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THE DEVELOPMENT OF A RURALLY BASED CASSAVA FLOUR INDUSTRY IN COLOMBIA

(Le développement d'une industrie rurale de farine de manioc en Colombie)

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SUMMARY

The paper describes an on-going cooperative project between the Centro Internacional de Agricultura Tropical, the Instituto de Investigaciones Tecnologicas, and the Universidad del Valle, whose objective is to determine the technical and economic conditions required for the development of a rural cassava flour industry in Colombia. The project is partially financed by the International Development Research Centre. The aim of the project is to design and implement a viable system for the production and use of cassava flour as a partial substitute por Wheat flour in bakery products. The principal areas that are being investigated are : (1) the introduction of improved cassava production technology to reduce costs and raw material prices ; (2) the development of an appropriate cassava processing technology to produce a high quality flour ; (3) the determination of mechanisms to motivate the wheat miller to produce and the baker to use composite flour ; (4) the optimization of baking procedures ; and (5) the evaluation of consumer preferences for and acceptance of composite flour products. The methodological framework within which the project is being carried out is presented, together with the results of the preliminary economic and technical studies that have been undertaken.

RESUME

La communication décrit un projet coopératif en cours entre le Centre International d'Agriculture Tropicale, l'Institut de Recherches Technologiques et l'Université del Valle. L'objectif de ce projet est de déterminer les conditions techniques et économiques pour le développement d'une industrie rurale de farine de manioc en Colombie.

Le projet est partiellement financé par le Centre de Recherche pour le Développement International (CRDI/IRDC). Le but du projet est de concevoir et de mettre en oeuvre un système viable pour la production et l'utilisation de farine de manioc pour remplacer partiellement la farine de blé en boulangerie.

Les principaux secteurs de la recherche en cours sont :

(1) L'introduction d'une technologie améliorée de production du manioc pour réduire les coûts et les prix de la matière première ;

(2) Le développement d'une technologie appropriée de traitement du manioc pour produire une farine de grande qualité ;

(3) La détermination de mécanismes pour motiver le minotier à produire et le boulanger à utiliser une farine mixte.

(4) L'évaluation des préférences du consommateur et l'acceptation de produits à base de farine mixte.

INTRODUCTION

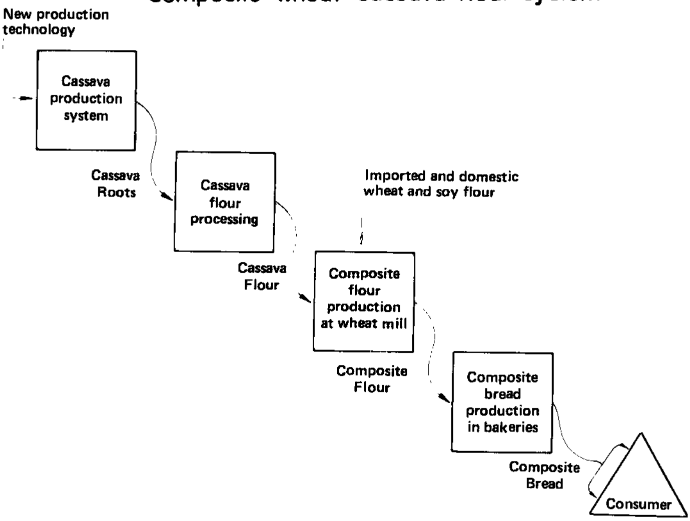
The rapid urbanization of the population in Latin American and Caribbean countries has brought with it an increase in the consumption of bakery products. This, in turn, has led to ever increasing imports of wheat, especially in the tropical countries of the region. In order to reduce the level of these imports and save foreign exchange, on various occasions it has been proposed that the wheat flour in bakery products should be partially substituted by locally produced flours, such as maize, rice, sorghum, potato and cassava flour.

In the specific case of cassava flour, research has shown that it is technically feasible to substitute wheat flour in bread up to levels of 20 per cent (CRABTREE, KRAMER and BALDRY, 1978). However, in practise the implementation of national composite flour programs based on wheat and cassava mixtures has not met with a great deal of success. There are a number of reasons for the failure of these programs. In some cases subsidies on imported wheat have made it impossible to produce cassava flour at a competitive price, in others the cassava flour processing technology has been inadequately selected and, in general, too little attention has been paid to providing incentives to encourage farmers to grow cassava, which has meant that the supply of raw material to the processing plants has often been insufficient and intermittent.

Colombia is one of the few countries in Latin America and the Caribbean that does not subsidise wheat and preliminary economic analysis suggest that the production and use of cassava flour in bakery products would be feasible, given the present cost of producing cassava in the Atlantic

FIGURE 1.

Composite wheat-cassava flour system



Coast region. In light of this, the Centro Internacional de Agricultura Tropical, CIAT, in collaboration with the Instituto de investigaciones Technologicas, IIT, and the Universidad del Valle, Univalle, have initiated a project with the objective of determining the technical and economic conditions required for the development of a rural cassava flour industry. The aim is to design and implement a viable system for the production of composite flour products that includes cassava production and processing, the blending of wheat and cassava flours, the elaboration of bakery products and their sale to consumers, Figure 1.

The project, which is partially financed by the International Development Research Centre, got underway in the second semestre of 1984. The experimental phase will continue for two years and, depending on the results achieved, may be followed by a semi-commercial or development phase. The present article describes the methodological framework within which the project is being carried out and some of initial results of the economic and technical studies that have been undertaken.

THE PROJECT

The principal activities to be tackled to achieve the objective described above are : (1) the introduction of improved cassava production technology to reduce costs and raw material prices ; (2) the development of an appopriate cassava processing technology to produce a high quality flour at a competitive price ; (3) the determination of mechanisms to motivate the wheat miller to blend and the baker to use composite flour, and (4) the evaluation of consumer preference for and acceptance of composite flour products.

The methodological framework that has been developed to carry out these activities is summarized in Figure 2. The project is divided into three basic research areas : 1) Economic evaluation studies ; 2) Design and Evaluation of processing plant and 3) Bakery product development. In the first year of the project, the economic evaluation includes studies on the Colombian wheat market, cassava production regions, the wheat milling and bakery industries and consumer habits and preferences with regard to bakery industries and consumer habits and preferences with regard to bakery products. This information will orient subsequent work on flour processing and bread making and indicate the most appropriate cassava production region for the establishment of the flour industry.

The design and development of the processing equipment is being carried out during the first year so as to be in a position to construct and operate a pilot plant for the production of cassava flour during the second year. At the same time, breadmaking trials are being undertaken to determine the optimum levels of wheat flour substitution, the need for fortification with soybean flour to maintain nutritional quality and the changes in bakery procedures required when using wheat/cassava composite flours. An important part of this work is to determine whether cassava variety and plant age affect bakery product quality.

In the second year of the project, seven tons of composite wheat/cassava flour will be produced in a wheat mill with the objective of testing both baker and consumer acceptance of the flour and its products. The results of these studies, together with the price and cost information obtained from the pilot processing plant and on-farm cassava production trials conducted in the selected region, will be used to prepare a feasibility study with recommendations as to actions necessary to establish the use of wheat/cassava composite flours in Colombia.

The rest of this article describes the progress that has been made up to the present time.

ECONOMIC STUDIES

With the information obtained through the wheat mill survey (WEISS, 1985), together with preliminary cost data on the production and processing of cassava, it has been possible to make a first estimate of the economic feasibility of mixing wheat and cassava flour, Figure 3. The cost of producing one ton of wheat flour is US$457. However, the miller recuperates US$63/t through the sale of the bye-

FIGURE 2. **PRINCIPAL ACTIVITIES IN THE CASSAVA BAKING FLOUR PROJECT**

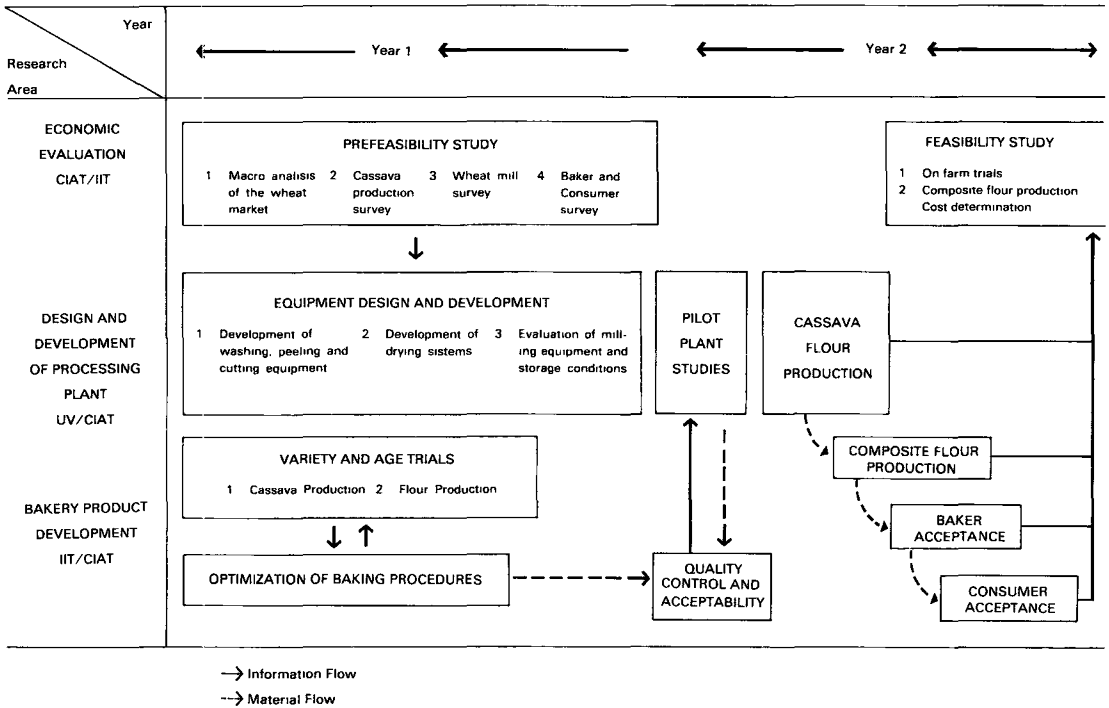
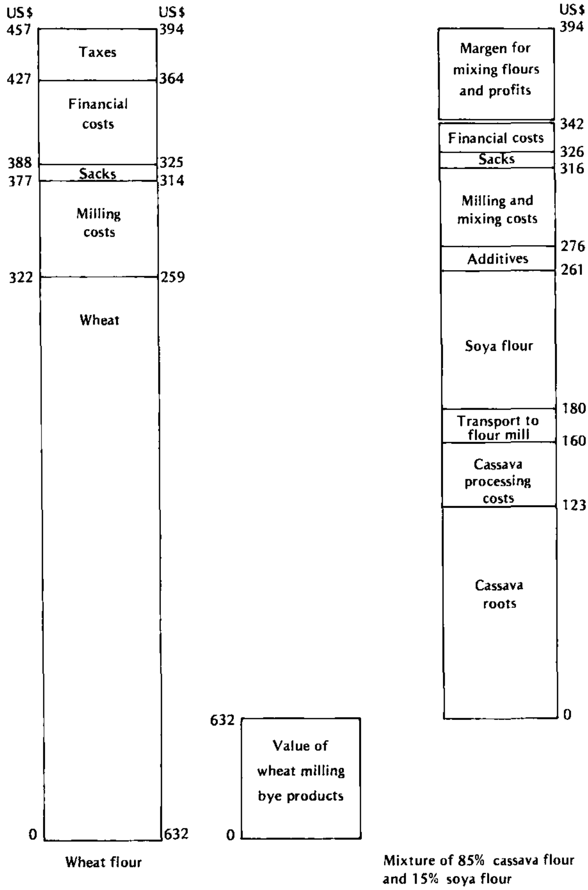


FIGURE 3.
PRODUCTION COST STRUCTURE OF WHEAT FLOUR AND A CASSAVA/SOY FLOUR MIXTURE. AUGUST 1984.



products so that the non-wheat diluent mixture will have to be produced at a cost of less than US$394/t. Assuming that the cassava-soja flour diluent mixture will have the same nutritional (protein) content as 100 per cent wheat flour, it appears feasible to produce this non-wheat flour at a price of US$342/t. This leaves a small positive margen of US$52/t which be needed to cover the wheat flour-cassava/soja flour mixing costs and also to provide a profit incentive to the miller.

It should be noted that the addition of the soya flour to the cassava flour represents 24 per cent of the total production costs of the mixture. Since the consumption of wheat flour products represents only 4 per cent of the total protein consumed in Colombian diets the elimination of the soya flour in the composite flour is unlikely to affect critically the nutritional status of the population. The removal of the soya flour would reduce the cassava flour production cost to US$282/t or to 72 per cent of the cost of producing wheat flour, and should therefore make its incorporation into bakery flour economically much more attractive.

EQUIPMENT DESIGN

In Colombia cassava is predominantly grown on small to medium sized farms. It is highly perishable crop and due to its bulkiness transport costs to urban centres are high. Taking into account these factors, the development of processing plant and equipment is being based on a batch or semi-batch modular design, with each module having a capacity to produce approximately one ton of cassava flour per day. At this scale, the processing technology should be suitable for operation by farmer cooperatives and/or small to medium entrepreneurs, with the plants being located as clone to the areas of cassava production as possible.

The operations involved in processing the cassava roots are shown in the flow diagram, Figure 4. After reception and weighing of the roots they are passed to a sorting table where deteriorated roots are discarded and fibrous stumps removed. Washing and peeling are then carried out in a continuous cylindrical rotary machine that is being adapted from a design by ODIGBOH (1978). The peeling process removes the periderm and part of the epiderm.

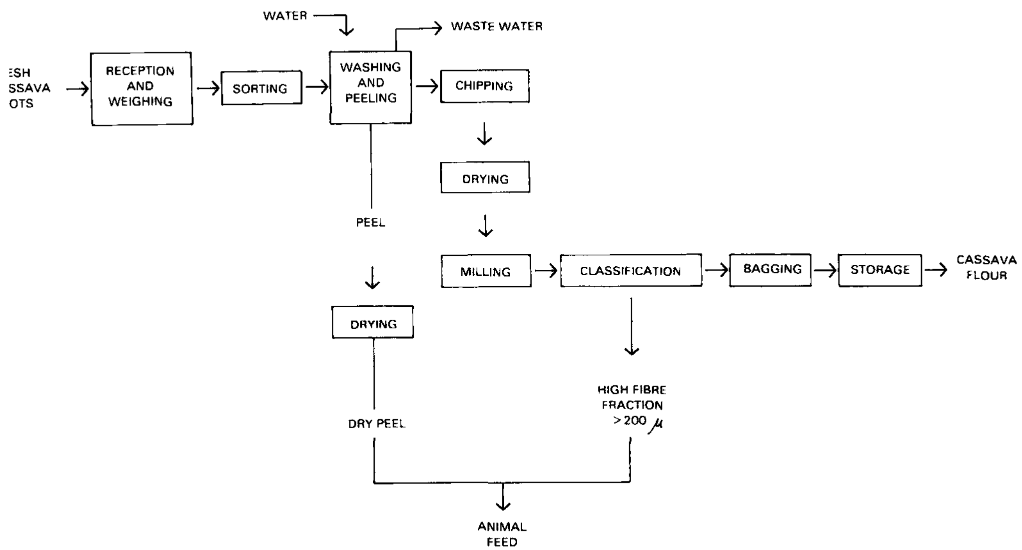


FIGURE 4. **FLOW DIAGRAM OF CASSAVA FLOUR PROCESSING PLANT**

Three types of cassava chipping machines, Thai, Malaysian and Brazilian (SUAREZ, 1985) are being evaluated and adapted for use in the process. To date, the Brazilian type cutter which produces rectangular bars of section 8 x 10 mm with a length of 10 to 50 mm, has performed best in terms of the drying characteristics of the chips and the ease of manufacture of the cutting blades.

Cassava chip drying is being evaluated using both natural and artificial systems. For natural drying, the inclined mesh bottom tray method has been chosen (BEST, 1978). Under the conditions prevailing at CIAT (26°C, 63 per cent RH, wind speed 1.25 m/s, solar radiation 0.72 cal/cm^2. min) (*) the optimum tray loading has been found to be 18 kg of fresh chips per m^2, for artificial drying, a through circulation deep be drier is being tested, using a coal fired burner to heat the drying air. The optimum loading of this drier is 150 kg of fresh chips per m^2, for a drying time of 9 hours, with a drying air temperature and flowrate of 60°C and 130 m^3/min. t respectively (FIGUEROA, ALONSO and VIERA, 1985). This system consumes 370 kg of coal per tonne of dry cassava produced and operates at a global thermal efficiency of 43 per cent. With a view to combining natural and artificial drying methods the development of a through flow tray drier is also contemplated.

The size reduction of the dry cassava chips to produce flour will be achieved using a hammer mill and trials are underway to determine the optimum operating conditions, in terms of rotor velocity and crib mesh size, that will maximise the production of flour with a particle size of less than 200 microns. Subsequent separation will be carried out using a rotating classifier. The high fibre fraction (200 microns) that should not exceed 20 per cent of the total flour produced, will be recuperated together with the cassava peel for use as an animal feed.

BAKERY PRODUCT EVALUATION

The baking trials that have been undertaken up to the present time have been orientated towards determining whether cassava variety and plant age have an effect on bread characteristics. Flours were prepared from four cassava varieties : M Col 22, CM 976-15, M Col 1684 and M Ven 25 at each of four harvest dates (8, 10, 12 and 14 months). The bread making formula used was : 85 per cent wheat flour 12 per cent cassava flour and 3 per cent soya flour. No additives were incorporated and the composite flour was compared against a 100 per cent wheat flour control. The trials were undertaken using the standard A.A.C.C. method N° 1010 (1969).

(*) Average conditions between 8:00 a.m. and 6:00 p.m.

In trials carried out using flours of the four varieties harvested at 12 months, the bread that gave the highest specific volume (4.36 cm^3/g(*)) was that containing M Col 22 flour. This bread was also superior in terms of bread score (84.0) (external and internal characteristics of the bread) compared with the other breads prepared from composite flours (77.0-83.0), but inferior to the bread score of the 100 per cent wheat flour control (92.0).

Subsequently, trials were undertaken using M Col 22 flour prepared at the four harvest dates. The results show that specific volume and bread score improve with increasing plant age. With eight month old cassava, the bread produced had a specific volume of 3.84 cm^3/g and a score of 73, whereas with fourteen month old cassava the volume was 4.38 cm^3/g and the score 81.0.

Additional experiments, of a preliminary nature, in which the bread flour composition was altered, have shown that the use of 15 per cent cassava flour, instead of 12 per cent cassava flour and 3 per cent soya flour, gives a product with an improved specific volume and bread score, Table 1. It therefore appears that the elimination of soya flour from the blend will have not only economic but also technical advantages. A more detailed study on the effect this may have on the nutritional quality of the product is underway.

TABLE 1 : Bread specific volume and score of wheat/cassava and wheat/cassava/soya flour blends

Bread formula	Specific volume cm^3/g	Bread score max.100
85 % wheat flour, 12 % cassava flour[a] and 3 % soya flour	4.20	84.0
85 % wheat flour, 15 % cassava flour[a]	4.60	89.5
100 % wheat control	4.30	92.5

[a]Cassava flour prepared from 12 month old roots of the variety M Col 22

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