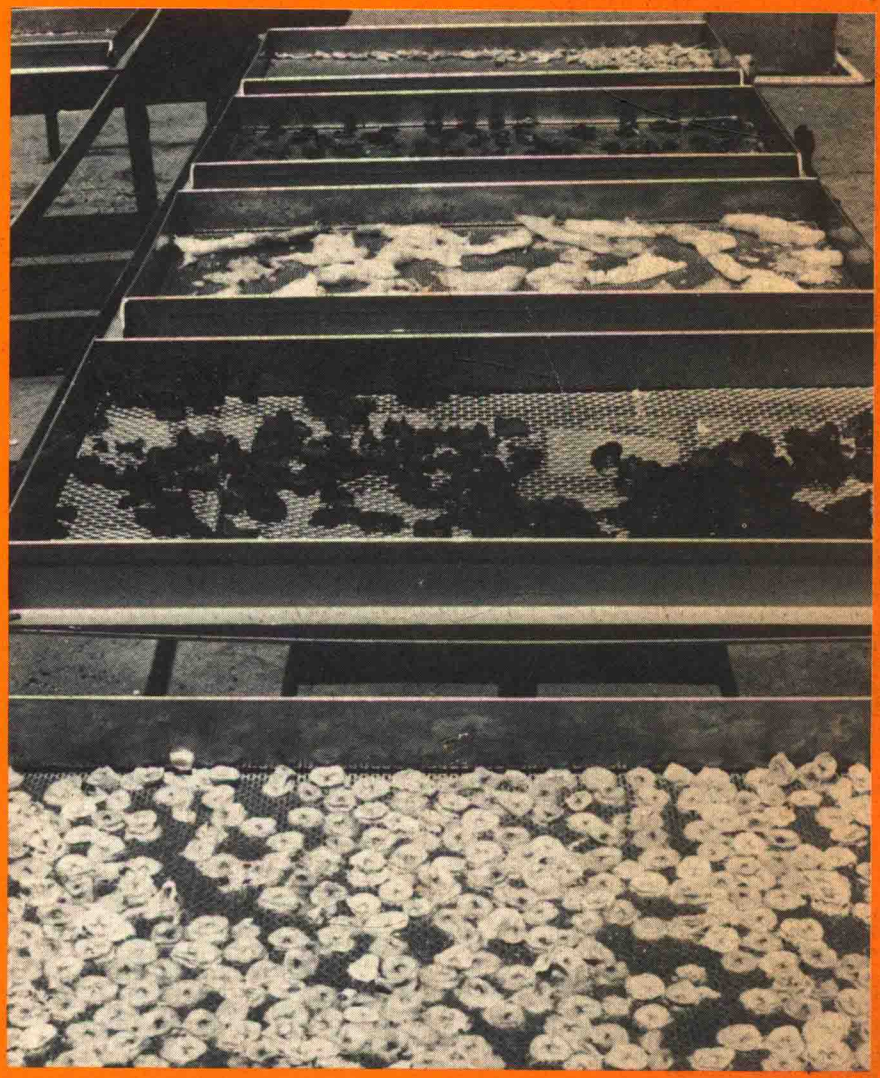
Solar drying: Practical methods of food preservation



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PREFACE

The lack of technical and socio-economic information on alternative or improved food processing technologies available to people living in rural areas of developing countries means that much food gets wasted. Excess production in the villages is rarely preserved for times when fresh food is not available. Emphasis is more often placed on large-scale food processing complexes which frequently require only a few skilled operators, use imported equipment and packaging, and produce foods which are expensive and have a low nutritional content.

Sun drying of foods is a technique that has been in use for centuries, with little change in the methods employed. This frequently results in poorly dried, infested products. The use of improved sun drying techniques and the introduction of solar drying, by which means foods can be dried even in humid, cloudy climates, can greatly improve both the quality and quantity of goods produced and be of great benefit to people living in rural areas.

This manual, which is an outcome of an ILO-executed project in four-least developed arab countries (Sudan, Somalia, Democratic Yemen and the Yemen Arab Republic) to promote the choice, development and application of appropriate food processing technologies, aims to explain in easily understood terms how food drying techniques can be introduced or improved. In this way, surplus food can be preserved which can be used later to make nutritious meals. All the equipment or materials necessary can be obtained locally. The project was financed by the United Nations Financing System for Science and Technology for Development (UNFSSTD).

During the project it became apparent that there was a need to give extension workers basic technical information which could be readily assimilated and which could be directly applicable. In the case of solar drying most of the work is, at present, carried out at an academic level in research institutes, and little attention is paid to the application of the information in rural areas.

It is hoped that this manual will supply agronomists, engineers and food technologists working in this field with the basic theory and practice of sun and solar drying. With an understanding of national needs and priorities they should then be able to advise extension workers of appropriate applications of these techniques. Some general guidance is also provided on the type of information extension workers might need and the methods they could use to obtain this. It remains up to the English-speaking reader to translate these into a locally comprehensible form for local use.

The manual includes a step-by-step guide to building different types of dryers using locally-obtainable raw materials. Fish drying, vegetable and fruit drying and grain drying are all covered, and appropriate processing methods discussed. The necessity of good packaging is stressed. It is very important to ensure an adequate "shelf-life" of the product and to prevent its untimely deterioration.

Some references are given as sources of more detailed, supplementary information. Access to technical literature can be difficult but the reader is reminded that solar drying is of world-wide interest and there may be a national or regional institute working in this field, from which information can be obtained.

Each chapter can be interpreted at two levels. Most of the technical information supplied will be of interest to the technologist. A summary of the pertinent points which should be passed on, in a suitable form, to the extension worker is given at the end of each chapter.

Chapter 1 provides an introduction to the type of information which is required and the approach which should be adopted to establish the feasibility of a solar drying exercise.

Chapter 2 describes the basic drying theory and explains how the sun's energy can be harnessed to dry foods. Some basic solar dryers are described with some guidance on their methods of construction.

Chapter 3 discusses how the technologist can work with the extension worker to encourage the adoption of improved technologies by the rural people in developing countries.

Chapter 4 provides information on simple methods suitable for drying fish. Vegetable drying is discussed in Chapter 5. The preservation of fruit by drying is covered in Chapter 6 and grain drying is discussed in Chapter 7.

This manual was prepared by Dr. C.I. Speirs of the Tropical Development and Research Institute, London, in collaboration with Ms. H.C. Coote, staff member of the Technology and Employment Branch of the ILO.

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CONTENTS

CHAPTER I

ELEMENTS IN THE CHOICE OF SOLAR DRYING OF FOOD PRODUCTS

I. Evaluation of solar drying potential

The preservation of foodstuffs by drying is believed to be one of the first food processing techniques used by man, developing in conjunction with the cultivation of food grains, in the Middle East. The traditional method of crop drying practised over the centuries throughout the world is sun drying, where the foodstuff is spread on a flat surface in the open air and exposed to the drying action of the sun. Variations on this technique include hanging the foodstuff from the eaves of buildings or from trees or gathering the harvest in bundles in the fields. Today, sun drying still remains the most widespread method of food preservation.

The success of the technique can be attributed to its simplicity and low cost. Under favourable climatic conditions good quality products can be obtained. However in an unreliable climate, losses due to spoilage can be excessive. In wet or humid weather moisture loss from the food can be intermittent and irregular and the rate of drying slows down. This increases the risk of spoilage and reduces the quality of the product. It is likely that some of the foodstuff will be overdried, while a portion may be unacceptably moist, depending on its location within the batch. Contamination by dust and infestation by insects is unavoidable. Birds and animals will consume some of the crop and also constitute another source of contamination. This creates an extra task: to remain vigilant in order to cover the crop in the event of rain or dust storms, and also to scare away potential predators in an attempt to control sun drying losses.

In the industrialised countries, the food processing sector is typified by high labour costs and increasingly stringent quality standards. One response to the problems associated with sun drying has been the development and use of high capacity, artificial drying plants capable of giving a high quality product irrespective of weather conditions. These plants are usually

energy-, capital- and technology-intensive, and have a low labour requirement using mainly skilled process and maintenance personnel. The dehydration units are relatively inflexible and are typically geared towards a large throughput of a single product. Such processes are not generally suitable for the needs of the small-scale farmer in developing countries who produces small quantities of foodstuffs to be dried for short periods throughout the year.

Artificial or fueled mechanical dryers are used in humid tropical regions, largely in the equatorial rain forest belt where daily downpours are predictable and the skies are usually overcast. In these conditions, the potential for sun drying is limited. Such dryers are typically associated with the so-called plantation crops such as cocoa, coffee and copra, where the cost of the drying operation can be justified by the foreign exchange generated by the product. A source of energy is required and the usual fuels available are wood or charcoal. This requirement restricts the use of such dryers to forested areas where such fuel is abundant and the ecological damage caused by cutting the wood is minimal. In some cases it may be possible to supplement or replace the fuel with by-products from the process such as bagasse in the case of sugar or coconut shells in the case of copra.

In arid or semi-arid regions where wood stocks are low and may already be insufficient to meet the cooking needs of the rural sector, the most suitable solution to processing problems may be to improve existing sun drying methods or to introduce solar drying techniques.

Solar drying, where the principal source of energy is derived from the enhancement of the sun's radiation, can be an improved alternative to sun drying. Compared with sun drying, solar drying provides higher air temperatures and consequential lower relative humidities which are conducive to improved drying rates and a lower final moisture content of the dried crop. As a result, the risk of spoilage during the actual drying process and in subsequent storage is reduced. The higher temperatures attained inhibit insect and microbial growth. Drying in an enclosed structure has the additional benefit of providing protection against rain, dust, insects, animals, and birds. All these factors contribute to improved and more consistent product quality.

On first impression, solar drying may appear to be the ideal solution to many food drying problems. The devices are of simple design and can be

constructed using a high local material content. The energy source is freely available and poses no waste disposal problems. However, it should be emphasised that the process is not always technically feasible, economically attractive, or socially desirable. Strenuous efforts must be made, in co-operation with extension agencies and other interested organisations, to determine as accurately as possible the nature and quantity of commodities that could be dried. The reasons for drying the selected foods and the required quality for the market outlets should be clear. An extension worker may be enthusiastic about introducing, say, solar pepper drying in his or her region, but without clear-cut reasons for doing so the project may be doomed to failure.

The extension worker should be aware that some building and maintenance costs will be involved, and it is obviously advantageous that the solar dryer be used for as long a period during the year as practically possible. It may be more cost-effective and socially desirable in some locations to use the dryer on a communal basis.

In the planning stage, therefore, the technologist should establish some of the facts listed below. Not all of the questions will be relevant to any one project, and time and manpower constraints may render a detailed investigation impractical. However, any information will be useful.

II.1 Estimation of commodity production

It is appreciated that it may be difficult to obtain detailed information on the quantity of the commodity that is harvested, particularly where the food is consumed by the producer or the producer's family and where there is no formal or centralised form of purchase or market. However, where possible, information should be collected on:

(a) the quantity of fresh material produced in the growing season by:
- each farmer/fisherman
- the organisation (e.g. cooperative) in which the farmer/fisherman participates
- each district
- the country;

(b) the duration of the harvest season:
- for a farm/fishery
- within a district;

(c) the amount of the commodity harvested in a day;

(d) the likely increase or decrease in the production of the commodity in the near future.

II.2 Present drying practices

It should be established whether the food stuffs are currently dried, and if so, by what means. Traditional techniques such as sun drying or even artificial drying may already be used.

If alternative drying practices are being carried out then the following facts should be established:

- the amount of an individual farmer's crop which is dried;
- the nature of any processing carried out after harvest and prior to drying;
- the moisture content of the commodity before and after drying; or alternatively, the wet to dry ratio, i.e. the weight of the commodity prepared for drying compared to its weight when dried;
- the size, shape and other important features of the commodity prior to drying;
- the actual techniques used to dry the commodity. Every effort should be made to obtain this information as precisely as possible. If possible, the cost of this operation should be established;
- the problems experienced with these techniques, e.g. high capital or operating costs, high labour requirement, poor product quality etc.;
- post-drying processing operations carried out prior to sale or storage;
- the means of storage of the dried commodity before further processing, sale or consumption.

II.3 Product quality considerations

The quality of the dried product is of considerable importance. For dried fruit and vegetables sold to the local consumer, the main quality factor

is the general appearance of the dried material whereas for commodities such as spices or pyrethrum, the content of extractable constituent is the main aspect of quality. For dried grain the moisture content is of particular importance. The importance of quality can be gauged from the following:

- the features of the dried product that determine its selling price, e.g. appearance, colour, size, shape, moisture content, purity, extractable constituent, degree of contamination, microbiological quality;
- the methods by which the quality factors are evaluated, e.g. by visual examination or laboratory analysis;
- variation of standards of quality for different markets;
- the relationship between product quality and selling price.

II.4 Markets for the dried commodity

As with any development of a new or improved product, knowledge must be gained at an early stage of the present market for the traditional product or the potential market for an improved product. Though such information may well be difficult to obtain in certain areas, particularly from rural communities, it is important that an attempt be made in order to determine the level of technology and the economic boundaries for the subsequent technical development of a solar dryer.

Information must be sought concerning the following:

- the (envisaged) outlets or markets for the dried commodity:

  (i) self-consumption;
  (ii) local sale;
  (iii) sale to large towns at some distance from the producer, either by the producer or via a third party;
  (iv) export;
  (v) further processing.

- consumer acceptability of the product. This is of particular importance when no dried product is currently available or is known to the potential market;

- marketing mechanisms or organisations for bringing producer and buyer/consumer together;