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Development of a vegetable dehydration model for a rural co-operative in Guatemala

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Abstract

A model pilot plant for vegetable dehydration which was used as the basis for a feasibility study in Guatemala is described.

Crop selection, production techniques and markets for the products are analysed as well as the technical constraints in the commissioning of such plants.

Throughout the development period, every effort was made to use locally-fabricated equipment although it was found necessary to use certain imported items, in particular the heater-blower unit which forms the basis of the dehydration system.

This study has now led to the establishment of a full-scale, rural-based, commercial facility for the dehydration of parsley and other vegetable crops.

Résumé

Une étude de faisabilité a été entreprise au Guatémala en prenant pour modèle une usine pilote de déshydratation de légumes qui est décrite dans ce travail.

L'analyse porte sur les techniques de sélection des cultures et les techniques de production ainsi que sur les marchés pour les produits finals; les difficultés techniques de la mise en service d'une telle usine sont examinées. Au cours de la période préparatoire tout a été mis en oeuvre pour utiliser l'équipement de fabrication locale, mais certains éléments ont dû être importés et, en particulier, la soufflante à air chaud qui constitue la base du système de déshydratation.

A la suite de cette étude, il a été possible de créer une installation industrielle, sur une base rurale, pour une gamme complète de fabrication, pour la déshydratation du persil et d'autres légumes.

Resumen

Se describe una planta piloto para el deshidratado de legumbres, la cual fue utilizada como modelo base para un estudio de viabilidad en Guatemala.

Se analizan la selección de cosechas, las técnicas de producción y los mercados para los productos, así como las incomodidades técnicas que pueden experimentarse durante la puesta en servicio de una planta de tal índole.

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En todo el período de desarrollo, se hizo todo lo posible para utilizar equipos de fabricación local, sin bien fue preciso emplear ciertos elementos importados, en particular la unidad calentadora-sopladora que forma la base del sistema de deshidratado. Este estudio ha resultado ahora en el establecimiento de una instalación comercial completa ruralmente basada para el deshidratado de perejil y de otras cosechas de legumbres.

Introduction

This work was initiated in conjunction with a Swiss Church group working with a rural co-operative in the Santiago Sacatapéquez area of Guatemala as a possible method of promoting the production of cash crops grown by the community to complement the growing of maize and beans.

Traditionally, the farmers have grown maize and beans for their own consumption and have been self-sufficient in these basic crops which would have a value of about Q300 per annum (1 Quetzal = 1 US dollar) from an average holding of 6 cuerdas (1 cuerda = 1118 m^2). It has been estimated by the Swiss group that a typical family of six people would need 1·8 kg (4 lb) of maize and 0·45 kg (1 lb) of beans per day and with the respective prices being Q0·18 and Q0·77 per kilogram (Q0·08 and 0·35 per pound), an annual income of Q245 would be required to provide basic grains. In addition, some Q0·10 per day or Q36 per annum would be required for the milling of the maize.

A farmer with a mixed maize, bean and vegetable system is likely to have a cash income of around Q660 from the sale of vegetables, in addition to maize and beans grown for home consumption. It has been found that the use of 2·5 cuerdas for the growing of cauliflower alone can yield around Q660 per annum.

The Swiss group found that a minimum daily food bill for an adequate diet for a family of two adults and four children is approximately Q3·15, assuming self-sufficiency in basic grains (Swiss Group, 1980). Such a family would also spend between Q10 and Q30 per month on fuel. It can be seen that the poorest families are unable to meet costs without reductions in their food bill.

An average of between 3 and 4 cuerdas was found to be necessary to grow the basic grains to feed a family of six. Farmers were encouraged to grow vegetables (cabbages, cauliflowers, leeks, parsley, cucumbers, peas etc.) on any land in excess of the 3 or 4 cuerdas to provide a cash income. Unfortunately, with variations in supply and demand there were sometimes wide fluctuations in the price of these vegetables. On many occasions it proved uneconomic to harvest, especially in the case of cabbage and potato. It was apparent that an efficient method of preserving the cash crops grown would make it possible to sell all year round at a more stable price. Success has been achieved with the sale of high quality cauliflower and Chinese peas to a freezing plant which markets these products by air-freight to the United States of America. However, since there is a large internal market within

Guatemala for dried vegetables, both for incorporation into packet soups and in the catering trade, it was thought appropriate to commence work with these end-products in mind.

The market for dehydrated vegetables in Guatemala

As an indication of the potential market for dried vegetable products, Table 1 shows the annual requirements of a multi-national producer of dried packet soups based in Guatemala.

Table 1
Annual requirements of dehydrated vegetables of one producer of packet soups in Guatemala

Vegetable	Weight dehydrated (kg)	Approximate fresh equivalent (kg)	Value/kg dehydrated (Quetzales)
Cabbage	1 500	50 000	4·50
Carrot	8 000	80 000	5·00
Parsley	9 000	140 000	8·00
Potato	8 000	80 000	4·00

In addition there are various other manufacturers of packet soups in Guatemala with, collectively, a demand for at least the quantities above, as well as catering outlets which have shown interest in the products.

Preliminary drying tests with the four vegetables listed in Table 1 indicated that, for the reasons outlined in the following section, parsley would be the best material with which to conduct large-scale trials.

Preliminary drying trials

A study was carried out at the laboratory and pilot scale with the following aims:

(a) To assess the market potential for those vegetables being produced by the co-operative of Santiago Sacatapéquez.
(b) To establish the economic feasibility of dehydrating those vegetables.
(c) To design a low-cost system for larger and commercial scale production of those products which proved feasible.

After careful study of these three points, parsley was found to be the most favourable vegetable for larger scale dehydration trials for the following reasons:

(a) More interest by prospective buyers had been shown in parsley than in any other crop.

(b) The crop yields a very favourable return per unit area under cultivation since the parsley plant can be cut for harvest approximately 12 times before replanting is necessary (Swiss Group, 1980).
(c) Capital equipment cost would be lower since the basic preparatory steps for dehydrating parsley are relatively simple; i.e. peeling, blanching (Feinberg, 1964) and dicing are not required.
(d) Pilot-scale studies had shown that parsley was the most economically profitable of the crops tested due to the high value of the final product compared with the relatively low cost of the primary product (Q8·00/kg dried compared with Q0·22/kg fresh). Costings for this plant had been carried out in a feasibility study (Anon, 1980).
(e) Swiss group agronomists had reported that there was little problem with disease or insect attack in the case of parsley.
(f) In the area where the Swiss group had based its operations (Santiago Sacatapéquez) there is a large unemployment problem and since the processing of parsley was in this case reasonably labour-intensive it would provide a good source of work for the community.

The production of dried parsley

Removal of stalks

Before the primary washing of the parsley as much of the stalk material as possible had to be removed. Since in Guatemala parsley is sold in 'manojos' (bunches) it was found easy for an operator to cut the stalks up to the leaf using only a knife. An operator was found to be able to cut about 180 kg (400 lb) per 8-hour day.

Washing

The cut parsley was washed three times in chlorinated tap water. The first washing was by hand and removed the majority of crude dirt and soil. The second and third washings were carried out in a revolving 90 litre drum for a period of 15 minutes each. The drum was agitated using a Croft's* rotatory powder mixer containing a charge of 9 kg (20 lb) of parsley. (*see* Plates 1 and 2).

Further work is currently being undertaken on the development of a low-cost mechanical washing system which will have a higher throughput and will be acceptable for use with a wider range of vegetable products.

*No longer available.

Preparation for drying

Before the drying was carried out it was necessary to reduce the parsley to a smaller size (pieces of 2 cm length). Although experiments were performed using a Crypto-Peerless TR-21* vegetable preparation machine, it was found that hand chopping using a knife was superior since it allowed another stage for removal of unsuitable material as well as offering employment to a number of operators. The parsley was then allowed to soak for 15 minutes in water containing 250 ppm of chlorine to ensure sanitary quality of the final product.

Drying

Drying was carried out in a locally built wooden drier (*see* Plate 3) using a Benson Zeta Indirect† heater-blower unit of capacity 216,290 kJ/hour (205,000 BTU/hour), utilizing diesel as fuel. However, using this drier at an altitude of 1524 m in Guatemala City, the rating was reduced to approximately 179,360 kJ/hour (170,000 BTU/hour).

The drier was a dual-chamber system constructed of 19 mm plywood, heavily painted inside to avoid warping, with the air flow directed into the bottom of the first chamber, up through a stack of 9 trays using a cross-current arrangement, and then directed into the bottom of the second chamber where the air was again directed through a 9-tray stack to the outlet (*see* Figure 1). The trays used (*see* Plate 4) were of wood (1 m^2 × 76 mm) with wooden cross-members for support for the nylon-mesh bottom. The trays stacked into a support made of welded iron which was painted to avoid rusting. Temperature was regulated by the use of a contact thermometer situated between the first drying chamber and the heater unit. The trays had a capacity of 5 kg and the projected drying times for each tray (using a linear air flow of 67 cm/minute) were calculated according to the method of Van Arsdel (1951). From this it was found that the first tray would be dry to 4–6 per cent moisture content after 2·4 hours using an inlet temperature of 65°C.

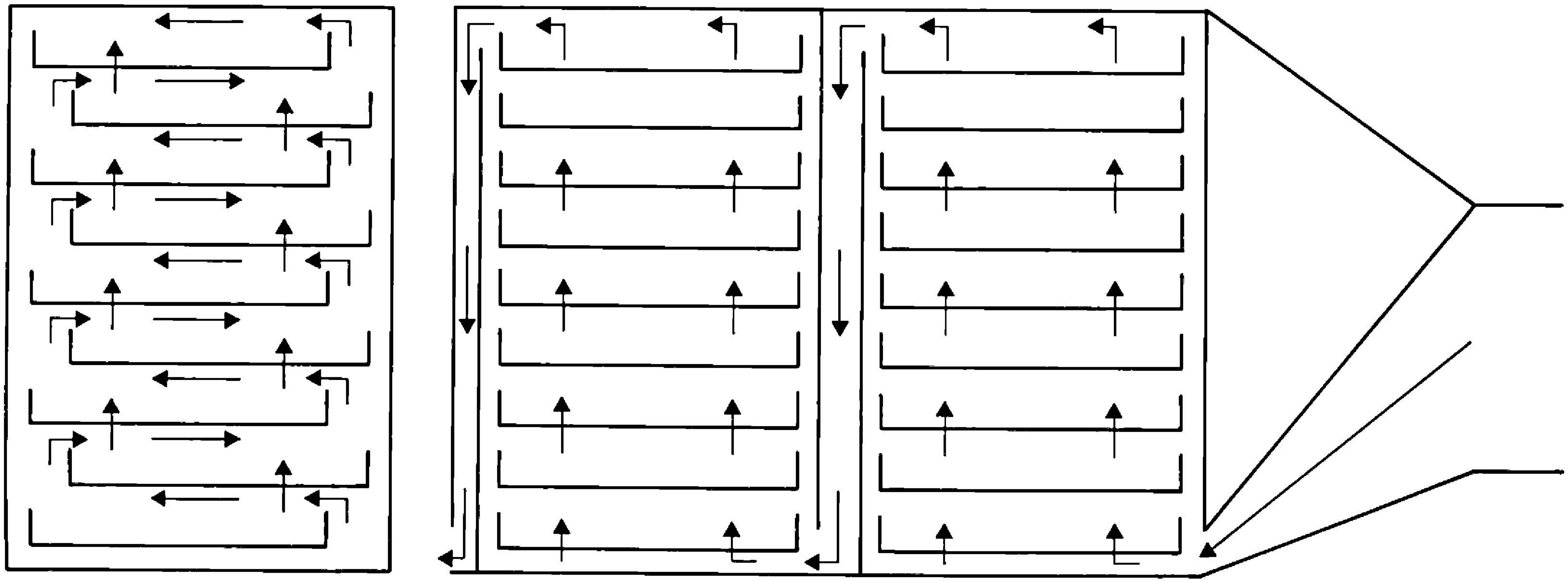
After the removal of the first dry tray subsequent trays were ready for removal at 25-minute intervals. These estimates were confirmed during pilot studies when a system of drying was used whereby the bottom tray in the first chamber was removed and replaced by the next tray up etc., a fresh tray of parsley eventually being replaced in the top shelf of the second chamber. After the first had been removed and replaced by the one above, each consecutive dry tray of parsley was removed after 25-minute intervals. A typical yield of dry material was 8 per cent by weight of the wet parsley.

*Crypto-Peerless Ltd, Bordersley Green Road, Birmingham B9 4UA.

†Benson Heating Ltd, Ludlow Road, Knighton, Powys.

Note: The quotation of proprietary names in the text is intended solely as a guide to the products used. No specific recommendation is implied.

Figure 1
Views of the drier showing air flow through and across the trays (cross-current arrangement)



End view

Side view

Separation of residual stalk material from the leaves

After drying, the material from the trays was further separated through a 6 mm mesh screen using a motorised system. (*see* Plate 5). Thicker, more durable stem material is retained by the sieve although particles of smaller stalk material pass through. These stalk particles were separated using a locally-built seed winnower-type machine, (*see* Plate 6). The final product was considered by local buyers to be better in appearance and texture than imported parsley.

Packaging

The final dry separated leaf material was packed in 8 mm gauge polyethylene bags with a double heat seal and 5 kg capacity. The shelf life of this product at ambient temperatures is around 6 months.

Equipment costs

The following list gives an indication of the approximate total cost of the dehydration plant. It should be noted that this does not take into account the cost of the building (in this case a block-built structure, of dimensions 6 m by 9 m, with a corrugated-iron roof and equipped with the services of electricity, mains water and drainage).

Drier (Benson Zeta Indirect)	Q1 500
Cabinet (locally-built)	Q 600
Primary stalk separator (locally-built)	Q 200
Secondary stalk separator (locally-built winnower)	Q 200
Washer	Q 800
Ancillary equipment (scales, tables, tools etc.)	Q1 000
	Q4 300

Conclusions

Whilst this paper is based on work on parsley, its aim is to indicate an approach to the transfer of technology to rural communities. The pilot plant operation provided data for a full feasibility study (Anon., 1980), provided trade samples that have resulted in a commercial contract, and trained staff to operate the plant with minimal outside help.

A small commercial factory of higher output than the model described has now been completed in the village in question. The establishment of this factory will have several social advantages:

(a) The provision of a market for raw materials at constant prices.
(b) The provision of workplaces for landless villagers.
(c) Twenty per cent profit from the sale of the parsley will be returned to the co-operative for further development work.

In addition, the mere presence of a flexible facility such as this will have other advantages for the community; for example, the drier could be used for drying basic grains when, as happens occasionally, the harvest coincides with rain which then precludes sun-drying of the grains. The winnower can also be used for seed cleaning. The greatest advantage, however, is that, to a large extent, the community has carried out much of the work themselves, thus increasing their confidence in their abilities to attempt similar technological projects in the future.

Acknowledgements

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