PRODUCTION AND MARKETING OF CASSAVA FLOUR IN COLOMBIA

ANNUAL REPORT

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PARTICIPATING INSTITUTIONS:

CENTRO INTERNACIONAL DE AGRICULTURA TROPICAL (CIAT)
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EXECUTIVE SUMMARY

Phase 3 (Commercial expansion) of the project "Production and marketing of cassava flour in Colombia" started in January 1992. The previous phase (Pilot project) attempted to integrate the production, processing, and marketing components of the cassava flour system under the real socioeconomic conditions of a cassava-growing region in the Atlantic coast of Colombia (Chinu, Cordoba), where a pilot plant for the production of cassava flour was built in 1989. Market studies indicated the potential use of cassava flour in multiple food categories, including processed meats and sweet cookies or biscuits.

The consensus at the end of the pilot phase was that plant investment and cassava flour production costs were too high and that cassava flour quality had to be improved in order to facilitate its marketing. In particular, the main problem was the long and inefficient drying process that was negatively affecting product quality as well. In addition, the need for in-plant milling was identified to reduce variable costs and enable the development of local markets.

Thus, the Third phase started with a still unproven pilot plant, and the task during 1992 has been to solve the quality problem, achieve commercial sales of the flour, and demonstrate the feasibility of the project. This report will detail the considerable progress made during the year in identifying the causes of the quality problems and implementing modifications to equipment and operating procedures to ensure acceptable product quality while maintaining costs within acceptable limits. Only when this has been satisfactorily completed can it be justified to proceed to the activities planned for the commercial expansion of the project.

The main objectives of Phase 3 or Expansion phase are (a) to improve pilot plant profitability, (b) to improve critical aspects that will facilitate agroindustry expansion in Colombia and, in a wider international context, (c) to understand factors affecting cassava-flour quality and their relation to end-product quality. The results will be utilized by public and private agencies in Colombia and elsewhere, if applicable, to promote the replica of rural cassava-flour producing plants and the use of the product by the national food industry.

During the second half of the year the pilot plant operated at low levels of capacity utilization, but product quality was satisfactory and the flour was sold to several food companies in the north coast region of Colombia. Repeat sales were made. This report therefore contains a final feasibility study based on the costs and prices obtaining at year end, 1992. Although some assumptions still exist, especially as regards capacity utilization, it is clear that a cassava flour industry is a feasible alternative for small farmer groups and small rural enterprises in Colombia. Capacity utilization will expand as the market develops, over time.

Given these encouraging results, it was decided in the mid-year meeting (August. Sincelejo) to initiate some of the activities related to project expansion beyond the pilot plant, such as plant redesign and design of other processing plant types, reassessment of criteria for plant site selection, and development of operational and management manuals. This report details the progress made in several of these activities, and the plans for 1993 for the remainder which have not yet been initiated.

From mid 1991, considerable research support has been received from the National Research Institute of England. As a result of this, the project has been able to make advances during the current year. The NRI has become more interested in improving flour quality through further process modifications, especially permitting the use of varieties with high levels of cyanogen, common in Brazil and Africa. From 1993, a complementary NRI-funded research project will be based in CIAT for two years to carry out this research. The pilot plant at Chinu will thus continue to be a valuable research tool into the future.

1. BACKGROUND

The urbanization process of the last 40 years in Latin America has generated changes in eating habits: the rural starchy staples such as maize, plantains, and roots have given way to more convenient foods such as rice and wheat-based processed foods such as bread and pasta.

Although cassava is well adapted to the tropics and is an efficient producer of carbohydrates, the urbanization process has hit market demand due to its rapid perishability which renders the root expensive and with quality problems in the urban context.

Cassava is grown mainly by small farmers in Latin America, usually under marginal edaphoclimatic conditions and in association with other crops such as maize. Due to the inelastic demand in the urban market for fresh roots, the main market, improved production technology will not impact on the small farmers' income unless new markets for cassava products are identified and developed.

A new product in Latin America, dry cassava for animal feed, has had an important development in Colombia, Brazil and Ecuador, thanks to the collaborative projects between national programs and CIAT.

Furthermore, cassava can be processed into a high-quality flour to be used as a partial or total substitute for other flours and starches in cost-reduced formulas. Because cassava is produced mainly by small farmers, previous large-scale projects have failed mainly due to lack of sufficient raw material. The current strategy is to create small cassava flour plants in areas where cassava is an important crop, with the value added remaining in the rural area.

The linkage of cassava production with substitution of flours in growing markets can provide a price floor for cassava and an opportunity to expand production and income of small producers.

CIAT has developed a methodology to design and implement Integrated Cassava Projects encompassing production, processing and marketing of cassava in a country or region. The methodology comprises the following phases:

(i) Macroplanning, in which one or more cassava products with market potential are identified, followed by

(ii) Microplanning, to define regions where research, market studies, and production diagnosis, etc. will be conducted.

(iii) the Pilot phase follows, when small-scale commercial activities are executed

(iv) Commercial Expansion, where market consolidation for the new agroindustry is pursued.

Within the integrated project framework, one can distinguish four product development phases for each potential cassava product, as follows:

(i) identification of product opportunities

(ii) the Research phase, in which processing technology is generated and a more profound analysis of marketing opportunities is carried out

(iii) the Pilot Project phase or Test Market, where the product is produced and marketed on a small scale under real market conditions, and

(iv) the Commercialization phase, when the market for the new product is consolidated and processing units are replicated.

All of the activities included in this methodology correspond to the production, processing and marketing functions.

<u>Evolution of the cassava flour project</u>

After identifying the opportunity for the product "cassava flour", product development continued with the Research phase, whose main objective was to determine the technical and economical conditions required for the development of the rural cassava flour agroindustry. Phase I included studies of cassava production systems and marketing in the Atlantic coast of Colombia, on-farm trials with the improved cassava production technology, economics studies of the milling and bread-making industries, the development of a small-scale processing plant for the production of high-quality cassava flour, and laboratory and consumer acceptability trials for bread-making products made with composite flour.

In summary, the process designed comprises the following steps: selection and preparation of cassava roots, mechanical washing, chipping, artificial drying, premilling, milling and sieving and packaging.

The results of this work point to the fact that, under the prevalent price and cost structure of cassava and wheat in Colombia, it is economically feasible to produce cassava flour at a competitive price versus wheat flour. Consequently, it was proposed to continue with Phase 2 or the Pilot Project phase.

It is important to point out that, in the Research phase, the main market was considered to be the bread-making category, where 15% of the wheat flour would be substituted with cassava flour. However, because the baker perceives a high risk of hurting his product quality when utilizing cassava flour, it was decided to focus Phase 2 towards other food categories where cassava flour will not offer functional disadvantages.

Phase 2 or the Pilot Project phase, executed by CIAT, Universidad del Valle, and the Integrated Rural Development Fund (DRI), attempted to integrate the production, processing, and marketing components of the cassava flour system under the real socioeconomic conditions of a cassava-growing region. Chinú (Córdoba) was the site chosen for the pilot plant built with an annual capacity of 180 tons. Market studies indicated the potential use of cassava flour in multiple food categories, including processed meats and sweet cookies or biscuits. The dry chips were milled and marketed in Medellin. The creation of an in-plant milling capacity was deemed convenient to penetrate local markets.

However, the consensus at the end of the pilot phase experience was that the plant investment and cassava-flour production costs were too high and that the cassava flour quality had to be improved in order to facilitate its marketing. Thus, the Third phase started with a still unproven pilot plant, and the task during 1992 has been to solve the quality problem, achieve commercial sales of the flour, and demonstrate the feasibility of the project. Only when this has been satisfactorily completed can it be justified to proceed to the activities planned for the commercial expansion of the project.

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2. REFORMS CONDUCTED AT THE PILOT PLANT

At the end of the pilot stage, problems were encountered with end product (flour) quality. This lead to research being conducted by NRI and CIAT to identify the causes of these problems (See final report of Phase II). A series of modifications to the pilot plant were made from March to May 1992 to correct these problems, consisting in the modification of the drying infrastructure to reduce drying time and to help solve the final product quality problem. The drying area was separated by building walls to avoid dust and animal contamination. The drying area was expanded: two 3 x 7 meter chambers were built separated by a wall. The purpose of the 3 by 7 width-to-length relation was to improve airflow distribution in each chamber. The second chamber was built to double drying capacity. Also, a new burner similar to the existing one was purchased, and both were connected in parallel to heat the air for the first chamber. In the meeting of January 1992 it had been agreed to change the metal burner for a brick one, based on the burner at the experimental plant at CIAT. Work was conducted in the design of this burner. but it was finally decided to purchase another metal burner due to cost and time reasons. The brick burner remains as an option for the second drying chamber that will double the drying capacity in the future. The cost of these reforms, including the new metal burner, was Col$4.500.000 (April 1992).

3. STUDIES CONDUCTED BY CIAT AND NRI

Due to problems with the microbiological quality of cassava flour produced in the pilot plant towards the middle of 1991, technical assistance was obtained from NRI staff (Nov. 1991), who left recommendations for the short and medium term that were implemented in the trials evaluating prewashing and holding. The objective of these trials (March 1992) was to establish the effect of prewashing and holding on final quality, without modifying the washing and drying operations. Results did not indicate a clear-cut impact of these treatments on the microbiological quality of the final product. It was also verified that the microbiological count goes down with storage.

To continue with the NRI's technical assistance, there was a subsequent visit of an official (March/April 1992) with the objective of researching the impact of washing and drying variables on the microbiological quality of the dry cassava chips. Four drying trials were conducted to investigate the impact of loading density, air flow and temperature on drying time, microbiological quality and cyanide content. It was concluded that a reduction in loading density caused a decrease in drying time, thus improving microbiological quality. However, drying efficiency was unfavorably affected.

Afterwards, the NRI functionary executed the following six trials: (i) three to study the effect of root harvest time (the same day or the previous one) and nighttime holding conditions (under water or dry) in microbiological quality, and (ii) another three trials to examine the impact of applying hypochlorite acid to the washing water on the microbiological quality of the dry chips. The loading density in all of the trials was low to enable a short drying period. The washing trials indicated that holding under water is better than dry holding relative to chip quality; it is also important to acidify the water with chloride. The use of a solution with a high chloride concentration after washing did not have the expected consequence. The best microbiological result was achieved with the control trial in which chloride was not added to the washing water, roots were harvested the previous day and holding was dry. In addition, it was noticed that microbiological quality improved significantly after a 4 to 6 week storage period at 35°C.

After her trials at CIAT, D. Jones left a list of recommendations that were followed in the trials regarding evaluations of "washing and holding" and "silage and holding under water".

The purpose of the first trial was to (i) measure the effect of holding the roots in sisal bags or under water, and to (ii) compare the effectiveness of two microbicides, sodium hypochlorite and TEGO. The results indicated that neither treatment was effective in controlling aerobic mesophylls and total coliforms simultaneously. It should be noted that TEGO was able to control mesophylls. The objective of the second trial was to compare the normal process at the pilot plant with three additional treatments, as follows: (i) nighttime silage of moist chips, (ii) immersion of fresh roots in a concentrated solution with hypochlorite acid prior to chipping, and (iii) fermentation of fresh chips under water. The data demonstrated that the normal process resulted in the best microbiological quality while fermentation facilitated the elimination of total cyanide.

Based on these results, it was decided to operate the pilot plant in the following manner during June-July 1992:

1. Minimize the time between harvest and arrival of roots at the plant.

2. Store during the night, if necessary, in sisal bags.

3. Wash for 5-7 minutes using chlorine at 10-20 ppm.

4. PILOT PLANT OPERATION IN 1992

In 1992 the pilot plant operated during the months of June, July, September, October and December. December is analyzed separately because in this month root supply expands greatly and the annual root price increase takes place. Only one lot was processed in July due to a damage in the well pump and has been considered as part of the June lots. TABLE 4.1 shows a summary of the main processing parameters for both periods.

Period 1 (June, July, September and October)

Processing in this period was used to evaluate the reforms executed in the drying system and to relate loading density, temperature and drying time with the microbiological quality of the cassava chip.

Nineteen lots involving 25.558 kgs of prepared roots (excluding rejected roots) were processed. Roots were purchased at $30/kg and, in general, exhibited a high moisture content. A total of 7.780 kgs of dry chips were produced; the conversion factor was 3.285. Roots came from the Chinu area and the major part was sold by members of COOPROALGA.

The percentage of rejected roots for the first five lots in the operation of root preparation was near the norm (5%), but afterwards it increased significantly when the on-farm preselection was interrupted. Labor demand was quite close to the 20 man-hours/ton standard.

The percentage of weight loss in the washing and chipping operations was near the 5% norm. Water consumption was also close to the standard of 2.0 m^3/ton of dry chips, but the weighted labor demand was 37% above the norm of 9 man-hours/ton of dry chips.

The drying operation requires three workers for loading, turning, handling of the burner and drying control, and for unloading. Weight loss was within the norm; labor was 37% above the standard (25 man-hours/ton of dry chips) due to the high moisture content of the roots and to the drying time exceeding 8 hours. The burners took around 4 hours to reach the target temperature of 80°C but the average temperature was below this value due to nighttime drying.

Loading density had a broad range because the purpose was to study its effect on drying time and coke consumption. Due to electricity rationing day and nighttime drying was conducted. The time between root harvest and initiation of drying was controlled to minimize the risk of root deterioration; it remained between 10 and 20 hours. The exceptionally high moisture content of roots augmented coke consumption and drying time. A strong relation was noted between loading density and drying time and, to a lesser extent, between loading density and coke consumption. The remaining factors do not correlate significantly with coke consumption.

Drying homogeneity was observed; little variations were noted in the air velocity above the perforated floor in different points of the drying chamber. This confirms that a 2:5 width-to-length ratio allows an adequate airflow distribution in the drying

TABLE 4.1. Main processing parameters of the cassava flour plant in 1992

Parameter	Jun/Jul	Sept	Oct	Dec	Norm
Lots	1-13	14-16	17-19	20-27	
Fresh cassava processed (kgs)	22122	5869	4121	25413	
Dry chips produced (kgs)	5416	1503	861	5681	
Reject (%) Preparation	11.5	32.4	35.4	34.4	5.0 (a)
Labor (man-hours) Preparation	22.0	20.7	29.7	25.5	20.0
Labor (man-hours) Washing & chipping	14.0	7.5	10.0	8.4	9.0
Labor (man-hours) Drying	37.0	22.8	37.0	24.5	25.0
Total labor (man-hours)	104.0	57.0	89.7	64.0	70.0
Conversion factor (b)	3.51	2.61	3.04	2.93	2.80
Coke consumption (kgs/ton dry chips)	1016	688	1265	551	
Total variable costs/ton of dry chips	198127	144550	202994	155245	145000 (c)

(a) This figure assumes preselection in the field; without preselection in the field the norm can be 25%.

(b) Considers fresh cassava after selection and preparation.

(c) A standard variable cost for December 1992.

chamber.

The average variable cost per ton of dry chips for this period was quite high, $190.959, due mainly to the low loading density (essential for the type of research undertaken), an elevated root-to-chip conversion factor and high coal consumption. However, for the three lots of September, this figure was quite low: $144.550, which can be explained by the low conversion factor.

Microbiological quality improved significantly, especially as regards to mesophyll and coliform counts, because all of the lots comply with wheat flour norms. It is considered that this progress is due to three factors, as follows: (a) drying time reduction from 22 hours in 1991 to 8-13 hours in 1992, (b) a decline in the time between harvesting and drying, from 36 to 20 hours, and (c) quality control of the fresh roots purchased. The high yeast and fungi counts may be due to sample contamination in the laboratory during delays caused by electrical rationing. In addition, total cyanide content of chips was slightly above the 50 ppm limit for human consumption.

Given the high coke consumption, contacts were made with the natural gas supplier, PROMIGAS, to explore the possibility of using this fuel in the pilot plant, but no reply had been received as of December 1992. In addition, a two-inch layer of refractory cement was applied to protect and insulate the metal of the combustion chamber of the first metal burner purchased. The manufacturer of the second burner purchased was requested to include this same insulation.

A method for controlling moisture of roots purchased by the pilot plant was established this year to control the conversion factor. However, it is difficult to implement in practice because most of the roots come from the same zone and, thus, the range of moisture variability is quite narrow. In addition, it is almost impossible to prefer varieties with a high dry matter content (such as Venezolana) because farmers plant several varieties in the same plot, with a predominance of P-12, a variety with high moisture content.

Period 2 (December)

Eight lots involving 16.660 kgs of fresh roots were processed this month to produce 5.681 kgs of dry chips, or a conversion factor of 2.832.

Capacity utilization in December was a low 40% because production was delayed by a damage in the well pump caused by sand abrasion. While the pump was being repaired, a three-inch PVC tube with a filter in the area of suction was inserted inside the existing four-inch PVC tube to avoid sand intake. Despite this repair, the well has to be cleaned every six months; personnel from the cooperative was trained for this operation.

Fresh roots were supplied by the Chinu area, but the price increased from \$30 to \$32/kg. The roots were only seven months old.

Root selection in the field was eliminated and instead this operation is performed in the pilot plant; this raised the reject percentage above 30%. Roots are spread in the floor and small roots and impurities are separated from large, healthy roots which are suitable for processing. Selected roots are subsequently prepared in the metal tables. Both operations (selection and preparation) demand 4 to 5 workers. Labor requirements have increased 30% above the norm of 20 man-hours/ton of dry chips. This increase may also be due to the large proportion of small roots caused by the fact that they have been harvested after only seven months.

The percentage of weight loss and labor demand in the washing and chipping operation were both below the norms (4.7 vs. 5% and 8.4 vs. 9 man-hours/ton of dry chips).

Weight loss in the drying operation was below the norm of 1.5%. The labor requirement was also below the norm of 25 man-hours/ton of dry chips. Initial root moisture was high (73%) due to their short age; loading density ranged between 70 and 120 kgs/m^2 and the drying time was between 8 to 14 hours.

The two coke-fired burners were able to achieve temperatures above 60°C two hours after initiating the drying process. Average drying temperatures below 55°C in some lots are due to the worker's inexperience or because drying was conducted at night. Coke consumption also declined significantly because the second burner was insulated, as already mentioned.

The reduction of air flow during the last hours of drying was tested to save coke but results were not as expected; an explanation could be that drying took place at night, when coke fuel requirements increase. However, drying of lot 27 was conducted with reduced air flow during the day and exhibited the lowest coke consumption, 443 kgs/ton. When drying was carried out with reduced airflow and if the temperature would not fall considerably, the burners were fed 5 kgs of coke every half hour vs. the normal 10 kgs.

Variable costs of production were lower in December (\$155.245 per ton of dry chips) than in the previous period, mainly because the conversion factor declined (3.285 to 2.935), as well as coke consumption (980 to 551 kg/ton).

The flour extraction rate of 58.8% was very low, compared to the target extraction rate of 80%. This topic will be discussed in depth in the next section (Point 5) of this report. This low flour extraction rate greatly affects profitability because the by-product, bran, is sold at less than half the price of first-grade flour. If we think of the sales price as a weighted average of the prices for first-grade flour and bran, this becomes more clear.

The outlook for 1993 is quite optimistic, given the current tendency towards continued reduction in variable costs and quality improvement. This latter aspect can facilitate flour marketing, which in turn will enable a significant increase in capacity utilization that will result in lower fixed costs.

5. EVALUATION AND OPERATION OF THE SMALL-SCALE MILLING SYSTEM

The small-scale milling system developed in 1991 consisted of a hopper where dry chips were deposited and then lifted and fed to a premilling machine by means of an endless screw. The premilling machine consisted of two cylinders that rotate in opposite directions and crush the chips, thus reducing their size. The small chips were then transferred to a hammer mill and then to two cylindrical screens which separated the first-grade flour from bran but also had a milling effect. The flour, sucked by a fan, was carried to a cyclone where air and flour are separated.

This system underwent several trials to identify problems and generate solutions. The following modifications were executed during the first semester:

- redesign of the cylindrical screen structures, especially the bottom one

- the width of the bottom hopper that receives the flour was increased and its form modified

- final design of the extraction system (fan and cyclone), based on the model at UNIVALLE

- construction of several openings to facilitate cleaning

- the velocity of the upper cylindrical screen was increased

Afterwards, the equipment was sent to the pilot plant where it was used to process almost three tons of dry chips with an average extraction rate of approximately 81%, similar to the one obtained in commercial wheat mills. Flour represented 12% of the milling by-product, bran. Particle size analysis demonstrated that 85% of the particles had a diameter below 100 um. The equipment capacity, with manual feeding, was 95 kg of flour/hour.

In September, the milling system was organized so that it could operate continuously and it processed 1.5 tons. The performance of the double screen was negatively affected by chip moisture above 14%, resulting in an extraction rate below 40%. This situation was corrected by drying the chips to lower moisture levels to 11%.

With regards to the mechanical operation, the stainless steel mesh of the lower cylindrical screen ruptured frequently due to the recurrent contact with the external cylindrical structure (wire netting). This was solved by adding a denser wire netting that would provide greater support to the steel mesh. This modification greatly improved the performance of the screen, as demonstrated by the fact that it has not ruptured after processing five tons.

FIGURE 5.1 shows the diagram of the continuous process used in the December milling. Although flour extraction increased to 60%, it did not reach the expected level. Based on past experience, it was noticed that both the coarse and fine brans still contained removable flour, especially the latter which represented 32%.

This was corroborated afterwards at CIAT, where the first-grade fine bran was reprocessed three times in a cylindrical screen and 17% of the original chip weight was recuperated as flour. In addition, 5% of the original weight was recovered as flour, after remilling the second-grade fine bran. This means that, under optimal conditions, the extraction rate in December at Chinu would have been above 80%.

The original low extraction rate could have been due to the following factors: (a) the moisture content was above 13%; in previous trials, the efficiency of the milling machinery improved when chip moisture was below 11%, (b) overfeeding of the double cylindrical screens; when it is impossible to reduce chip moisture, equipment capacity has to be lowered to increase retention, especially in the lower screen, and (c) high fiber content of the roots, which is a function of variety and edaphoclimatic conditions.

The lower cylindrical screen is the component limiting the system capacity to 250 kgs of chips/hour, since the premilling machine and upper screen both have a throughput of approximately 900 kgs/hour. If the diameter of the lower cylindrical screen is increased by 40%, from 18 to 25 cm, the system capacity can be doubled.

Particle size analysis indicated that 90% of the particles had a diameter below 100 µm. This means that cassava flour has finer particles than wheat flour, which exhibits only 60% of the particles below 100 µm.

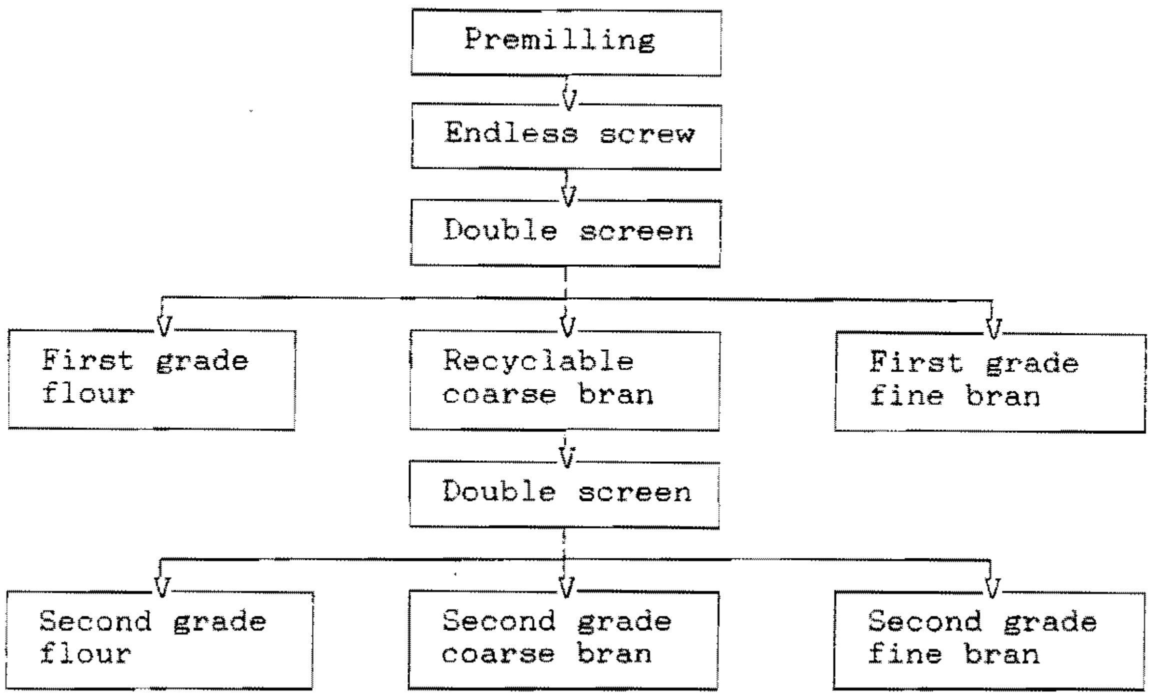


FIGURE 5.1. Diagram, including products and by-products, of the cassava chip milling system

In the milling conducted in January, the chips were drier (9% moisture content) and the coarse and fine bran were reprocessed; an extraction rate of 75% was obtained.

The effect of variety on equipment performance was studied by means of a trial in which flour was produced from three different cassava varieties. The system generates low extraction rates with high-fiber cassava varieties.

The small-scale chip milling system could be further improved by modifying the design of the rotating fins and determining optimum screen size and rotational velocity.

6. MARKETING OF CASSAVA FLOUR

Although it was a valuable learning process, the marketing effort conducted in Medellin during Phase 2 was not successful due mainly to the deficient microbiological quality of the cassava flour. This task focused mainly on firms in the food sector, especially in the processed meats category.

The impossibility of in-plant milling at the time blocked the development of local markets for cassava flour. The installation of the small scale, in-plant mill designed as part of this project, enabled the concentration of marketing efforts in the

Atlantic coast region. In this occasion, the product had a better quality due to drying time reduction by almost 50%.

Four different markets for cassava flour were determined, as follows:

- the food industry, made up of companies in categories such as processed meats, cookies, cones, soups, sauces, spices, powdered drink mixes, etc. These firms tend to be large and medium-sized.

- neighborhood bakeries; through key distributors, hundreds of bakeries can be supplied with a cheaper composite wheat/cassava flour for making cookies and cakes. These bakeries are usually small.

- household use; cassava flour has many in-home uses (nursing bottles, porridges, etc.) similar to those of wheat flour and corn starch. 200 and 400 gram packages can be distributed by means of corner shops and supermarkets.

- industrial companies producing plywood and adhesives.

Promotion

Three cycles of sales visits were conducted in May, July and November. In the first visit, four meat processing companies and five flour wholesalers (including two wheat mills) were visited in Sincelejo, Cartagena and Barranquilla. The sales presentation to wholesalers emphasized the opportunity for selling a composite wheat/cassava flour to bakeries for production of cookies. Wholesalers insisted in the importance of receiving technical and promotional assistance. The need for attractive packaging for cassava flour and for the development of cassava flour recipes for bakeries and in-home use arose during this visit. A simple eight-recipe book was developed immediately in the Cassava Utilization Section. Afterwards, the development of recipes for bakeries and households in the Atlantic coast region was contracted with a professional breadmaker in Barranquilla.

In the second visit, in July, follow-up contacts were made with three meat-processing firms in Barranquilla and one in Sincelejo and 15 kg samples were handed. The use of a composite wheat/cassava flour for pastry was recommended and recipe books were provided in two Barranquilla bakeries.

The objective of the third visit in November was to promote cassava among four spice-producing companies and two dedicated to marketing flours for household use in Barranquilla. Five kg samples were handed.

It should be noted, that, in addition to these visits, follow-up phone calls were made from Cali. Letters, technical information and samples were also sent to Rica Rondo (processed meats, Cali), Laboratorios Griffith (premixes for processed meats, Medellin), Noel (cookies, Medellin), and Tecnas (premixes for processed meats, Medellin), and Nestle (soup mixes, Bogota and Cookies, Pereira).

Furthermore, COOPROALGA, the farmer cooperative managing the pilot plant, is interested in developing the local in-home use flour market and has developed a product development and marketing plan which includes the following: (a) graphic design of 200 and 400 gr polyethylene bags with recipes in the back, (b) promotional events with consumers such as taste sampling, and (c) sales and distribution in corner shops and supermarkets.

Results

The main achievements of this effort were the following:

- penetration of the processed meat category market, with two clients, one in Sincelejo and the other in Barranquilla, who purchased six tons at $220/kg during the period from July to November 1992; another client conducted a trial and purchased 125 kgs.
- interest was stimulated among wholesalers selling flours and other inputs to bakeries; currently, there are two wholesalers, in Sincelejo and Barranquilla, who plan to launch a composite wheat/cassava flour for cookies and pastry in 1993.

Price

The price for cassava flour was established based on the production cost structure and also seeking to be 15 to 20% below the wheat flour price. A price list was prepared that included discounts for the first purchase (5%), payment in cash (1.5%) and volume.

One must be flexible when establishing prices for cassava flour because the price of its competitor, wheat flour, varies according to location and type of client. For example, wheat flour for a bakery is more expensive in Sincelejo ($280/kg) than in Barranquilla ($260/kg); on the other hand, a flour wholesaler in Sincelejo purchases at a lower price ($240/kg) than a meat-processing firm ($280/kg).

Product development

<u>Brand</u>

A brandname was established for cassava flour (YUKARIBE) and the process of registering it nationally to protect it from eventual competitors was initiated.

<u>Packaging</u>

A 0.5 by 0.8 meter, 25 kg, polypropilene (density 80) bag, printed in red and green was designed at CIAT and produced in Medellin. This weight was selected because the bulkiness of cassava flour made the 50 kg size impractical.

Distribution

A direct distribution is proposed for large buyers, such as meat processors; for small clients such as bakeries, a wholesaler is recommended.

Outlook for 1993

An aggressive personal sales campaign is planned for 1993 in the four markets already mentioned (food industry, bakeries, in-home use, and industry), emphasizing the bakery and industrial markets. For this purpose, a Barranquilla-based salesman will be hired for three months to operate in the main cities of the Atlantic coast.

7. REPORT OF THE COOPERATIVE´S MANAGER

COOPROALGA, the executing small-farmer organization, has 41 members with ages between 20 and 40 and with a relatively good educational level.

Hernando Moreno, the current manager of COOPROALGA, accepted that when Phase 2 started, the cooperative was not properly involved in the project. This was corrected with his return to the cooperative as manager of the two processing plants (chips and flour). One of the decisions made was to stabilize workers in their jobs. Actions are being undertaken to improve relations and services from the cooperative towards the community, including a survey on cassava production, water service, acceptance of the cooperative by the community, housing and schooling needs, etc.

Of the 10 hectares planted in cassava/maize, half are destined to supply raw material for the pilot plant. In addition, with a credit from DRI and FEDECOSABANA, 22 ha. were rented and P-12 and ICA Costeña were planted each in one ha. Cassava and maize in association were planted in the remaining area and also supply roots to the plant. However, the continuation of this credit for production is uncertain which is unfortunate because the production of cassava under the cooperative's management is a good strategy for securing the optimum quality and timeliness in root supply.

COOPROALGA is a leader in training in the Cordoba department, since it has been very receptive to these type of offers. Eight members of COOPROALGA and two of FEDECOSABANA participated in a project-funded course on "Management of small enterprises". This course, encompassing nine topics, was offered by FUNDECOR, a non-government organization related to Fundación Carvajal of Cali. In addition, SENA offered a one-week course on "Equipment maintenance".

With regards to the cassava flour project, it can be said that processing efficiency will improve once electrical rationing is ended. One of the metal burners needs to be replaced. Having corrected most of the processing problems, now the bottleneck is the lack of markets. The cooperative is interested in collaborating in this aspect by developing the local market for in-home flour consumption and will prepare the corresponding proposal. In addition, COOPROALGA is interested in serving as a chip-milling center.

The production license for the pilot plant was requested from the Health Secretariat of Monteria, linked to the Colombian Ministry of Health. The government officials already visited the plant and made several recommendations. The workers underwent medical examinations as a requisite for receiving their legal permit for food manipulation.

COOPROALGA is conscious of the importance of participating in a portfolio of business enterprises in order to minimize risk. However, the lack of credits in general is restraining business activities, to the extent that many cooperatives in the Atlantic coast are currently immobilized.

8. ECONOMIC ANALYSIS OF THE PILOT PLANT

Although the financial model of the cassava flour pilot plant has used data obtained during the pilot project phase, some assumptions still remain, especially as regards to capacity utilization, which is set at 80%.

Data and/or parameters fed to the model must be updated regularly because of inflation and according to the latest findings and experiences on the pilot plant. The results presented below correspond to December 1992.

TABLE 8.1 shows the process parameters used in the model. These also appear in ANNEX 8.1.

TABLE 8.1
Parameters of the Cassava Flour Production Process Used in the Model (December 1992)

Plant capacity	180 tons
Capacity utilization rate	80%
Root-to-dry chip conversion factor	2,8:1
Man-hours per ton of whole flour	70
Bags per ton of flour	40
Kw-hour per ton of whole flour	150
Coke (kgs) per ton of chip	550
Water (m^3) per ton of chips	7
First grade flour extraction rate	85%
Bran extraction rate	14%
Milling losses	1%

Profitability

The model indicates that if the pilot plant operates at 80% capacity, the FRR will be 28%. The opportunity cost of capital in Colombia is 30% and, hence, some improvements are required to make investing in this business attractive.

The required investment in buildings and equipment is US$63.174. The average sales price is Col$201.000 per ton (Col$700 = US$1.00), the variable costs amount to $159.916 per ton, and the fixed costs add up to $15.166 per ton, and therefore the net margin is $41.084 per ton.

Sensitivity of the FRR

FIGURES 8.1 to 8.6 present a sensitivity analysis of the FRR to several parameters such as initial investment, capacity utilization, cost of cassava roots, root-to-dry chip conversion factor, first-grade flour extraction rate, and sales price of first-grade cassava flour. The FRR is quite sensitive to all of the latter variables but is especially responsive to sales price of first-grade flour and cost of fresh roots.

Cost Structure

The model is also helpful in identifying price composition and the relative importance of the different costs (See FIGURE 8.7). As already mentioned, the price used is a weighted average of both the first-grade flour and the bran. This information also appears in page 2 of the model printout.

The most salient characteristics of the price structure is the importance of the raw material cost, the high costs of coke (the fuel used for drying), and the relatively minor weight of fixed costs.

In the section of "Results" above, we mentioned that the current profitability of the pilot plant, assuming a capacity utilization rate of 80%, was of 28%. Since this parameter is slightly below the opportunity cost of capital, there is a profitability problem. However, if we analyze the efficiency of the various process operations and complement it with the application of the model for (a) simulating the impact on the FRR of several processing and marketing alternatives, and for (b) conducting sensitivity analyses, including factors such as initial investment and capacity expansion, a viable strategy can be proposed for raising the FRR to acceptable levels.

The current project strategy to maximize the FRR includes the following points:

(a) Increase capacity utilization to the 80% level assumed in the model. This will require promotional activities to achieve market penetration.

(b) Improvement in drying efficiency through use of alternative fuels (natural gas); this option will also reduce labor costs.

(c) A 25% reduction in the cost of future plant buildings. This can be achieved by means of a cost-reduced design built with different cost-efficient materials. Another option is to eliminate the milling operation in plants and instead execute it in a central site. This could allow a 50% decrease in plant building costs.

(d) Capacity expansion of the pilot plant. Once capacity utilization of the pilot plant reaches 80%, a small additional investment will double capacity.

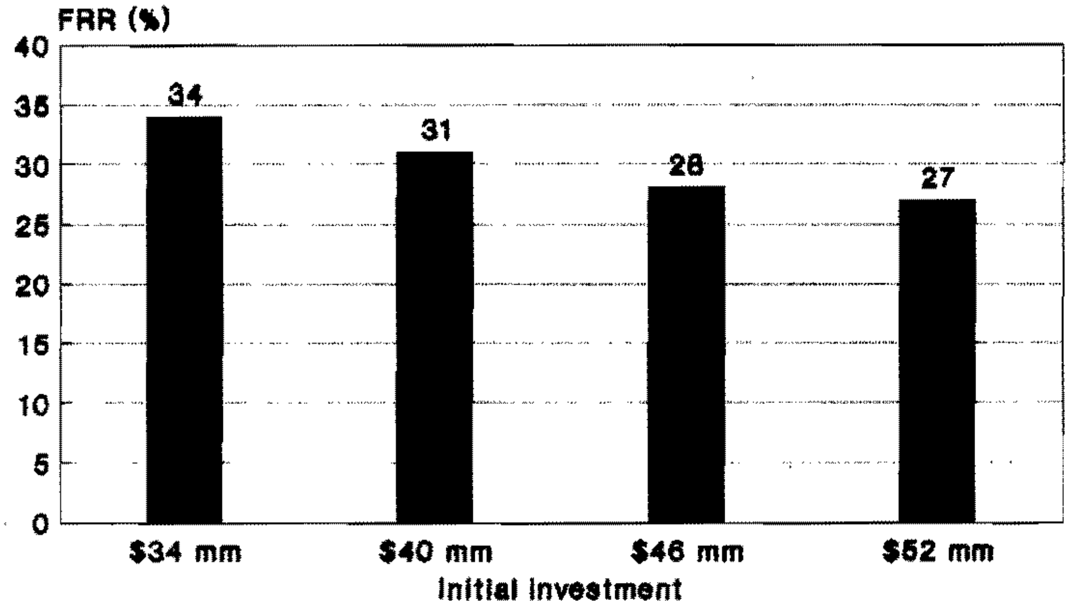
FIGURE 8.8 shows the cumulative effect of actions (b) to (d) on the FRR. The effect of capacity expansion on FRR is very pronounced.

9. MANAGEMENT AND OPERATIONAL MANUALS

Two reference manuals will be developed as an aid to cassava flour plant managers. The first one, a management manual, will be targeted to plant managers and will deal with general aspects of the cassava flour business. The second one, an operational manual, is directed to heads of production and will concentrate mainly on the processing aspects.

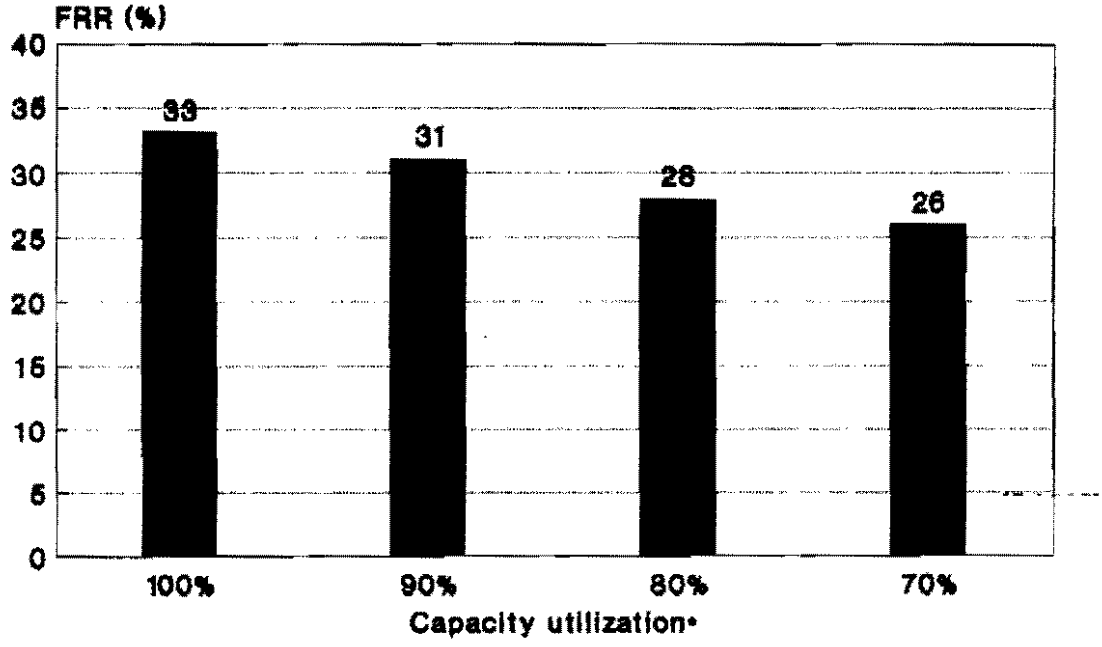
Both manuals will have a didactic focus and use a simple language; they will encompass both theoretical aspects that can be pertinent to any business as well as topics that are particularly related to a cassava flour enterprise.

Figure 8.1
Sensitivity of the FRR to the amount of the initial investment



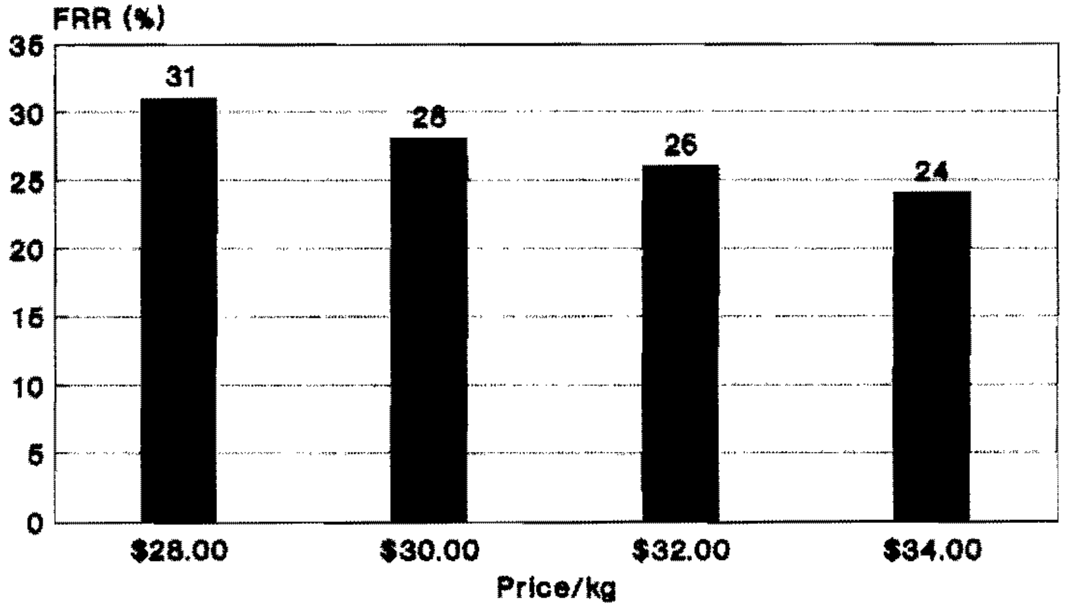
• Capacity: 180 tons/year; Utilization rate: 80%

Figure 8.2
Sensitivity of the FRR to the capacity utilization rate



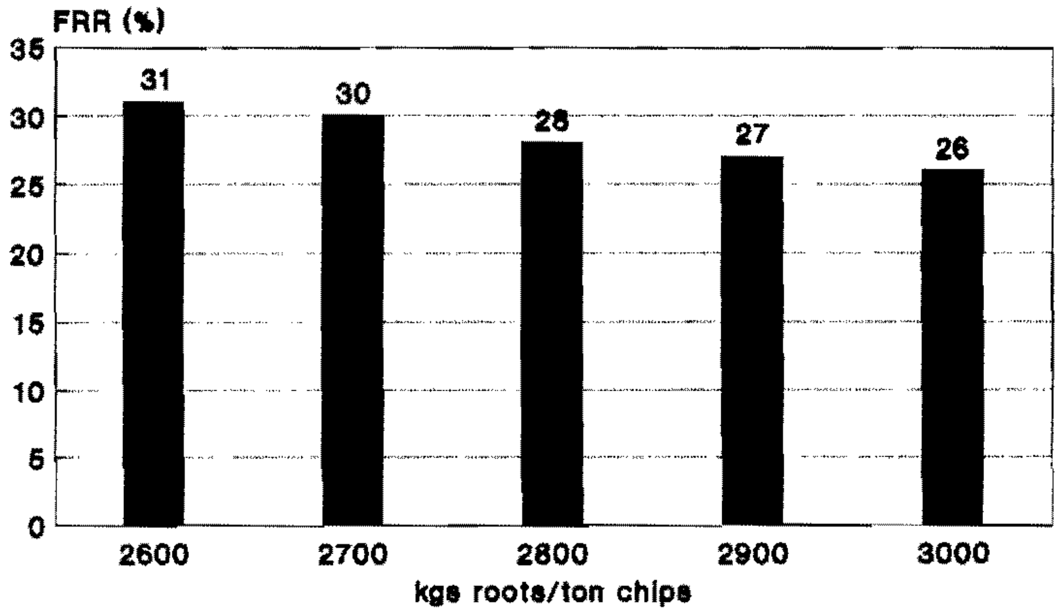
* Capacity: 180 tons/year

Figure 8.3
Sensitivity of FRR to price of cassava roots



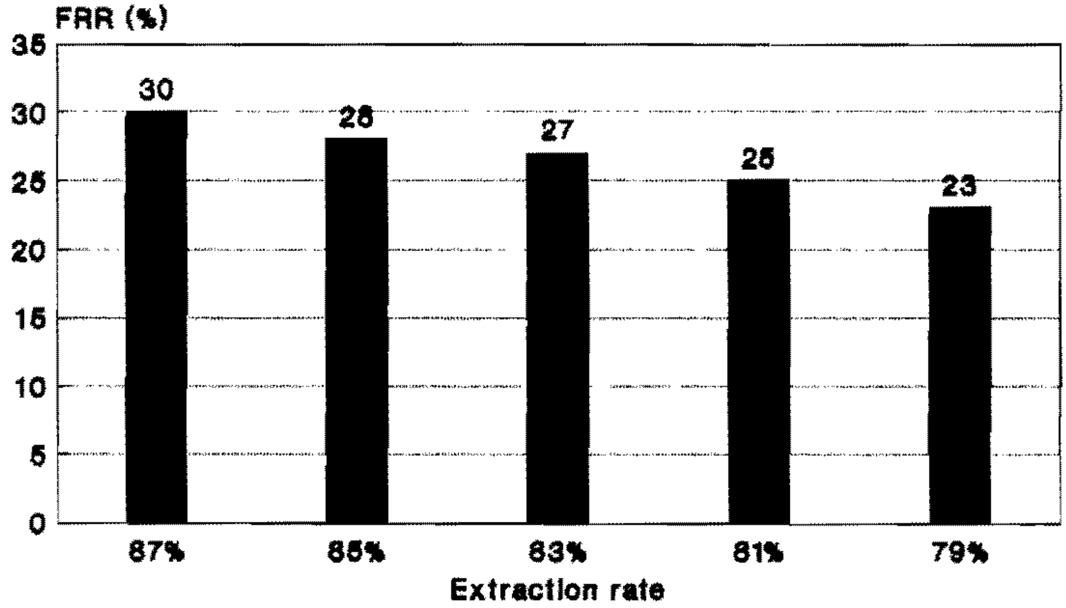
* Capacity: 180 tons/year; Utilization rate: 80%

Figure 8.4
Sensitivity of the FRR to the root-to-chip conversion factor



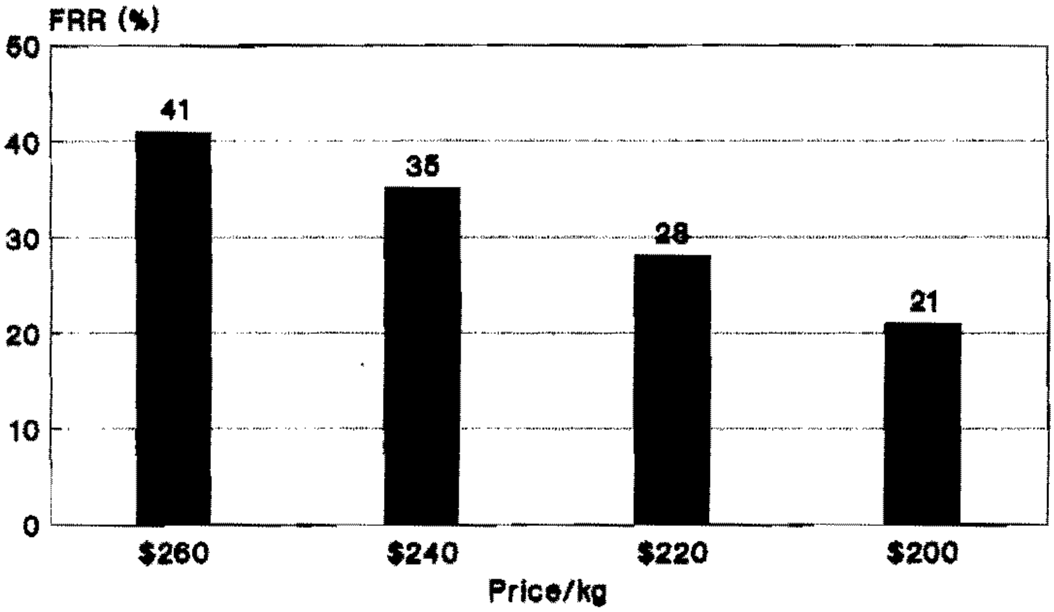
* Capacity: 180 ton/year; Utilization rate: 80%

Figure 8.5
Sensitivity of the FRR to the first-grade flour extraction rate



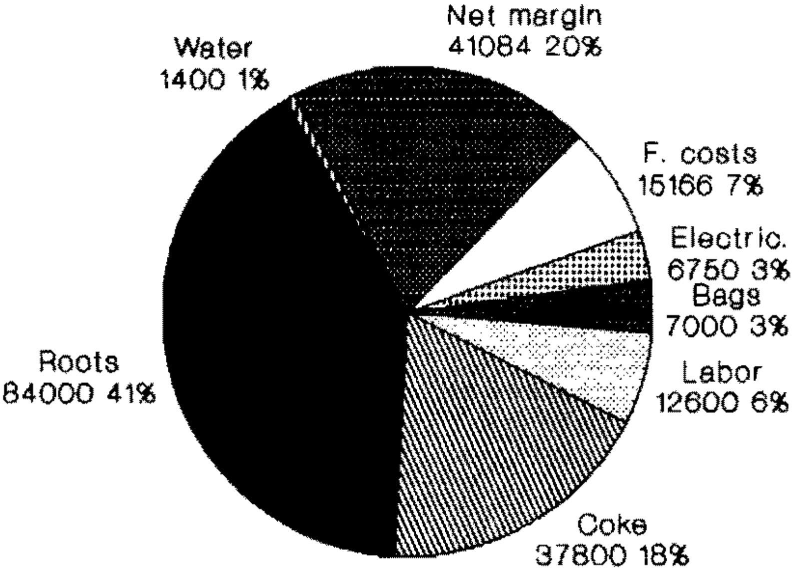
* Capacity: 160 tons/year, Utilization rate: 80%

Figure 8.6
Sensitivity of the FRR to the sales price of first-grade flour*



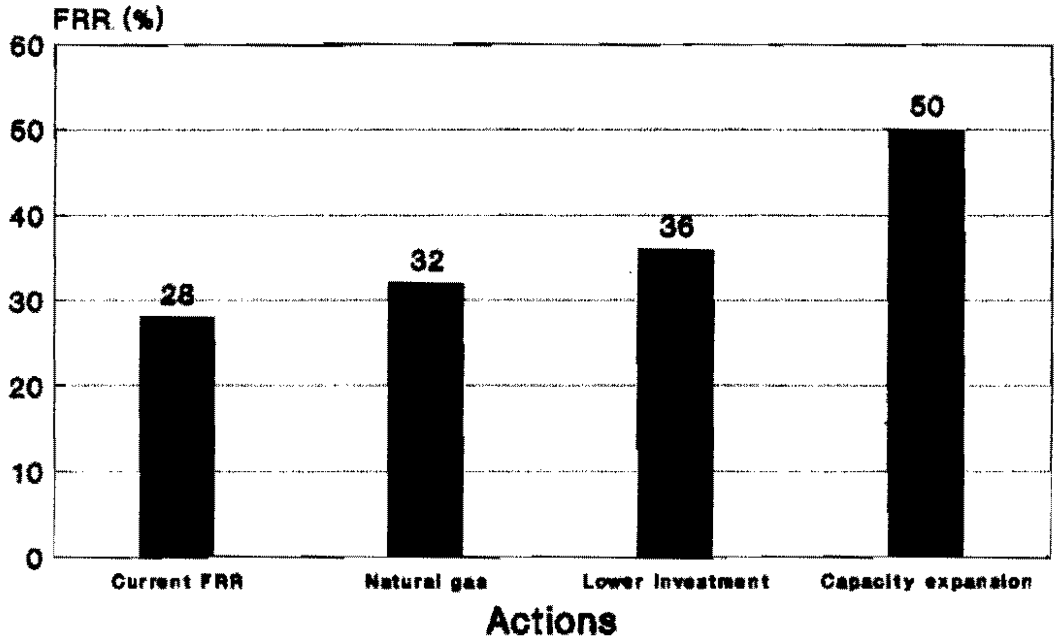
* Placed in Chinu; Capacity: 180 t/year
Utilization rate: 80%

Figure 8.7
Price structure of cassava flour
Weighted average price per ton: $201.000



+ Includes flour and bran
Capacity: 180 ton/year, Utiliz: 80%

Figure 8.8
FRR maximization strategy for cassava flour plants



ANNEX 8.1 MODEL OF FINANCIAL PROFITABILITY ANALYSIS
CASSAVA FLOUR PROJECT IN THE ATLANTIC COAST OF COLOMBIA
FINAL PRODUCTS: CASSAVA FLOUR AND BRAN DATE: DEC. 1992

A. ESTIMATED INVESTMENT & MAINTENANCE COST (COL$ DEC 1992)

CONSTRUCTION (1)		MAINTENANCE COEFFICIENT	COST OF MAINTENANCE
SOIL STUDY	133000		
SURVEYING	133000		
CONSTRUCTION	25000000	0.005	125000
TRANSPORT. OF EQUIPMENT	1000000		
EQUIPMENT INSTALLATION	500000		
SUPERVISION	800000		
ADMINIST. & CONTINGENCIES (15%)	3750000		
SUBTOTAL	31316000		
EQUIPMENT & SUPPLIES			
SCALE (500 KG)	180000	0.010	1800
ROOT SELECTION TABLE	300000	0.005	1500
WATER PUMP	180000	0.020	3600
WASHING MACHINE	1000000	0.020	20000
CHIPPING MACHINE	420000	0.100	42000
HOPPER	55000	0.050	2750
MOTOR FOR CHIPPING MACHINE	200000	0.020	4000
MOTOR STARTER	145000	0.020	2900
FAN	700000	0.010	7000
FAN MOTOR	430000	0.020	8600
MOTOR STARTER	140000	0.020	2800
COAL BURNERS (2) WITH DUCT	1500000	0.050	75000
DRYING CHAMBER	680000	0.050	34000
DRYING CHAMBER COVERS	120000		
METAL SHOVELS (6)	23000	0.200	4600
WOODEN RAMMERS (6)	100000	0.005	500
CARTS (2)	200000	0.005	1000
FUNNELS (2)	120000	0.005	600
TRANSFORMER 50 KVA (INCL. PROTECTION, PERMIT, & SUBSTATION)	3000000	0.010	30000
SISAL BAGS (40)	18000	1.000	18000
PREMILLING MACHINE	750000	0.050	37500
MOTOR FOR PREMILLING MACHINE	100000	0.050	5000
MOTOR STARTER	45000	0.050	2250
SMALL-SCALE MILLING SYSTEM	2800000	0.050	140000
BAG-CLOSING MACHINE	350000	0.050	17500
FURNITURE	350000	0.020	7000
SUPPLIES	200000		
CONTINGENCIES (5%)	695300		
SUBTOTAL	14801300		
TOTAL	46117300	TOTAL	587900
US$ DOLLARS 730	63174		

(1) IT IS ASSUMED THAT THE LAND IS DONATED BY THE FARMER COOPERATIVE

B. BASIC CAPACITY & COST INFORMATION (COL$ 1992)

ANNUAL PLANT CAPACITY (TONS) (ii)	180
ANNUAL PLANT PRODUCTION (TONS)	144
CAPACITY UTILIZATION RATE	80%

ITEM	UNIT	UNIT COST	# UNITS/TON OF WHOLE FLOUR
FRESH ROOTS IN PLANT	KG	30.00	2800 (iii)
LABOR	MAN-HOUR	180	70
POLYP. BAG	BAG	175	40
ELECTRICITY	KW H	45	150
COKE	KGS	60	550
WATER	M3	200	7.00

VARIABLE COSTS PER TON OF WHOLE FLOUR		COST WEIGHT
RAW MATERIAL (ROOTS)	84000	52.53%
COKE	33000	20.64%
LABOR (4 WORKERS)	12600	7.88%
ELECTRICITY	6750	4.22%
POLYPROP. BAG	7000	4.38%
WATER	1400	0.88%
TOTAL	144750	90.52%

FIXED COSTS PER TON OF WHOLE FLOUR		
MANAGER ($80000/MONTH) (iv)	2778	1.74%
FOREMAN ($50000/MONTH)	3472	2.17%
WATCHMAN ($46000/MONTH)	3833	2.40%
PLANT MAINTENANCE	4083	2.55%
OTHER EXPENSES ($200000)	1000	0.63%
TOTAL	15166	9.48%

TOTAL PRODUCTION COST/TON WHOLE FLOUR: 159916 100.00%

C. SALES PRICE AND MARGINS

PRICE/TON PLACED AT CHINU (v)	201000
NET MARGIN (%)	0.20
NET MARGIN/TON ($)	41084
GROSS MARGIN (%)	0.28
GROSS MARGIN/TON ($)	56250

	PRICE/TON	EXTRACTION RATE
FIRST GRADE FLOUR	$220.000	85.00%
BRAN	$100.000	14.00%
LOSS		1.00%

(ii) ASSUMES THAT PLANT OPERATES DURING TEN MONTHS
(iii) ASSUMES THAT SELECTED & PREPARED CASSAVA IS USED AND THAT REJECT IS PURCHASED AT MARKET PRICES BY CHIP PLANT.
(iv) THIS AMOUNT IS SHARED BY CHIP AND FLOUR PLANTS
(v) WEIGHTED AVERAGE OF FIRST GRADE AND BRAN SALES PRICES

D. CASH FLOW MATRIX

	1992	1993	1994	1995	1996	1997	1998	1999	2000
INFLATION RATE		0,250	0,250	0,250	0.250	0,250	0.250	0,250	0.250
INITIAL INVESTMENT	46117300								
WORKING CAPITAL (vi)		2302790	575698	719622	899527	1124409	1405511	1756889	2196112
INCOME:									
SALES		28944000	36180000	45225000	56531250	70664063	88330078	110412598	138015747
SALVAGE VALUE (vii)									109952211
WORKING CAPITAL									10980558
LESS:									
VARIABLE COST		20844000	26055000	32568750	40710938	50888672	63610840	79513550	99391937
FIXED COST		2183900	2729875	3412344	4265430	5331787	6664734	8330917	10413647
TOTAL PRODUCTION COST		23027900	28784875	35981094	44976367	56220459	70275574	87844467	109805584
NET CASH FLOW	-46117300	3613310	6819428	8524284	10655355	13319194	16648993	20811241	146946821

E. CALCULATION OF PROFITABILITY PARAMETERS

FINANCIAL RATE OF RETURN (FRR): 28%

MINIMUM ACCEPTABLE FRR OR
OPPORTUNITY COST OF CAPITAL (viii) 30%

NET PRESENT VALUE USING
A 30% DISCOUNT RATE -2557461

(vi) WORKING CAPITAL IS INCREASED ANNUALLY ACCORDING TO INFLATION RATE TO MAINTAIN PURCHASING POWER
(vii) ASSUMED TO BE 40% OF INITIAL INVESTMENT; INCLUDES LAND VALUATION
(viii) ACTUALLY, THE CURRENT OPPORTUNITY COST OF CAPITAL IS LOWER THAN THE INFLATION RATE, BUT THE 30% FLOOR USED IS MORE REALISTIC BECAUSE THE INVESTOR WILL WANT TO BEAT THE INFLATION RATE BY AT LEAST THREE % POINTS

The chapters envisioned for the management manual will include the following: Principles of administration, The cooperative enterprise, The cassava flour product system, The cassava flour production process, Administration of production, Total quality control, Simplified accounting, Financial aspects, Costs and profitability, Marketing, and Personnel administration. In addition, the following three annexes are contemplated: Timetable for the establishment of a cassava flour plant, Designs of three cassava-processing plant types, and Construction management.

The operational manual encompasses the following chapters: Final product, Raw material, Processing, Equipment, Processing logistics, Process requirements, Infrastructure, Quality control and Maintenance.

10. DESIGN OF CASSAVA-PROCESSING PLANT TYPES

This activity includes not only the redesign of the current cassava flour pilot plant but also the design of two other plant types: a cassava chip producing plant and a chip milling plant.

There are three factors, two of financial and one of entrepreneurial character, that explain the importance of this activity, as follows: (a) the financial model has demonstrated that the insufficient profitability can be improved by means of a viable 30 to 40% reduction in initial investment, (b) it is important to reduce the cost of processing plants to facilitate the replication process, and (c) it is judged convenient to centralize chip milling and packaging to enhance business profitability and product quality.

Consequently, this project component includes the following three aspects. Firstly, three types of plants will be designed for the Atlantic coast, as follows: (a) chip producing plant, (b) chip milling plant, and (c) composite plant. The latter is equivalent to the pilot plant in the sense that it embraces all of the operations. The designs must respond to functional and environmental conditions. Secondly, if pertinent, novel construction materials will be proposed for the Atlantic coast plants. Thirdly, detailed construction budgets will demonstrate that, in fact, the new designs respond to the need for investment reduction. Cost targets are the following (in Oct 1992 Col$): chip producing plant with an annual capacity of 350 tons ($17.000.000); chip milling plant with a capacity of 1750 tons per annum ($25.000.000); and composite plant with an annual capacity of 350 tons ($23.000.000).

This design exercise is being conducted by a team of four, eighth semester Architecture students (UNIVALLE) under the supervision of a Faculty of Architecture professor and with the advise of staff from the Cassava Utilization section. The design team underwent an induction which comprised presentations at CIAT providing background information and, afterwards, a five-day visit to the Chinu area where they visited the pilot plant, got acquainted with the cassava flour production process, and interviewed key individuals.

11. CRITERIA FOR SITE SELECTION OF CASSAVA FLOUR PLANTS

The list of criteria that was used for site selection of the cassava flour pilot plant in 1989 was revised to incorporate the experience obtained during the pilot project phase. The criteria have remained virtually the same but they have been disaggregated to facilitate the analysis for future site selections. The new list is presented below.

The new criteria include the following: educational level and entrepreneurial capacity of executing organization (IA2); proximity to fuel sources such as natural gas and coal (IC4); availability of a natural drying plant (IC5); availability of machine repair shops (IC6); quality of roots (IIB6); location with respect to road system (IIIB), and availability of means of transportation (IIIC). In the annual meeting of the project (3-4 March), this list will be discussed and a final version obtained. Then the site selection survey for Colombia will be conducted based on these criteria.

LIST OF CRITERIA

I. RESOURCE AVAILABILITY

A. Human resources of the executing organization

1. Existence of organization or firm
2. Educational level
3. Entrepreneurial capacity

B. Institutional support

1. Organization and training
2. Credit for production
3. Credit for infrastructure
4. Technical assistance

C. Basic infrastructure

1. Roads
2. Electricity
3. Water
4. Natural gas/mineral coal/coke
5. Availability of natural drying plant
6. Availability of machine repair shop

II. RAW MATERIAL SUPPLY

A. Social and economic importance of cassava
B. Potential for increasing production

1. Availability of land among members
2. Potential for increasing production
3. Competition with fresh market /starch
4. Price level
5. Potential for buying cassava from other regions
6. Root quality (healthy, dry matter content)

III. MARKETING

A. Proximity to final markets
B. Location with respect to the road system
C. Availability of means of transportation

12. FLOUR PROPERTIES RELATED TO END-PRODUCT QUALITY

The necessity of conducting research on the relationship between the physico-chemical and functional properties of cassava flour and the final quality of food products made with that flour led to this subject being included as a research component in a separate project. This new project includes UNIVALLE, CIRAD, NRI, ORSTOM and UNESP (State University of Sao Paulo, Brazil) and has component activities including new product development of derivatives of cassava flour and starch, market studies and in the area of raw material quality. The project is financed by the EEC and starts in January 1993.

The organization of the research component relating raw material, flour and end-product quality is described below. The CIAT core collection of cassava germplasm (650 out of 5500 clones in the total collection) was screened for cyanide and dry matter content and starch amylose percentage. On the basis of these results, ten groups (clusters) of clones were identified, and three clones per cluster selected for further research. These 30 clones will be used for evaluation of their root parenchyma physico-chemical properties and especially starch functionality. Three of these clones, from distinct clusters, were selected for in-depth evaluation of the effects of different process options on flour quality: flour will be produced under different drying temperatures (40, 60, 80°C) and under different milling and classification systems. In this way, samples reflecting interactions between raw material and the process will be obtained and used to prepare three end products: processed meats, biscuits (cookies) and noodles or simple extruded products. This will be conducted at UNIVALLE, CIAT and, in the UK, at NRI and Nottingham University, where a professor from UNIVALLE (Alejandro Fernandez) will carry out this doctoral research.

13. INTERNATIONAL INTERACTION WITH CASSAVA FLOUR PROJECTS

Ecuador

The second-order organization of cassava-processing cooperatives, UATAPPY, based in Manabi province, has continued to produce small quantities of high-quality flour for sale to small bakeries and a pasta manufacturer. A national market study has been conducted to determine the relation between flour and starch quality and the different end uses. From this study, a better definition of the product categories which should be targeted for the high-quality flour is expected, as well as the identification of specific additional clients for the flour. The process used differs from that employed in Colombia, consisting of the natural drying of chips made from manually peeled roots. The microbial quality of this flour appears variable, and not critical for the small local clients currently purchasing this product. Market expansion may require quality improvement, however.

Peru

A cassava flour plant was constructed near Pucallpa by Dra. Sonia Salas of the Instituto Peruano de la Amazonia. The equipment was imported from Colombia and is identical to that of the Chinu pilot plant. The plant is operated by a small farmer group. Incomplete reports of the commercial operation of this plant are very positive: the plant is operating at high rates of capacity utilization, and the resulting flour is sold to industrial markets (glues, plywood) where it replaces expensive imported wheat flour. Locally produced cassava flour can easily compete with expensive wheat flour in locations such as Pucallpa, where transport costs make goods imported into the region expensive. The industrial markets do not require the exacting standards of hygiene and cyanide contents which have until recently limited market development in Colombia. A more complete report of this project will be sought in the coming months and Dra. Salas will be invited to the international meeting on cassava flour when this is held.

Brazil

The Brazilian experience with cassava flour has focused on large-scale industrial plants located in urban centers where cassava is least able to compete with wheat. There may be considerable potential for the development of a small-scale, rurally based, cassava flour industry in the Northeast and Amazonian regions of the country. Here, cassava can be cheaply produced, and wheat flour is imported from the south of the country, making it relatively more expensive. The presence of an Integrated Cassava Project in Ceara state, and the successful operation of over 100 natural drying plants during the last two years, provides a useful base on which such an industry could be built. There is interest among policy makers in Ceara in cassava flour production by farmer groups, and a visit by one policy maker to Chinu is expected in March 1993.

One drawback is that the cassava varieties grown in these regions of Brazil are high in cyanide content, and thus could not be processed safely using the chipping and drying processes developed so far. The elimination of a greater percentage of the total cyanide would be needed, which will require modifications, perhaps substantial, of the existing chipping and drying systems. The NRI has, from January 1993, placed a Chemical Engineer (Deborah Jones) in CIAT to conduct the process research necessary to produce a high-quality flour from high-cyanide cassava varieties, with the aim of taking this to a pilot stage in Brazil in 1994.

Bolivia

Natural drying of cassava for the animal feed market has been developed in the Chapare region of Bolivia as one component of the agroindustrial program associated with the Alternative Development Coca Substitution Project. However, difficulties have been found in offering an attractive price to farmers for the fresh cassava while at the same time providing a cost-competitive alternative to local maize for animal feed ration formulations. Additionally, the project is moving to artificial drying systems due to the prolonged drying times caused by the high and evenly distributed rainfall pattern of the region. A refocusing of their efforts towards producing a high-quality flour for human consumption was recommended during the recent visit of C. Wheatley to this project. Wheat grain is imported at almost twice the world market prices into Bolivia, due to the high transport costs from the USA: the competitive position of cassava here is therefore strong. Contact will be maintained with this project and training provided where required if the initial trials suggest there is commercial potential for cassava flour.

Indonesia

The government-sponsored, small-scale cassava flour plants at the village level have been unsuccessful due to the lack of a sound methodology (such as the one used by CIAT in Integrated Cassava Projects) for developing a rural-based agroindustry. In addition, the large competitor, MARIZA, has its own flour plants and will not buy from them.

A starch-processing by-product in Lampung, "onggoh", is being milled to produce a low quality cassava flour which is used in the formulations of low-cost noodles, tempeh and ketchup. It is suspected that this "flour" is being mixed with wheat flour.

<u>Africa</u>

The NRI, interested in the potential of cassava flour in Africa, will conduct studies of the market potential in selected African countries, starting 1993. The process-development work being carried out at CIAT will be relevant to the implementation of projects in those areas of Africa where high-cyanide cassava varieties are common.

This overview of activities related to cassava flour outside Colombia demonstrates the integration of this project with the Integrated Cassava Production, Processing and Marketing Projects in other Latin American countries and, through the research input of the NRI, with Africa.

14. CONCLUSIONS AND RECOMMENDATIONS FOR 1993-4

The annual meeting of the project, to beheld at CIAT from 3-4 March 1993, will provide the opportunity for detailed planning of project activities for 1993, and will set the agenda for the last year of the project. In general terms, the project will place more emphasis on preparations for expansion and less on the pilot plant at Chinu.

Pilot plant activities will be reduced during 1993, especially once the market development work starts to pay off. If the plant capacity utilization approaches 80% by mid 1993, the small additional investment to double capacity will be made. Efforts to obtain the connection to a supply of natural gas will continue.

A concerted effort will be made to complete all the activities related to preparations for the expansion of the cassava flour industry within Colombia by the end of 1993. These consist of:

- Process manual
- Cassava Flour Enterprise Management manual
- Videos (possibly two videos, one didactic, one promotional)
- Definition of criteria for site selection
- Site selection survey
- Meetings with national, regional and local institutions, private sector, NGO's, etc. to plan for expansion in 1994

CIAT's in-house unit for the development of training materials will assist in the preparation and production of both manuals and the video.

The International Meeting on Cassava Flour will be held in January 1994 in Colombia, together with the first annual meeting of the new EEC-funded project on the development of novel products from cassava, which includes CIRAD, NRI, UNIVALLE and the Universidad Estadual do Sao Paulo, Brazil. This project also includes research on the effects of variety and process on cassava flour functional properties, and how these properties relate to suitability for particular end uses. The joining of these two events represents an opportunity to invite a wider range of participants, and to present a larger picture of cassava research. The meeting will also include presentations on the links between research and development, through Integrated Cassava Projects.

As a result of their input into the project to date, the NRI has become interested in the potential of cassava flour for other regions of the world, especially in Africa. A complementary project, in which an NRI scientist will be stationed at CIAT from January 1993, will carry out further process research to improve efficiency and product quality. Special emphasis will be placed on development of a process suitable for use with the high cyanide varieties grown in many African countries and in Brazil.

The slower than expected development of this project during the first year of execution, due to the time required to solve the quality problems encountered at the end of the second phase of the project, will mean that it is unlikely that all of the project objectives will be accomplished by the end of the three-year period. During 1993 this will be evaluated, and a request for a 6- or 12-month extension made so that all objectives can be achieved.

Interest in the cassava flour project remains high in Colombia and elsewhere. In Colombia, requests for information and assistance from the public, NGO's, farmer cooperatives and private sectors are common. The site selection survey will be crucial in determining where the project should place the training resources in Colombia for maximum impact. The complementary research project now being initiated by the NRI is a direct result of the problems encountered in the pilot phase, and will greatly assist the propagation of the results and impact of the project to other cassava-producing regions.