

INTEGRATED CASSAVA RESEARCH AND DEVELOPMENT PROJECTS IN COLOMBIA, ECUADOR, AND BRAZIL: AN OVERVIEW OF CIAT'S EXPERIENCEError! Reference source not found.

B. Ospina, S. Poats, and G. Henry*

Abstract

The Cassava Program at CIAT has developed an integrated cassava research and development project (ICRDP) approach and methodology. The origin, justification, methodology, results, and lessons learned are presented, comparing experiences in Colombia, Ecuador, and Brazil. The ICRDPs have formed an effective vehicle for the Program to interact with various national research, rural extension, and development institutions. Existing technologies for the production, processing, and marketing of cassava have been validated and adapted to specific regional conditions, using the ICRDP framework. New technologies were generated through the synergy promoted by the ICRDP. Results have demonstrated to research and development (R&D) institutions, donors, governments, and policy-makers that cassava can play an important role in achieving development goals by promoting, especially among landless producers, small-scale, rural agro-industries that are based on cassava and require low opportunity costs. Through this integrated approach, traditional cassava markets have diversified, overall demand has increased, price variability has diminished while yields have increased, and, as a result, incentives to adopt improved technologies have been created. Additionally, poor farmers' income and employment opportunities have improved.

Introduction

The objectives of the Cassava Program at CIAT (Centro Internacional de Agricultura Tropical) during its first 10 years (1973-1982) emphasized germ plasm development and agronomic practices. Research results demonstrated clearly that such new technology could significantly increase cassava production. However, farmers showed little interest in adopting new production technology to raise their efficiency or productivity. One reason is a reduced market: with an increasing concentration of Latin America's population in urban centres, preferences shifted away from cassava as a basic dietary staple to more easily transportable, storable, and exchangeable foodstuffs. Any expansion in the use of cassava in Latin America was therefore dependent on the development of new products that would use or transform the roots from their fresh state to a storable or higher value product, and/or the development of new markets for those products (CIAT 1987).

In 1979, the Program took an innovative step by adding the Utilization Section. The Program

* CIAT, Cali, Colombia.

was not the first to look at the industrial potential of cassava. Many earlier projects, especially in South-East Asia, had involved the agro-industrial transformation of cassava into meal, flour, starch, alcohol, or other derived products. In Latin America, relatively few attempts were successful. Some tried to improve production but ran into marketing problems; others invested in processing plants and encountered problems with price or raw material availability. Analysis of these projects highlighted the need for an integrated approach to cassava production, processing, and market development. Cassava development could not be appropriately addressed unless all three areas were simultaneously put into action in an integrated fashion. Research and development (R&D) needed to begin at the market-place, identifying potential markets for cassava and its products. After this first step was completed, product development, processing, production, and commercialization would begin to develop the market effectively.

Initial activities of the Utilization Section concentrated on developing cassava-root conservation technology for fresh consumption and on drying technology for the animal feed industry. Research on sun-dried cassava chips was aimed at solving the problem of the poor quality of chips and pellets produced in Thailand and Indonesia and exported to the European Union (EU) for incorporation into animal feed concentrates. During the 1970s, world cassava trade expanded from about 1 million t in 1970 to almost 5 million t in 1980 (Calpe 1991). The increase was primarily a result of expanding and adopting modern technology for processing, handling, and storing, facilitating the production of cassava feedstuffs that met consumers' needs at competitive prices.

Through this work CIAT gained considerable experience in cassava drying, especially natural drying techniques. It was not until 1980, however, that this know-how could be applied in Latin America. A series of reviews had cast doubts on the Program's ability to reach farmers with the technologies generated and to attain increased productivity. After a series of internal planning exercises focusing on specific social objectives, a new R&D framework was formulated that included the need to be directly involved in cassava-based, rural development programmes as a *sine qua non* condition for developing the crop (Cock and Lynam 1990).

At the time the Cassava Program was searching for partners and sites to test this new approach, the Colombian Ministry of Agriculture, through its Integrated Rural Development Programme (DRI, its Spanish acronym) sought CIAT's collaboration. DRI had to solve problems related to increasing production and decreasing demand and prices of cassava in an extensive area of Colombia known as the Atlantic Coast (or North Coast). The experiences gained in the resulting collaborative exercise, as well as in subsequent similar projects in other countries during the last 12 years, allowed CIAT to develop the ICRDP methodology discussed here.

The first section of the paper analyses the justification, methodology, and results obtained with this integrated approach, using examples from projects in Colombia, Ecuador, and Brazil. The second section compares the cases, presenting lessons learned and the implications for CIAT and

counterpart national institutions when implementing ICRDPs. The paper concludes with a proposition of future activities needed to consolidate the ICRDP methodology.

Importance of cassava to Latin America

Latin America grows 21% of the world's cassava. Brazil, Paraguay, and Colombia account for 92% of the cassava produced in the region (FAO 1990). The crop is usually cultivated in the more marginal, rainfed, areas by small farmers who have limited access to land, inputs, and improved technology. Where cassava is grown extensively, climate and soil constraints are often such that farmers have no alternative crops.

Usually, only one or two traditional markets are available to cassava growers, either as fresh roots or as traditional processed products like *farinha da mandioca* (toasted cassava flour) in Brazil. Although demand for processed products may remain stable or even increase as a result of urbanization, the overall demand for cassava tends to decline, creating price fluctuations and increasing commercialization risks. Lacking additional market opportunities for fresh cassava, farmers have no incentive to adopt improved production technologies.

Fortunately, cassava has several comparative advantages, compared with other root crops, with respect to price, yield, nutritional value, quality, and availability. The dry matter (DM) content (35%-40%) of cassava roots is higher than in other root crops, giving optimal conversion rates of 2.5:1 or better. More than 85% of root DM consists of highly digestible starch. Cassava starch has agglutinant properties that make possible the substitution of expensive artificial agglutinants used in feed pellets for shrimp or fish and other animals (Cock and Lynam 1990).

The disadvantages of using fresh cassava roots directly as animal feed are bulkiness, rapid perishability, low protein content, and the presence of cyanogens. Simple processing techniques, such as chipping and natural drying, can overcome bulkiness and rapid perishability. Sun-drying also eliminates most of the cyanogens from root tissues. Cassava's low protein content can be addressed by increasing its price competitiveness with respect to other carbohydrate sources and by differentiating the uses of its high quality carbohydrate structure and composition.

Linking small-scale cassava farmers to potential growth markets through new processing technology and product development is an important option that can help meet several social policy objectives such as income generation among marginal farmers and landless poor (Lynam 1978). This does not, however, occur spontaneously. Penetration of alternative markets by cassava will generally require an integrated project framework that incorporates competitive farm-gate prices, investment in processing capacity and management, and coordinated expansion in production, processing, and use.

Over the years, the CIAT Cassava Program has gained experience in developing, within the

framework of multi-institutional integration, a project-approach methodology aimed at coordinating changes on the farm with changes in the marketing system.

Integrated cassava research and development projects (ICRDPs)

- (1) ***Definition.*** The ICRDP is an institutional, technological, social, and organizational intervention designed to link small-scale cassava farmers to new or improved growth markets, thereby stimulating demand for production technology with potential to improve small farmers' welfare.
- (2) ***Methodology.*** There are four stages that should be implemented sequentially to achieve success (Figure 1):
 - (a) a. ***Macroplanning.*** The overall economic situation of the country or region initially targeted for an ICRDP is analysed. Among the parameters considered are the potential demand for cassava and its derived products, the ability of the crop to compete with other products and markets, and the potential for cassava production in different regions. Information gathered in this phase ensures that the correct region and the most promising markets are selected.
 - (b) ***Microplanning.*** Information is generated to define market characteristics, production practices and constraints, availability of institutional support, existing farmers' organizations, cassava processing technologies, and the development priorities of the regional government. The end result of this phase is the selection of the targeted area for implementing the pilot project.
 - (c) ***Pilot phase.*** Available technologies are adapted to local conditions. The project's institutional and organizational framework serves as the point of intersection for cassava production, processing, and product development research. Farmer organizations are included from this stage onwards, becoming permanent actors and decision-makers within the project. At the end of the pilot stage, sufficient reliable information is available to test the assumptions made during the planning stages; and a full-scale commercial phase is either justified or rejected.
 - (d) ***Commercial expansion phase.*** Replication or expansion of the cassava processing technology and the new or improved products can now be implemented. Commercial costs of the new technology and the resources required to promote its adoption on a wider scale are estimated, including credit lines for crop production, establishment of processing capacity and operational capital, and institutional requirements for training and technical assistance for farmers. During the initial

activities of the commercial phase, a monitoring system should be established, building on the information-gathering mechanisms initiated during the pilot stage. Finally, the project framework should not be a permanent mechanism per se, and hence, the end result of this stage should be a self-supporting, economically sustainable, cassava-based, agro-industry.

- (3) *Anticipated outcomes:* (a) The involvement of national research, extension, and development agencies in a concerted effort to improve small-farmer welfare through activities focused on cassava; (b) the development of cassava processing and product markets as income-generating activities; and (c) the creation of demand for improved cassava production technology.

Experiences and Results

CIAT has joined efforts with national counterpart agencies to initiate ICRDPs in nine Latin American countries (Table 1). These projects, which have included different products, markets, and processing technologies, have attained different stages of development. The projects were not successful in two countries: in Mexico, a lack of strong farmer commitment and involvement from the project's outset, and a lack of coordination among production, processing, and commercialization activities were the main reasons behind the failure. In Peru, the long distances between the targeted area and the markets, and strong competition with a more profitable agro-chemical enterprise—cocaine processing—made the cassava-based project economically unviable.

To review the lessons and implications of CIAT's experiences with the ICRDPs, the discussion focuses on three countries: Colombia, Ecuador, and Brazil. The main aspects and results of the ICRDP approach are presented for each case. This is followed by a comparative analysis across cases. In all three projects, the Cassava Program received special funding so that Program staff could be directly involved in their implementation.

The Colombian ICRDP

The Atlantic Coast of Colombia is a major cassava production zone in the country. In 1990, it accounted for 52% of the total cassava production, representing 13% of the total land under cultivation and 20% of the total value of agricultural production of the region. According to Janssen (1986), 40% of the total small-farmer income from agricultural production in this area is derived from cassava cultivation. On-farm consumption and fresh cassava sold to urban markets have traditionally been the two main marketing outlets for the crop, although some typical, processed, cassava-based products for human consumption account for a small share of the cassava market. Industrial uses have been virtually non-existent in the region.

In the late 1970s, the DRI programme was already promoting the cassava crop as a development option for the Atlantic Coast. This traditional production-oriented approach, providing credit and technical assistance, was relatively successful; and cassava production increased rapidly, primarily as a result of the increased credit availability. This period of rapid growth saturated the local cassava markets, and prices dropped to such levels that farmers were unable to find buyers for the crop and recover their costs. To resolve this problem, the DRI set up a post-harvest committee, which contacted CIAT for help in finding alternative markets. At the same time, the CIAT Cassava Program was analysing the possibility of using dried cassava to supply a large and expanding animal feed market in the country. These two efforts were therefore integrated.

The most promising option was to establish cassava-based producer organizations to operate drying plants and sell the dried cassava to animal feed factories. The approach was attractive because (1) the resource-poor farmers in the area could not each afford to establish processing infrastructure; (2) the drying process could act as an instrument to create an effective floor price for the roots so that if prices on the fresh market were high, farmers could sell into these markets and make enough profit to pay off loans on the drying plants; (3) roots unsuitable for the fresh market could be sold to the drying plants, allowing them to operate at greater capacity. Conversely, if the prices for cassava roots dropped, farmers could sell the roots to the drying plants and still make some profit. To test the validity of this model through a pilot project, the first farmer-operated, natural-drying plant was established in the municipality of Betulia, Department of Sucre, in 1981.

Colombian farmers, despite their total lack of experience and tradition in cassava processing, quickly adapted to and assimilated the technology. Initial promising results led to the decision to expand the project, which went into two additional phases: semi-commercial (1981-1983), and replication or commercial (1984 to present).

In 1991, about 150 drying plants were operating on the Atlantic Coast (Figure 2), 105 of which were owned and operated by small-scale producer associations and/or cooperatives. The remaining 45 plants were exploited by private entrepreneurs, who, during 1987-1991, greatly increased their participation in the industry. During 1991, these 150 plants produced about 25,000 t of dried chips, corresponding to 62,500 t of roots and thus to a demand that represented 6.6% of the cassava produced in the region that year and 5.7% of the total cassava area planted (Henry 1992).

Project activities led to a rapid penetration of the Colombian animal feed market with dried chips. From the project's beginning, cassava producers and processors received important institutional support, especially credit lines, technical assistance, and training. Expansion in processing outputs was supported by efforts in improving production technology. The impact of the Colombian ICRDP can be best assessed by considering the additional monetary value of the annual production of dried cassava, the savings in foreign exchange from decreased imports of cereals for animal feed, the additional employment opportunities generated in rural areas through the expansion

of cassava production and processing activities, and the enhanced linkages with goods sectors and services.

Gottret and Henry (1993) calculated that from 1984-1991, the cassava sector in northern Colombia benefited by almost US\$22 million as a result of the integration of research on improved crop management, processing, marketing, and consumer preferences, within the framework of cassava-based development projects involving strong farmer participation. Gottret and Henry (1993) have shown that adoption of production technology components in areas with ICRDP activities is significantly higher than in those not influenced by the project. In 1991, for example, cv. Venezolana was adopted by 93% of cassava producers in areas with drying activities and strong institutional presence. In contrast, those areas not directly influenced by the ICRDP activities had a rate of only 48% (Gottret and Henry 1993).

The most important lesson from the Colombian project was the demonstration that farmers can and did become important partners for R&D institutions, and made valuable contributions to the identification, adaptation, and evaluation of alternative solutions. Moreover, by creating new markets and better prices for cassava, the ICRDP model encourages farmers' to adopt improved production technologies. The project demonstrated that small-farmer associations are indeed a viable strategy for technology diffusion.

The Ecuadorian ICRDP

This project represented a challenge for CIAT to replicate the Colombian experience but at lower institutional costs. Initiated in 1985, the project was conceived as both a social and technical experiment, requiring specific institutional and organizational arrangements and allowing new roles to be played by farmer organizations and national research and extension staff in the field (CIAT 1992a).

The project was implemented in a traditional cassava-processing area in the seasonally dry, coastal Province of Manabí. The region accounts for 20%-30% of total national cassava production (INEC 1990). As a small-farmer household industry, cassava starch extraction has existed in the area for more than 100 years, with little change in processing technology. Although early studies identified the potential of drying technologies as a viable alternative for promoting alternative markets, conditions for launching the ICRDP in Manabí became economically favourable only in 1985.

The region was characterized as 'optimal' for the project because of its climatic conditions (favourable for cassava processing and sun-drying), presence of excess production, and predominance of small farms. Farmers were organized into small producer-processor associations called APPYs (Asociaciones de Productores y Procesadores de Yuca), and, from the start, these

associations were joined into one, second-order, farmer organization, UAPPY (Unión de Asociaciones de Productores y Procesadores de Yuca). The UAPPY broadened its legal status in 1992 to become a UATAPPY, thus permitting the legal participation of small farmers who lacked land titles and landless rural workers such as women who would readily benefit from processing-generated jobs. The Union now includes 17 associations and performs a variety of functions, including technical assistance, credit, marketing, accounting, training, product development, and monitoring. Farmers meet annually as stockholders to evaluate progress and make recommendations to leaders and other project collaborators.

A participatory approach to technology generation, adaptation, and dissemination was adopted from the beginning. Colombian farmer-processors were brought to Ecuador to teach Manabí farmers the new technology. These farmer-to-farmer contacts were later reinforced with visits to Colombia by Manabí farmers, who could therefore see in action the different features of the Colombian processing plants. From the start, farmer-processors played an important role as promoters, technology transfer agents, teachers, and leaders of the project. CIAT and local agency staff supported their efforts. The basic chipping technology adopted was the same as that in Colombia. Drying trays—a technology introduced by CIAT—were quickly adopted as an intermediate step towards building a cement drying floor, allowing poorer farmers to start quickly with less initial investment.

Project leaders and CIAT researchers assumed that the end market for dried cassava in Ecuador would be the same as in Colombia: the balanced feed industry for poultry and livestock. Early in the project, cassava was found to be an ideal substitute for imported chemical agglutinants used in feed pellets by the local shrimp industry. The potential demand for cassava flour would be >8,000 t/y.

Transforming dried chips to flour for shrimp feed required new steps in the processing technology and a different management system. Peeling the roots soon became an important source of additional income for member and non-member families—mostly poor women, children, and elderly people—who usually had no additional sources of income during the dry season. The Union developed a processing plant with portable hammer mills to grind the chips into flour. This process catalysed the idea of developing a Union-owned and administered 'demonstration centre', where new processing technologies could be designed, adapted, and tested; and training and demonstration events for farmers could be held. Training and research activities were shifted to specific farmer associations, facilitating more participation.

In 1989, strong competition from Asian producers and problems with a shortage of larvae ponds drastically reduced shrimp production, eliminating 95% of the demand for cassava flour. The Union reacted quickly, launching a campaign to identify other markets. The demonstration centre allowed farmers to adapt existing products for new markets rapidly. For example, the whole-root flour was refined by passing it through a mechanical vibrating sifter, yielding flour with the same

granular size as wheat flour. This refined cassava flour is used as a substitute for wheat in the fillers for resins used in plywood, thus capturing an important share of this market. Bran, the by-product from sifting, was sold to the livestock feed industries as a source of fibre.

A valuable lesson was thus learned about the importance of diversifying products and markets. Today, seven different primary products (Table 2) and four by-products are produced, reaching more than 40 different buyers.

Given initial strong market demand and reasonable funding for construction and operational credit, processing associations expanded rapidly from 2 to 16 between 1985 and 1988. Later, the formation of new associations became difficult, given shortages of donor funds for construction and a rapidly increasing inflation rate. In 1992, 17 associations, with 320 members, were operating (Figure 3).

Two characteristics are unique to the Ecuadorian project: functions normally assigned to supporting state institutions or non-governmental organizations (NGOs) were managed by the UATAPPY, including the handling of development funds. This has strengthened and promoted sustainability in a type of project where state institutions and NGOs terminate their support when funds run out. The second characteristic was the direct and active participation of women in all project activities, as producers, processors, and managers. Today, three kinds of processing associations operate: all men, mixed, and women's groups. Women comprise nearly 33% of total membership.

The Ecuadorian experience served to validate the following principles:

- (1) Transfer of technical and social technology is more rapid, efficient, and effective when end-users are directly involved and responsible.
- (2) Farmer organizations are effective intermediary agents between farmers and institutions and can be used as an efficient channel for project services, provision of credit, and information dissemination.
- (3) Farmer organizations should be part of the institutional strategy of an ICRDP. Collaboration among farmer organizations and supporting institutions should be encouraged without creating relationships of dependence.

A similar experience was initiated in North-East Brazil with funding from the WK Kellogg Foundation. The overall objective was to support the introduction of improved cassava production and processing technologies and appropriate organizational schemes for institutions and farmer groups throughout the main cassava-growing areas of the state of Ceará, North-East Brazil.

In this region, about 110,000 ha of cassava are harvested yearly with a total output of almost 1.2 million t of roots. For centuries, the main marketing outlet has been the communal-type, small-scale, processing units (*casas de farinha*) that produce a flour or meal called *farinha de mandioca*, which is a staple food product. In Ceará alone, more than 14,000 *casas de farinha* operate, with an annual output of almost 200,000 t of cassava flour that represents about 65% of total cassava production in the state.

The highly variable rainfall pattern in North-East Brazil results in wide yield fluctuations. Consequently, supply and prices of *farinha* show great variability, thus creating highly unstable incomes for small farmers who depend largely on selling the flour. Flour quality is affected by the prevalent rudimentary processing, resulting in even lower prices.

The strategy followed was to consider the animal feed market as a large, relatively permanent, alternative market for an excess cassava production with low prices. A pilot project was established to implement cassava-based, rural development programmes with a potential for benefiting targeted groups. A long-term aim was to generate a national capacity to carry out similar programmes in other regions of Brazil.

Project implementation was influenced by prior activities already carried out in small-scale cassava farming and processing by other state agencies. From the beginning, the Brazilian ICRDP incorporated management, policy-makers, and local agency staff who had some experience with other country ICRDPs and were key elements for the project's organizational and operational strategies.

A cassava committee for the Ceará state (CCC) was recognized as the coordinating body for the project and all activities related to promoting and developing the crop in the state. The establishment of regional cassava committees (RCC) was vital to ensure the decentralization of project activities and integration among local research and extension collaborating agencies.

By the end of the project, 158 farmer groups were organized around dried-cassava processing units (Figure 4). This expansion was a consequence of the strong support received from national and state governments in terms of financial aid for building processing plants. The role of the CCCs and RCCs was crucial in approaching different governmental agencies and programmes on behalf of the farmer organizations to obtain grants. They also had access to project funds for assisting and supporting farmer activities. Despite the adverse economic situation faced by the country during the project, considerable sources of financial support were identified and channelled

towards targeted groups. The total local agency financial support was almost US\$1 million, excluding local staff salaries.

Similar to the ICRDPs in the other countries, the Ceará project followed an implementation model, based on the transfer and adaptation of available processing technologies and taking advantage of a strong extension service. Project activities also included production technology research. Initial results (demonstration plots) indicated that the adoption of improved technology components could help increase productivity in the region by as much as 50%, compared with yields obtained in farmers' plots. However, the project has still to assess the extent to which small-scale, resource-poor farmers will invest in inputs, such as organic fertilizers or weed control activities, as happened in Colombia.

The relationship between *farinha* and dried chips is the main factor determining the financial success of dried-cassava-based plants. When market prices for *farinha* are low, the cassava-drying plants function efficiently as an alternative market. Conversely, when the *farinha* markets offer attractive prices, it becomes difficult to find adequate supplies of raw material for the dried-cassava plants.

After only 3 years' since implementation, conducting a complete *ex post* evaluation of the project's impact is difficult. But a monitoring and evaluation (M&E) model was used during the pilot project, and results suggest a rapid adoption of processing technologies for dried cassava has been taking place in new regions and rural communities. This was reflected in the increased number of drying plants, the continuously improving market for dried cassava, and the strengthening of the organizational structure implemented for both institutions and farmer groups.

Preliminary data analysis of two surveys indicate that the pattern of on-farm consumption and use of cassava is changing. Farmers are now selling part of their production to the drying plants. Farmers in the project are now starting to adopt the new processing technology, and the new market has stimulated them to become more market-oriented. Qualitative information available indicates that the pilot project served as a vehicle to increase community development in general (organization, knowledge, employment opportunities, incomes) and to strengthen local institutional support (technical assistance, working capital). The constraints of small farm size and slow adoption of improved production technology affected cassava productivity adversely.

The early success in the Ceará ICRDP indicates that a potential exists for consolidating farmers' organizations through stronger institutional commitment to support their efforts. The initial task of these groups was to improve their marketing alternatives. Those plants based on cassava that could operate during the project contributed to the creation of additional employment opportunities, opened up alternative markets, stimulated local industry, raised farmers' incomes, and encouraged overall community development.

Benefits and beneficiaries of the ICRDPs

Benefits generated by the ICRDPs are captured principally by members of the cassava-based farmer organizations as follows: (a) a new market for their roots at more stable prices; (b) additional employment and training opportunities; (c) value added to non-commercial roots that were previously discarded; and (d) the annual share of profits generated by the farmer organizations. Benefits a, b, and c applied to anyone from the larger community within which the ICRDP operated (Gottret and Henry 1993).

Total income (over 3 y) for farmer members of the processing groups was US\$163,689, of which 37.3% corresponded to sales of roots, 10% to processing wages, and 52.7% from sharing annual profits (Figure 5). An additional source of benefits was captured by non-members who sold 61.6% of the 7,080 t of roots processed during the project. The annual average income earned by farmer members of the Ecuadorian ICRDPs over 6 y was US\$225; for non-members, US\$89 (Figure 6).

For the Colombian ICRDP, Gottret and Henry (1993) estimated that nearly three-fourths of the total project benefits (US\$16.2 million) went directly to farmers (producers and processors). Considerable indirect benefits were also generated: backward linkages to several small industries supplying materials for constructing and operating the drying plants, and forward linkages, especially the income-generating effect from increased rural incomes. This will have a multiplier effect to the extent that increased rural demand for goods and services will boost urban manufacturing. As such, rural agro-industries have an important positive effect on overall economic development.

ICRDPs also represent an important source of benefits for groups such as women and landless farmers, who tend to be marginalized from the main project benefits. For Ecuador, US\$15,000 was paid for peeling roots in 1990/91, and 80% of that went to poor, non-member women and children. In Ceará, 58.9% of the total income gained by farmers went to smallholders, 32.4% to tenant farmers, and 8.7% to sharecroppers.

Besides the economic benefits, other important benefits obtained by the larger community within which the cassava-based agro-industries operate include easier access to credit programmes and training opportunities, more visible institutional presence and strengthening of community spirit. The improvement in local income during the dry season has resulted in increased purchase of foodstuffs and other items from local shops in rural communities, stimulating local economic growth. In some Manabí communities, cassava processing activities decreased the migration of men to other regions to look for work.

An additional benefit is that the cassava processing infrastructure can be used for other commercial and cultural activities. The drying patios are rented to dry other products, such as maize,

castor beans, cacao, and rice. In several communities, the cassava-based associations stimulated the creation of day-care centres and the building of roads and bridges, sponsored with government funds. In Ceará, the wives of ICRDP members started their own small poultry fattening operations next to cassava-drying floors to generate complementary income and improve overall nutritional status.

A highly innovative approach to farmer education was initiated during the last year of the Ceará ICRDP, aimed at providing 50 farmer groups with basic reading and writing skills. This programme also benefited members of the larger community within which each plant operates.

Types of institutions involved in ICRDPs and their functions

In ICRDPs, different activities have to be developed simultaneously (e.g., production, processing, marketing, organization, training, and monitoring), based on farmer organizations, but generating a substantial demand for institutional resources and interinstitutional coordinating mechanisms. Table 3 shows the range of institutions currently participating in the projects in Colombia, Ecuador, and Brazil, and the different functions that each performs.

For Brazil, state public institutions played leading roles, while farmer second-order organizations have been slow to form. In Colombia, the second-order organizations are limited to marketing activities and some large-scale input buying. In Ecuador, a wide range of institutions played a multitude of roles; but the UATAPPY was a key player for almost all ICRDP functions.

Recommendations for implementing ICRDPs

The dynamic interaction provided by the framework of the ICRDPs has facilitated the validation and adaptation of existing production and post-harvest technology, together with market analysis techniques. Based on these experiences, the CIAT Cassava Program has identified the following critical factors that need to be addressed when implementing an ICRDP:

- (1) 1. **Product and market development.** Thus far, the ICRDPs have depended on a reduced number of market outlets for cassava, which include the traditional market (fresh root consumption) and a new one (animal feed). The long-term viability of the model will depend on the processing organizations' ability to move their products into a wider range of markets and/or to develop a broader range of product end uses, especially those that can offer a higher margin of profitability.
- (2) **Crop production technology research.** The development and adoption of production systems that will sustain or increase productivity and reduce costs are critical to the

ICRDPs' being successful. To maintain competitiveness, cassava farmers may have to adopt more intensive farm practices, which, in turn, could place greater pressure on the natural resource base. Research and development of suitable production systems need to be initiated, continued, and strengthened.

(3) ***Interinstitutional organizations***

- (a) *Governmental and non-governmental organizations.* The interinstitutional coordination mechanisms required by an ICRDP are usually new to local implementing organizations and will require a period of adjustment until they can function appropriately. One institution must be designated as coordinator, and sufficient funds allocated for coordinating activities. To be successful, interinstitutional coordination must include at least three components: identification of a coordinating institution; agreement on the functions of each participating institution; and development of coordinating mechanisms at project, regional, and national levels.
- (b) *Farmer groups versus organizations versus private enterprises.* First-order farmer organizations are weak in the areas of business management and administration. Suitable methodologies and educational materials for improving these skills are not always available; and even if they were, their use is often hindered by the farmers' low level of education. The formation of second-order farmer organizations can (i) support members with a wide range of services and represent them in dialogues with other collaborating institutes or government policy-makers (lobbying), thus providing greater autonomy to first-order organizations. (ii) the interests of farmer cooperative-based agro-industries need to be reconciled with the interests of small or medium-scale, entrepreneurially oriented, agro-industries. In the Colombian project, conflicts of this nature have already arisen.

(4) ***Human resource development.*** Two important strategies are:

- (a) *Training.* Great demand exists for training opportunities for (i) research and extension personnel, and (ii) for farmers, in areas such as cassava processing, crop management, basic accounting, production technology, human and financial resource management, marketing, market analysis, and M&E. Thus far, training activities have been mainly orientated towards building the capacity of local agency staff rather than of farmers. An exception is Ecuador, where farmer training has been carried out by UATAPPY and collaborating institutions. The sharing of training, management, and delivery has resulted in greater collaboration among partner institutions.

Current farmer training strategies tend towards formal courses and mass communication activities centred on technology transfer services. Only those farmers with the needed skills benefit, resulting in segregation from the rest of the community. The Ecuador ICRDP has tried to improve this by having an explicit UATAPPY training function, managed by a designated farmer member.

- (b) *Networking*. Forging links within and between regions is a major aspect of implementing ICRDPs. The project framework within which ICRDPs are usually implemented facilitates the integration of several national institutions into a network-type of structure, providing a forum to exchange experiences and methodologies and resolve problems that are common across regions and projects.
- (5) ***Monitoring and evaluation (M&E)***. Project M&E is an integral part of the ICRDP methodology. It helps define potential products, markets, research priorities and sites, and beneficiaries, refine specific objectives, and undertake the subsequent corrective actions.

An early M&E system designed for the ICRDP in Colombia included a data bank with continuously updated information from the farmer organizations, an annual survey of a large sample of collaborating farmers, and an intensive monitoring of a subsample of farmers (Bode 1991). However, data bank updating and subsequent annual reports became the only M&E activities. Reports were circulated to only a few collaborating institutions. Feedback to farmer organizations was insufficient.

An improved M&E model was developed for the Ecuadorian and Brazilian projects. An important factor was that the second-order farmer organizations had to be able to analyse the system internally and coordinate its operation. Collaborating institutions limited their roles to technical assistance to ensure that effective feedback of appropriate information was delivered in a timely fashion to the relevant audiences. Secondly, the M&E system had to be flexible to account for project dynamics (Table 4). Parameters of interest during early stages may not be relevant for expansion phases. Adoption and impact studies need to be included over a longer horizon (Gottret and Henry 1994). Different monitoring activities were introduced at different stages of project evolution, that is, market studies need to be conducted in the experimental phase to identify viable potential markets. As these markets evolve, the studies need to be repeated at different stages to ensure a sustainable market potential or to identify product and market diversification opportunities (Brouwer 1992; CENDES 1993). The intensity of data collection decreases as the rate of adoption increases.

Based on this new M&E, adoption and impact study results in Colombia were fed back to research managers, scientists, second-order farmer organizations, policy-makers, and donors. For Ecuador, additional market studies were conducted recently, generating

evidence of potential demand for alternative cassava flour uses in non-conventional industrial products (Brouwer 1992; CENDES 1992). In Brazil, processed data are being fed back to farmers' organizations within a month, allowing them to assess their own performance and compare it with that of other farmer groups.

- (6) ***Policy support and decisions.*** From their very inception, ICRDPs have been related and influenced by governmental policy decisions. Given that all tropical Latin America countries are net importers of cereals and that most of their governments have tried to supply the increasing demand for carbohydrates through policy interventions and subsidized production credit, traditional starchy staples such as cassava have to compete with grains at a substantial disadvantage. The central issue in developing cassava-based markets and products depends on the economics of the whole process, not on technological aspects.

For Colombia, policy issues were relevant from the outset: the pilot project was located in an area where a land reform programme was operating, and farmers were already receiving credit and technical assistance aimed at increasing cassava production in the region. Throughout the project farmer organizations had access to credit lines for cassava production and processing. Policy interventions in relation to the import of cereals into the country and the inclusion of dried cassava within the list of minimum prices for agricultural products were also important. Policy issues became even more important during 1993/94 when decreased import duties allowed the importation of high-quality cassava pellets from Indonesia at below-market prices. This led to a series of high-level discussions involving a group of R&D institutions to establish the framework, individual responsibilities, and an action plan for a collaborative long-term effort to optimize the economic sustainability of the cassava sector in general and the ICRDP, in particular.

In Ecuador, the lack of government intervention to provide credit to small-scale farmers has hindered the establishment of cassava-based agro-industries, preventing expansion of project activities to other potential regions. Brazilian cassava farmers have benefited from policy decisions in the form of several grant-type programmes for setting up processing plants and credit programmes for cassava production and processing, based on price variation of cassava products.

Conclusions

The comparative analysis of the three ICRDPs leads to the following conclusions:

- (1) The ICRDPs clearly demonstrate the critical need to **integrate production, processing, and marketing R&D** activities to realize the full potential of the cassava crop. The

ICRDPs provide an appropriate mechanism for bringing together these activities in a context where multiple types of institutions—including farmer organizations—can collaborate effectively.

- (2) 2. ICRDPs **provide important social and economic benefits** to small and medium-scale farmers and landless rural workers in more marginal farming sectors. Cassava's exceptional adaptability to such marginal areas makes it a natural indicator for poorer households and an appropriate vehicle for organizing income-generating activities in regions with few other alternatives. ICRDPs attract other types of development efforts and can provide a base for increased social stability and greater economic growth.
- (3) The ICRDPs have clearly proven that when increased value for the cassava crop is created through the identification of new markets and the development of new products to suit these markets, **farmers will invest in improved production technologies**. This has profound implications for the adoption of new technologies to increase productivity and to induce resource sustainability.

To get the most out of an ICRDP, the following tasks should be considered:

- (1) A concerted effort is required to systematize these experiences and make the results available for wider consumption.
- (2) These consolidated experiences need to be incorporated into training programmes, using dynamic training materials with a flexible format that can be constantly updated.
- (3) The ICRDPs will be able to gain time and reduce duplication of negative experiences through networking and exchange visits between projects and through horizontal training and technical assistance between technicians and farmers. Funding and leadership need to be put in place to create a more permanent structure to facilitate such interchange.
- (4) ICRDPs offer an ideal ground to explore the issue of the long-term sustainability of integrated cassava systems. The more developed ICRDPs must focus attention on the impact of cassava production and processing, including work on productive capability, water and waste management, and relationships with complementary and competing systems. If ICRDPs can accomplish this, then this scheme will have a greater chance for long-term viability, thus benefiting the rural people who depend on cassava for their livelihood.

References

Proceedings of the Tenth Symposium of the International Society for Tropical Root Crops, held in Salvador, Bahia, Brazil, October 23-29, 1994

- Bode P. 1991. Monitoring and evaluation systems for cassava drying projects. In: Pérez-Crespo CA, ed. Integrated cassava projects. Working document no. 78. Cassava Program, CIAT, Cali, Colombia. p 196-226.
- Brouwer R. 1992. The cassava flour demand in the plywood industry in Ecuador. Thesis. Department of Market Research, Wageningen University, Wageningen, Netherlands.
- Calpe C. 1991. Roots, tubers and plantains: recent trends in production, trade and use. Paper presented at the FAO Expert Consultation on the Use of Roots, Tubers, Plantains and Bananas, 21-25 Jan, CIAT, Cali, Colombia.
- CENDES (Centro de Desarrollo Industrial del Ecuador). 1992. Estudio de mercado para conocer la demanda potencial de productos elaborados por la UATAPPY: Informe preliminar.
- CIAT. 1987. Global cassava research and development: the cassava demand studies and implications for the strategies for the CIAT Cassava Program. CIAT, Cali, Colombia.
- CIAT. 1992a. Cassava Program 1987-1991. Working document no. 116. Cali, Colombia.
- CIAT. 1992b. Cassava Program annual report, 1992. Working document no. 142. Cali, Colombia.
- Cock JH; Lynam J. 1990. Research for development. In: Howeler RH, ed. Proc. 8th Symposium of the ISTRC, Oct 30-Nov 5, 1988. CIAT, Bangkok, Thailand. p 109-119.
- FAO (Food and Agriculture Organization of the United Nations). 1990. Production and trade statistics for 1970-90. Rome.
- Gottret VM; Henry G. 1993. La importancia de los estudios de adopción y impacto: El caso del Proyecto Integrado de Yuca en la Costa Norte de Colombia. Paper presented at the Simpósio Latinoamericano sobre Investigación y Extensión en Sistemas Agropecuarios, 3-5 marzo, Quito, Ecuador. 1994. Also published in: Iglesias C, ed. Interfase entre los programas de mejoramiento, los campos de los agricultores y los mercados de la yuca en Latinoamérica. Working document no. 138. CIAT, Cali, Colombia. p 193-224.
- Henry G. 1992. Adoption, modification and impact of cassava drying technology: the case of the Colombian North Coast. In: Scott GJ; Ferguson PI; Herrera JE, eds. Product development for root and tuber crops. Centro Internacional de la Papa (CIP), Lima, Peru. Vol III.
- Janssen W. 1986. Market impact on cassava's development potential in the Atlantic coastal region of Colombia. CIAT, Cali, Colombia. 357 p.
- Lynam J. 1978. Options for Latin American countries in the development of Integrated Cassava Production Programs. In: Monograph no. 11. Development Studies Centre, Australian National University, Canberra, ACT. p 213-256.
- INEC (Instituto Nacional de Estadística y Censos). 1990. Encuesta de superficie y producción por muestreos de áreas. Resultados de 1990. Departamento de Programación, ? (MAG), Portoviejo, Manabí, Ecuador. Vol 1.

Table 1. Integrated cassava research and development projects in Latin America.

Error! Reference source not found. Products and markets (Countries)	Dried cassava chips (Animal feed)	Cassava flour		Cassava starch		Fresh roots (Human uses)	Cassava leaves (Animal feed)
		Human uses	Industrial uses	Human uses	Industrial uses		
		Colombia	Commercial	Pilot			
Ecuador	Commercial	Commercial	Commercial	Commercial	Commercial		
Brazil	Commercial					Pilot	Pilot
Paraguay	Pilot			Pilot		Pilot	
Panama	Commercial						
Bolivia	Pilot						
Argentina				Pilot			
Mexico	Unsuccessful						
Peru						Unsuccessful	

Table 2. Market sections and products in the Ecuadorian integrated cassava research and development project, 1989-1992.

Market sectors	Products	Total annual output (t)				
		1988/89	1989/90	1990/91	1991/92	1992/93
Shrimp feed and exports to Colombia	White industrial flour		574	984	304	631
Shrimp feed ^a	White industrial flour	1100	304	258	464	127
Plywood industry	Refined whole industrial flour			200	170	292
Ice-cream cone factories	Refined white food flour		33	6		33
Cardboard box industry (Ecuador and Colombia)	Industrial starch		70	188 ^b	57 ^b	256 ^b
Bakeries, traditional and large scale	Food starch	5	10	6 ^b	9 ^b	17
Livestock feed	Starch fibre and flour bran		24	103	29	166 ²
Total		1105	1015	1743	1033	1522

a. After 1990/91 most of the whole industrial flour was used for other livestock feed, not shrimp pellets.

b. Includes starch fibre purchased by UATAPPY from private starch processors.

Table 3. Institutions^a involved in the integrated cassava research and development projects (ICRDPs).

Type of institution	Country (region)		
	Colombia (North Coast)	Ecuador (Manabí)	Brazil (Ceará)
Agricultural research institutes	ICA	INIAP	EMBRAPA, EPACE
Technical assistance agencies	ICA		EMATERCE
Rural development institutes	DRI	FODERUMA	SUDENE
Credit agencies	Caja Agraria		Banco do Nordeste
Farmer organizations:	180 groups, e.g.,	18 groups, e.g.,	165 groups, e.g.,
1st order	ASOCOSTA	UATAPPY	COOPEMABA
2nd order	ANPPY		COPROMA
Non-governmental organizations	FUNDIAGRO		ESPLAR
International institutes	CIAT CIDA	USAID	CIAT IRDB KELLOGG Foundation
Governmental agencies:			Min. Agric.
National	Min. Agric.	Min. Agric.	Sec. Agric.
Regional	Sec. Agric.	Sec. Agric.	Sec. Commerce and Industry

a. For an explanation of some of the acronyms, see “Acronyms and Abbreviations Used in the Text”, starting p. XX.

Table 4. A modified monitoring and evaluation (M&E) model for an integrated cassava research and development project (ICRDP).

Error! Reference source not found. Activity	Source ^a	Experimental	Semi-commercial	Commercial stage
Monitoring (short term)				
Technical	1, 2	X	X	X
Financial	1, 2	X	X	X
Social	2	X	X	
Commercial	2	X	X	X
Institutional	2	X	X	
Monitoring (long term)				
Markets	2, c	X		X
Models	2, c			X
Adoption				
Processing plants	2		X	X
Production technologies	2, c		X	X
Other technologies	2, c		X	X
Impact				
On-farm/processing plant	2, c	X		X
Community	c			X
Aggregate	c			X

a. 1, 2 = First- and second-order farmer organizations; c = Collaborators (e.g., institutions, universities, NGOs).

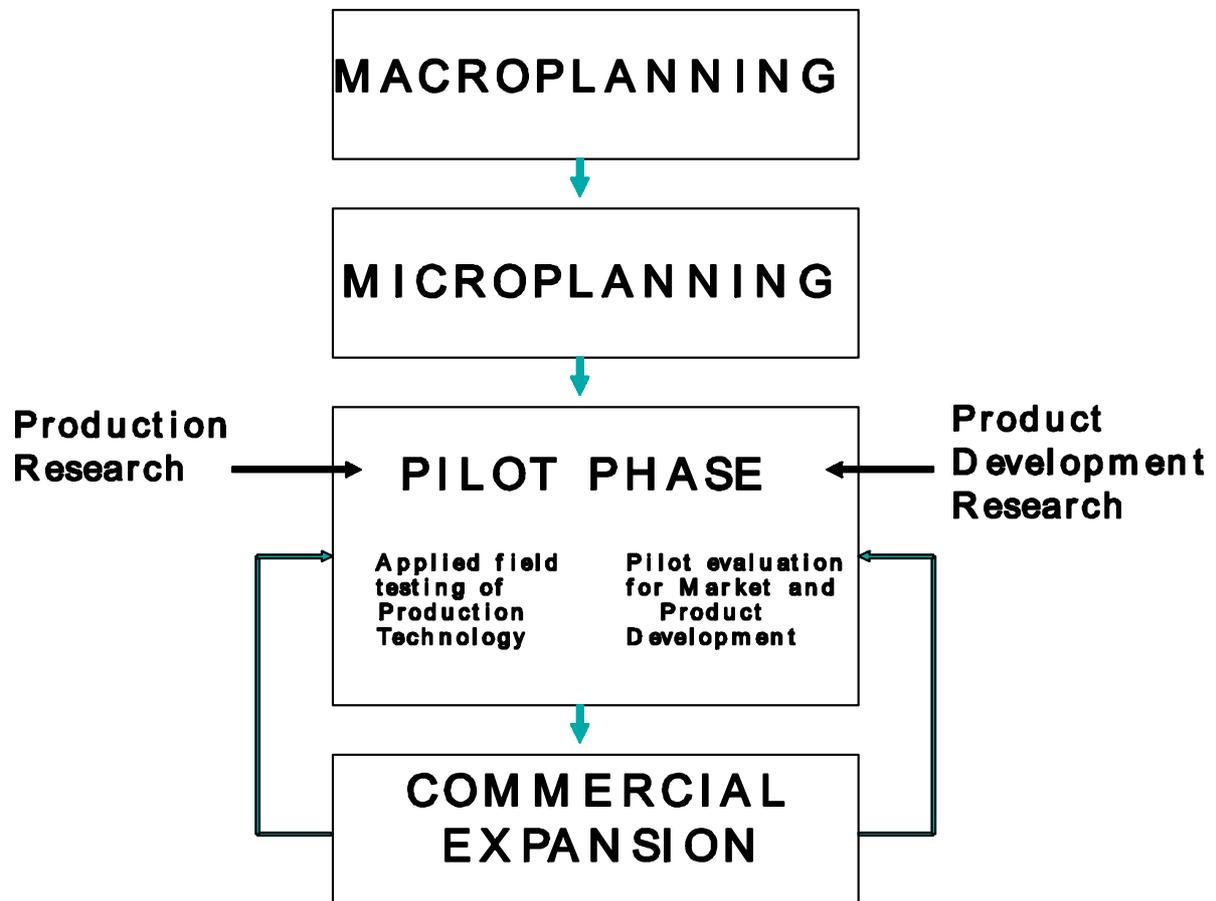


Figure 1. Flow chart of integrated cassava research and development projects (ICRDPs).

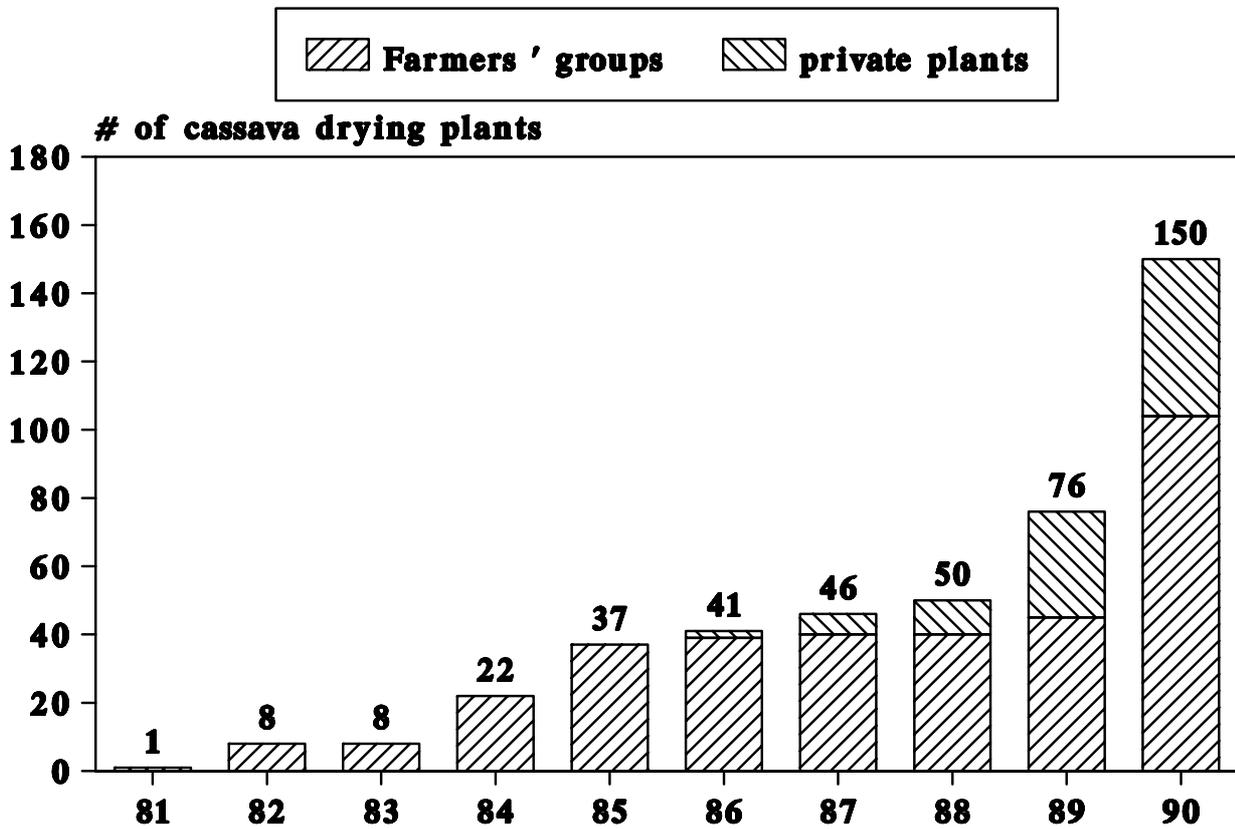


Figure 2. Adoption of cassava-drying plants in Colombia, 1981-1991. /// = plants belonging to farmers' groups; \\\ = privately owned plants. (After Henry 1992.)

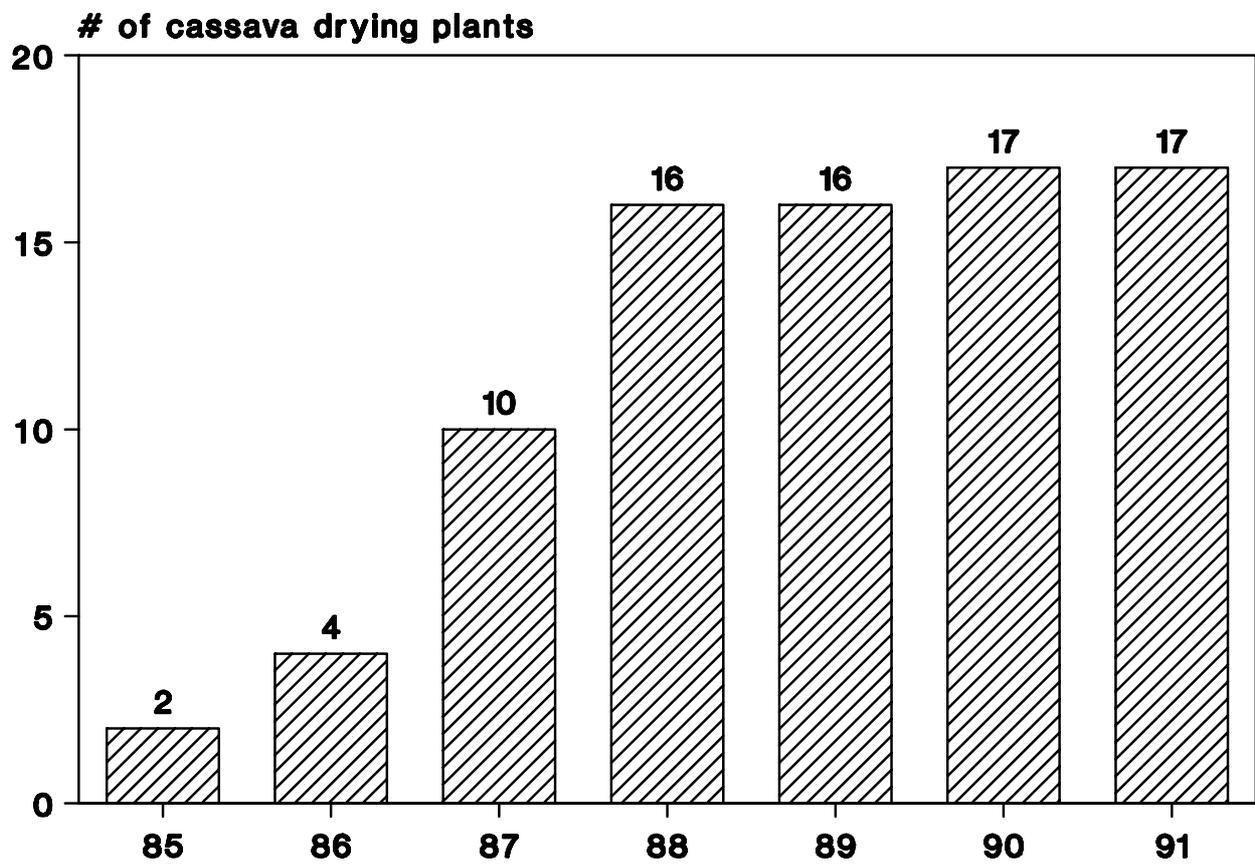


Figure 3. Expansion of cassava-drying agro-industry in Ecuador, 1985-1991.

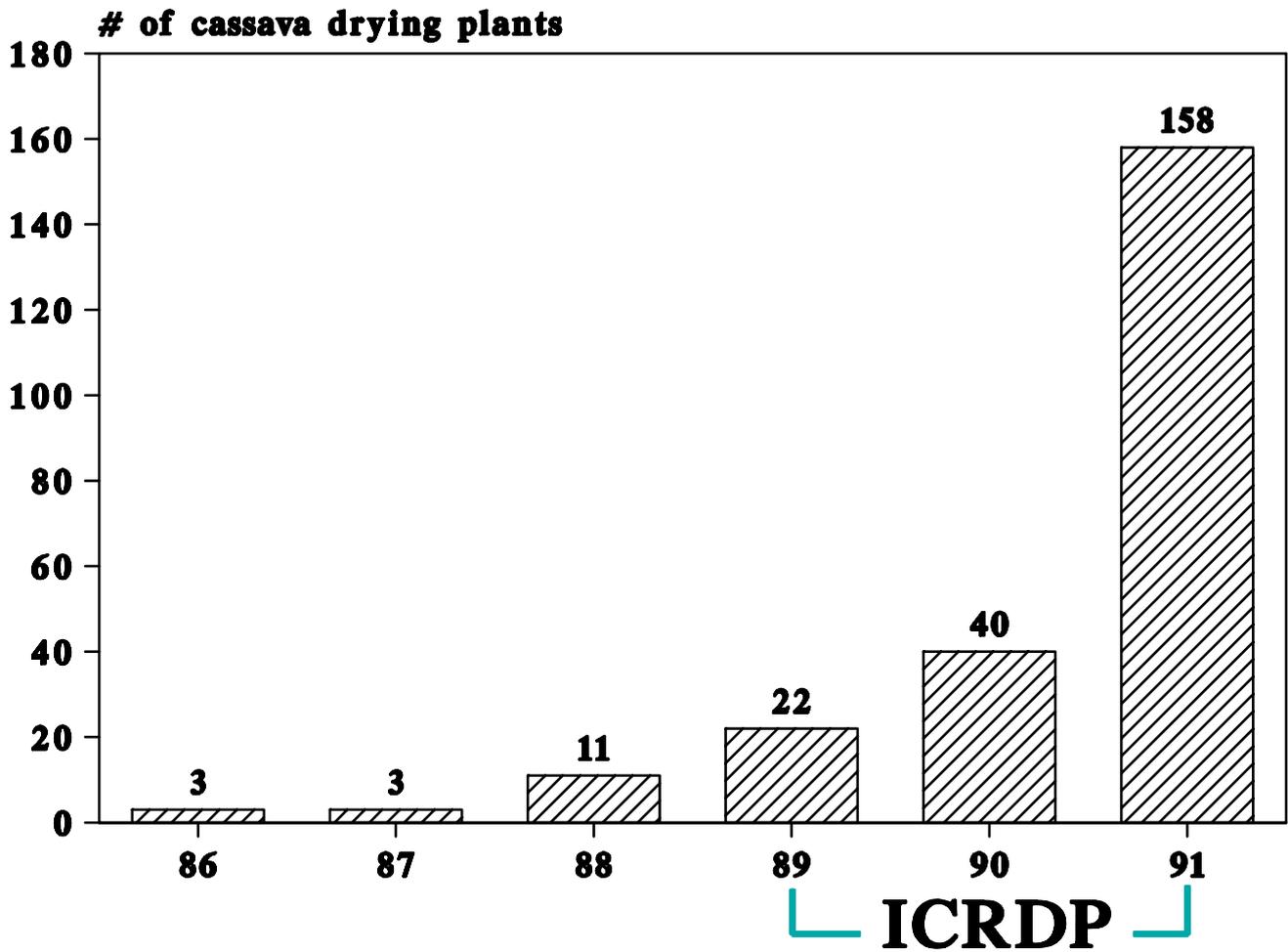


Figure 4. Expansion of cassava-drying agro-industry in the state of Ceará, Brazil, 1986-1991.

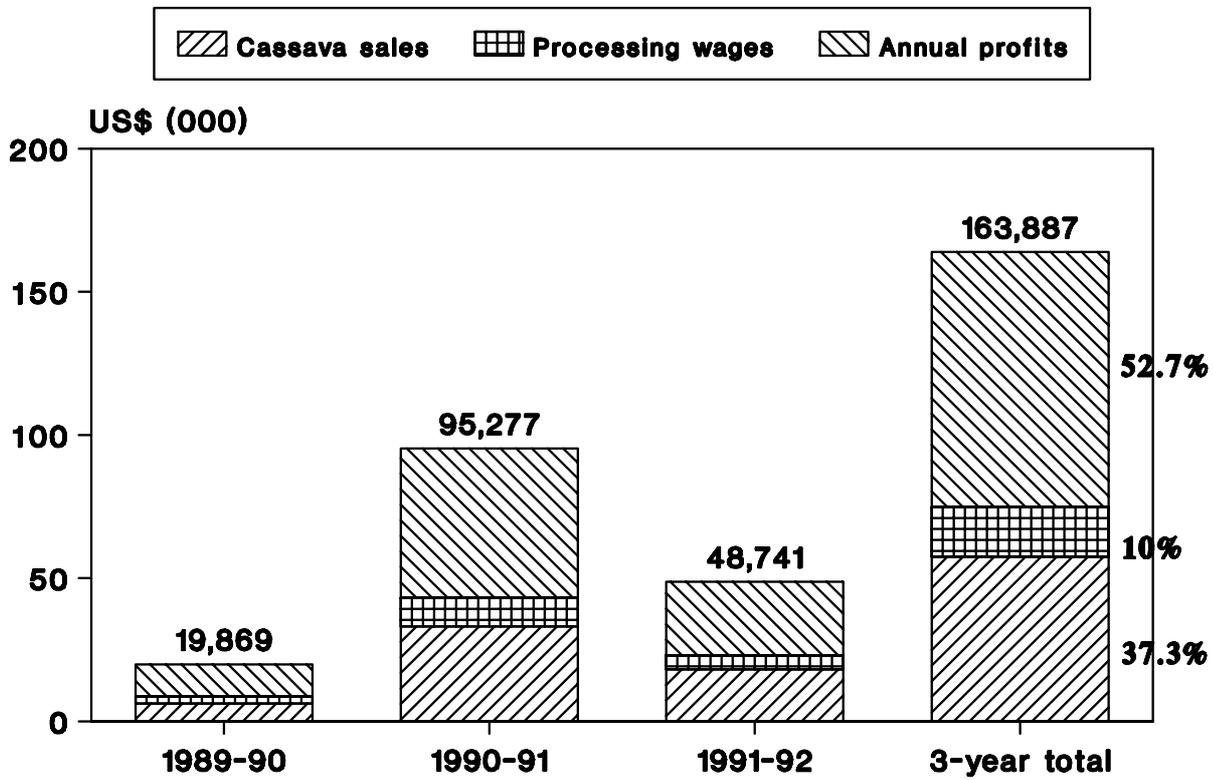


Figure 5. Total income for members of farmer groups owning cassava-drying plants, state of Ceará, Brazil, 1989-1992. /// = Cassava sales; +++ = processing wages; \\\ = annual profits. Percentages indicate proportions of total income.

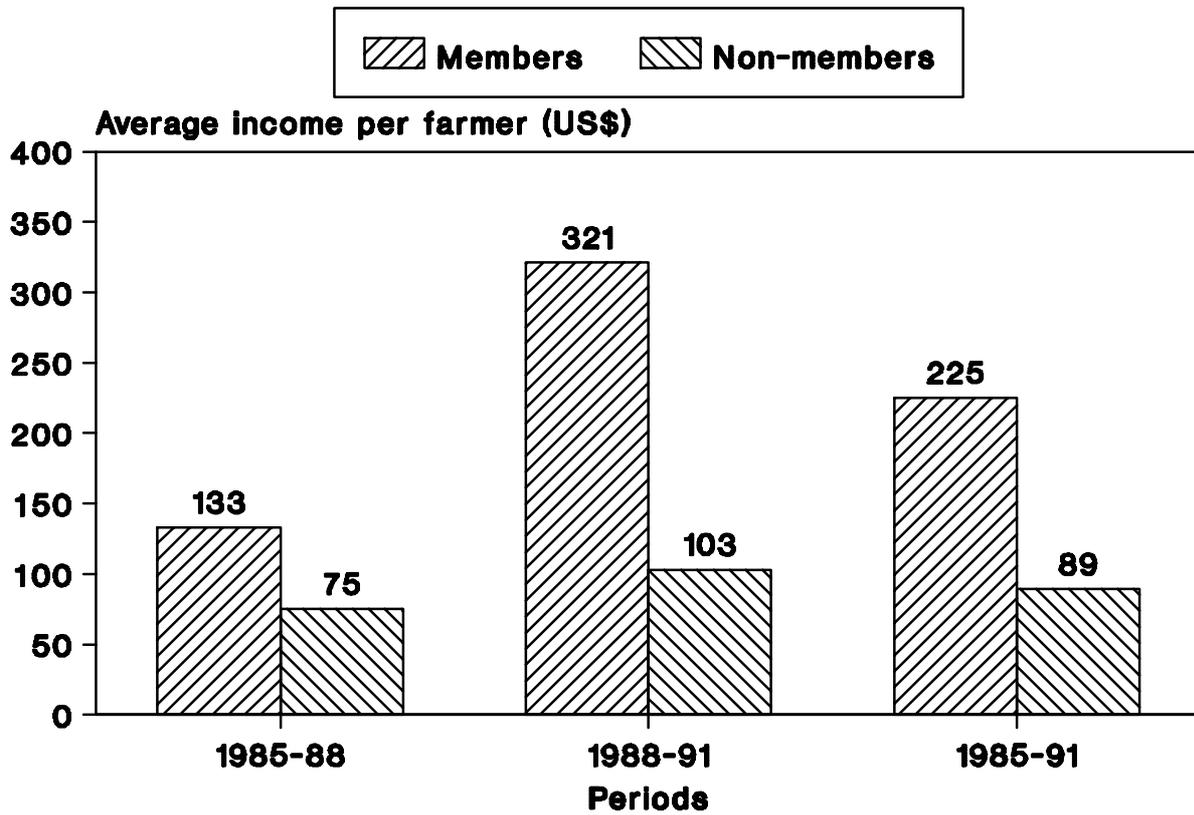


Figure 6. Income earned by members (//) and non-members (\\) of farmer groups owning cassava-drying plants, Ecuador, 1985-1991.