Working Document
No. 78

Integrated Cassava Projects

Carlos A. Pérez-Crespo
Technical Editor

CIAT Centro Internacional de Agricultura Tropical

Centro Internacional de Agricultura Tropical (CIAT)
Apartado Aéreo 6713
Cali, Colombia

Working Document No. 78
Press run: 200
June 1991

CIAT (Centro Internacional de Agricultura Tropical). 1991.
Integrated Cassava Projects. Pérez-Crespo, C. A. (ed.).
Cali, Colombia. 242 p.

CONTENTS

Page

INTRODUCTION

It is our hope that this book will be useful to many researchers and development practitioners, regardless of whether or not they actually work with cassava. The key concept of this book is that the integrated project approach could and should be used to take advantage of the potential that any crop may have to generate rural development. The essence of the integrated cassava approach is not its commitment to a crop or a particular technology, but rather its commitment to people and their right to benefit from socioeconomic development.

The purpose of this book is to present a strategy for increasing the income of small farmers and generating socioeconomic development in tropical regions. The strategy consists of setting up an integrated development project for catalyzing technical, financial, and organizational resources so farmers can link themselves to expansive new markets for their produce, through the introduction of novel or improved conservation or processing technologies. The project's net benefits reach farmers in the form of profits and ability to manage their own resources. This last point is important because, after the initial stages of state and private investment, the project must evolve into a commercially viable venture, independent from institutional support.

The success of this strategy rests on the following fundamental guidelines:

1. Efforts to promote cassava production must be matched to the capacity of the market to absorb the increased supply of roots. Processing infrastructure has to be established along with organizational support to assist farmers in the management and operation of the facilities, which, in turn, must have a regular and opportune supply of roots and other necessary inputs. Cassava production, processing, and marketing activities must be coordinated, and a favorable disposition toward cassava-based products must be created among producers and consumers.

2. Integrated cassava projects must be supported by interdisciplinary teams encompassing technology experts, marketing specialists, organizational and financial consultants, and community organizers. Biological sciences, engineering, and social sciences must be integrated.

3. Technology-generating and development institutions must be responsive to farmer needs and consumer preferences. Research and development interventions must be client-centered rather than product- or

process-centered. Hence, an internal institutional reorientation may need to accompany project implementation.

4. Farmers must be empowered to increasingly assume responsibility for the services the project provides. Thus, training must play a critical role. Training domains must encompass technical, financial, administrative, and organizational issues. Projects must encourage farmer participation from the project design stage all the way through implementation.

Chapters 1 and 2 of the book set the framework in which cassava development takes place. In Chapter 1, development models are outlined to shed light on cassava's potential to generate economic growth. The author's conclusion is that cassava is a crop well suited for assisting low-income farmers, and that to tap this resource public and private institutions must join efforts in integrated projects. Chapter 2 discusses some of the actual and potential markets for cassava in tropical Latin America. Data are presented for Brazil (the world's largest cassava producer), Paraguay (the Latin American country with the highest per capita cassava production), the Andean countries, Central America, and the Caribbean.

Chapter 3 describes strategies that have been used for cassava development: market penetration, product development, market development, diversification, and integrated agroindustrial transformation. It defines the concept of the integrated cassava project and discusses its origins in the context of CIAT's Cassava Program as it strove to be more effective and responsive to farmers.

Product development according to consumer-defined specifications constitutes a key to success for integrated cassava projects. Chapter 4 describes the process for generating and selecting concepts for new products and turning them into successful commodities. It points out similarities and differences between product development for the commercial food industry and the development of cassava-based products through integrated cassava projects, outlining the main steps in the cassava product development process. Chapter 5 shows how this model has worked in Colombia in the case of fresh cassava marketing.

Chapters 6 and 7 deal with cassava production. In Chapter 6, the emphasis is on the need to conduct research on agricultural systems. Understanding traditional systems facilitates technology development. Chapter 7 concentrates on one essential component of the agricultural system, namely, farmers. It discusses the benefits that ensue for both farmers and researchers from direct farmer participation in the research process.

Chapter 8 concentrates mostly on the technical and administrative aspects of the cassava natural-drying project on the Atlantic coast of Colombia, in a review of its development process. It also provides details on drying technology.

Chapter 9 deals with the actual socioeconomic impact of the cassava natural-drying project on the Atlantic coast of Colombia and discusses ways in which this impact can be further improved.

Chapter 10 describes in detail how farmers have organized themselves in the integrated cassava projects. It presents a typology of farmer organizations according to their structure and activities undertaken. It discusses the organizations' linkages with external institutions, and presents guidelines for planning farmer organizational development.

Chapter 11 discusses models for cassava project monitoring and evaluation, and focuses on the system that has been created and honed over time to follow up on the Colombian Atlantic coast project. This system is based on a data bank, in-depth surveys, and intensive follow-up on a sample of farmers. The author states that there should be a close fit between institutional data requirements and the monitoring system's ability to provide them.

Chapter 12 concludes the analysis of integrated cassava projects by depicting topics that project administrators must bear in mind while planning and implementing the projects. It stresses the need for farmer participation and institutional integration, and emphasizes the importance of project leadership in drawing together the different actors involved.

Chapter 1

THE DEVELOPMENT CONTEXT

James H. Cock*

The Rural Sector in an Urban Society

Latin America has shown a marked change in its social structure in the past thirty years, going from being a mainly rural society to an urban society. The extremely skewed land distribution in most Latin American countries has left little opportunity for small farmers to improve their welfare, and as a result they have frequently left rural areas to seek more gainful employment in the urban sector. However, the growth of employment opportunities in the urban sector has not kept up with migration, which has led to poverty in Latin American cities. Recently, more attention has been paid to the development of the rural sector and, in particular, the small farmer.

Urban and rural development are closely linked. The rural sector has traditionally provided food and a labor pool for urban development. Furthermore, the urban sector needs internal markets for its industrial products and services. A buoyant rural sector will provide such a market. The need for a balance between rural and urban development is obvious.

The small-farmer sector must be effectively linked to complex modern society, of which it is itself a part, so that it is stimulated to invest in improved technology in order to increase its productivity. An effective demand for products provides the incentive to produce. This demand takes many forms: individual urban consumers, organized by markets; industrial consumers such as feed mills, textile plants, paper producers, and the pharmaceutical industry; state marketing and distribution systems in socialist countries; and onfarm use for home consumption or animal feed. It is recognized that the situation is complex and demand may take many forms,

---

* Leader, Cassava Program, Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia; currently, Director General, Centro de Investigación de la Caña de Azúcar de Colombia (CENICAÑA), Cali, Colombia.

and it need not necessarily be in the market economy. Modern society often requires products that differ from those traditionally produced by the small-farm sector. This demand can be met either with new crops or by processing traditional crops in such a manner that their demand characteristics are radically altered. In the developed countries, the rise of soybean and rapeseed production are examples of the former strategy, and the use of maize in animal feed an example of the latter.

Traditional products of the rural sector may in fact be highly appreciated; however, they may not be easy to handle. A case in point is fresh cassava in Latin America. It appears that urban consumers find fresh cassava a desirable but highly inconvenient food. The demand characteristics of fresh cassava would be far more elastic if it were a less perishable and more convenient product. Hence, new processing technology that changes the storage characteristics of the fresh roots opens up new possibilities for the producer. On the other hand, in Latin America, until recently, little cassava was processed for use in balanced feed rations. This market, in which cassava substitutes partially for grains, is expansive and allows producers to greatly increase the supply of cassava with little effect on the price. Traditional and new uses for cassava can exist side by side. In the north coast of Colombia, the traditional market for fresh cassava continues to be of major importance and functions alongside a growing industry for the production of cassava chips for use as animal feed.

In the past, most efforts in the arena of agricultural development have concentrated on the production side. It is our premise that production per se will achieve little unless it is geared to meeting the needs of society as a whole. In fact, in the agricultural development process, more emphasis should be placed on defining the needs of society as a whole and its specific demands before looking for the means to meet them. We would go as far as suggesting that a reversal in the traditional thinking on agricultural production should occur. The needs and requirements of the consumer (including industry, onfarm users, etc.) should first be assessed and then production, processing, and marketing technology should be geared to meeting those needs, rather than looking first at increased production and then trying to find a market for goods which may have little demand.

The ideas set out in the preceding sections indicate that the small-farm sector must be linked to meeting the needs of a modern urban society. Modern society demands products that are convenient and often processed. The modern consumer does not buy wheat and maize, he purchases bread and ready-made tortillas. These are processed products and the raw material usually makes up only a small proportion of the final cost to the consumer. If improved rural welfare through generation of rural income is a political goal, then one way to assist in reaching that objective is to process traditional products in the rural sector so that at least part of the value added remains in that sector. Thus the rural areas will move away from exporting unprocessed raw materials toward the sale of processed goods. In this manner it is possible to increase the income-generating power of traditional crops. The question is how this focus fits into overall strategies of development. In the postwar period, there have been various shifts of emphasis in models of rural development.

Development Models

In the decade of the 1950s, development economists foresaw decreasing importance of the agricultural sector in the overall development of the Third World. The major emphasis in rural development was placed on community development and the diffusion model. Community development was based on bringing people together to form harmonious communities and mobilize them for common endeavors (Holdcroft, 1984). But, these programs did not bring the expected benefits of economic development in rural areas because, as pointed out by Holdcroft (1984), basic conflicts and differences could not be reconciled purely by the persuasive efforts of community development workers, and community development efforts declined in the early years of the 1960s.

The diffusion model (Hayami and Ruttan, 1971) indicates that agricultural development is based on "more effective dissemination of information and a narrowing of dispersion of productivity among individual farmers and among regions." In the 1950s, attempts were made to transfer technology from the developed temperate regions to the tropics. These efforts were not successful on a wide scale because, first, the ecologies of the tropics are vastly different from those of the temperate regions and, second, there are vast social and economic differences between the source and target areas of transferred technology. Furthermore, the basis of this diffusion model assumed that traditional farmers were not allocating resources in an optimal fashion. Schultz (1964), however, challenged this viewpoint, indicating that the traditional farmer is rational within his own particular environment. Hayami and Ruttan (1971) analyzed the arguments of Schultz and indicated that in their opinion, "The key to transforming traditional agriculture into a productive source of economic growth is investment to make high-pay-off inputs available to farmers in poor countries."

For this strategy to succeed, the farmers must have access to varieties that are well adapted to the tropics and that respond to inputs. Research on tropical rice and wheat produced such varieties and the "Green Revolution" was born in the 1960s. This achieved the goals of the researchers involved in stimulating growth in the agricultural sector and increased food production. This was not, however, considered sufficient as the "Green Revolution" did not resolve the problems of disparities in welfare (Bengtsson, 1983).

The equity issue then became of paramount importance, and integrated rural development programs, which were specifically directed to the poorest parts of the rural sector, became popular (Lacroix, 1985). These projects were complex as they included all aspects of improving the welfare of a society, ranging from health and education to crop production and provision of infrastructure. The high cost of these projects and the difficulty of managing the interactions among such diverse sets of activities have led to doubts concerning their effectiveness.

More recently, emphasis has been on overall growth, with the basic assumption that the benefits will trickle down to the poor. It is evident to anyone who has traveled extensively in rural areas of the Third World that trickle-down effects are by no means universal. As Lewis (Lewis, 1955, quoted by Beckford, 1984) indicates, the sugarcane industry grew very rapidly but the workers "continue to walk barefooted, and to live in shacks."

Recently, attempts to redress these problems in those agroindustries based on plantation crops with large-scale processing requirements have used the concept of the nucleus estate. A central processing plant is supplied by a plantation that guarantees minimal supply of raw materials and smallholders provide the remainder (Ruthenberg, 1985; Nataatmadja, 1987). These estates have been successful in providing the basis for growth and also ensuring that the small farmer is not marginalized in such cases as rubber production in Malaysia. This model appears to be appropriate for certain crops, although it is questionable whether it can be generalized and used for all crops. Furthermore, the infrastructure needed is frequently capital intensive and such projects are thus costly to establish. They do, however, provide a guide to some important principles that can be applied in a more general sense. The nucleus estates are normally centered on a single commodity that is processed in the production area and then sold to a large and expansive market. The primary product is usually substantially transformed near the production site, and processing is an integral part of the overall system. Furthermore, the establishment of the nucleus estate with its processing capacity is based on an intimate knowledge of the market toward which the final product is aimed. In the later years of the 1970s, the Cassava Program at CIAT found that small-farmer cassava producers were to a large extent marginalized from the development process in Latin America. The Program then began to look for a means to allow these producers to participate in the development of modern society on more favorable terms.

The constraints to small farmers are often outside the production sphere. In the case of cassava, we found that farmers perceived primary constraints in the area of marketing. Ruttan and Hayami (1984) indicate in their induced development model that "there is clear evidence that technology can be developed to facilitate the substitution of relatively abundant (hence, cheap) factors for relatively scarce (hence, expensive) factors in the economy." For example, the inelastic supply of land can be offset by high-yielding crops that facilitate the substitution of fertilizers for land. The emphasis here is on the elasticity of the production factors; however, in many cases the constraint for the producer may be on the elasticity of the product itself. Ruttan et al. (1978) do, however, recognize the potential importance of changes in demand in the induction of innovation. It is our contention that these constraints on the demand side are often of paramount importance and can also be relieved by technology changes. In fact, we would even go as far as to say that in many cases the major constraints to reaching the goals of improved rural welfare are on the demand side and that concentrating on production factors often does little to improve rural welfare. Returning to Lewis, we find that "however vastly productive the sugar industry may become the benefit accrues chiefly to the consumers" (Lewis, 1955, quoted by Beckford, 1984).

In light of the foregoing, the Cassava Program at CIAT has tried to define development strategies that are clearly oriented toward the poorer segments of the rural population, while wherever possible contributing to increasing urban welfare as well. This strategy is based on what we call integrated production, processing, and marketing projects.

Integrated Production, Processing, and Marketing Projects

Background

The development of the integrated project strategy has evolved over several years of being involved in cassava-based projects aimed at improving rural welfare. These projects were subject to several constraints and were based on various assumptions. It was assumed from the start of the project that redistribution of income without growth was an unrealistic goal. We do recognize that the approach we use has great potential in land reform projects to provide, at relatively low cost, the basis for beneficiaries of such programs to improve their livelihood. But it appeared unrealistic to tie all of our efforts to land reform programs. Rather, growth within the existing social structure was to be the basis for improving the welfare of poorer segments of rural communities.

A major constraint was that efforts had to be concentrated on one commodity, that is, cassava. The major question was whether a single commodity could be the locomotive of development, bringing benefits to a broad range of people in the rural sector without a full-scale, high-cost integrated rural development program. This was a particular concern as cassava is rarely grown as a monocrop and normally fits into complex agricultural systems. Furthermore, cassava as a crop faced constraints on the demand side and increased production per se was unlikely to lead to increased farmer income and hence growth in the rural sector. Thus, from the beginning it was realized that interventions would have to be directed toward a whole range of activities terminating in the sale of a cassava-based product at a reasonable price.

The strategy that evolved was that efforts should concentrate on only those aspects of the community that could impinge on the development of a cassava-based industry. But, within this sphere all constraints were potential candidates for intervention. Thus, if the ability of members of farmers' associations to read so that they could keep accounts was a limiting factor, then they should be taught to read and how to keep simple accounts. The goal would not be that of literacy per se but rather to remove the particular constraint. This distinction is important as it results in a more focused series of interventions and less complexity than in a full-scale integrated rural development project. However, as growth occurs in the cassava-based industry, it is expected that many improvements in infrastructure and social services normally seen as part of an integrated rural development project will be implemented by those who receive the benefits of growth in the economic community. In order for this to occur, it is necessary to achieve increases in income that will stay in the production area and also to create a community spirit. In the cases in which we have been involved, this has been achieved by first concentrating efforts on the indigenous population of the region, which is likely to reinvest any gains in the region, and second by promoting organizations of producers and processors as the basis of community development, rather than private entrepreneurs.

There are two ways of looking at the single commodity approach. The first is to decide on a commodity and then analyze in which regions of a country it can be produced and the potential markets into which it can be sold, while the second approach is to select a region and then look at the possible products that it can supply. The characteristics of the commodity are critical in both cases in determining whether it can in reality be the locomotive of equitable development. In our particular case, we chose cassava because we felt it had innate qualities that made it attractive while at the same time we recognized that it had certain limitations that would have to be addressed.

First of all, cassava is an important crop in the small-farm sector and is extremely reliable to grow. A measure of this level of importance is that in terms of production of calories for human consumption within the tropics it is the fourth most important crop after rice, maize, and sugarcane. It is an important component in the diet of some 700 million people mainly in rural areas of the tropics. The question arises as to the potential increase in demand for cassava either in traditional forms or if it is processed into a more acceptable form for modern society. As a basic source of starch, cassava has multiple potential end uses.

The cassava plant survives drought periods and grows well with limited supplies of water. In addition, it is tolerant of acid soils and yields well on marginal soils without excessive use of costly soil amendments. These qualities have endeared cassava to small farmers and it is almost exclusively grown by them. The ability of cassava to grow on poor soils in areas of uncertain rainfall has led to much of the production being in areas considered as marginal for agricultural production. While these areas are not marginal for cassava production, they usually have limited investment in infrastructure and therefore can be considered as marginal at the community level.

Cassava roots consist mainly of water and starch. The high water content of 60%-70% makes the unprocessed roots bulky and difficult to handle. The roots are extremely perishable and start to deteriorate within one or two days after harvest. This characteristic is not of grave concern in rural society but is not conducive to the crop's use by urban markets distant from production centers.

The relatively large labor requirements, the high cost of specialized mechanization, the logistics of handling this very perishable crop, and the high assembly and transport costs for the harvested roots tend to ensure that, first, small-farm systems will continue to dominate and maintain their comparative advantage over larger scale production systems and, second, that primary processing will have to be close to the production site. Given that cassava can be a source of increased income, any gains in productivity will be captured by the small farmer.

All these characteristics of cassava made it a logical choice for projects directed toward assisting the rural poor. When the commodity is not taken as a given parameter, but the area or region is defined first, great care must be taken in selection of a commodity that has inherent characteristics that skew benefits toward the target sector.

In the case of cassava, a major constraint was that the Cassava Program had limited financial resources. In addition, as initial projects were exploring new ground and risk of failure was always a possibility, the project structure had to be such that if things started going wrong the process could readily be aborted at various stages without massive financial loss either by supporting institutions or by farmers. Termination of a project was always seen as a last resort and considerable flexibility was introduced to the structure of projects so that when problems were encountered the project could be reassessed and research carried out to resolve unforeseen difficulties or constraints. In fact, one of the major features of these projects is that they are very closely linked with research to the extent that operational research is an integral part of the projects. The operational research follows closely the definition of Watson-Watt as "investigation by the scientific method on real operations--current, recent or impending--and explicitly directed to better more effective and economical conduct of similar operations in the future" (Deighton, 1977).

Projects of this nature require the active participation of various public and private entities and the rural community itself. No one agency or group had the power or the authority to insist on action; voluntary participation was the norm. Project design had to ensure that all those required to be actively involved in the project must receive some benefit. This benefit could vary and includes financial, political, and social advantage to be gained from participation. Project activities should also fit within the capabilities of local agencies to provide support in such areas as credit and extension.

The projects were also designed to provide benefits to as wide a range of persons in the rural community as possible. This, coupled with limited financial resources for credit, indicated that technology should be labor intensive rather that capital intensive. Rural poor are often landless labor, and have few employment opportunities. Capital items would, however, obviously be necessary and should wherever possible be produced locally to stimulate local industry. These design parameters fit well with experience in Latin America that large-scale projects for cassava production and processing normally failed due to poor linkage between the production and processing components. A further objective was that the value added to the primary product should be maximized, and this added value should be captured in the rural rather than the urban sector, thus stimulating growth in rural communities.

Project stages

The execution of integrated projects follows a series of stages in their development. These phases allow for the reassessment of the project before continuing with the following phase. Planning is not rigid from the project's inception as actions to be taken in each phase depend on the analysis of the preceding phase. Thus, although there is an ultimate goal to improve rural welfare, the strategy to reach that final objective is continually revised during the life of the project.

Macroeconomic analysis. The first phase consists of placing cassava in the overall development context of a country or region. This involves a macroevaluation of the economic situation of the country, evaluation of potential demand for cassava and cassava products, and an evaluation of the ability of cassava to compete in different markets and the production potential of cassava in different regions. This evaluation provides the basis for the selection of a region or regions where integrated projects based on cassava could possibly be developed and markets into which the products will be sold.

Pilot project site selection. The macroeconomic analysis is used for the selection of a pilot project site. The basis for this selection is a series of criteria such as access to markets, existence of farmers' organizations, institutional support, and the availability of viable production and processing packages suitable for the specific site chosen. However, the final decision is often somewhat subjective. It is preferable to make a decision on the site rather than to spend excessive time and money on extensive theoretical analysis that at best can only be hypothetical.

Pilot plant implementation. The implementation of the pilot project phase brings together all aspects of production, processing, and marketing of cassava-based products. In this phase, the most appropriate available technology is tested in a real-life situation. Problems are encountered in a wide range of areas, such as acquisition of credit, production, poor quality of the final product, or social organization of the processes involved in ending up with a marketable product. Operational research directed toward resolving problems **in situ** is an essential component of this phase. The pilot project phase continues until either the problems have been resolved and a viable model exists or the project is deemed unlikely to have a sound future and is terminated. It is our experience, in the case of cassava, that in general a latent production capacity exists and that if the first interventions are in the area of marketing and processing, farmers will rapidly respond with increases in production up to a certain level. However, improved production practices are necessary to achieve maximum potential benefits.

Project expansion. Once a viable pilot project is functional and shown to produce benefits to the rural poor then the expansion or replication phase can begin. Expansion is achieved primarily through an increase in the number of operational units rather than in an increase in the scale of operations. Thus, experiences in the pilot phase are relevant to the expansion phase. The projects do not, however, stagnate in the expansion phase. Monitoring of projects is an essential component of this phase that gives feedback on problems that must be resolved by changes in the project's implementation.

A Case in Point

Several years ago in the north coast of Colombia, DRI and CIAT saw marketing as the problem of small farmers producing cassava. The major local wholesale market for fresh cassava in the region is Barranquilla; however, the capacity to absorb cassava at a reasonable price for farmers is limited. In 1981, there was a bumper harvest for cassava and farm-gate prices were so low that many farmers did not even harvest their entire crop. This situation did not provide farmers with an incentive to produce cassava and hence there existed an imbalance between supply and demand, with farmers normally scared to invest in cassava production as the marketing risks were too high.

The solution seemed to be to fix a minimum floor price for cassava. However, with a perishable crop such as fresh cassava, the government obviously could not step in and buy the cassava at a guaranteed price even if it wished to do so. An option was to open up an expansive alternative market. The animal feed market was identified as such an alternative. The overall idea behind this was that farmers would have a stable minimum price for their produce and thus, first, they would have an incentive to increase production and, as a result, their income, while, second, as the overall production level increased, the price for the urban consumer would become lower and show less fluctuation.

An industry for producing dried cassava for use in animal feed was established on the basis of small-producer associations. When the local fresh market price is high, these associations can sell into that market, but when prices drop, they then have the alternative of drying the cassava. The first pilot plant was established in 1982 and after two years problems were resolved to the extent that the decision was made to go ahead with the expansion phase. The drying associations first began to function on a significant scale in 1984 and have effectively provided cassava producers with a stable floor price. There are now more than forty such plants functioning in the north coast of Colombia and these are bringing benefits in terms of increased income, employment, and a new community spirit. As one of the pioneers of this industry has commented, there is now a future for his children in the region.

It is very difficult to monitor the level of production of the myriad small cassava producers in the region. Survey data indicate that farmers are responding to the more stable markets with increased production, thus providing growth in the region. Furthermore, in the major market for fresh cassava in the area, the real price of cassava to the consumer has decreased and become more stable. Over the period 1970-1983, the average price of cassava to the Barranquilla consumer was Col.$4.5 (1978 prices), whereas after the plants became operational in a significant manner in 1984, prices have shown less fluctuation and have dropped by 27% to Col.$3.3 (1978 prices). The total benefits to the population of Barranquilla can then be estimated as on the order of US$4 million per year (Carolina Correa, personal communication).

The farmers are making more money. Consumption of cassava in the major city of Barranquilla has increased and farmers capture the benefits of increased sales into this market. At the same time, the dried cassava industry is selling close to US$1 million worth of dried cassava and providing a stable market for fresh roots. Who are the losers in a situation like this? It is difficult to see who they might be with the possible exception of some middlemen who may have been working on very large profit margins. But, they appear to have increased the volume they handle so even they may have gained something.

The example given here will be covered in more detail elsewhere in this book. However, it is briefly described to show how the strategies outlined above can lead to improved welfare of the rural poor and also assist in meeting policy goals for the urban sector. It seems that everyone involved in this project stood to gain and that is possibly the key to its success.

References

Beckford, G. L. 1984. Induced innovation model of agricultural development: Comment. In: Eicher, C. K. and Staatz, J. M. (eds.). Agricultural development in the third world. Johns Hopkins University Press, Baltimore, MD, USA. p. 75-82.

Bengtsson, B. M. I. 1983. Rural development research and agricultural innovations. Swedish University of Agricultural Sciences, Department of Plant Husbandry, Report 115. Uppsala, Sweden. 377 p.

Deighton, L. 1977. Fighter: The true story of the Battle of Britain. Triad-Grafton, Collins Publishing Group, Glasgow, Scotland. p. 118.

Hayami, Y. and Ruttan, V. 1971. Agricultural development: An international perspective. Johns Hopkins Press, Baltimore, MD, USA. 367 p.

Holdcroft, L. E. 1984. The rise and fall of community development, 1950-65: A critical assessment. In: Eicher, C. K. and Staatz, J. M. (eds.). Agricultural development in the third world. Johns Hopkins University Press, Baltimore, MD, USA. p. 46-58.

Lacroix, R. L. J. 1985. Integrated rural development in Latin America. World Bank staff working paper #716. World Bank, Washington, DC, USA. 81 p.

Nataatmadja, H. 1987. Nucleus estate smallholder program: A bold social engineering experiment. Indones. Agric. Res. Dev. J. 9:47-51.

Ruthenberg, H. 1985. Innovation policy for small farmers in the tropics: The economics of technical innovations for agricultural development. Clarendon Press, Oxford, England. p. 143-147.

Ruttan, V. W.; Binswanger, H. P.; Hayami, Y.; Wade, W. W.; and Weber, A. 1978. Factor productivity and growth: A historical interpretation. In: Binswanger, H. P.; Ruttan, V. W.; et al. Induced innovation: Technology, institutions, and development. Johns Hopkins University Press, Baltimore, MD, USA. p. 44-87.

_________ and Hayami, Y. 1984. Induced innovation model of agricultural development. In: Eicher, C. K. and Staatz, J. M. (eds.). Agricultural development in the third world. Johns Hopkins University Press, Baltimore, MD, USA. p. 59-74.

Schultz, T. W. 1964. Transforming traditional agriculture. Yale University Press, New Haven, CT, USA. 212 p.

Chapter 2

CASSAVA IN THE ECONOMY OF LATIN AMERICA

James H. Cock and John K. Lynam*

Latin American agriculture is characterized by very skewed land distribution, with the smaller farmer usually being relegated to poorer land and producing the basic traditional food staples of maize, beans, and cassava. Policies have often favored large farmers who produce export crops and cattle on an extensive basis. Policies have also focused on the provision of cheap supplies of food for the urban population through subsidies or cheap grain imports, all of which has led to stagnation in the small-farm sector. The debt crisis in Latin America has forced governments to review these policies and make new plans.

In order to plan with specific social goals in mind, it is necessary first to define those goals or objectives. In the case of cassava, we have defined the primary objective as increasing rural incomes by producing goods with an elastic urban demand. Whenever possible, these goods should be directed toward providing final products that are consumed by the lower income segments of the urban population. This latter condition is, however, secondary to the rural income objective and is considered as a side benefit that is advantageous when it can be simultaneously achieved. These two objectives are not necessarily mutually exclusive.

In order to determine how the stated objectives can be met, it is necessary to look at the overall system terminating in the sale of a product that will generate income. In fact, the approach is to work down from the salable product, through marketing channels, processing, and finally production of the raw material. Basic traditional cassava products are usually inelastic in their demand characteristics. Thus, we must first of all define the demand characteristics of alternative products based on cassava. These markets may

---

* Leader, Cassava Program, Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia, currently, Director General, Centro de Investigación de la Caña de Azúcar de Colombia (CENICAÑA), Cali, Colombia; and head, Economics Section, Cassava Program, CIAT, Cali, Colombia, currently, senior scientist in Agricultural Sciences for the Rockefeller Foundation, stationed in Nairobi, Kenya, respectively.

already be well established, such as that of dried cassava for animal feed, or thay may be new markets, such as the one recently opened up in Ecuador using cassava flour as an agglutinant in shrimp feed. Those that are shown to be more elastic can be further studied to analyze how they can be commercialized and what product characteristics are required to enter the market. This knowledge is then used to determine the appropriate processing technology in terms of product quality and also so as to ensure the generation of income in the rural sector. This then allows the determination of where and how to produce the basic raw material. The overall system has to be analyzed afterwards to determine whether it is socially, economically, and technically viable.

This type of analysis cannot be carried out on a global scale. For example, in different regions the availability of competing products will differ, the type of product will be determined by local needs or preferences, policies concerning prices and importations will vary, and the production potential of cassava will depend on local conditions. Thus, a separate analysis is required for each country or region. The methodology for this analysis will, however, be similar for the different conditions. Furthermore, the analysis is not rigorously carried out for all possible cassava products: judgment will be used to preselect the most likely lines of success, and efforts will be concentrated on these.

In developing this methodology, a holistic approach is required as the cassava system cannot be looked at in isolation. For example, it is only possible to determine the potential for cassava in the animal feed market by analyzing the demand for different animal products, the relative price of other energy sources, the availability of alternative sources of protein, and how all these are affected by government policies. Thus, within the general methodology of first identifying products with the required demand characteristics, special emphasis is placed on evaluating cassava's ability to compete with alternative products and the constraints on its entering the markets. These constraints are highly variable and are certainly not all on the production side. In fact, as will be seen in the following sections, the supply side does not usually dominate. Furthermore, although one aspect or constraint may dominate in the initial phases of development, the resolution of this constraint will normally uncover other constraints, thus an integrated approach that predicts and resolves multiple constraints must be adopted. The analysis of the viability of a possible development project can be extremely complex and dependent on a large number of variables that are difficult to estimate. Hence, the approach adopted has been to evaluate the potential of a project in rather broad terms and then to set up a pilot project to determine in practice its viability, and to uncover the second generation constraints that appear. In the following sections, a broad picture of some of the potential markets for cassava is presented for different regions of the tropics in the Western Hemisphere.

Brazil

Latin American cassava production figures are dominated by Brazil, which produces more cassava than the rest of the region combined. Not only is Brazil the world's largest cassava producer but it also possesses a tremendous diversity of cassava production and utilization systems that function under quite different conditions of social development. For this reason, demand in Brazil is treated separately for the south, the central region, the northeast, and the north. The crop has traditionally been grown in the southern part of the country. The heavy subsidies to wheat in the seventies stimulated a shift from the use of cassava for human food to its use as a pig feed on farms where it is produced. Survey data indicate that over 80% of the cassava in this region is used as animal feed. Cassava competes directly with maize, which is also grown in this area. Maize is generally sold, whereas cassava is used on the farm. The increasing demand for meat products in Brazil suggests there is room for expansion of cassava production for use as a feed on the farm.

In the states of São Paulo, Rio de Janeiro, and Minas Gerais, cassava flour (**farinha da raspa**) used to be an important cassava-based industry. The use of cassava flour in bakery products increased from 50,000 tons in 1967 to 180,000 tons in 1975. With the massive wheat subsidies implemented in the first years of the seventies and estimated to have reached levels of US$1.5 billion per year in 1986, cassava flour became uncompetitive in price terms, and this industry was essentially destroyed. Some 300 processing plants were closed in the State of São Paulo alone in the seventies. The World Bank has estimated the efficiency of food subsidies in reaching the target poorer segments of the population and has shown that the wheat subsidy is inefficient (Table 1). The Brazilian government is committed to removing the wheat subsidies in the coming years, and this can be expected to bring about a revival of the flour industry. With the decline of the flour industry in the region, cassava has been increasingly used as a fresh vegetable and as the raw material for the starch industry. The supply of fresh cassava to São Paulo has increased from 8000 tons in 1975 to 25,000 tons in 1984. In Rio de Janeiro, total fresh cassava consumption has increased by 50% in the period 1980-1984.

Table 1. Efficiency of a price subsidy on selected foods in Brazil.

Food	Per capita consumption		Income transferred to target group per US dollar of subsidy (cents)
	Target population (g/day)	Total population (g/day)	
Bread	30	58	18
Farinha	279	139	60
Beans	88	68	39
Maize	35	26	40
Rice	86	111	23

SOURCE: World Bank.

Economic analysis shows an increasing demand for fresh cassava in major urban centers in the region. This demand is not being met with a convenient product due to the perishability of fresh cassava. Newly available technology developed at CIAT can move cassava into urban markets as a less perishable and more convenient food.

In northeastern Brazil, cassava is a basic staple, providing about 25% of the calorie intake for about 25 million people, mainly in the form of **farinha da mandioca**. In the drought at the end of the seventies and the beginning of the eighties, cassava was the major staple for survival in the region. Prices rose dramatically and demand outstripped supply; nevertheless, under normal circumstances the prices for cassava and farinha show large fluctuations as variations in supply and demand for this inelastic product are not perfectly in phase. There is little incentive for farmers to increase production in the face of market uncertainties. At the same time, the area has a large deficit of feed grains for the rapidly expanding animal feed industry. Linear programming models indicate that dry cassava can readily enter into animal feed rations at the present prices of competing products such as maize, which is brought in from the south or central-west region. This would increase the demand for cassava and effectively place a floor price on it, which would in turn give added security to cassava producers and provide them with an incentive to increase production. Brazilian officials are already moving to establish a cassava drying industry in the region.

In northern Brazil, cassava is an important staple, particularly in the frontier areas that are being colonized. Cassava is planted on the first land that is cleared and provides basic food needs while settlers clear more land to establish perennial tree and fruit crops that are suitable for sustained production under these fragile environmental conditions. In these hot, humid climatic conditions, cassava is one of the few basic starchy staples that can be produced efficiently. The cost of transporting staples from other areas is prohibitive; as a result, demand for cassava is likely to be buoyant. This situation corresponds very closely with that of the Indonesian transmigration schemes where cassava is the dominant pioneer crop, even exceeding rice in area planted. However, the long-term trend for cassava demand as these areas develop is not clear.

Andean Zone

Cassava is a minor staple in highland urban areas and an important basic staple in many of the lowland areas of the Andean countries. In contrast to Brazil, where most cassava is eaten in the form of flours such as farinha da mandioca, in the Andean zone cassava is mainly consumed in the form of fresh cassava. Urban consumption is much less than rural consumption, largely due to the high price of cassava in urban areas (Table 2), and its lack of convenience as a food. The very rapid urbanization in Latin America has led to a decrease in total demand for fresh cassava in the last two decades. However, with 70% of the population now in the urban sector, the rate of urbanization must obviously decelerate. In the urban sector, demand for fresh cassava is expanding rapidly and at a rate faster than the population growth in that sector (Table 3).

The income elasticity of fresh cassava was found to be similar to that of rice (which is a preferred good) in Colombia (Table 4). Fresh cassava's own price elasticity is generally difficult to estimate from available time series data due to the confounding effects of urbanization. In Colombia, cross-sectional data allowed a more accurate estimate to be made and fresh cassava was estimated to be relatively elastic with regard to its own price (Table 4). In the absence of data to the contrary, the most reasonable hypothesis is that this holds true for the other Andean countries. It can therefore be expected that as the urban population grows, mainly through autonomous growth in the future rather than through migration, and as incomes rise when development takes place, there will be a substantial increase in the demand for fresh cassava in urban areas. Marketing margins for cassava in major urban centers are commonly 400% to 500% of the farm-gate price.

Table 2. Prices of fresh cassava as a percentage of farm-gate price.

Country	Metropolitan area	Town/rural area
Colombia (1983)	560	340
Ivory Coast (1984)	420	160
Indonesia (1980)	400	210

Table 3. Annual volumes of fresh cassava arriving in major urban wholesale markets in Latin America (in thousand tons).

City	Year			
	1975	1978	1980	1984
Caracas	5.4	10.4	22.2	17.9
Bogotá	n.a.	31.4	42.1	51.2
Lima	n.a.	n.a.	18.2	30.2
São Paulo	8.2	n.a.	16.3	25.9
Rio de Janeiro	n.a.	n.a.	8.2	12.1

Table 4. Cross-section estimates of demand elasticities for cassava and rice by income strata, Colombia, 1981.

Income quintile	Fresh cassava		Rice
	Price	Income	income
1	-0.84	1.47	1.32
2	-0.92	1.23	1.46
3	-0.93	0.27	1.10
4	-0.92	0.64	0.85
5	-0.83	-0.04	0.13

As demand is relatively elastic, any decrease in marketing margins that leads to a decrease in the consumer price can be expected to further increase demand. Thus, adoption of new conservation technology that offers the opportunity to decrease the very high marketing margins of fresh cassava, thereby reducing the consumer price, would greatly increase consumption. Economic analysis indicates that demand for fresh cassava in urban centers would be increased by 30% to 50% in urban markets over the next decade by adoption of the new technology. The estimates of demand increase are conservative as the new conservation technology not only opens the way to decreasing consumer price but also provides the consumer with a more attractive product. In initial testing of the technology on a commercial scale in the cities of Bucaramanga and Barranquilla, Colombia, consumer attitudes were extremely positive to this new, convenient product. In addition, cassava is often produced far from the major urban centers and cannot reach them before spoilage occurs. The new conservation technology, for example, opens up the possibility of producing cassava in the highly productive jungle area of Peru and moving it into the capital, Lima, which has a food deficit.

The whole Andean region has a deficit of feed grains for its burgeoning livestock industry (Table 5). These deficits are increasingly being overcome by cereal imports. It is, however, well established that dry cassava can readily substitute for a large proportion of the cereal grains in balanced diets. In Colombia, economic analysis indicated that cassava could compete with feed grains in the livestock industry. Nevertheless, it was only with institutional support to the small, low-resource-base farmers who produce cassava that a successful cassava drying industry was established in Colombia. Economic analysis shows that cassava can compete with locally produced cereal grains (where these are not subsidized) in all Andean countries.

Not only are the Andean countries importers of feed grains but also of wheat for human consumption. Economic analyses in Colombia show that at present it is possible to substitute cassava flour partially for wheat flour. In the other countries with neutral pricing and subsidy policies, this also appears possible. However, there are still technical problems related to the quality of cassava flour, which varies according to root variety and management, and the production of high-quality flour without contamination or discoloration unless costly energy-consuming technology is used to dry the roots.

Paraguay

Paraguay has the highest per capita production of cassava in the Americas at over three quarters of a ton per year. Average per capita consumption of

Table 5. Imports of feed and food grains in 1985 and annual growth rates (1970-1980) in selected Andean countries (imports in thousand metric tons and growth rates as percentage annual growth rate).

Country	Wheat		Sorghum/maize	
	Imports	Growth rate	Imports	Growth rate
Colombia	628	4.0	217	14.1
Ecuador	352	13.5	--	--
Peru	1010	4.5	358	24.5
Venezuela	1045	2.2	1581	10.9

fresh cassava is about 1 kg per day in rural areas and one-third of a kilogram in urban centers, giving an overall average of one-quarter of a ton per capita per year. It is unlikely that per capita consumption will increase since, at least in rural areas, the physical capacity to ingest cassava is already being reached. Nevertheless, at slightly reduced consumption levels it has been estimated that population growth alone will increase total demand by 1 million tons by the year 2000.

Approximately one-third of the cassava in Paraguay is used for animal feed on the farms where it is produced. It is highly competitive as an energy source in animal feed rations and is likely to maintain that status if the already high yield levels are maintained. As demand for meat products is increasing rapidly, it is expected that demand for cassava as an onfarm feed will increase. Even if more intensive systems of pig production are adopted, the small units should still be able to survive in much the same way as the intensive onfarm systems in southern Brazil.

Mesoamerica

Cassava is not an important crop at present; however, in all the countries analyzed, a strong demand exists for animal feed and high-quality flours that is not being met by domestic supply. The analysis to date indicates that cassava can readily enter animal feed markets; but, governments have to support the development of such an industry.

The Caribbean

Cassava is an important staple only in Cuba, the Dominican Republic, and Haiti. In Cuba, production has doubled as a result of high-yielding, cost-reducing technology. Furthermore, the introduction of the early maturing CMC40 from Brazil has extended the season when cassava is available in the market, thereby increasing the total demand. Nevertheless, overall demand for the fresh market is not likely to increase markedly. Thus, the Cuban policy is to utilize cassava as a cheap source of calories in animal feed rations.

The demand for fresh cassava in most of the Caribbean islands does not appear to be great. In addition, high labor costs and absence of large tracts of underutilized land do not make the prospects good for increasing the supply of low-cost cassava in the region. In the case of Haiti, cassava is an important staple; however, unless the major structural problems of underdevelopment are attacked as a whole, it is difficult to see a future role of cassava assisting in the development of the agroeconomy of that country. Because of cassava's importance as a basic food staple, it should obviously form part of any development plans for the country. But, it cannot be conceived of as the locomotive that will pull the country out of its depressed economic state. This situation contrasts strongly with that of Brazil and the Andean areas, where cassava can be seen as a vehicle to improve the welfare of the underprivileged small farmer on marginal agricultural lands.

Conclusions

Changes in government policies in South America as a whole in the 1980s have resulted in reduced subsidies to products that compete with cassava, thus enhancing the competitive ability of the crop. Expansive markets are seen for fresh conserved cassava for human consumption, dried cassava for animal feed, and high-quality cassava flours for human consumption.

In Mesoamerica, cassava has the potential to compete in animal feed markets, but, in general, lack of institutional support for the crop constrains the development of a dried cassava industry.

In the Caribbean, with the exception of Cuba, Haiti, and the Dominican Republic, cassava is unlikely to have a significant role in the agricultural economy. In Cuba and the Dominican Republic, as demand for fresh cassava is satisfied, an increasing proportion of production will move into animal feed markets.

Chapter 3

INTEGRATED CASSAVA PROJECTS: A METHODOLOGY FOR RURAL DEVELOPMENT

Carlos A. Pérez-Crespo*

Introduction

The Latin American economic development model, and particularly its food production model, has not been favorable for cassava. Basically, Latin American fiscal policies have been oriented toward developing industry at the expense of agriculture. These policies have aimed to provide cheap subsistence foods by controlling prices for agricultural products. As a result, the prices of these products have deteriorated since the 1930s in relation to the prices of industrial products (Valdés E., 1973). Policies have also used overvalued exchange rates to promote export products and to favor importation of materials for industry.

These policies have brought about confrontations between industrialists and large landowners. Nevertheless, these confrontations have been partially resolved through a selective institutional promotion of agricultural products for export and nonbasic goods (Valdés E., 1973; Schuh, 1968). As a result, support prices have been maintained for crops such as cotton, barley, and sesame, whereas low prices for basic foods have made their production less profitable. Likewise, governmental support in the form of credit, road and irrigation infrastructure, and technical assistance has mostly been directed at large agricultural producers. The best lands have been used to produce lucrative commodities that include cattle and crops other than essential foods. This situation has further exaggerated unequal distribution of rural income, which affects 60% of rural Latin American families that have little or no access to land (FAO, 1974; Hewitt de Alcántara, 1974; Kalmanovitz, 1978; Lassen, 1980; World Bank, n.d.).

---

* Anthropologist and senior research fellow, Cassava Program, Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia; currently, field research associate of the Institute for Development Anthropology of Binghampton, New York, USA, and adviser to the Program for Alternative Development of Cochabamba, Bolivia, stationed in Cochabamba.

Additionally, stagnation in production of basic grains and displacement of popular consumer crops, such as cassava or maize, have been related to agricultural overproduction in developed countries. Overproduction has been solved through massive export of food to developing countries rather than through deflation. The exported foods have been sold at prices so low that they made domestic production of grains and alternative crops scarcely competitive. In many cases, this situation has been accepted because it has favored capital accumulation in the domestic industrial sector on the basis of cheap foodstuffs and wages (de Janvry, 1983; Hall, 1978; Lappe and Collins, 1977). The profound changes in nourishment patterns of Latin American populations are largely the result of these fiscal policies.

Although the Latin American economic development model has created conditions unfavorable to the consumption of cassava in current markets, the crop's development in the form of new products and new markets is an attractive policy option. The challenge lies in converting cassava into competitive commercial products with high market versatility by using knowledge of consumers' needs and expectations and by using advanced production and processing technology.

The Origin of the Concept of Integrated Project

The concept of the integrated cassava project arose as an alternative model to articulate research and development in cassava both at the national and international level. Well into the second half of the twentieth century, strong programs for agricultural research still did not exist in Latin America. Research in cassava was fragmentary, with large unexplored areas, and it was restricted to aspects of production. Research on cassava, as well as many other tropical crops for domestic consumption, was considerably behind research on crops produced in temperate climates. A body of accumulated knowledge in agricultural research centers on tropical crops that could be tested and transferred to developing countries did not exist.

It is in this context that CIAT's Cassava Program was born with a mandate to solve cassava production problems through the development of new varieties and efficient agronomic practices, combined with basic research in physiology and pathology. Implicitly, the mandate required the establishment of cooperation links with national research institutions that would use the research results. In most cases, the Program was required to contribute to the creation of national programs for the crop.

During its first decade (1969-1979), the Program concentrated its efforts on the improvement of varieties and agronomic practices because it shared the philosophy of the green revolution and its objectives of generating high-yielding varieties with wide acceptability. The success of rice and wheat varieties in Asia, however, was not replicated for cassava or any other crop. It was evident that a much longer term strategy was needed than the one that originally had been advanced. Technology could not be transferred easily and without various adaptations. Research work concentrated on pathology, physiology, entomology, and soil management.

During this period several national research programs were set up for cassava. In spite of training given to researchers of national programs and the transfer of germplasm, farmers did not adopt technology produced by CIAT or national programs.

In the late 1970s, the results of CIAT's Cassava Program were promising. The Program, however, had critics who insisted that the process of transferring the improved technology that CIAT had produced was very slow (Froman, 1979). These criticisms, valid also for national programs, included questions about the reasons why Latin American farmers were not increasing cassava production. Critics also asked why there were only a few national cassava programs despite the many years of CIAT's Cassava Program. Finally, some critics doubted the Program's capacity to generate an important technological breakthrough, and the possibility of developing competitive national markets for cassava in the context of the growing demand for livestock products and balanced feeds based on maize and sorghum (Mellor, 1984).

The limited impact of CIAT's cassava research program had several explanations. First, the Program had sought to produce widely adaptable varieties, but the clones tended to be appropriate only for particular environments. Second, the market should have been expanded and the prices of cassava stabilized. Otherwise, increases in crop production could depress prices. Third, the process of technological innovation consisted of scientists defining problems to investigate, testing new technologies, and passing them on to extensionists to be diffused. The role of the farmers was essentially passive; their knowledge and experience were not incorporated into the design of technology. Fourth, the model of technology generation and transfer was one-directional (researcher to extensionist to farmer). There was a need to establish vertical mechanisms for information feedback integrating all these levels, and to form more direct and permanent nexuses among the institutions of technology generation and rural development. Fifth, the international agricultural research centers had an image of themselves as production research (and training) institutions. With this focus, the IARCs paid little attention to postharvest activities, commercialization, service delivery, and structural limitations.

In the late 1970s, the Program abandoned efforts to develop widely adaptable varieties. Instead, it chose to generate populations that could be selected for the different ecosystems in which cassava was produced. It also adopted a similar strategy for production technology. As it entered the 1980s, the Program emphasized that increased production needed good markets. Hence, it was essential to count on both good markets and technology to increase production. The Program recognized that the producer lacked incentives to produce cassava in the absence of assured markets. As long as limitations existed for marketing cassava, it was expected that the demand for improved production technology would remain low.

The Program decided to carry out studies on preservation technology and cassava commercialization. The Program's focus was on the development of dry cassava conservation technology and drying roots for human and animal use, although it continued to include the generation of low-cost production technology (CIAT, 1984a). The Program aimed to increase its impact in the medium term through processing that would then enable it to upgrade the crop's marketability (Best et al., 1985; CIAT, 1984a and 1985a; Moreno et al., 1988). From the early 1970s, CIAT's Cassava Program pointed out the need to count on cassava conservation technology and on characterization studies of the commercialization process (Cock, 1987). Due to the dearth of permanent internal funds for this type of research, the Program's concerns about postharvest problems in the early 1970s were manifested only in a series of special cooperative projects with the Tropical Products Institute (the present-day Overseas Development and Natural Resources Institute, ODNRI) in England. The Cassava Program's utilization section was not formally created until the late 1970s.

In 1984, the External Program Committee of CIAT's Board of Trustees asked the Program to carry out studies toward certifying that potential demand for cassava in human and animal markets existed in Latin America and elsewhere in the world. It hypothesized that cassava production would not be profitable and that the potential return from CIAT's cassava research would be less than investing these resources in alternative crops. It requested that CIAT accelerate ongoing studies in order to substantiate or reject these hypotheses (CIAT, 1984b).

Between 1985 and 1987, the Program conducted studies on the potential demand for cassava in markets of Brazil, Colombia, the Dominican Republic, Ecuador, Jamaica, Mexico, Panama, Päraguay, Peru, and Venezuela (Ibáñez-Meier, 1987; Janssen, 1986; Lynam, 1987b; Sáez, 1987a and 1987b; Sanint, 1987a, 1987b, and 1987c). These studies complemented the analyses of demand in Asia. As a result of the demand studies for Asia and Latin America, CIAT's Program Committee "was convinced...that the demand for cassava is strong and is growing. In Asia, the demand for dry cassava for animal nourishment is especially strong, in addition to its use in many countries for human consumption. In Latin America, there exists a great demand for fresh cassava for human consumption and also for dry cassava for animal nourishment. A potential use exists of the dry product for flour that can be made into bread" (CIAT, 1987a).

The pressure exerted on the Program obliged it to wisely consider the effective impact of this research among producers. Thus, the need to participate directly in cassava development projects as a sine qua non condition for the development of the crop was accentuated.

As a coincidence, Colombia's Integrated Rural Development Program (DRI) at that time requested the collaboration of CIAT's Program to solve problems related to the inelasticity of demand and the instability of cassava prices for human consumption in the market of the departments of Córdoba and Sucre on the Atlantic coast. CIAT immediately began to participate in a pilot project of drying cassava for animal feed. The pilot project, launched in 1981, began with the construction and operation of a patio (measuring 300 m^2) for cassava solar drying, the training of farmers and technicians in processing and production technology, the establishment of commercialization agreements for dry cassava as a raw material for the balanced feed industry, and the conformation of a multidisciplinary and multi-institutional team for directing the project. Parallel to this activity, the project began collecting and analyzing information in order to determine economic and technical levels of efficiency in plant operation and the characterization of production systems and their limits. This information was used to redesign and adjust the project. Both the methodology of analysis and the general strategy of this first experience have guided the project's expansion, which in 1988 included 36 drying plants with a total of 34,035 m^2, distributed in the departments of Atlántico, Bolívar, Cesar, Córdoba, Magdalena, and Sucre (CIAT, 1982; Gómez, 1983; Best, 1984; Best and Ospina, 1985 and 1986; CIAT/DRI, 1987).

In 1985, CIAT and the DRI Program began a fresh cassava conservation project for the urban market of Bucaramanga. This project sought to test the commercial viability of a low-cost technology for fresh cassava conservation by packaging it in polyethylene bags and treating it with a fungicide, which would lengthen the useful life of the root up to three weeks after harvest without refrigeration (Janssen and Wheatley, 1985). The greatest challenges were to ensure high-quality control of the cassava in bags, acceptable price levels, and an effective promotion of the new product.

The fresh cassava pilot project began with three comparative studies. In the first study, a survey was conducted to compare patterns of commercialization and consumption of cassava and potatoes (de Morrée, 1985). In the second study, a 400-household sample was used to measure consumer attitudes and patterns of purchase and consumption of cassava and other food products (de Haan, 1986). In the third study, members of 100 households were asked to evaluate the cooking quality of processed and unprocessed cassava. The methodology developed in the first two studies was later used in studies of marketing and consumption, with the participation of national institutions in Lima, Peru (CIAT, 1987b), in Barranquilla, Colombia (van Koersveld, 1987), and in Guayaquil, Ecuador.

These pilot projects, both of dry and fresh cassava, emphasized the interdependent character of production, processing, and commercialization of cassava. The project operation required constant adjustment in processing and marketing strategies. It also necessitated reliable mechanisms for increasing crop productivity, selecting varieties, and guaranteeing cooking quality. The projects served as a vehicle to put the results of years of experimental research into practice, to channel the participation of more than 10 public and private organizations, to form groups of cassava processors, to support the internal capacity of each processing group, and to design methodologies for the training of new groups.

Preliminary Results

The potential of diversified development with cassava is evidenced by the impact of the integrated projects, particularly in Colombia and Ecuador. In the 1986-87 cycle, drying plants on the Atlantic coast of Colombia processed 9900 tons of fresh cassava to produce 3800 tons of dry cassava. These plants generated approximately US$550,000. Small farmers have organized themselves in 36 organizations with a total membership of 1300 that chipped and dried cassava on the Atlantic coast. These organizations have provided sources of indirect income for another 6000 people and have also provided benefits to consumers (see Cock, Chapter 1, this volume). According to Amín Martínez, President of the National Association of Cassava Producers and

Processors, "Producers have begun to think like the businessmen they are." Increasingly, small farmers are playing a more active role in cassava production, processing, and commercialization, and also in the training of new members and in technology transfer.

The economic success of the integrated projects has been repeated by producers not linked to the DRI-CIAT agreement. In the same area, producers processed some 400 tons of dry cassava with their own capital. Additionally, in the departments of Santander, Norte de Santander, and Cauca, drying plants appeared "spontaneously" and without technical assistance being delivered to small-farmer communities. With these "spontaneous" drying patios that were inspired by the integrated cassava project, the total capital generated in Colombia by cassava drying was at least US$937,000 in 1988.

The processing and bagging of fresh cassava treated with fungicides must also be added to these activities. In the cities of Bucaramanga and Barranquilla, about 150 tons of cassava were processed, and were valued at US$1,500. Thus, diversified development of cassava in Colombia has generated direct activities at the producer level, which generated about US$1 million in 1988. As the opening of new cassava markets has stabilized fresh cassava prices, the beneficiaries of the integrated projects in Colombia have encompassed both farmers and consumers (see Wheatley and Izquierdo, Chapter 5, this volume).

In Ecuador, after only three years of commercial cassava drying, 17 producer organizations exist and have a total of 400 members. The organizations have obtained 50% of their raw materials from farmers not linked to the cassava drying project. Farmers participating in the integrated project produced 1100 tons of flour in the 1988-89 cycle. This flour was acquired by the shrimp-producing industry, with a value of over US$200,000. They also produced 13 tons of starch for human consumption and industrial use. Moreover, they exported 24 tons of fresh cassava treated with fungicide to the United States, and they sold another 20 tons of fresh processed cassava in the national market.

Prior to the project, cassava remained in the fields for many months without being harvested. The few buyers in the long-established starch industry in Manabí did not offer producers good prices and did not guarantee that they would purchase their roots. Today, the demand for roots is growing, and the surface area under production has increased from 7700 ha in 1985 to 15,000 ha in 1988. The organizations' growth has been stunted due only to insufficient credit, because 90% of the members lack property titles for the lands they cultivate, and thus they do not have the collateral necessary to guarantee loans.

Both in Colombia and Ecuador, the diversification of cassava has contributed to considerable improvement in price stability for the roots, and thus it has boosted the incomes of producers. Integrated projects have served not only as generators of profitable economic activity but also as nuclei for development with implications beyond the producers themselves. They have created opportunities for broad sectors of wholesalers and retailers, and they have stimulated the development of the balanced feed industry, shrimp production, and manufacturing industries in general. The projects have made it possible for small-farm and small-industrial producers to play an active role in the technology transfer process. Finally, they have served as nuclei for interinstitutional cooperation and as a means for effective promotion of the agroindustrial development of cassava.

In synthesis, cassava has an enormous potential for contributing to social development. To realize this potential, it is necessary to design an efficient combination of new products, prices, distribution systems, and promotion schemes. One of the possible strategies to achieve this combination is that of integrated cassava projects. These projects allow for the promotion of the agroindustrial transformation of the crop by using improved production and processing technology, marketing techniques, and social technology in processes requiring technical and institutional integration. The projects create several opportunities for social development, and they contribute to the definition of new roles for national and international agricultural research and development centers.

Strategies for the Development of Cassava

The concept of integrated projects, to generate economic stability for producers through cassava agroindustrial production, has crystallized in four strategies: to penetrate the market, develop a product, develop the market, and diversify (cf. Ansoff, 1957). Strategies of market penetration and product development have been used in current markets, and strategies of market development and diversification have been used for new markets.

Market penetration

For market penetration, efforts are channeled into intensifying cassava sales using current cassava products in existing markets. This strategy has primarily consisted of improving the production system, transportation to consumpton centers, and commercialization mechanisms, particularly networks of middlemen and sales outlets.

One of the most successful experiences of market penetration has taken place in the area of Caicedonia, Colombia. In the late 1960s, the National Coffee Federation explored the possibility of planting cassava in this traditional coffee-producing area. It aimed to produce local varieties with a high commercial acceptance and sell them in the fresh-cassava market in Bogotá, and thus reduce the area's dependency on coffee. The Federation provided farmers with technical assistance, credit, and a sophisticated commercialization system that guaranteed regularity in the flow of supply and corresponding stability in prices. Between 1974 and 1978, the land area planted in cassava climbed from 500 ha to 1300 ha. As a result, cassava became an important economic activity, and today it produces 10 million dollars annually for the area (Cock, 1989).

Product development

The product development strategy consists of replacing or improving existing cassava-based products with other new ones for the existing market. The product development strategy considerably broadens and improves the perspectives of cassava commercialization. Examples of the product development strategy are peeling, freezing, and dehydrating the roots for sale in supermarkets.

The successful application of strategy may be illustrated by the San Carlos area of Costa Rica. Since the 1970s, the area's agroindustrial companies have processed and frozen cassava for export to the United States. In harvests, the plants process 18 to 25 tons of fresh cassava daily with hired labor of 100 operators per company. They pack roots in 700-gram bags, which are stored in refrigerated containers for export. The plants feed the cassava peels to pigs located within the confines of the enterprises. They sell the pigs to generate additional income.

Market development

The market development strategy consists of utilizing current products in new markets. The case of starch is particularly illustrative. Starch has traditionally been used in baking breads. In Colombia, Costa Rica, and Panama there are some industrial enterprises that currently use starch for the industrial fabrication of condiments, dehydrated soups, premixtures for cold meats, appetizers, sweets, and compotes. These industrial enterprises have expanded the markets of a traditional product. The new markets cover new functions. Cassava starch leaves the sphere of basic foods (breads) and enters the environment of sumptuous foods. This broadens the price margins that buyers are willing to pay for cassava. The new markets also cover new geographic areas where cassava previously was not used, such as appetizers that are also exported. These conditions open enormous opportunities for the development of cassava.

Diversification

The diversification strategy consists of using new products in nontraditional markets. Perhaps the most successful application of this strategy is the incorporation of dry cassava chips as raw materials in the balanced feed industry. This approach has expanded cassava's participation to include the industrial production of poultry, pigs, and shrimp. Ecuador generates US$300 million annually from breeding and exporting shrimp raised in lagoons. Originally, Ecuadorian shrimp producers employed sea water and its nutrients. Subsequently, they began using balanced feed in pellet form. The pellets last about six hours before decomposing in the water, and so crustaceans can completely consume them. In Manabí, Ecuador, the ABA factory of balanced feed has replaced the costly chemical agglutinant that was imported from Europe with locally produced cassava starch. This new market has brought about an increase in the area under cassava production in Manabí from 6500 ha in 1986 to 13,000 ha in 1987. The demand for starch, however, has not yet been satisfied, and thus expansion of production is expected (CIAT, 1988b).

To use these strategies, cassava agroindustrial development needs to establish new research and development, and production and promotion links in the current structure of cassava production. As strategies' success depends on innovative capability in technology and marketing, project development requires solid research backing. Most cassava producers cannot fill this need alone. They require an institution that assumes responsibility for, and the costs of, research and technical assistance, and that provides general financial support.

To enable small producers to gain access to agroindustrially developed cassava, a group of institutional interventions should be developed. These interventions will take advantage of technological developments in production and processing, and advances in commercialization and promotion systems, within an atmosphere minimizing risks for small farmers. These actions will serve as a nucleus to relate the producer to the final consumer, and will benefit both of them. In this context, an optimum path to accelerate agroindustrial diversification of cassava, while activating producers' groups, is with integrated projects that require both new technology and institutional support.

Development of Technology and Institutional Strengthening in an Integrated Cassava Project

The strategy of an integrated cassava project assumes interventions in two different but complementary areas: technology and institutional strengthening.

Technology

Coherent and mutually influencing interaction is accentuated in the project, along with simultaneous control of the technical functions of production, processing, and commercialization in a context that changes over time (Best et al., 1985; Moreno et al., 1988). The assumption is that the need to offer a product with desired market characteristics will affect the production and processing technologies that small farmers use. The activities of processing cassava will modify, in their turn, current volumes of cassava production in the area, the quality of roots produced, and the harvest date. Finally, increases in root production will require changes in the capacity of product processing and commercialization.

The integrated project simultaneously addresses aspects related to production, postharvest treatment, and marketing of the crop. Nevertheless, neither production nor postharvest treatment, and even less so the sale of the product, are ends in themselves. They are essential components that are systematically articulated to develop a commercial product and make it accessible to the consumer. The integrated project defines the tasks of production and processing in such a manner that they are conceived and implemented as a part of the product development task. It orients product development in accordance with the specific characteristics of a final market and interprets the effectiveness of its actions from the viewpoint of objectives that go beyond what is strictly agricultural.

Commercial acceptance of the final product is the element in which the activites of crop production, processing, and commercialization are integrated, and to which they are oriented. Therefore, the methodological starting point of the integrated project is the area of contact between the final product and the consumer, a contact that is established after commercialization, and that is a necessary requirement for effective marketing. Hence, the characteristics that consumers attribute to a product that they wish to acquire mark the critical starting point.

The demanded characteristics in a particular market define the range of usable production and processing technologies, the optimum technical and economic levels under which the crop will have to operate, and the most appropriate approach for commercialization of the final product. Likewise, demand serves as a guide to determine both the advised volume of production and processing of the crop as well as the final form in which the crop is presented to the consumer through marketing. The performance of the crop in the market is also an essential point of reference for evaluating the effectiveness of an agricultural program. The success of the tasks of crop production or utilization cannot be defined independently from each other or independently from the market, but at the rate in which these elements contribute in a harmonious manner to the development of a marketable product. Hence, production and utilization are part of a system that carries itself out through commercialization.

This methodological organization does not contradict the existence of an internal process in which the production, utilization, and commercialization components each have a temporary preeminence in the process of final product development. On the one hand, it is possible to consider these functions as "episodes" (even parallel ones) at the rate in which they are integral, albeit distinct, parts of the whole. On the other hand, the functions of production, processing, and commercialization take turns in assuming the role of "leader" during the process of creating the final product. In any case, the individual efficiency of each component strongly affects the results of the whole of the integrated project.

Institutional strengthening

Integrated cassava projects require high levels of commitment, social participation, and administrative performance. In an integrated project, the design of effective organizational strategies for implementation is emphasized. This assumes an evaluation and refinement of systems that will gradually transfer power to farmers so they can autonomously administer cassava-based agroindustrial enterprises and also provide the general direction of the regional development that these enterprises will generate. The project also requires accentuating technical, administrative, and organizational training for farmers. Finally, it identifies channels and models for establishing cooperation between the various public and private institutions that offer support services in technology generation, product design, technical extension, credit, and marketing and promoting products.

An integrated cassava program has elements in common with integrated rural development programs. Both emphasize the relationship and mutual support of economic and social development and the importance of active participation of beneficiaries. For both, decision making is a multifaceted process because they seek multiple objectives at different levels. Hence, the programs need to use multidisciplinary teams. Both programs explicitly identify the rural poor as their principal clients. As a result, they seek to raise employment and income levels, to promote more equitable distribution of income, and to increase access to rural services for the less privileged sectors of rural areas.

Nonetheless, an integrated cassava program differs from an integrated rural development program. First, an integrated cassava program concentrates its activities in a reduced geographic area and seeks narrower objectives than those of an integrated rural development program. A cassava program can therefore be incorporated within integrated rural development. Second, an integrated cassava program requires public and private investment, but it is above all a technology-induced development program. The element that releases development is not so much the infusion of capital for infrastructure or operations but the adoption of a technology. Technological innovations permit the exploitation of a series of national resources, especially local ones, that previously were underused. These resources include acid soils suitable only for production of a few crops. These underused resource bases also include entire geographic regions that are disadvantageously and unequally integrated into the national economies.

References

Ansoff, H. I. 1957. Strategies for diversification. Harvard Business Review.

Best, R. (comp.). 1984. Plan piloto para el desarrollo agro-industrial del cultivo de la yuca en algunos departamentos de la Costa Atlántica de Colombia. Proyecto Cooperativo DRI/ACDI-CIAT, tercer informe, junio 1983-junio 1984. Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia. 126 p.

________. 1988. Cassava utilization. In: Cassava Program annual report 1985. Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia. p. 109-171.

_________; Janssen, W.; and Moreno, R. 1985. Integrated cassava pilot projects: An outreach strategy for Latin America. Presentation at CIAT annual internal program review, 1984. Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia. 23 p. (In typescript.)

_________ and Ospina, B. (comps.). 1985. El desarrollo agro-industrial del cultivo de la yuca en la Costa Atlántica de Colombia. Proyecto Cooperativo DRI-CIAT, cuarto informe, tomo 1, julio 1984-junio 1985. Centro Internacional de Agricultura Tropical/Fondo de Desarrollo Rural Integrado (CIAT/DRI), Cali, Colombia. 42 p.

_________ and _________ (comps.). 1986. El desarrollo agro-industrial del cultivo de la yuca en la Costa Atlántica de Colombia. Proyecto Cooperativo DRI-CIAT, cuarto informe, tomo 2, julio 1984-junio 1985. Centro Internacional de Agricultura Tropical/Fondo de Desarrollo Rural Integrado (CIAT/DRI), Cali, Colombia. 93 p.

CIAT (Centro Internacional de Agricultura Tropical). 1982. Plan piloto para el desarrollo agroindustrial del cultivo de la yuca en algunos departamentos de la costa norte de Colombia. Proyecto Cooperativo DRI/ACDI-CIAT, primer informe, noviembre 1981-junio 1982. Cali, Colombia. 45 p.

_________. 1984a. Achievements: A summary of results obtained by the Cassava Program, with emphasis on the 1977-1983 period. In: Cassava Program report (revised version). Cali, Colombia. p. 8-87.

_________. 1984b. CIAT response to report of the Second External Program Review. Cali, Colombia.

_________. 1985a. Economics. In: Cassava Program annual reports for 1982 and 1983. Cali, Colombia. p. 487-509.

_________. 1985b. Cassava Program annual report 1984. Cali, Colombia. 270 p.

_________. 1987a. CIAT's Board of Trustees, CIAT Program Committee Report. Cali, Colombia.

_________. 1987b. The cassava economy of Latin America: A food staple in transition. In: Global cassava research and development. Cali, Colombia. (Draft version.)

________. 1988a. Cassava Program annual report 1985. Cali, Colombia. 371 p.

________. 1988b. Rising tide in Ecuador for cassava shrimp farming. CIAT International 7(2):3-6.

CIAT/DRI (Centro Internacional de Agricultura Tropical/Fondo de Desarrollo Rural Integrado). 1987. El desarrollo agro-industrial del cultivo de la yuca en la Costa Atlántica de Colombia. Proyecto Cooperativo DRI-CIAT, quinto informe, julio 1985-agosto 1986. Cali, Colombia. 46 p.

Cock, J. 1987. Cassava Program history and current strategies. Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia.

________. 1989. La yuca, nuevo potencial para un cultivo tradicional. Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia. 240 p.

de Haan, G. de. 1986. Buying behaviour and changing cassava consumption habits in Bucaramanga. M.S. thesis. Agricultural University of Wageningen, Wageningen, Netherlands. 90 p.

de Janvry, A. 1983. The agrarian question and reformism in Latin America. Johns Hopkins University Press, Baltimore, MD, USA.

de Morrée, D. 1985. A comparative analysis of marketing and consumption of cassava and potatoes in Bucaramanga: The possibility of the introduction of a storage technology for cassava. Agricultural University of Wageningen, Wageningen, Netherlands.

FAO. 1974. Agricultural development and employment performance and planning: A comparative analysis. Agricultural Planning Studies no. 18.

Froman, J. 1979. CIAT: The Cassava Program (Colombia). Harvard Business School Report 4-580-033. Harvard University, Cambridge, MA, USA.

Gómez, G. (comp. and ed.). 1983. Plan piloto para el desarrollo agroindustrial del cultivo de la yuca en algunos departamentos de la costa norte de Colombia. Proyecto Cooperativo DRI/ACDI-CIAT, segundo informe, julio 1982-mayo 1983. Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia. 53 p.

Hall, L. 1978. Food aid and agricultural development: The case of P.L.480 wheat in Latin America. Ph.D. dissertation. University of California, Berkeley, CA, USA. 222 p.

Hewitt de Alcántara, C. 1974. Social and economic implication of the large-scale introduction of new varieties of food grains. Country Report-Mexico.

Ibáñez-Meier, C. 1987. Brazil: Economic study of cassava. In: Global cassava research and development. Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia. 96 p. (Draft version.)

Janssen, W. 1986. Market impact on cassava's development potential in the Atlantic Coast region of Colombia. Ph.D. dissertation. Agricultural University of Wageningen, Wageningen, Netherlands. Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia. 357 p.

__________ and Wheatley, C. 1985. Urban cassava markets: The impact of fresh root storage. Food Policy 10(3):265-277.

Kalmanovitz, S. 1978. Desarrollo de la agricultura en Colombia. Editorial La Carreta, Bogotá, Colombia. 360 p.

Lappe, F. M. and Collins, J. 1977. Food first, beyond the myth of scarcity. Houghton Mifflin, Boston, MA, USA.

Lassen, C. 1980. Landlessness and rural poverty in Latin America: Conditions, trends and policies affecting income and employment. Rural Development Committee, Cornell University, Ithaca, NY, USA. 187 p.

Lynam, J. K. 1987a. On the design of commodity research programs in the international centers. Paper presented at the workshop on Social Science Perspectives on Managing Agricultural Technology. IIMI-Rockefeller Foundation, Pakistan.

_________. 1987b. The cassava economy of Asia: Adapting to economic change. In: Global cassava research and development. Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia. 394 p. (Draft version.)

Mellor, J. W. 1984. Letter to the director for resources research and international cooperation. Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia.

Moreno, R.; Best, R.; and Janssen, W. 1988. Integrated cassava production, processing and marketing projects. In: Proceedings of the VIIth symposium of the International Society for Tropical Root Crops held in Gosier, Guadeloupe, 1-6 July 1985. Institut National de la Recherche Agronomique (INRA), Paris, France. p. 495-503.

Sáez, R. 1987a. Cassava potential in Mexico and its relationship with the rest of the economy. In: Cassava Program economics. Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia. (In manuscript.)

_________. 1987b. Cassava potential in Panama and its relationship with the rest of the economy. In: Cassava Program economics. Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia. (In manuscript.)

Sanint, L. 1987a. Colombia: Potential demand for cassava. In: Global cassava research and development. Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia. 50 p. (Draft version.)

_________. 1987b. Paraguay: Potential demand for cassava. In: Global cassava research and development. Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia. 36 p. (Draft version.)

_________. 1987c. Venezuela: Potential demand for cassava. In: Global cassava research and development. Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia. 37 p. (Draft version.)

Schuh, G. E. 1968. Effects of some general economic development policies on agricultural development. Am. J. Agric. Econ. 50(5):1283-1293.

Valdés E., A. 1973. Trade policy and its effect on the external agricultural trade of Chile 1945-1965. Am. J. Agric. Econ. 55(2):154-164.

van Koersveld, E. 1987. The impact of a storage technology on cassava marketing and consumption in Barranquilla. M.S. thesis. Agricultural University of Wageningen, Wageningen, Netherlands. 55 p.

World Bank. n.d. The PIDER Rural Development Program. Washington, DC, USA. (Unpublished working document.)

Chapter 4

CASSAVA PROCESS AND PRODUCT DEVELOPMENT

Christopher Wheatley and Rupert Best*

Introduction

For small cassava farmers to link themselves successfully to growth markets in Latin America, new markets for cassava must be found. This means novel cassava-based products and processes must be developed and commercialized. Product and process development is a new area for CIAT and many national research and development institutions but is standard practice for all successful commercial enterprises. It is therefore worthwhile to consider how the food industry organizes and undertakes new product development, then determine how the differences between a cassava development project and industry will be reflected in differences in the product development process.

New product development is defined as the process of generating and selecting ideas for new goods and services, and converting them into commercially successful products. For the purposes of this article,"new product" includes traditional cassava products which are improved through better quality and/or more efficient processing. It therefore includes such activities as marketing and socioeconomic research, organization of distribution channels, product positioning, promotion campaign concepts, technical research into new products and processes, packaging design, and financial aspects such as feasibility, margins, and price structure.

The Industrial Approach to New Product Development

During the last 50 years, industry has improved the success rate of new product development programs. Before 1950, the emphasis was on company research departments to come up with technically innovative and superior products, which were assumed to result in increased sales and profits (product approach). In the 1950s, a variety of sales-increasing devices (credit facilities, discounts, hard-sell techniques) were developed to maximize sales as

---

* Senior research fellow in the Cassava Utilization Section, Cassava Program, Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia; and head of the same Section, Cassava Program, CIAT, Cali, Colombia, currently, Leader, Cassava Program, CIAT, respectively.

a primary objective (sales approach). Only in the 1960-70s did the market approach become dominant. Now, the emphasis is on identifying unsatisfied consumer needs (market opportunities) and designing products to fulfill them. Long-term company objectives of maximizing profits are better realized by identifying and satisfying consumer needs than by concentrating on producing technically excellent products or by maximizing sales in the short term.

Companies also distinguish between two basic types of market, consumer and industrial. The differences are due to the way purchase decisions are made. Industrial purchases are made using trained expert staff to make rational decisions based on product price, quality, and service. Individual consumers, however, do not necessarily compare competing products in a rational manner and are influenced by factors other than price and quality (e.g., packaging, convenience), and advertising can have a large impact on this. The development of new products for these two markets does not therefore follow the same pattern, especially in the later stages of test marketing and commercial introduction.

Description of the commercial product development process

A clear definition of project objectives is required to avoid confusion during the project. At the same time, project constraints should be explicitly stated at the beginning of the product development process. These could be related to the product itself (nutritional), processing (equipment to be used), marketing (distribution system), finance, organizational aspects (company expertise), or legal requirements (food regulations).

The commercial product development process encompasses the following steps insofar as consumer market products are concerned:

Idea generation. Ideas can be generated from consumers (surveys, group discussions, etc.), scientists, competitors, a sales force, or management. This process can involve both secondary sources and original research input (technical or market/consumer research).

Idea screening. A two-stage process is involved. First, those ideas not in accord with company plans and technical and financial capabilities, or otherwise outside the limits set by project constraints, are rejected. Second, the remaining ideas are rated by a range of factors related to likely product success such as marketability, product durability in the marketplace, the company's productive ability, and market growth potential. In order to execute this rating of ideas, some original research may be needed, such as market studies to determine consumer needs and characteristics and potential demand for a product, as well as a technical study to evaluate possible processes and products and to estimate both development costs and potential profits.

Concept testing. A product idea is defined in functional objective terms. The product concept is a subjective consumer-oriented meaning built onto the idea. Product concepts are tested with consumers to determine if they appreciate the product benefits directed at them. This also helps to determine the correct positioning of the product in the market (positioning differentiates the product from competitors through linking consumer needs to product characteristics).

Business analysis. Estimates of first and repeat sales, rate of market penetration and hence projected sales, profits, and rates of return can all be obtained at this early stage without the need for the product to be physically available, based on the information already gathered. Product ideas and concepts that are unlikely to meet the company's minimum acceptable rate of return can be rejected.

Product development and testing. In this stage, the heart of the project, the product is first tested as a prototype, and then the process is finalized for manufacture if the prototype is evaluated positively. Final-product specifications are then produced and a pilot plant is constructed and put into operation. The product resulting from pilot plant operation is then consumer and laboratory tested. Finally, some marketing decisions can be made, for example, product name and package specifications and design.

Market plan. Based on previous results, a plan is elaborated for distributing the product in target markets, and for its promotion.

Test market. The product is tested in one or a few trial markets together with an associated promotional compaign in order to check whether the product fulfills expectations, that the promotion campaign is correctly planned, and that the distribution network functions as outlined, and to determine sales under real conditions. Test results are used to select the best promotional strategy (media mix) to optimize product sales and profit potential. It is necessary to determine trial and repurchase rates through product shipment data, store audits, buyer surveys, etc.

Commercial introduction. The physical plant is built if necessary and training of production and sales forces completed. Early product adopters can be identified and targeted for promotion. Market expansion is planned to harmonize with the gearing up of production capacity, and stocks are accumulated. Finally, the product is distributed and the promotion campaign initiated. Great care is needed to coordinate all aspects, and timing of the commercial launch is crucial.

Evaluation. Actual sales data (trial and repeat rates) are used to adjust the promotion mix, product specifications, sales strategy, etc. These data should show that the rate of return on investment and profit produced are in line with expectations.

Regarding industrial market products, ideas often come from the sales force, which is in close contact with industrial clients and knows their needs. Concept testing is carried out with industrial contacts; test marketing is not needed. The product can be given to a few industrial clients for testing and, if successful, full commercial production will follow. The promotional strategy usually involves direct selling and little advertising. Because customers are fewer and their requirements better known than for normal consumers, the new product development sequence can be shorter and errors are less likely to occur. Close contacts with industrial clients are, however, essential.

Differences between product development in the food industry and cassava-based projects relevant to new product development

The socioeconomic and institutional framework within which a cassava-based product development project operates is different in many respects from the environment within which a commercial enterprise undertakes product development. Cassava projects involving CIAT must be compatible with overall program objectives of increasing incomes of the rural poor and of developing good-quality products suitable for the low-income consumer. In addition, products must be commercially viable. This is the prime concern of a commercial enterprise engaged in product development. Location of the processing facility in rural areas close to cassava production is essential in order that benefits of value added to the raw material reach the poor farmer and landless laborer. A purely commercial enterprise would have no such restriction, although practical advantages of having the plant located close to the site of raw material production are obvious.

Cassava is a small-farmer crop with significant problems in running large-scale plantations and managing a bulky vegetative propagule with a low multiplication rate, and it presents many difficulties with raw material supply. Normally, commercial enterprises either purchase raw materials on the open market or directly control their production. Cassava-based product development projects are faced with the problem of organizing supply on a continual basis from a large number of small farmers, and frequently competing for the raw material against other markets which can at times offer a higher price (especially the fresh market). Cassava is in many places seasonal, and is highly perishable in the fresh state once harvested. Stockpiling to even out supply problems is thus not an option.

The most successful model to overcome these difficulties is the formation of small-farmer cooperatives to perform processing operations. Farmers themselves can best organize a supply of raw material to their own plant, since they have a financial stake in its success. This model implies substantial investment in small-farmer training and organization. Experience has shown that many small cooperatives are more successful than a few large ones as the levels of management in poor rural areas are generally insufficient to capture possible economies of scale that could theoretically accrue to larger more complex organizations.

Small farmers, however, have little experience operating in a commercial environment, especially when interaction with other, larger enterprises in the sale of their product is required. Similarly, they have little expertise in the distribution and marketing of consumer-oriented products. This is second nature to the typical food company, and thus in order to operate effectively in this environment, the cassava-based project must contain substantial components of institutional support for processing and marketing operations. It is important that this support not be seen as a perpetual necessity but as a means to developing within the processing and marketing organizations their own capacity to perform these functions.

Many state institutions themselves have little experience operating in the commercial arena, however, and the project must take account of this. Specifically, the institutions involved in providing credit, training for cooperative management, and training in cassava production, processing, and marketing must all work together. In such cases, decisions are reached by consensus. A food company, on the other hand, has a hierarchical decision-making structure and will operate in a more timely and efficient manner. The cooperative itself will need to develop this ability, and a self-sufficiency, which a plethora of supporting institutions can delay.

If many small cooperatives are involved in producing a particular product, quality control will be a difficult issue. A food company, which directly controls the process in one or a few plants, can control product quality relatively easily. In order to achieve a similar result among many independent cooperatives, a strong second-level organization is an advantage. A federation of cooperatives, which can control product marketing more effectively and have direct contact with purchasers, be they consumers or other industries, can effectively control quality through both training and purchase-price negotiations with the individual cooperatives. A second-level organization is advantageous in other aspects of product marketing. For example, whereas a food company can easily change the volume of the final product as demand changes, a strong second-level organization is needed to help farmer cooperatives adapt quickly to such market changes. Product distribution is normally under the control of the company which produces it. This is an area where individual farmer organizations are particularly weak, especially for products aimed at consumer markets, where intermediaries are traditionally strong and have large profit margins. There is a strong case for mounting a separate and commercially run distribution and promotion operation for such cassava-based products. Again, a second-level organization could fulfill this aim.

Most of the differences mentioned so far put cassava-based products at a disadvantage compared with those produced by a food company, which has few of the social or raw material constraints of cassava. However, cassava-based projects do have some advantages. For example, a food company normally has heavy expenditures in research to develop a new product from the original idea. In the cassava-based projects described in this book, technical, socioeconomic, and marketing research operations are usually funded not by the farmer cooperatives themselves but by external agencies, especially IDRC (International Development Research Centre), USAID (United States Agency for International Development), ODNRI (Overseas Development and Natural Resources Institute), and CIAT itself. Thus, research expenses do not have to be set aside against future profits by individual enterprises but can be considered as a public good. The social returns on such an investment in making products viable can be high, but such investment is unlikely to occur in the private sector, hence reinforcing the need for public sector investment.

Whereas a company would have its own research department, and in many cases technical research would be practically completed before the product concept was even developed, much technical research is required for cassava-based products during most stages of the product development process, with adaptive research at the pilot-plant level being especially important. Given the many differences between a commercial enterprise engaged in product development and the type of organization usually involved in a cassava project, and the inherent problems involved in managing the raw material itself, the product development process in cassava has turned out somewhat different. The next section will attempt to explain this in detail.

New Product Development for Cassava

New product development in cassava forms a fundamental part of integrated production, processing, and marketing projects, which themselves constitute the basis for cassava-based development activities. These integrated projects are location-specific, being sited in particular cassava production regions where macroeconomic studies have demonstrated a potential market for some new or improved product. One product can be relevant to more than one region, however, and the initial experimental work on the product and/or process can be nonlocation-specific. Thus, for example, a product developed at CIAT can form the basis for several integrated projects, but a pilot plant would be necessary in each project in order to adapt both process and product to local conditions and preferences.

Project goals are to use the development of new or improved cassava-based products to benefit small cassava farmers and landless laborers through income increase and employment generation in the formation of rural agroindustries, and to benefit low-income consumers through the provision of acceptable cassava-based products. The project has a few constraints: cassava must be used as food or feed, the process should be capable of operation and management by unsophisticated small-farmer organizations (i.e., small scale, low technology, and low capital cost), and it should fulfill a need for low-income consumers (i.e., low cost, basic food, and thus a large potential market).

Steps for defining the development of new cassava products

Idea generation. Ideas for cassava-based products can come from research scientists, consumer and market research, competing products that have other ingredients for which cassava could substitute, and improvements to traditional products. Macroeconomic studies also generate potential ideas, such as perspectives for cassava in the national economy. They also serve to identify potential cassava production areas for pilot projects and to identify product opportunities.

A range of traditional products can be listed a priori: fresh storable cassava; dried cassava for animal feed; refined cassava flour for human consumption; sweet and fermented starch; alcohol, glucose, and other sugars (industrial uses); single-cell protein; etc. A whole series of derived products can also be imagined, such as fresh, prepared cassava; dehydrated cassava chips (like French fries); frozen cassava chips (like frozen French fries); extruded snack foods; pastas; breads and bakery products; modified starches for food and other industries; etc.

Idea screening. Those ideas not compatible with the social objectives of integrated projects are discarded. For example, single-cell protein is too sophisticated a process for small-farmer operation, as well as uneconomical. Similarly, alcohol and glucose at an industrial scale are discarded since, where economical, private enterprise has a comparative advantage. A list of products compatible with the basic aims and constraints of these projects is thus obtained.

In addition to this initial filter, a detailed screening of ideas is used. In order to evaluate which of the remaining product ideas have the best potential for meeting the objectives of the product development process, more information is required. This will involve some research being conducted, either technical, economic, or market related. Several kinds of information are required for evaluating the market potential of each product. These can be summarized in four categories concerning product marketability, life span in the marketplace, productive ability, and growth potential. Using these criteria, those products which can successfully compete with other products, which have a long life span in the marketplace, which the enterprise will not find difficult to produce, and which have good market growth potential will be selected. These four major categories can be broken down into many specific questions, the answers to which can be rated on a five-point scale for each question. Answers can then be weighted according to their relative importance. This enables screening to be conducted on a more objective level. Some examples follow.

Categories for Evaluating New Product Market Potential

Marketability

a. Are new marketing channels needed or can existing channels be used? (If new channels are needed, how to initiate, organize, finance, etc.)
b. Does the new product complement current cassava products (i.e., does it fill a gap in the market)?

c. Is the new product's price below that of competing products of similar quality?
d. Are few sizes or quality grades required? (If many are needed, large inventories are obligatory.)
e. Are the product characteristics better than those of competing products, and can they be successfully promoted?
f. Will this product help or hinder sales of current products?

Life span of product in marketplace

a. Is the product basic (i.e., will it always have a use?)?
b. Is demand national, with a wide variety of consumers and a potential for export?
c. Is the product resistant to economic cycles (inflation, recession)? (Note subsidies on competing raw materials.)
d. How exclusive is product design (patentable)?

Productive ability

a. Equipment needed: best if no new investment is required.
b. Are production knowledge and personnel sufficient, or is there a need to expand and train more?
c. Raw material availability: certainty of supply, seasonal factors, etc.

Growth potential

a. Place in market. Is product really new, filling a need not now being met?
b. Value added. If high, will restrict number of competitors.
c. Are end users expected to increase in number?
d. Promotional opportunities compared with those of competitors.
e. Size of market.

In order to obtain the information required for this analysis, technical and market research will almost certainly be needed. A final screening can be made by evaluating the product concepts obtained from relating the product idea to the target market. So, at this stage the technical and economic feasibility of the product is linked to target consumers. For this, information on socioeconomic population groups, food consumption habits, shopping habits, preferences, etc., must be known. Food companies already selling products have a good knowledge of their target consumers, especially in developed countries, but the aspiring manufacturers of cassava-based products may have little experience in this area, and secondary information may be very limited. Thus, integrated projects often need to conduct detailed consumer and market surveys in order to obtain this information.

Concept testing. Based on a knowledge of the market and consumer characteristics and needs, the product idea can be elaborated into a series of concepts for testing, as shown below.

Examples of New Product Ideas and Concepts

Idea: Fresh cassava, storable for two weeks with stable quality.

Concepts:
1. Cassava in 4-kg-sized bags for sale to upper/middle income consumers, for storage at home.
2. Cassava in 12-kg-sized bags for sale to shopkeepers in poor neighborhoods where the consumer cannot afford 4-kg-sized bags. Units for purchase by consumers will be smaller.

Idea: Whole-root dried cassava for animal feed.

Concepts:
1. Dried chips for sale to feed concentrate companies for chicken, cattle, or pig feed (industrial market).
2. Flour for sale to feed companies for use as agglutinant in shrimp feed (industrial market).
3. Chips or flour for sale to intensive cattle farmers (consumer market).
4. Mix of cassava flour with other feed components for sale to chicken or pig farmers as complete balanced feed (consumer market).

Concept testing for industrial markets is relatively simple, since potential purchasers are few and good contacts and feedback can be developed. For consumer markets, formal concept-testing surveys must be carried out with target consumers in target markets. For concept testing, consumers are normally presented with a text and photograph of the concept, with a price already fixed. Consumers are asked if the concept is understood and if product benefits are relevant to them. Consumers are also asked whether benefits are superior to those of competitors, how they would use the product, who would use it, and what is their buying intention and the reasons behind it. They also suggest any possible improvements. All this is possible without having to prepare a prototype of the product.

In the food industry, the actual processes to be used and the plant for making the product would be known at this stage, using experiences gained from similar products already being marketed, and from the research department of the company concerned. Since this research needs to be carried out for cassava from a minimal knowledge base, the concept-testing phase must also include sufficient research to resolve any technical problems, and the process for manufacturing the product should be defined. For cassava this has meant executing research projects jointly with universities and technical institutes, developing prototype machinery, and designing pilot production plants.

At the end of this stage, a product information base has been accumulated. Characteristics of the market and consumers are known in detail, the concept has been tested by them, and technical aspects of production and its process are also largely known. The many initial product ideas have been screened and a few viable product concepts remain at the end of this process.

Feasibility study. For a company, the business analysis stage of new product development is relatively straightforward. It considers profit estimates, sales, and rates of return, and rejects those new product concepts which fail, for example, to reach the company's preestablished rate of return. But for cassava, the situation is more complicated. Assuming a tentative pilot-plant design is already available, then some information on product costs can be calculated. But the study must also show how the raw material supply is to be organized, and how social benefits would accrue to farmer and consumer groups. Although product profitability is improved by product development costs not being set aside against future profits (because of external financing), this is countered by the need to show positive social benefits if the product is to reach the marketplace. Those products which are either not economically feasible or fail to deliver the expected social benefits are thus rejected at this stage.

Product and process development and testing. In the previous stages of product development, sufficient information, both economic and technical, has been collected to allow the design of a pilot plant for producing the cassava-based product. Usually, CIAT-based research is matched with conditions and requirements of the integrated project area to produce this design. A pilot plant is built in the project area, with the cooperation of a national development or research institution and a farmer organization. The establishment of such a pilot plant is often based on partial financing by direct grants as the initial entrepreneurs cannot be expected to assume the high initial risk of an investment, the benefits of which will eventually be reaped by a large number of people who are not involved in the initial pilot project. The viability of such a pilot plant can be assessed not only from the technical but also from the social and economic point of view. Before the pilot plant is built, product specifications are finalized, based on consumer requirements as assessed in the concept-testing exercise, and individual components of the process are also finalized in order to obtain a product of the required quality at the lowest cost. Once the pilot plant is operational, many aspects can be evaluated.

It is important that members of the farmer organization can manage the process. For this, substantial training may be involved, with input from other institutions required. Institutional support is thus a critical factor at this time. Farmers must also be able to see the benefits of operating the plant, not only in terms of margins remaining for the cooperative but also for employment generated. The process itself must operate as designed, and adaptations are often required to match equipment to local conditions. As the pilot plant operates, its ability to capture raw material, usually fresh cassava roots, can be evaluated, and problems with supply solved. Often, research on cassava production is necessary, for example, to increase the length of the harvest period or the dry-matter content of roots.

The product resulting from pilot-plant operation is sold, both to gain information on market potential, price commanded, etc., and to evaluate the project's overall economic feasibility. In addition, it is important that product quality be monitored, both in the laboratory (where the product has to meet legal standards for hygiene, for example, if a food for humans is being sold) and by consumers. This can take the form of at-home product testing to ensure, for example, that storable fresh cassava does indeed last for two weeks as claimed. Cassava-based products can also be tested against other competing products in the marketplace. This can yield important information on consumer preferences and help to determine product price in the marketplace. Overall, it is vital that the product meet specifications set for it. Failure to do so will result in consumer dissatisfaction and product failure on commercial launch. The design and operation of a plant may be altered, and further research may be needed to accomplish this in order to improve product quality.

However, if product quality meets specifications, the process is economical, and farmers can operate it successfully, then preparations can be made for a test market. Before this can start, however, several marketing decisions must be made: product name(s) and packaging type and design. Consumer surveys may be needed to help select a name among several alternatives. In this case, it is important to survey consumers in all potential markets rather than just in the proposed test market. Some technical research to determine which packaging material provides the best storage life for the product at the lowest cost may also be needed.

Market plan. The market plan provides the framework within which both the test market and commercial launch are conducted. The plan will propose a product distribution system and promotional campaign activities associated with the product's launch. At this point, the final market for the product becomes important. A relatively straightforward plan for a product destined for the industrial sector, such as dried cassava for animal feed, involves direct distribution from the farmer organization to feed companies. No formal test market is required, and good feedback on product quality and future demand can be obtained from the companies. Little promotion is required, since the number of companies purchasing is low and direct contact can be made with all of them. If the product is aimed at the consumer market, the situation is very different. There are millions of potential customers, and both the product distribution system and the promotional campaign used are complex and varied. It helps to separate consumers into groups with similar characteristics, such as income level or site of product purchase, in order to target the product at those potential consumers shown by previous surveys to be most interested in the product.

The enterprise making the product must decide if it wants to be responsible for placing the product with consumers directly, with retailers, or with wholesalers or other intermediaries. Since marketing is not an area of expertise for cassava farmers, it is easier to sell the product at a wholesale level and concentrate on the process itself. However, through involvement in the later stages of marketing, cooperatives can ensure that they receive a larger percentage of the marketing margin, rather than this being captured by a few wholesalers. One possibility is for a second-order organization to specialize in marketing for a number of smaller cooperatives. It is important that ventures into this area be undertaken as a strictly commercial activity, and institutions responsible for assisting cooperatives should have commercial expertise.

In addition to the product distribution network, promotional activities must also be planned. It is pointless to place a product in the market if the consumer is not aware of its existence, let alone its superior quality, lower price, or other advantages. Promotion can help to increase consumer awareness of the product and its advantages. The choice of the correct promotional campaign, faced with a variety of media and the promotion of rival products, is critical. Expert advice may well be needed if an efficient investment is to be made.

Test market. This is a trial of the product and its distribution system and promotion campaign at one location, usually selected as typical of the potential market as a whole. Simply placing a product in the market without any complementary promotion does not represent a true test market, since sales volumes will not reflect a real commercial situation. The test market is thus the operation of the market plan in miniature.

For a test market to be carried out, the distribution network must be set up and promotional materials ready for use (TV, radio, press advertisements ready, leaflets printed, etc.). Sufficient product must be available to meet initial demand and to have stocks for the increase in volume expected as the campaign gets under way. An efficient system of monitoring product shipments, along with first and repeat sales and other consumer information, is needed. First and repeat sales data are especially important. Both sales need to be high for a commercial launch to be justified. If trial purchases are good but repeat purchases are low, the product is failing to live up to the claims made for it in the promotional campaign. If the opposite is true, the promotion campaign itself needs to be improved. If both sales are poor, then the product is not fulfilling a need and should be abandoned. A trial market can also be used to try to vary product price, or to test several packaging designs. At the end of the test market stage, a decision to proceed with a commercial launch, to improve the product further, or to abandon the product is made. A new feasibility study may be required to facilitate making this decision.

Commercial launch and expansion. This is the introduction of cassava-based products to the market, first to dealers and then to final consumers. Everything must be carefully coordinated; supply of the finished product must increase in step with demand. For cassava, this implies that enough capacity at the farm and small-processing-plant level is available to cope with rapid demand increases once the promotion campaign gets under way. Training and extension teams must be involved in this. Demand can be increased progressively by slowly expanding sales within the target market, such as gradually increasing the number of cities or outlets within cities. However, if promotion is national, then the product must be available nationally. It is both dangerous and a waste of money to create a demand which cannot be satisfied. This is less true for an industrial market, such as dried cassava for animal feed, where a large potential market has existed for years without being fully exploited. In the absence of enough dried cassava, feed companies use more expensive carbohydrate sources.

A detailed activity network should be developed, listing activities sequentially with a timescale (PERT). This should cover raw material supply and processing, pilot plant construction and operation (credit, farmer organization, institutional input), product distribution (institutional input, distributor organization, and finance, if necessary), and promotion (campaign design, management, finance). All areas mut be coordinated so that supply and demand grow together.

Timing product launch can be crucial. For example, it could be advantageous to start when competing products are in short supply or high in price because of seasonal variations. Although this is unusual in the food industry, in the case of cassava products, the supply of competing products (e.g., sorghum for animal feed) may vary greatly. Timing commercial launch to take advantage of this could be important to product success. The promotion budget could be wasted if the product is launched at the wrong time.

Evaluation. Cassava product development projects are evaluated both on commercial viability (did sales and profits reach the levels expected?) and social benefit distribution (did poor farmers and consumers benefit?). This may mean undertaking special studies, financed by the project and not set aside against profits, but it is needed to justify investments to donors, to ensure that the project is proceeding as planned, and to help plan any market expansion in the future. These studies can also be used to identify new product ideas for future projects. Possible fine-tuning of product specifications, promotion strategy, etc., is possible if studies show a need for this.

The Role of Research in Cassava Product Development

As stated earlier, a strong research input is needed for product development in cassava, in all stages. Technical, socioeconomic, and marketing research is carried out. Technical research is usually assumed by industry to have already been done before product development starts. With cassava, however, often the processes required to obtain the desired product concept are unknown. Macroeconomic research is needed to screen ideas and for feasibility studies, while marketing research is obviously important in the areas of concept development and test marketing. All three types of research are important in the product development and testing phase, where the process is refined at the pilot plant, real costs are obtained, and the product is available for consumer testing (Table 1).

Table 1. Research needs during different stages of product development.

Product development stage	Research		
	Technical	Socioeconomic	Marketing[a]
Idea generation	XX	X	XX
Idea screening/concept testing	XX	XX	XX
Feasibility study		XX	X
Product development	XX	XX	XX
Market plan		X	XX
Test marketing			XX
Commercial launch and expansion			X
Evaluation		XX	X

a. X and XX signify relative amounts of research needed, with XX meaning more than X.

Bibliography

Best, R. 1990. The role of the International Agricultural Research Centers in generating and transfering root and tuber crop post-harvest technology: CIAT's experience. In: Howeler, R. H. (ed.). Proceedings of the Eighth Symposium of the International Society for Tropical Root Crops (ISTRC) held in Bangkok, Thailand, 30 October-5 November 1988. ISTRC and Department of Agriculture of Thailand, Bangkok, Thailand. p. 76-91.

________. (comp.). 1984. Plan piloto para el desarrollo agro-industrial del cultivo de la yuca en algunos departamentos de la Costa Atlántica de Colombia. Proyecto Cooperativo DRI/ACDI-CIAT, tercer informe, junio 1983-julio 1984. Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia. 126 p.

________ and Ospina, B. (comps.). 1985. El desarrollo agro-industrial del cultivo de la yuca en la Costa Atlántica de Colombia. Proyecto Cooperativo DRI-CIAT, cuarto informe, tomo 1, julio 1984-junio 1985. Centro Internacional de Agricultura Tropical/Fondo de Desarrollo Rural Integrado (CIAT/DRI), Cali, Colombia. 42 p.

________ and ________. (comps.). 1986. El desarrollo agro-industrial del cultivo de la yuca en la Costa Atlántica de Colombia. Proyecto Cooperativo DRI-CIAT, cuarto informe, tomo 2, julio 1984-junio 1985. Centro Internacional de Agricultura Tropical/Fondo de Desarrollo Rural Integrado (CIAT/DRI), Cali, Colombia. 93 p.

CIAT (Centro Internacional de Agricultura Tropical). 1982. Plan piloto para el desarrollo agro-industrial del cultivo de la yuca en algunos departamentos de la Costa Norte de Colombia. Proyecto Cooperativo DRI/ACDI-CIAT, primer informe, noviembre 1981-junio 1982. Cali, Colombia. 45 p.

CIAT/DRI (Centro Internacional de Agricultura Tropical/Fondo de Desarrollo Rural Integrado). 1987. El desarrollo agro-industrial del cultivo de la yuca en la Costa Atlántica de Colombia. Proyecto Cooperativo DRI/CIAT, quinto informe, julio 1985-agosto 1986. Cali, Colombia. 46 p.

________. 1988. El desarrollo agro-industrial del cultivo de la yuca en la Costa Atlántica de Colombia. Proyecto Cooperativo DRI/CIAT, sexto informe, diciembre 1986-noviembre 1987. Cali, Colombia. 31 p.

Cock, J. H. 1985. Cassava: New potential for a neglected crop. Westview Press, Boulder, CO, USA. 191 p.

Earle, M. D. and Anderson, A. M. 1985. Product and process development in the food industry. Harwood Academic Publishers, Chur, Switzerland. 295 p.

Gómez, G. (comp. and ed.). 1983. Plan piloto para el desarrollo agroindustrial del cultivo de la yuca en algunos departamentos de la costa norte de Colombia. Proyecto Cooperativo DRI/ACDI-CIAT, segundo informe, julio 82-mayo 1983. Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia. 53 p.

Janssen, W. G. and Wheatley, C. C. 1985. Urban cassava markets: The impact of fresh root storage. Food Policy 10(3):265-277.

Kotler, P. 1976. Marketing management: Analysis, planning, and control. Prentice Hall, NY, USA. 529 p.

Tull, D. S. and Hawkins, D. I. 1984. Marketing research: Measurement and method. Third edition. Macmillan, NY, USA. 794 p.

Wheatley, C. C.; Izquierdo, D. A.; and Lynam, J. K. 1990. Increasing fresh cassava consumption in urban Latin America: The introduction of storage technology. In: Howeler, R. H. (ed.). Proceedings of the Eighth Symposium of the International Society for Tropical Root Crops (ISTRC) held in Bangkok, Thailand, 30 October-5 November 1988. ISTRC and Department of Agriculture of Thailand, Bangkok, Thailand. p. 364-373.

Chapter 5

CASE STUDY: FRESH CASSAVA STORAGE

Christopher Wheatley and Diego Izquierdo*

Introduction

The consumption of fresh cassava roots as a boiled or fried vegetable is the major traditional utilization of the crop found in the Andean countries of Latin America and in Paraguay. Fresh cassava consumption has decreased greatly in almost all urban centers of these countries over the last 30 years as cassava has failed to make the transition from rural to urban staple. The reasons for this are many, but all are related to the rapid postharvest deterioration of the roots, which makes them inconvenient, of poor quality, and expensive in an urban environment.

A product development approach was therefore taken to develop a fresh cassava product more attuned to consumer needs, that is, storable, of high quality, and price-competitive with other carbohydrate sources. This case study will present the research carried out during the 1980s to develop this new product, starting from the product idea and progressing through the stages outlined by Wheatley and Best (this volume). It is hoped that presenting the case study in the same format as that outlined in the chapter on product development will highlight the practical application of that basically conceptual chapter.

Project Goal

The goal is to improve the traditional market for fresh cassava by developing a product more attuned to consumer needs.

---

* Senior research fellow in the Cassava Utilization Section, Cassava Program, Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia; and research assistant, Cassava Program, CIAT, Cali, Colombia, and Plan Nacional de Rehabilitación (PNR), Santander de Quilichao, Colombia, stationed at CIAT headquarters.

Project Constraints

The production and marketing of any new product based on fresh cassava will occur within the framework of the socioeconomic environment of cassava farmers and urban consumers. Since the introduction of the product must provide concrete social and economic benefits for these groups, a number of constraints must be imposed at the outset of the product development process. In the case of fresh cassava, these constraints are:

1. Any processing or treatment operations should be appropriate for use by the small farmers who produce most cassava.

2. The product should be compatible with the existing distribution and marketing system for fresh cassava.

3. Any extra cost incurred should result in decreased marketing margins so as to provide benefits to farmers and/or low-income consumers.

4. Small farmers should be the primary beneficiaries of the improved product and, when possible, low-income consumers should also receive benefits.

5. The product should comply with national and international regulations for any chemical treatment involved.

Product Idea Generation

What does the consumer want?

Detailed surveys of consumer purchase and consumption habits for cassava have been carried out in many Latin American cities during the 1980s (see Tables 1, 2, and 3). Taken as a whole, these show that consumers consider several characteristics important in fresh cassava, and these are listed below.

Fresh cassava has very variable eating quality. This is because of both rapid postharvest physiological deterioration, which renders cassava inedible within three days of harvest, and the inherent variability in eating quality of the fresh cassava root, which is related to its textural and taste characteristics.

Fresh cassava is inconvenient for urban consumers to purchase and use. Since cassava is highly perishable, the roots must be eaten or prepared the same day as purchased. For daily consumption of cassava, inconvenient daily purchase is required. Other starchy staples can be purchased on a weekly

Table 1. Salient characteristics of cassava retail purchase and consumption in five major Colombian cities.

Factor	City									
	Bucaramanga		Barranquilla		Cali		Bogotá		Medellín	
	L[a]	H	L	H	L	H	L	H	L	H
Reason for selecting purchase site										
Convenience (%)	--	--	38[b]	68	47[c]	72	76	84	73	94
Purchase frequency (times/week)	3.1	3.1	4.2	2.3	2.8	2.4	1.5	1.6	1.9	1.7
Purchase quantity (kg)	--	--	1.0	1.8	0.6	0.7	0.9	1.2	0.4	0.7
Consumption frequency (times/week)	--	--	--	--	3.4	2.4	1.8	1.8	2.6	1.9
Consumption (kg/capita/year)	39	27	42	34	8	13	11	18	8	7

a. L = low-income consumers; H = high-income consumers.
b. 33% = quality.
c. 33% = price.

SOURCES: de Haan (1985); van Koersveld (1987); CIAT/CORFAS (1989).

Table 2. Place of purchase of fresh cassava in five Colombian cities.

Group and city	% consumers purchasing cassava in:			
	Markets	Shops	Supermarkets	Other[a]
High-income consumers				
Bucaramanga	81	2	17	0
Barranquilla	8	23	49	20
Cali	44	0	50	6
Bogotá	0	6	66	28
Medellín	0	17	86	0
Low-income consumers				
Bucaramanga	64	36	0	0
Barranquilla	16	72	1	11
Cali	20	64	3	13
Bogotá	55	31	14	0
Medellín	7	90	3	0

a. Other = mobile markets (Bogotá, Cali), street sellers (Barranquilla).

SOURCES: de Haan (1985); van Koersveld (1987); CIAT/CORFAS (1989).

Project Constraints

The production and marketing of any new product based on fresh cassava will occur within the framework of the socioeconomic environment of cassava farmers and urban consumers. Since the introduction of the product must provide concrete social and economic benefits for these groups, a number of constraints must be imposed at the outset of the product development process. In the case of fresh cassava, these constraints are:

1. Any processing or treatment operations should be appropriate for use by the small farmers who produce most cassava.

2. The product should be compatible with the existing distribution and marketing system for fresh cassava.

3. Any extra cost incurred should result in decreased marketing margins so as to provide benefits to farmers and/or low-income consumers.

4. Small farmers should be the primary beneficiaries of the improved product and, when possible, low-income consumers should also receive benefits.

5. The product should comply with national and international regulations for any chemical treatment involved.

Product Idea Generation

What does the consumer want?

Detailed surveys of consumer purchase and consumption habits for cassava have been carried out in many Latin American cities during the 1980s (see Tables 1, 2, and 3). Taken as a whole, these show that consumers consider several characteristics important in fresh cassava, and these are listed below.

Fresh cassava has very variable eating quality. This is because of both rapid postharvest physiological deterioration, which renders cassava inedible within three days of harvest, and the inherent variability in eating quality of the fresh cassava root, which is related to its textural and taste characteristics.

Fresh cassava is inconvenient for urban consumers to purchase and use. Since cassava is highly perishable, the roots must be eaten or prepared the same day as purchased. For daily consumption of cassava, inconvenient daily purchase is required. Other starchy staples can be purchased on a weekly

Table 1. Salient characteristics of cassava retail purchase and consumption in five major Colombian cities.

Factor	City									
	Bucaramanga		Barranquilla		Cali		Bogotá		Medellín	
	L[a]	H	L	H	L	H	L	H	L	H
Reason for selecting purchase site										
Convenience (%)	--	--	38[b]	68	47[c]	72	76	84	73	94
Purchase frequency (times/week)	3.1	3.1	4.2	2.3	2.8	2.4	1.5	1.6	1.9	1.7
Purchase quantity (kg)	--	--	1.0	1.8	0.6	0.7	0.9	1.2	0.4	0.7
Consumption frequency (times/week)	--	--	--	--	3.4	2.4	1.8	1.8	2.6	1.9
Consumption (kg/capita/year)	39	27	42	34	8	13	11	18	8	7

a. L = low-income consumers; H = high-income consumers.
b. 33% = quality.
c. 33% = price.

SOURCES: de Haan (1985); van Koersveld (1987); CIAT/CORFAS (1989).

Table 2. Place of purchase of fresh cassava in five Colombian cities.

Group and city	% consumers purchasing cassava in:			
	Markets	Shops	Supermarkets	Other[a]
High-income consumers				
Bucaramanga	81	2	17	0
Barranquilla	8	23	49	20
Cali	44	0	50	6
Bogotá	0	6	66	28
Medellín	0	17	86	0
Low-income consumers				
Bucaramanga	64	36	0	0
Barranquilla	16	72	1	11
Cali	20	64	3	13
Bogotá	55	31	14	0
Medellín	7	90	3	0

a. Other = mobile markets (Bogotá, Cali), street sellers (Barranquilla).

SOURCES: de Haan (1985); van Koersveld (1987); CIAT/CORFAS (1989).

Table 3. Consumer attitudes toward cassava and other starchy foods in Colombia (% of consumers agreeing with statement in a particular city).

Statement and product	City				
	Bucaramanga	Barranquilla	Cali	Bogotá	Medellín
This product is difficult to store.					
Cassava	88	96.9	33	67.3	89.5
Potato	35	23.8	30	40.0	75.0
Rice	2	0.6	4	8.9	6.2
This product is eaten the same day as purchase.					
Cassava	59	83.2	56	51	61.1
Potato	51	57.1	38	30	12.9
Rice	48	47.8	46	30	16.0
This product is "tasty."					
Cassava	78	70.2	--	--	--
Potato	91	77.0	--	--	--
Rice	87	56.5	--	--	--
This product has very variable quality.					
Cassava	92	87.6	91	70	80.5
Potato	84	27.3	76	70	32.7
Rice	38	8.7	68	57	17.7
This product is risky to purchase (quality reasons).					
Cassava	90	80.7	34	61	91.0
Potato	69	17.4	54	40	20.0
Rice	1	3.1	42	24	0.9

SOURCES: de Haan (1985); van Koersveld (1987); CIAT/CORFAS (1989).

basis and are thus much more convenient than cassava (Table 3), and have gradually replaced it in the diet of the increasingly urban society in Latin America over the last 30 years (Janssen and Wheatley, 1985).

Fresh roots have a high price. Their perishability makes marketing cassava a risky business, and losses during this process can be high. Traders cover their losses through high marketing margins, resulting in cassava being more expensive than other staples in most urban centers. Price is also determined by retail outlet, with local neighborhood shops often having the highest prices. Since these tend to be frequented most by lower income populations, the effect on consumption can be very negative.

Fresh cassava is inherently liked. Despite the disadvantages outlined above, cassava as such is liked by consumers, and is even considered nutritious by many. Taste and texture evaluations for cassava compare favorably with those of rice and potatoes in many Latin American urban markets (Table 3). There is therefore no inherent dislike or nonpreference for cassava, but rather a negative reaction to those quality, convenience, and price characters outlined above.

Consumers require a product that, in the fresh form, is more convenient, less expensive, and of higher quality. This can be achieved by developing a cassava that does not suffer from postharvest deterioration, and is therefore more storable, permitting consistent and stable quality. It is also more convenient, allowing for storage at the wholesale, retail, and household levels. In addition, the fresh product should have good and consistent inherent eating quality.

What does technology offer?

Basic and strategic research during the 1970s led to an understanding of the deterioration process and, from this, the design of possible technologies to prevent its occurrence. Two types of deterioration are found (Booth, 1976; Rickard and Coursey, 1981): physiological deterioration, 2-3 days after harvest; microbial deterioration, 5-7 days after harvest.

Physiological deterioration is caused by rapid postharvest accumulation of certain phenolic compounds, especially scopoletin, which in turn becomes complex in the presence of oxygen to form colored (blue, black, and brown) pigments (Rickard, 1981; Wheatley and Schwabe, 1984). This deterioration initiates at points of root mechanical damage, and is related to tissue dehydration from these wounds (Booth, 1976; Marriott et al., 1978). Root curing (wound healing) can be encouraged, however (Booth, 1976). This results in the rapid formation of a protective suberized layer of tissue over the damaged cells, preventing moisture loss and oxygen entry to the tissues. This inhibits the onset of deterioration, and results in the maintenance of good-quality fresh roots. The conditions that favor rapid wound healing are temperatures of 30-35 °C and a relative humidity of 85%.

These conditions are, however, very favorable for the development of secondary or microbial deterioration, which results from the growth of fungi or bacteria, principally the former, on the root tissues (Booth, 1976; Noon and Booth, 1977). This fungal infection also results in changes in root phenolic metabolism, and in the appearance of colored pigments around the infection sites. This deterioration is best controlled by a chemical treatment, of which several have been investigated at CIAT. The best option is to use a thiabendazole-based product (Mertect or Tecto), which is of very low toxicity and in wide postharvest use in many crops, including potatoes and bananas (CIAT, 1983; Wheatley and Janssen, 1988). A combination of rapid root curing and chemical prevention of microbial deterioration is thus a feasible approach to obtaining a product acceptable to consumers.

Several methods of achieving rapid root curing are possible: root reburial after harvest (Booth, 1977), packing in boxes with a moist medium (sawdust) (Booth, 1977), or packing roots in plastic or polyethylene bags (Oudit, 1976; Wheatley and Janssen, 1988). The use of plastic bags to maintain humidity and chemical treatment to control fungi led to the development of viable storage systems for commercial use (Lozano et al., 1979; Wheatley and Janssen, 1988).

Product ideas

Several product ideas for providing the consumer with a storable, high-quality fresh cassava root can be generated.

1. Through plant breeding develop a cassava plant that does not suffer from physiological deterioration and is of good eating quality.

2. Develop a system of fresh root preparation (peeling, freezing, vacuum packing) to provide a fresh prepared product for the consumer.

3. Use wooden boxes and moist sawdust packing to cure roots, inhibiting the development of root deterioration.

4. Use paraffin wax dips to artificially cure roots and prevent deterioration.

5. Use a low-cost packing material (polyethylene bags) and chemical treatment to prevent deterioration.

6. Use preharvest pruning to prevent physiological deterioration.

Idea screening

A positive correlation exists between root starch content and deterioration after harvest, that is, the higher the starch content, the faster roots deteriorate (CIAT, 1983; Wheatley et al., 1984). In general, this relationship also holds for eating quality, so that the best roots are also those that deteriorate fastest. The inherent difficulty in reconciling these two objectives through breeding, given the high priority assigned to high root starch content as a quality factor, means that this approach for resolving the deterioration problem would not be the most efficient in terms of time and cost. IDEA REJECTED.

The use of high-technology methods of preservation, such as freezing or vacuum packing combined with root preparation into a more convenient form, is highly attractive. The resultant product can even be precooked to provide very convenient fresh cassava pieces ready for instant cooking. However, the equipment required to elaborate this product is expensive and more suited to private industry than a small-farmer cooperative venture. Indeed, such products are already available in many countries of the region. Frozen products have the added disadvantage of needing a refrigerated distribution system for cassava, beyond the capacity of all the countries at the moment. Because of the expense of the processes involved, these frozen fresh cassava products are of interest only to upper income population groups, which tend to consume little cassava anyway. This product would not therefore provide benefits to small farmers or to low-income consumers. IDEA REJECTED.

The system for curing cassava roots by packing in boxes with a moist medium of sawdust or other material is currently used in Latin America and the Caribbean to some extent, but solely for the export of cassava to the United States or other high-value markets. This is because local or national markets are not economic given the high transport and labor costs involved in this operation. IDEA REJECTED.

Artificial root curing through paraffin wax treatment (Zapata and Riveros S., 1978) is a viable method for the postharvest preservation of cassava, but the costs involved are too high to be economic for national markets. The scale of operation is also likely to be unsuitable for a small-farmer-controlled enterprise. IDEA REJECTED.

Although pruning plants 2-4 weeks before harvest does drastically reduce physiological deterioration, it also results in a reduced root starch content, which negatively affects eating quality: roots become hard (glassy) in texture (Wheatley et al., 1984). Also, microbial deterioration remains a problem. IDEA REJECTED.

The use of polyethylene bags and a safe chemical treatment to prevent deterioration is both effective and economic, and compatible with the level of technology suitable for small farmers. IDEA ACCEPTED.

Following the initial screening, based on each idea's suitability with regard to project goals and constraints, only one product idea is left: cassava roots chemically treated and packed in bags. This option needs to be considered in more detail before embarking on development of the idea, however. A better knowledge of the marketing system currently in operation and further technical trials of the storage methodology allow a judgment to be made to proceed or not with the idea.

Technical trials of the methodology

At CIAT, a series of trials were carried out (see CIAT Annual Reports 1982-85) to determine the optimum conditions of treatment and packing for the cassava. The major results of these were as follows.

1. Bag color did not affect storage results.

2. Bag sizes of from 1- to 20-kg capacity of roots were acceptable, providing the thickness of the bag was sufficient to withstand the weight of roots contained inside.

3. Roots should be packed into the bags within two hours of harvest to prevent the onset of physiological deterioration.

4. The thiabendazole chemical can be applied by aspersion or by immersion. The former method is both more effective and cheaper, with over 10 tons of cassava treated per liter of chemical, applied as a 0.4% solution.

5. If aspersion of roots already packed in the bag is employed, perforations in the base of the bag can be used to drain excess liquid from the bag without impairing the effectiveness of the storage technology.

6. The effectiveness of the root-curing process decreases with altitude, so that above 1,500 m in the tropics the technology is not effective. However, roots can be transported to urban centers in cool climates after storage for 1-2 days in hot environments, by which time the wound-healing process has progressed sufficiently to prevent physiological deterioration.

7. Eating quality of stored roots remained stable for two weeks after harvest. At longer storage times, the progressive breakdown of starch to sugars resulted in a sweet taste developing. While not always evaluated as a negative characteristic by all consumers, this change effectively limits the use of the storage technology to a two-week postharvest period.

8. Some varieties are more suitable for storage than others. Unsuitable varieties are those that are round or conical in root shape, which tend to split longitudinally along the peel layer during storage, thus allowing rotting to begin early in the storage process. Cylindrical roots do not show this phenomenon. The susceptibility of different varieties to physiological deterioration is not an important variable, since wound healing prevents this from occurring in all clones.

Market and consumer characteristics

The consumer and market surveys conducted in several cities showed that the following aspects of cassava commercialization were generally important, and should be taken into account when designing technology.

Consumers (see Table 1). Middle- and upper-income consumers tend to shop once a week, often in supermarkets. Low-income consumers shop more frequently and make smaller unit purchases. They normally purchase cassava in small neighborhood shops or at markets if these are close by. The small unit purchases of low-income consumers are related to their purchasing power, that is, they are unable to take advantage of the storable cassava themselves because they can afford to purchase food for only one day at a time. For the storage technology to benefit this important group of consumers, the benefits of quality and price also brought by the technology are still relevant: storage up to the point of sale will provide a higher quality, cheaper product even if it is purchased in small unit volumes.

Convenience is the most important factor governing purchase site for cassava. Many consumers in developing countries do not have refrigerators. Those who do may store cassava there for a few days, but changes in texture and taste result. Consumers resent putting cassava in the refrigerator because it takes up valuable space better used for higher value foodstuffs. The preferred storage space is alongside potatoes or other vegetables, under ambient conditions, and the bag of cassava must be capable of storage under normal household conditions.

Markets for fresh cassava. The wholesale level is usually very concentrated, with only 5-20 traders in a central wholesale market where cassava normally enters. Urban distribution, however, is characterized by many traders each handling a small volume of cassava for a short time only. No root selection occurs during this process, despite the rapid onset of deterioration. Roots usually arrive at the wholesale market in the early hours of the morning, and are on sale to the consumer later that morning, often less than 24 hours after harvest. In most cities, the largest volume of cassava is sold through small shops. These have the poorest quality cassava, since they come at the end of the long distribution chain. Their cassava losses are also the highest, as are the prices they charge their low-income clients. Storage technology must therefore meet the needs of small shopkeepers and market retailers, but not necessarily those of the few wholesalers. A conscious decision is thus needed to recognize that wholesalers, a few of whom control a market and often take large margins, may not benefit, at least initially, from this technology, which offers the possibility of constructing a more efficient marketing operation for the consumer of fresh cassava. This is possible because if the product is no longer so perishable and thus time is not such a crucial factor, farmers have more chance to negotiate prices and even mount their own distribution network at wholesale levels. The technology therefore offers a possibility to benefit both consumers and farmers through increases in the efficiency of the marketing system. Given this option, a storage time of one week is necessary, to enable cassava to pass from farm to shop or stall, and to allow for a few days of storage at the retail outlet.

Several conclusions can be drawn from this analysis of market and consumer characteristics.

Total storage time of two weeks is required to meet consumer and market requirements for fresh cassava, comprising up to one week for commercialization and a further week for at-home storage.

Small shops prefer a bag size of 12-15 kg of cassava for selling individual roots to low-income clients, and 2-4-kg bags for sale directly to consumers who can purchase and store at home.

Wholesalers are usually more knowledgeable than retailers or consumers about cassava quality and varietal characteristics. In most cities, few consumers can recognize any particular variety, although many may rely on some visible characteristic such as peel color or root shape. Eating quality of cassava is notoriously difficult to assess before cooking, and most consumers highlight this difficulty, given the highly variable quality of cassava, even of one cultivar. Thus, root selection in an attempt to standardize eating quality would be an added consumer attraction to the storage technology itself.

In many of the market-related factors relevant to the success of a new or improved product, fresh, storable cassava is evaluated highly. It would obviously compete with the traditional product extremely well, especially if the reduction in marketing margins resulted in a product which was not only better but also cheaper. The size of the market would be large, especially if options regarding bag size were realized so as to develop a product attractive to low- as well as middle- and high-income consumers. Since the product is a basic good, its lifespan in the market should be long. Little capital investment would be needed, and the appropriate nature of the technology makes it especially suitable for operation by small farmers. Some change in the distribution system may be required (to bypass the wholesalers), but this is not a negative point. It should result in a more equitable distribution of benefits if the farmers can absorb this part of the marketing margin into a distribution enterprise of their own. Finally, the technology is easy to promote, since the advantages of the new product over the traditional one are obvious and useful to the consumer.

The conclusion for this section is that the idea of using chemical treatment and plastic-bag packing of cassava to provide a high-quality, storable, and convenient product to consumers is accepted for further evaluation.

Concept Testing

Two concepts for this product can be presented (see "Concept testing," Wheatley and Best, this volume), one for middle- to high-income consumers who can purchase a complete 2-4-kg bag, and another for small shopkeepers supplying low-income clients, who require 12-15-kg bags, for sale of cassava root by root.

The concept of a 2-4-kg bag was tested in four Colombian cities to discover the degree of consumer product acceptance. The results (Table 4) show that the purchase intention of all consumers tested was high except in Bogotá, where cassava is not a traditional staple foodstuff. The product is therefore serving a need for consumers, and merits further development.

At this stage, a technically feasible product is available, and initial consumer reaction is favorable. In addition, market surveys have suggested the best concepts to develop, and have also suggested how distribution and marketing operations should be constructed.

Table 4. Consumer purchase intention for cassava in bags in four Colombian cities.

Intention (%)	City			
	Barranquilla	Cali	Bogotá	Medellín
Definitely yes	42	61	23	39
Probably yes	54	32	42	37
Don't know	0	7	21	9
Probably no	2	1	11	6
Definitely no	2	0	3	9

SOURCES: CIAT/CORFAS (1989) and unpublished data.

Feasibility Study

Initial studies and costs of CIAT experiments showed that treatment and bag costs were acceptable (<US$0.02/kg of cassava) and that the reduction in marketing margins should amply cover this cost. A detailed cost breakdown obviously depends on the price of fresh cassava at farm and retail levels in any particular market, since this price is normally so variable. Other factors such as raw material supply will also depend largely on price. It was therefore considered justified to proceed to the pilot level immediately to obtain accurate costs from one particular market. This was especially easy in this case since zero capital investment was involved.

Before embarking on a pilot project, the expected distribution of benefits to farmers and consumers should also be analyzed, and the project halted if these are not adequate, or all benefits go to intermediaries, for example. Some economic analyses (Janssen and Wheatley, 1985) clearly showed the potential of the benefits to reach consumers and farmers. The project was thus meeting the requirements expected of it. Benefit distribution is improved if the farmers can take over some of the marketing functions of the intermediaries and/or wholesalers. This can best be achieved through the formation of a farmer cooperative or association that can take charge of harvesting and packing roots, as well as marketing them in the city at the wholesale level. The greater storability of the bagged product permits farmer commercialization of cassava, which was not feasible previously. The pilot project should thus include organization and consolidation of farmer cooperatives in order to optimize benefit distribution. This implies the active involvement and support of other national organizations responsible for these activities, in addition to the national agricultural research programs also included.

Pilot Projects in Colombia

Bucaramanga

The initiation of the fresh cassava pilot project was planned following the success of the CIAT/DRI projects on dried cassava for animal feed. The Fondo de Desarrollo Rural Integrado (DRI) is the rural development agency of the Colombian government, and it coordinates the actions of all the organizations involved in rural development (e.g., credit, technical assistance, cooperative organization, commercialization, etc.). CIAT thus entered into the project by providing technical assistance to farmers, and worked alongside the other organizations involved.

The Colombian region chosen for the first pilot project was Santander Department, centered on the major urban market of Bucaramanga. Fresh cassava sold in the city comes principally from two production regions: the Magdalena Valley, 2-5 hours from the city, and Arauca, a 24-hour journey away by truck and located in a different department. The project was therefore located in the Magdalena region, with the objective of supplying the Bucaramanga cassava market.

There were several reasons for selecting this region and market for the pilot project.

1. Bucaramanga has a tradition of cassava consumption, and is high in per capita terms compared to the Colombian urban average (Bucaramanga, 39 kg/year, 1985; urban Colombia, 17 kg/year, 1981).

2. The production region and the urban center make up a closed system, that is, the cassava from the Magdalena region is not marketed in other major urban centers. Thus, from a project point of view, there are no other interfering markets to survey.

3. The local DRI office was keen to proceed with the project, seeing real benefits for this region's farmers.

4. The major cassava production region of the country, the Atlantic coast, was the site of the dried cassava pilot project, and it was thought that

the two projects could be incompatible (i.e., the fresh market might dominate the nascent drying industry). Thus, the project was not located in this region.

Before beginning a storage trial with farmers, a series of farm, market, and consumer surveys were conducted in order to understand the structure, problems, and opportunities inherent in the present system, and to provide data for later studies after the introduction of the technology.

Farmer study. The cassava production region in the Magdalena Valley region is of relatively recent colonization, with a mean farm size of 42 and 21 ha in the two districts of San Vicente and Barrancabermeja, respectively. However, only 7% of this area is planted with cassava; no other crops are grown and the rest of the land is either in low-grade pasture (1 head of cattle per hectare) or not used (fallow or natural vegetation). Thus, although cassava yields are low, at 3-7 tons/ha, the potential for increasing production through planting more cassava is great. The technology used by farmers for cultivating cassava is low input, with zero use of chemicals, no stake selection, and manual land preparation. The land in general is gently undulating and not of high risk for erosion. Mechanized land preparation is feasible in some areas, although rarely used. Rainfall is well distributed, making planting practical for many months a year (January-April and June-September). Cassava can thus be harvested throughout the year, although the months of September and October have the lowest volumes. In the San Vicente district, over 70% of production is marketed, mainly to Bucaramanga, but also to other cities in Santander Department. Production in Barrancabermeja is less market oriented (27% sold). In both districts, cassava is the major staple in the diet, with over 1 kg/capita/day being consumed. This totals 350-400 kg/capita/year, making cassava consumption in this area one of the highest ever reported.

Farmers sell an average of about 1 ton on each occasion, generally to an intermediary who transports the cassava to the Bucaramanga wholesale market for sale to wholesalers. Because this region has poor communications with its capital city, few of the farmers make any prior arrangement with traders regarding sale of their crop. Such arrangements can be useful for cassava farmers, given the perishable nature of the roots. Farmers were complaining strongly about the price paid by intermediaries for their produce: only US$0.05-0.07/kg, compared with a retail price in Bucaramanga of US$0.33/kg. The farmers pay for the cost of harvest and for transporting the cassava by mule from the fields to the road where the intermediary's truck collects the roots. This latter cost can be substantial if the field is far from the road.

Thus, the farmers' profit from the sale of cassava can be minimal or zero. For this reason, the farmers were interested in the conservation technology as a means for improving the commercialization of the crop, which would allow them to obtain a decent remuneration for their efforts. Several interested farmers in one area, called El 32, were sufficiently interested in collaborating in a series of onfarm experiments with the technology.

Market study. A survey was undertaken in which the marketing of cassava was compared with that of potatoes in Bucaramanga (de Morrée, 1985). The principal market channel for both crops is for the product to arrive at the wholesale market of San Francisco, either through intermediaries or by farmers directly commercializing the roots and tubers, although the latter is more common for potatoes than cassava. Wholesalers sell the product to retailers, either small market stall-holders or small shopkeepers. Supermarkets form a small percentage of the total market for both products. Interviews were conducted with a representative sample of all these groups, and with consumers stratified by income. Cassava wholesalers purchase an average of 15 tons/week, with potato wholesalers trading in double this volume. The latter have an advantage in being able to store the fresh potatoes if prices fall, in the hope of obtaining a better price later on. Cassava traders do not have that option, since product deterioration is so rapid. During the short time they hold the cassava, some losses due to deterioration do occur, and such roots can be sold off at a lower price for starch extraction or pig feed. The starch factory in Bucaramanga can accept 13 tons of cassava per day, or 18% of the total volume traded in the market. Whereas the potato varieties have different prices, only two cassava varieties are distinguished, and no price differential exists between them. Potato traders have the option of returning poor-quality or damaged sacks back to their suppliers; no such guarantee exists for the more risky cassava. Potato traders have good arrangements with suppliers. This is never the case with cassava wholesalers, nor do they receive or give credit. Potato traders regularly do both.

Retailers bear the distribution costs of transporting cassava and potatoes from the wholesale market to their shops or market stalls. Bucaramanga has a well-developed network of markets in the different barrios or neighborhoods of the city, but small shops can be very important in those areas where no markets exist, in practice meaning the lower income, marginal areas of the city. It is precisely the inhabitants of those areas, who consume the most cassava, who have the greatest difficulty in obtaining it. The cassava sold in small shops in marginal areas of the city also tends to be of poor quality, due to the length of the marketing chain and the time taken to reach the shop. In addition, these small shops are the most expensive place to purchase cassava. In the larger municipal markets, the amount of cassava sold per trader is half that of potatoes (640 kg/week).

Consumer survey. A stratified survey of 400 consumers in Bucaramanga (de Haan, 1986) was designed to elucidate consumer purchase habits and factors influencing consumer purchase of cassava. Consumers usually visit a market only once a week, unless they live in the immediate vicinity of one, while small local shops are visited every day for minor purchases. Low-income consumers living in outer marginal areas far from markets visit less than once a week, the journey being made difficult by the long and costly bus trip. They use local shops more than other consumers, despite the higher costs and lower quality of food products at these outlets. Middle- and high-income consumers shop either in the large municipal markets (for those to whom quality is important) or in supermarkets, if convenience is more important. Thus, both spatial distribution of consumers with respect to markets and income level are important in determining purchase sites of food in general.

Consumers will not usually make special shopping trips to purchase a basic foodstuff such as cassava. The purchase site is thus often that of foods as a whole. Consumers were, however, less likely to purchase cassava than other foods in supermarkets, because of the poor quality of the product on offer at these outlets. Consumers who shop once a week in a large municipal market may purchase enough cassava for only one or two days. Later in the week, further purchases may be made from local shops. However, potato consumption (at 82 kg/capita/year) is more than double cassava consumption. Because of the tradition of cassava consumption in the city, consumers have a good knowledge of some quality factors related to the product. For example, root size, peel color and peel damage, and parenchyma color (as an indicator of deterioration) were all used by housewives when selecting cassava. In addition, the price of cassava varied more between the different retail outlets than did the price of potatoes.

Several factors affected cassava consumption. A multiple regression analysis was carried out to determine the significance of the possible variables influencing cassava consumption, which included the following significant variables:

income (consumption falls as income increases);
household size (larger households consume less);
market access (consumption falls as access decreases);

refrigerator ownership (this increases consumption); and
housewife employed (this decreases consumption).

Many of these variables are the expression of the convenience difficulties involved in purchasing a highly perishable product. Interestingly, potato consumption was not affected by the same factors: market access was not significant, nor were income, refrigerator ownership, or employment of the housewife. This demonstrates that convenience-related factors for cassava weigh more heavily than for potatoes, which are not so perishable.

Consumers were asked some questions concerning their attitude toward the as yet unseen storage technology. Fifty-four percent of consumers were initially positive, with 27% negative, mainly because of the use of a chemical treatment and fears about the quality of the cassava provided. However, 85% were willing to receive sample bags of cassava to try at home.

Onfarm trials of the storage technology. Two series of trials were conducted with farmers in the Barrancabermeja cassava production region of Santander Department, located in the community of El 32. In all trials, cassava stored under ambient conditions was totally deteriorated after only three or four days. Cassava packed in 5-kg bags suffered 12% losses after two weeks in one trial, and less than 1% losses in the second series. In addition, one trial produced 38% losses due to storage in an unventilated room, where temperatures in the bag exceeded 40 °C and substantial rotting occurred. In the first trial, roots were analyzed for changes in dry matter and starch content. No changes occurred in the first week of storage, but during the second week the starch content fell by 6% and the dry matter content by 1.5%. Despite this, the farmers cooked and consumed the cassava, and noticed no eating quality changes over the two-week period.

In the second series of trials, information was gathered comparing spraying with dipping the roots in thiabendazole solution, and the costs and extra labor involved in the treatment and storage operations. The spraying method was found to be both more effective and cheaper. An average of 77% of the roots harvested were suitable for storage. Substantial variation in the amount of cassava that could be harvested and treated per man-hour was found, related to the difficulty of harvesting in some soil types, and to the inexperience of the workers involved in the trial. The total extra cost involved in treatment operations (chemicals, bags, labor) was US$0.03/kg of roots.

Consumer panel operation and results. A consumer panel was set up in Bucaramanga to test the storage system at home. The objectives were to evaluate: losses and quality changes during storage; the ability of housewives to manage the storage system at home; consumer interest in purchasing bagged cassava; consumer perception of advantages and disadvantages of the system; and possible changes in consumption following the introduction of the technology.

The panel consisted of 100 families selected from those interviewed in the previous consumer survey who expressed interest in the storage technology. They were representative of the socioeconomic divisions of the city, and also contained people with different levels of access (ease or difficulty) to markets (i.e., with different shopping habits). Each consumer received a bag containing 4 kg of freshly harvested and treated cassava of one variety from the same farmer's field. In addition, a 2-kg sample of freshly harvested cassava with no treatment or packaging was included. The fresh, unbagged sample was consumed immediately, and an interview conducted concerning the eating quality of this sample. The bag of cassava was stored at home in the kitchen for one week. The bag was then opened, and half the contents prepared and consumed. Another interview was conducted concerning the eating quality of this stored cassava. The cassava remaining in the bag was stored for a further week (the bag was closed with string) and a final interview conducted on this after two weeks of storage. In this way, the eating-quality evaluations of fresh cassava and cassava stored for one or two weeks (of the same variety) could be compared using the same consumer sample.

Over 95% of the consumers carried out their instructions correctly, consuming each sample on the day instructed. No problems were encountered in managing the bags in the house, or in closing them with string for the second week of storage.

Storage losses were low and acceptable in all but one of the five neighborhoods involved. In this latter case, a preharvest fungal infection inside the root caused rotting in some roots during storage, resulting in losses of 15% after two weeks. This highlighted the need for more stringent quality control in the field.

There were no significant differences in eating quality between fresh roots and those stored for one or two weeks (Figure 1). No sweet taste was noted in the stored roots. There was some difference in external root appearance due to the cured tissues taking on a darker color, but this was not a negative characteristic and such roots were still rated as acceptable.

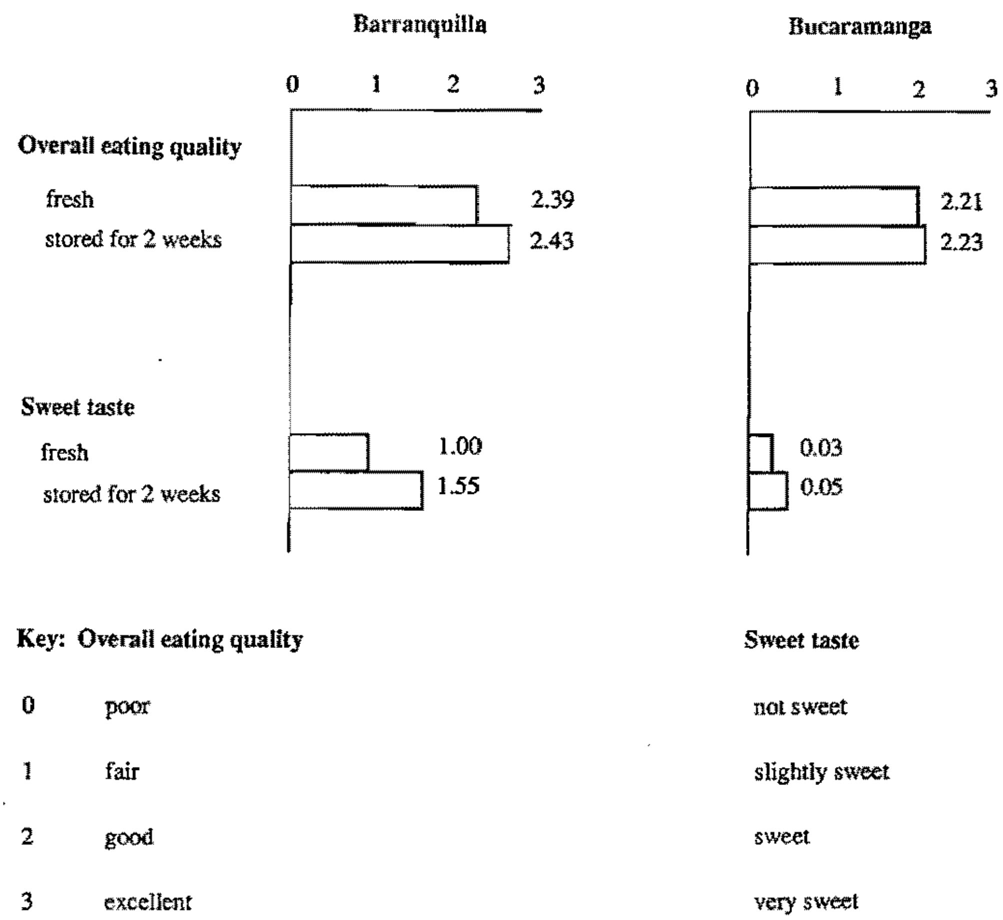

Figure 1. Results of fresh cassava storage rated by consumer panels in Bucaramanga and Barranquilla: evaluation of the eating quality of fresh and stored cassava. (Adapted from CIAT, 1988, and van Koersveld, 1987.)

The principal advantages (Figure 2) for consumers of cassava in bags were: storability, good eating quality, and less frequent purchase necessary. All these were rated as being important to consumers. The disadvantages of not being able to select individual roots, the chemical treatment, and greater cost per unit of purchase were given little importance. However, the high price of a bag of cassava compared to purchasing a few roots was more of a disadvantage for the poorest income group interviewed. A different sales strategy may be needed for this group.

Almost all (90%) consumers would purchase cassava in bags rather than cassava as traditionally sold if the two were on sale at the same price per kg of roots, or if the bags were cheaper. If the bagged cassava was 20% more expensive than the traditional cassava, still over 80% of consumers would prefer to purchase the bagged cassava. This is a clear indication that the benefits of the technology to consumers are real and highly appreciated.

If cassava in bags were readily available in the marketplace, consumption would increase, by 8% to 28%, depending on the neighborhood concerned, with the largest increases occurring in those areas where market access is most difficult and where consumers depend more on small shops for cassava.

The consumer panel confirmed that the technology worked at the household as well as the farm level, and that benefits to consumers were real and worthwhile. A good market for the product therefore existed.

Initial commercial experiences. Following the successful results of the consumer panel, initial trials of cassava in bags at a small-scale commercial level were started. A cooperative of approximately 15 farmers from El 32 was established for this purpose. Following the onfarm and consumer trials, the farmers were convinced of the effectiveness of the technology and market possibilities. The chance to become involved in marketing their product and to obtain the margin that previously went to the rural intermediary was also appealing. Institutional support for the farmer cooperative was available from DRI (project coordination), CORFAS* (credit and technical assistance in marketing), and SENA* (assistance in formation and operation of cooperatives and basic bookkeeping). The cooperative purchased cassava from individual farmers (members were paid a higher price than nonmembers) after a test for eating quality to ensure that roots were acceptable to consumers. The

---

* CORFAS = Corporación Fondo de Apoyo a Empresas Asociativas; SENA = Servicio Nacional de Aprendizaje.

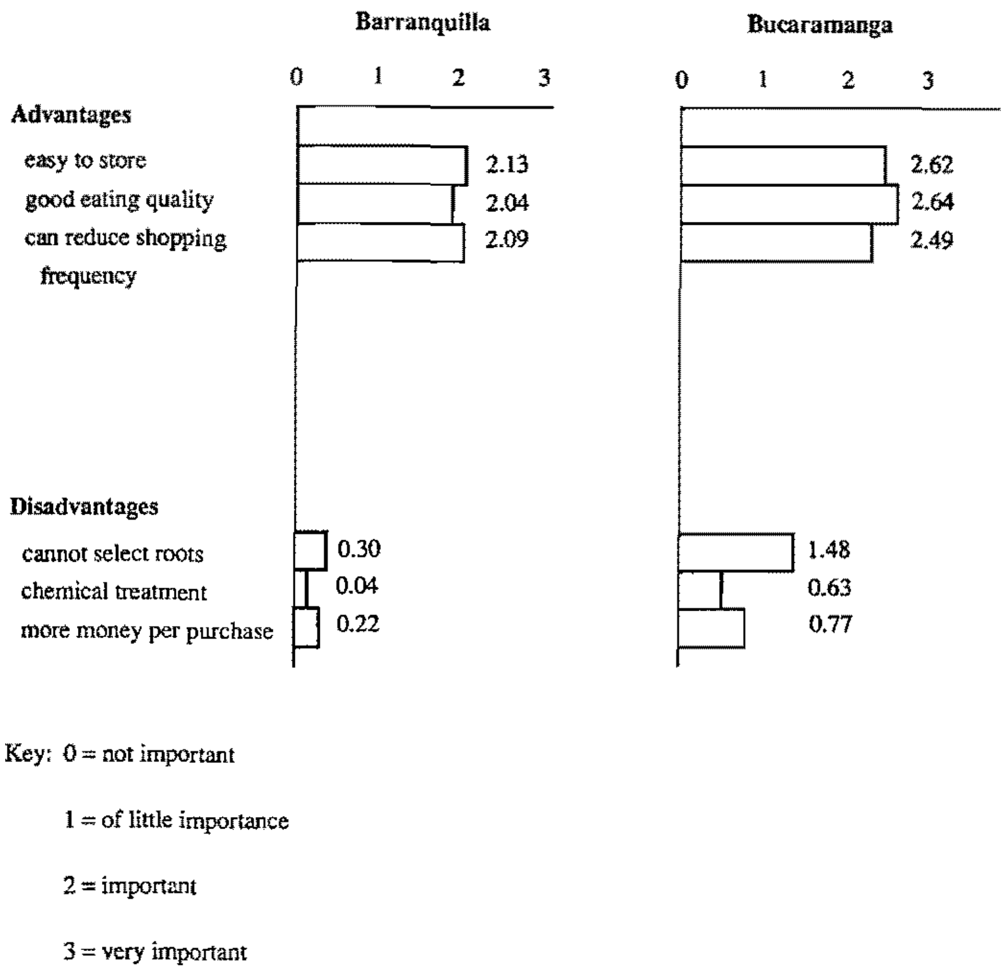

Figure 2. Results of fresh cassava storage rated by consumer panels in Bucaramanga and Barranquilla: evaluation of the advantages and disadvantages of the technology. (Adapted from CIAT, 1988, and van Koersveld, 1987.)

cooperative took charge of the treatment and packing operations, and paid members for their labor input. A truck was hired to transport the cassava to Bucaramanga.

On arrival in the city, the bagged cassava was distributed to a number of small shopkeepers in (at first) two neighborhoods of lower to middle-class consumers. As the number of shops grew over the succeeding weeks, an urban distributor was found, who, for a small margin, delivered the cassava to each shop directly. Two harvests a week were required. The number of shops selling the product and the volumes traded increased steadily for several months, reaching approximately 6 tons/week, and benefits were found both by farmers and consumers. Shopkeepers not only reported increased cassava sales after switching to the new product but also that more customers visited the shop, and that sales of other perishable goods increased.

Table 5 shows a breakdown of costs during this period. It is remarkable to find a technology that not only increased the farm-gate price but also produced a cheaper good for the urban consumer, as well as benefiting the cooperative. The only loser was the intermediary/wholesaler, whose functions were being usurped by the cooperative. However, Bucaramanga has only 15 wholesalers.

By the end of 1987, the commercial success of the product was apparent: farmers were making a steady profit, distributors and retailers were interested in increasing volumes, and consumers were satisfied with the product. However, continued progress was not possible for the following reasons.

1. The local DRI office had a change in director, and the new one gave a lower priority to the project. This resulted in one of the organizations involved pulling out of the project, leaving the farmers with no technical assistance in the project's commercialization aspects.

2. The farmers felt this immediately because they lost their contact with the urban distributor of the product. The group was not yet sufficiently consolidated to undertake this complex activity alone. Gradually, therefore, shipments of cassava diminished, and this was exacerbated by public security problems in the area.

3. The guerrilla group that had been operating in the Magdalena Valley for some time became more active, frequently obstructing the road between the production region and the city. This meant that delivery of bagged cassava became sporadic, and the urban distributor could not guarantee

Table 5. Costs of storage treatment in Bucaramanga and Barranquilla, and retail prices[a] (1987).

Cost factor	City	
	Bucaramanga	Barranquilla
Fresh roots	15.07	26.43
Labor	2.25	1.84
Bags and staples	3.30	2.45
Mertect	0.65	0.99
Transport	3.33	4.49
Sale price	27.00	44.44
Margin for cooperative	2.40	8.25
Increase in fresh root price paid over the current price paid to intermediaries	3.00	2.00
Price of traditional cassava to consumer	50.00	52.00
Price of storable cassava to consumer	45.00	60.00

a. Prices given in Colombian pesos (US\$1.00 = Col.\$260.00).
SOURCE: CIAT (n.d.).

the product to his clients. Another effect of the guerrilla activity was to make the other national institutions more reluctant to visit the project area (because of fears for their personal safety), and thus technical assistance was reduced.

Despite these unfortunate occurrences, the farmer group did not disband, however, but instead concentrated its efforts on producing dried cassava, the commercialization of which is much easier and not affected by road closures. The group had already started to dry the cassava that was not suitable for storage because of mechanical damage, and was producing a small but regular volume of dried chips. Gradually, the group shifted into dried cassava production for most of the cassava available, and a 500-m^2 drying area was constructed. One further drying cooperative has since been formed in this region, in spite of the continuing guerrilla problems.

Thus, although the technical and commercial success of the stored cassava was assured, for institutional and public order reasons the project was discontinued in 1988. By this time a second pilot project was already under way, focused on the Atlantic coast city of Barranquilla.

Barranquilla

The experiences of the Bucaramanga pilot project showed that far from being competitive products, dried and fresh cassava were in fact complementary, with the high-quality roots going to the fresh market and the lower quality or older roots being used for drying. Thus, one of the original reasons for avoiding the coast region was not valid. In addition, the DRI program was keen to start the storage technology in the coastal region, given its technical success in Bucaramanga and the fact that cassava is a basic staple in Barranquilla, the largest city in the area. Because of the dried cassava project, the institutional organization was strong and the knowledge of and interest in cassava in all the involved organizations were good.

The pilot project was therefore conceived to pass through the same stages as the Bucaramanga project, but in less detail and faster. In 1987, the first surveys of farmers, consumers, and traders were made, and trials of the storage technology started with a cooperative of small farmers already organized (and currently commercializing tomatoes).

The existence of experienced cooperatives in this region was a big advantage over the Bucaramanga project. Following the successful results of the storage trials on farm, the first commercial trials were started, with good results. These results are briefly presented below.

Cassava production. The region of Repelón, 85 km from Barranquilla, was selected as the main production region for the project because year-round cassava harvests are facilitated by the irrigation scheme operating in the region (35,000 ha), high-quality fresh cassava is produced, and small cassava farmers were already organized into a cooperative (with several years successful experience commercializing tomatoes).

Although cassava is not the main crop in this area, cooperative members were very interested in the possibility of commercializing the crop themselves. They had experienced several years of poor results with tomatoes, because of low prices and poor yields, and were looking for alternative crops. They traditionally produced cassava only for harvest in the off-season (i.e., using irrigation to harvest when other cassava regions that supply Barranquilla have no cassava to offer). The conservation technology gave the farmers an improved option for marketing their cassava, and they were willing to undertake the initial trials of the technology, and to provide cassava for the consumer trials. No formal experiments were conducted as at Bucaramanga, but sufficient technology tests were made at the farm level to give the farmers confidence that the technology lived up to its promise, and to determine that the treatment and packing operations were accepted by the farmers as being practical and feasible in their environment.

Market and consumer surveys. Consumption at Barranquilla reaches 32,000 tons of fresh cassava each year. This is supplied by many production regions throughout the five departments of the north coast. Because of differences in microclimatic and edaphic characteristics of each region, planting and harvest times differ. The main planting season is from April to May, with harvests from December to April. A few regions are specifically identified by the market for the provision of excellent-quality cassava for human consumption: Santa Cruz and Repelón in Atlántico Department (capital Barranquilla) and María la Baja in Bolívar Department. These regions also supply cassava in the off-season. The market structure in Barranquilla is very different from that of Bucaramanga (van Koersveld, 1987). The latter city has a network of municipal and local markets, whereas Barranquilla has only one marketplace. This fulfills both retail and wholesale functions, but only a small percentage of cassava is sold there at retail levels. Because of the lack of markets distributed throughout the city, the 5000 small shops in Barranquilla are especially important as retail outlets for cassava among lower and middle-income groups, with supermarkets playing an important role for high-income consumers. The main market (called Barranquillita), however, remains the place where almost 100% of the cassava is purchased from rural intermediaries by wholesalers, and is thus a vital stage in the marketing process. In total, there are 40 wholesalers in Barranquillita and 140 minoristas, or secondary wholesalers. The latter sell only about 130 kg per day. Because of the difficulty most consumers have reaching the marketplace in order to purchase cassava, the volumes retailed in other types of outlets are more important. For example, 65% of the fresh cassava volume is sold through small shops, of which over 5000 exist in Barranquilla. Each shop sells only 103 kg per week. The shopkeeper buys from the small secondary wholesaler in the marketplace. This part of the marketing chain has the most problems with deterioration, since it is the longest part of the chain, and physically the furthest from the marketplace. The rest of the cassava is sold to supermarkets (7%), through street sellers (8%), and to restaurants (9%), with only 11% being purchased directly by consumers from the marketplace. The most important factor governing choice of purchase site for cassava is proximity to home or work.

Consumer consumption habits in Barranquilla depend largely on consumer income level, with purchase frequency and consumption/capita/year decreasing as income rises, but with the unit of purchase increasing with income. In all groups, the vast majority of cassava is eaten at lunch, boiled. The most important quality factor related to consumer purchase of cassava is product freshness (e.g., white parenchyma color).

Onfarm and consumer panel trials. Repelón is an area containing nearly 300 farms on an irrigation district organized by the Colombian national land reform agency. The cooperative already formed for tomato marketing had 82 members. After explaining to the farmers about the opportunities created by the technology for improving the marketing of their cassava, and recounting the positive experiences of the Bucaramanga project, a series of technology trials was carried out with the farmers. These trials involved both farmer participation and consumer testing of the bagged cassava. Farmers were initially interested in developing the supermarket option, since they would receive a higher price than if they sold to small shops. Supermarkets supply mainly high-income consumers, hence the initial consumer testing was carried out with this group. A panel of 40 consumers was organized as at Bucaramanga, with excellent results (van Koersveld, 1987). There were no significant differences in eating quality between fresh cassava and cassava stored for one or two weeks (Figure 1), and the stored roots were easier to peel and cooked faster. A slight sweet taste was noted in the stored roots, but this was not considered to be negative. As in Bucaramanga, the advantages of the technology outweighed the disadvantages (Figure 2). All consumers involved in the panel would prefer to purchase bagged cassava rather than unpacked traditional cassava, and the preferred bag size was 4.1 kg. A similar study was carried out with retailers (small shopkeepers), who evaluated the stored cassava as being of better quality than the freshly harvested sample. Ninety-five percent of shopkeepers were positively disposed to purchase the product, and thought they would sell more cassava. The bag size most preferred was 12.5 kg (i.e., for sale of individual roots to their low-income clients). Finally, a trial sale of cassava in bags was made in one supermarket, with a follow-up interview for consumers who purchased the bags. Eighty-one percent of consumers considered that the quality of the storable cassava was better than that of the traditional product. Cassava consumption increased following the trial purchase, and 98% of consumers said they would make repeat purchases. These results were communicated to the farmers, who were convinced that a market existed for the cassava. In addition, the supermarket chain where the trial took place was interested in stocking the new product. A semicommercial phase was thus initiated.

Initial commercial experiences. During the first two months of this phase of the project, 51 tons of cassava were sold to two supermarket chains in Barranquilla. During this period, the farmers gained experience with the practical aspects of the treatment and packing technology, and the costs and margins of the process were carefully monitored. The overall results from this period were that the individual farmer was paid a price 8% higher for his cassava than was currently prevailing in the market, and the cooperative received a reasonable, if not large, margin on selling the bagged cassava directly to the supermarkets. Although the supermarket paid 25% more for this cassava than for traditional cassava, the final price to consumers was only 15% higher (Table 5).

During the following year, volumes slowly increased to total approximately 10 tons per week. Sales were expanded to other supermarkets and to some small shops, although sales to these outlets were limited by lack of a good distribution network for the product, or a centrally located warehouse where it could be purchased. Other cooperative groups were trained in the conservation technology in order to provide a year-round supply of the product to the market. However, it became apparent that two major limitations were restricting the growth of this technology: lack of an efficient wholesale marketing system for reaching the 5000 potential small-shop clients, and the lack of product promotion on a scale sufficient to create general consumer awareness of the product and its advantages over the traditional cassava.

Market plan. The Barranquilla project had thus reached the stage at which the Bucaramanga project faltered and closed. Conclusions were that the product was technically successful and had excellent consumer acceptance, but that traded volumes were still small, at 10 tons/week, compared with a total market volume of 800 tons/week, that is, only 1.2% of the market. An objective of achieving a market share of 20% was proposed, and the means to realize this were devised. It was apparent that a vital project component was missing: product promotion. While the vast majority of consumers had no knowledge of the improved product on offer, it was difficult to increase demand. A concerted publicity campaign aimed at both low- and middle/high-income consumers and at traders, especially small shopkeepers, was needed. Promotion's effect should be to make the consumer aware of the new product's advantages, and to encourage its purchase. The mere presence of cassava in bags on supermarket shelves was not enough. However, if demand was to increase following promotion, the supply had to be ready to respond to it. A survey of the current production areas of good-quality cassava was undertaken, and the possible collaborating cooperatives identified. Only in a few areas were totally new cooperatives needed. A complicating factor is that the harvest period for cassava varies among the different microregions of the coast. While this has the advantage of assuring continuity of supply, the disadvantage of having to change cooperatives during the year is obvious. However, a plan for providing for a gradually increasing demand from different cooperatives was produced.

An efficient and profitable distribution network is also required. During the trial commercial period, each cooperative marketed its own product, reaching direct agreements with supermarkets and urban distributors. In the event of a greatly expanded market, competition between the cooperatives must be avoided, and a central marketing organization would be the best option. The cooperatives would thus sell their packed and treated cassava to this new organization, which would in turn coordinate distribution to shops and supermarkets. This would allow good coordination of supply and demand, as well as facilitating quality control.

In fact, a second-order federation of cooperatives was formed in early 1989, which comprised cooperatives of cassava producers and small shopkeepers in Barranquilla. It was thus the ideal candidate to supervise a marketing operation for the fresh storable cassava. Preparatory to the initiation of these activities, some preliminary development of market promotion materials was done.

First, an advertising agency was hired by DRI to produce a brand name, campaign slogan, and overall design of the campaign activities. Using the brand name, a series of posters and leaflets were printed, ready for use when the campaign proper started.

The selection of a brand name and the legal registering of this name are important to the product's success. It is possible that other entrepreneurs may start to enter the market with this product, since the technology is freely available. It is therefore important that the cooperatives have a secure way of distinguishing their product from imitators. The use of a brand name is also essential from a publicity point of view, since the consumer needs an easily remembered name to associate with product advantages. A series of possible product names were consumer-tested in several Colombian cities during 1988, and a name associated with freshness (Yucafreska) was clearly favored by consumers. A campaign slogan was also chosen ("calidad por la-a-argo rato," or la-a-asting quality), and a new design for the bag was made, highlighting both name and slogan and also featuring a brief list of product benefits and instructions for use.

At the time of writing, the project is waiting for the arrival of funds to initiate promotional activities. The federation of cooperatives is starting to set up a distribution network, based on a centrally located warehouse in

Barranquilla. The project has therefore reached the stage of a test market, where the distribution network is to be tested with the promotional campaign for the first time. If successful in Barranquilla, DRI and the Colombian government intend to expand the project to the country's other major cities. This will also serve as a pilot experience for other Latin American countries starting to experiment with this storage technology (Paraguay, Ecuador, and northeastern Brazil).

Conclusions

To date, the pilot projects in Bucaramanga and Barranquilla, Colombia, have demonstrated that the storage technology developed at CIAT is technically viable when carried out by farmers. It is also economical, and the product is attractive and acceptable to consumers. Additional projects are being initiated in other regions of Colombia (Sucre, Cesar, and Santander departments). Projects are also under way in Paraguay and northeastern Brazil.

However, the final objective of obtaining a significant market share for cassava in bags in any urban center has yet to be achieved. Problems will undoubtedly be encountered in going from a volume of 10 tons/week to 100 tons/week or more. These will require creative solutions, both technical and organizational. In particular, the optimal organizational structure for marketing this product has yet to be developed (cooperative, small business, among others). A further constraint is the lack of financing for promotional activities, which are essential to create widespread product awareness among the general consumer, but cannot be financed by the marketing enterprise alone. This may be the critical constraint still to be overcome for the project objective to be achieved. It is interesting to note that introducing a technically superior new product such as storable cassava is not in itself sufficient: distribution and promotion in these final stages of the product development process will determine whether the initial investment in technology development will be cost-effective, yet these activities are normally considered to go well beyond the terms of reference of international centers. Since the commercial viability of these technologies relies on the successful linkage of small-farmer cooperatives to expanding markets for new products, CIAT must gain experience in these novel nontechnology aspects of product development in order to ensure replicability of these projects in other countries of Latin America and elsewhere.

References

Booth, R. H. 1976. Storage of fresh cassava (*Manihot esculenta*), I: Post-harvest deterioration and its control. Exp. Agric. 12(2):103-111.

_________. 1977. Storage of fresh cassava (*Manihot esculenta*), II: Simple storage techniques. Exp. Agric. 13(2):119-128.

CIAT (Centro Internacional de Agricultura Tropical). 1988. Cassava Program annual report 1985. Cali, Colombia. 371 p.

_________. n.d. Cassava Program annual report 1987. Cali, Colombia. (In print.)

CIAT/CORFAS (Centro Internacional de Agricultura Tropical/Corporación Fondo de Apoyo a Empresas Asociativas). 1988. Características de la comercialización y el consumo de la yuca en Bogotá, Medellín y Cali y sus implicaciones para la introducción de la yuca conservada [Consumption and marketing characteristics of cassava in Bogotá, Medellín and Cali, and the implications for the introduction of storable cassava]. CIAT internal document. Cali, Colombia. (In mimeograph.)

de Haan, G. 1986. Buying behaviour and changing cassava consumption habits in Bucaramanga. M.S. thesis. Agricultural University of Wageningen, Wageningen, Netherlands. 90 p.

de Morrée, D. 1985. A comparative analysis of marketing and consumption of cassava and potatoes in Bucaramanga: The possibility of the introduction of a storage technology for cassava. Agricultural University of Wageningen, Wageningen, Netherlands.

Janssen, W. and Wheatley, C. 1985. Urban cassava markets: The impact of fresh root storage. Food Policy 10(3):265-277.

Lozano, J. C.; Cock, J. H.; and Castaño, J. 1979. New developments in cassava storage. In: Brekelbaum, T.; Bellotti, A.; and Lozano, J. C. (eds.). Proceedings of the Cassava Protection Workshop held in Cali, Colombia, 7-12 November 1977. Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia. p. 135-141.

Marriott, J.; Been, B. O.; and Perkins, C. 1978. The etiology of vascular discoloration in cassava roots after harvesting: Association with water loss from wounds. Phys. Plant. 44(1):38-42.

Noon, R. A. and Booth, R. H. 1977. Nature of post-harvest deterioration of cassava roots. Transactions of the British Mycological Society 69(2):287-290.

Oudit, D. D. 1976. Polyethylene bags keep cassava tubers fresh for several weeks at ambient temperatures. J. Agric. Soc. Trinidad & Tobago 76(1):63-66.

Rickard, J. E. 1981. Biochemical changes involved in the post-harvest deterioration of cassava roots. Trop. Sci. 23(3):235-237.

_________ and Coursey, D. G. 1981. Cassava storage, I: Storage of fresh cassava roots. Trop. Sci. 23(1):1-32.

van Koersveld, E. 1987. The impact of a storage technology on cassava marketing and consumption in Barranquilla. M.S. thesis. Agricultural University of Wageningen, Wageningen, Netherlands. 55 p.

Wheatley, C. C. and Janssen, W. G. 1988. Effects of the introduction of storage technology on the urban fresh cassava market of Colombia. In: Degras, L. (ed.). Proceedings of the VIIth symposium of the International Society for Tropical Root Crops held in Gosier, Guadeloupe, 1-6 July 1985. Institut National de la Recherche Agronomique (INRA), Paris, France. p. 649-666.

_________; Lozano, J. C.; Marriott, J.; and Schwabe, W. W. 1984. Pre-harvest environmental effects on cassava root susceptibility to post-harvest physiological deterioration. In: Proceedings of the sixth symposium of the International Society for Tropical Root Crops held in Lima, Peru, 21-26 February 1983. International Potato Center (CIP), Lima, Peru. p. 419-430.

_________ and Schwabe, W. W. 1985. Scopoletin involvement in post-harvest physiological deterioration of cassava root (*Manihot esculenta* Crantz). J. Exp. Bot. 36(166):783-791.

Zapata, L. E. and Riveros S., H. 1978. Preservación de yuca fresca. IIT Tecnología 115:9-20.

Chapter 6

DEVELOPMENT OF BETTER TECHNOLOGY FOR CASSAVA PRODUCTION SYSTEMS WITHIN THE CONTEXT OF INTEGRATED PROJECTS

Raúl Moreno*

Introduction

In farming oriented toward the market, and even more in types of farming strongly influenced by the market, demand for technology that farmers exert to improve production of a given good runs parallel to demand that consumers exert for that good (or its byproducts).

The phenomenon of urbanization has resulted in physical distance between extensive crop production centers and their consumption centers. This distance favors the commercialization of nonperishable agricultural products that can be transported and stored with fewer risks of loss than fresh cassava roots. In this spatial distribution, demand for fresh cassava has been negatively affected in urban consumption centers, which has caused a low demand for improved technology in rural production centers.

When better technology cannot be applied, cassava continues to be produced in what is termed "the traditional form of production," which is usually characterized by maximization in the use of land and labor resources, together with minimum possible use of capital and technology. In some cultivated species, and particularly in the case of cassava, their high efficiency in conversion of solar energy into carbohydrates makes it possible to obtain considerable harvest volumes, even within traditional production patterns.

The total volume of cassava production in a region thus tends toward a state of equilibrium with the volume in demand, which is the sum total of home consumption at the farm level and what is marketed outside its boundaries.

To increase significantly the demand for improved production technology, a rather considerable increase in demand for the product and/or its by

---

* Agronomist, Cassava Program, Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia.

byproducts should exist in consumption centers. If the increase in demand for products in these centers is not significantly greater than existing demand, farmers can possibly satisfy it by turning only to technological knowledge already available or by simply increasing surface area cultivated with traditional technology, if that is possible.

All of the previous concepts are valid only if the productive base of existing natural resources in a given region is kept constant, that is, if a phenomenon of reduction in cassava yields over time is not being faced. This reduction could be due to degradation of the environment (decrease in soil fertility caused by erosion, for example) or a phenomenon of gradual degradation of the species itself (as would be the case of yield reduction as a consequence of virus-type diseases in cassava).

New or improved markets that result from integrated cassava programs frequently require the establishment and operation of a drying plant for cassava chips; the treatment and bagging of fresh cassava; the installation or improvement of starch production plants, etc. Whatever the manner of utilization adopted for the development of markets within a cassava production improvement plan may be, this new market is undoubtedly going to affect production in some way, due to the state of equilibrium mentioned that is achieved between production and consumption.

If opening and developing a new market for cassava in a given region of a country really increases demand for technology to produce the crop significantly better, it might be necessary and advisable to dedicate efforts toward the development of this improved technology, for which it is necessary to modify cassava production systems used by farmers in some way.

Cassava Production Systems

The cassava production system may be the whole, or one additional component, of the food production system within the farm. Thus, it competes or complements itself with other activities within this unit for the use of capital, land, and labor resources.

The farmer will assign resources available on the farm for this system, in greater or lesser proportion, according to the comparative profitability and/or degree of complementarity of the cassava production system with the other systems that integrate the farm.

From the physical point of view, in production systems based on cassava, a close dependency exists between the growth rhythm of the plants throughout the year and the timeliness and frequency with which water, soil nutrients, and solar radiation become available throughout the growing season. This synchronization between the growth rhythm of the plants and the passing of time is also a characteristic of other small-farmer production systems. The tighter this synchronization is, the more traditional a production system is considered to be.

From the biological point of view, cassava production systems show a close interaction of the crop with other cultivated species. This interaction is the result of intercropping, crop associations, relay cropping, and other similar cropping patterns that are typical of small-scale farming, and whose practice is owed to reasons already widely discussed in the literature.

Also from the biological point of view, one of the interesting characteristics of cassava is a relative stability in production. In comparison with other cultivated species, cassava is not usually subject to marked variations in production for the market, which constitutes an element of security and risk reduction for the farmer. Analyzing the causes of this fact goes beyond the nature of this work.

From the social point of view, and considering man only as a producer, cassava production systems are characterized by high labor intensity and, in general, low profitability of this production factor per unit of product obtained. Finally, from the economic point of view, the most important characteristic of cassava production systems is without a doubt the low investment of capital with which they are carried out. This is reflected above all in the low use of inputs acquired in the market, chiefly fertilizers and other agrochemicals.

All these characteristics cause cassava production systems, especially in Africa and Latin America, to be qualified as traditional. One of the most notable characteristics of traditional production systems is simply the repetition year after year of the same cultural practices, almost in an identical manner and order, each time that the same environmental conditions are repeated.

Development of Technology

Cassava is a typical crop of small farmers, and this strongly conditions the strategy adopted for the development of better technology with which to produce it, both from the socioeconomic and the physical-biological point of view.

The purpose of developing improved cassava-producing technology is to have technical recommendations available that, upon being applied to systems currently used by farmers, allow improving production conditions, mainly by increasing the quantity of product obtained per unit of limiting resource used.

Technology development for small farmers, which is different from agricultural research of a more controlled nature, is instead an activity of synthesis that nourishes itself from knowledge developed by applied research and, in the end, by basic or fundamental research.

This process of technological development thus implies the availability of proven, useful technical knowledge; the correct identification of that which is relevant to specific production conditions that one wishes to improve; testing in conditions of producers; and, finally, its adaptation to specific production conditions.

It is hoped that these technical recommendations will permit improvement of the efficiency with which cassava transforms resources into useful products, while trying to conserve the productive base of natural resources in the region.

In the particular case of technology development for small farmers, it is necessary to consider carefully that any technological innovation is in itself a social-type product. Therefore, each technological manifestation implicitly bears the nature of the society that developed it. To then assure the successful use of a technology component by any human group, it is necessary for this technology to be developed in conditions very similar or equal to those that are going to be in operation at the time in which this technology is applied.

For this reason, much importance has been given in the last few years to technology development on farmers' holdings, along with the greatest possible participation on their part in the whole process of development of this technology. It is hoped that with this development approach, the already well-known and described phenomenon of inefficient technology transfer can be partly avoided.

At any rate, it is necessary to keep in mind that however traditional a production system is, in reality, farmers that practice it are constantly testing new ways to carry out a given cultural practice. It is possible that the effect of the application of this new practice will not result in significant advances upon comparing one season of crops with the next, but, undoubtedly, in an undegraded environment, methods are constantly adjusted and their positive results are seen gradually over a long term. This gradual adjustment of new cultural practices makes their positive effect sometimes go unnoticed by the observer.

The ability to innovate is thus present in the majority of small-farmer groups. It can be increased if positive stimuli exist in the environment. This ability is closely related in turn to the ability to discriminate and then integrate useful knowledge.

Thus, for this type of producer, a logical technology development approach is that of onfarm work, with active participation of farmers in the process of improving technology, so that it will turn out to be immediately adapted to production conditions.

Yield, Environment, and Management

Technology is normally developed for the purpose of modifying the yield of a species, whether in its quantity or quality.

Yield is a vectorial-type quantity. It can be said that:

$Y = (f)\ E, M$
where Y = yield, E = environment, and M = management.

In other words, yield is a function of environment and management. In this case, physical-biological variables of a material type are included in E.

In an effort to develop better technology, it is important to decide precisely which components of E are going to be dealt with as parameters and which as variables. Usually, in small-scale farming, parameters are considered to be all those characters of the environment that are unmodifiable by man, unless he carries out works of infrastructure. Rainfall, topography, temperature, etc., are frequently classified as parameters. Variables are considered to be those characters such as soil fertility, natural enemies, weeds, etc.

In some cases, the amount of inputs assigned to the cassava production system can be considered as a parameter. That is, the entire technology development process would consist of the search for better ways to assign a given amount of inputs in order to improve the system's yield.

Management is the body of decisions, and their consequent actions, that man carries out so that a species (cassava in this case) or a group of them (cassava associated with maize, for example) will transform the resources of a given environment (basically solar energy plus nutrients and soil water) into products of value to satisfy a need (cassava for consumption, for sale, for processing, etc.).

For each different environment, E_1, E_2, ... E_n, the farmer adopts management practices that are also different, M_1, M_2, ... M_n. Thus, knowing the E x M relationship for a given environment (E_1, M_1), (E_2, M_2), ... (E_n, M_n) is essential for understanding a production system and for taking the first step to improve it.

In the case of cassava production in a region that is the target of an integrated production, utilization, and commercialization project, it is assumed that the opening of a new market or the improvement of an existing market is going to imply (for farmers) the need to supply this market with a given volume of roots, with a particular quality, and in a timely manner that is determined mainly by this market. That is, it is necessary to modify M in such a way that it will be manifested significantly in Y, and thus assure that the production system will be adapted to the requirements of this new demand.

In general, and dealing with small-scale farming, physical characters included in E are considered to be given.

Methodological Considerations for Developing Better Technology

Some of the concepts that are frequently associated with what is termed onfarm research are rather useful for giving a conceptual framework to technology development for improving production systems based on cassava, which are found in regions that are targets of an integrated production, utilization, and commercialization project. These concepts are applied in certain methodological steps that have been thoroughly described in the literature. They are therefore not dealt with in detail here.

Basically, the methodological steps can be summarized as follows:

1. Description of production systems, the physical-biological environment, and farmers, for the purpose of identifying the chief limitations that affect production systems and establishing possibilities for improvement.

2. Design of improved production options that basically consists of the elaboration of improved models that will satisfy production needs and be within the physical possibilities of farmer management and, of course, within the farmer's cultural values and economic possibilities.

3. Field testing of improved options (a product of the previous phase) with farmers, and their later evaluation to verify whether these options meet proposed objectives.

4. Validation of the best technological options with a larger number of farmers, and elaboration of production and transfer plans.

These methodological states are not of a discrete type but rather they operate simultaneously in time in a process of gradual approach toward better forms of production.

The initial phase of description and identification of limitations and opportunities should be constantly enriched. The diagnosis or conclusion at which one will arrive after this process is thus a product of:

analysis of the productive process in itself;
analysis of the environment in which production is carried out; and the study of the wishes and aspirations of farmers with regard to their production unit as a whole and their cassava production systems in particular.

The description of the environment and of the farmers should point to the possibility of identification of more or less homogeneous production areas, both from the physical and socioeconomic point of view. It is assumed that technology available or in the process of development should be extrapolated at some time toward similar areas within the target region of the integrated cassava program.

Regarding the design of better technology, it is only necessary to mention that this design is basically a process of a more intellectual type in which the following come first: identified limitations; known aspirations; available or known technology; and the means that one has to produce in a different manner.

In the specific case of cassava, some technology components tested at experiment stations and in diverse environments exist, and frequently it is necessary to test them in different areas for the purpose of establishing their goodness of fit with other circumstances. Such is the case for selection of appropriate planting material; disinfecting of the cutting before planting; possible use of Karmex (diuron) and Lasso (alachlor) as preemergence herbicides, etc. If some of the problems identified in the description phase can be solved with the application of any of these technology components already existing, it is then in the design phase of technology that they should be included as possibilities.

One of the characteristics of cassava at the small-farmer level is its frequent intercropping with other species. Therefore, the technology components that exist for the other species normally associated with cassava should be considered in the design phase of the new technology. The small farmer rarely sees an individual species as a primary objective of his efforts, unless that species will have a profitability very much above that of the others that he frequently grows. The farmer usually pays more attention to the general performance of the group of species grown and evaluates their agronomic performance not only by considering their possible increases in production but also by considering how well they are adjusted together to the habitual performance of their production unit. Thus, technology available for other species should be included in the design of better technological options, especially in the study of the effect that this technology will have on cassava production.

Regarding field tests, these are really only the physical execution of what is designed as advisable for making improved technology available. Experimental designs should be so simple that they will allow farmer participation in the conducting of trials, but at the same time complex enough to allow decisions regarding the statistical precision of information obtained.

Information obtained from field trials should be integrated into a technical production recommendation that is nothing more than a group of technological components that allow better production to be obtained when they are applied in sequence.

Technical Recommendations and Pre-Production Tests

Often, both agricultural researchers and personnel assigned to technology development from institutions in the farming sector will think that structuring technical recommendations is more a task that corresponds to agricultural extension rather than to research. This is true in part, but, in reality, the idea that neither truly relevant research nor technology development can be conducted unless one has prior access to a conceptual-type model on the technical recommendation that is pursued is stronger all the time. Therefore, the formulation of a technical recommendation in its preliminary form is an important part of the beginning of the technology development process.

Technical recommendation in this case is understood as the group of technological components that allow a modification of output in some way when applied in the logical production sequence. The phrase "logical production sequence" has been used in the sense of the group of productive activities that take place in the farming cycle and that normally begin with land preparation; continue with preparation and planting of seed; weeding, etc.; and normally end with harvest, transportation, and sale.

Actually, for more or less homogeneous areas, if improved technological production components do not exist, the technology currently in use by the farmer is the base technical recommendation. This statement is warranted by the fact that if farmers have been producing at that site for some time, existing technology possesses sufficient attributes to serve as a basis for later development of a better one. Therefore, the detailed description of production systems presently used by farmers is very important in the methodology of onfarm research. Likewise, this emphasizes the importance of understanding the E x M relationship for each particular case.

The practical way to develop an improved production model is simply to describe the entire production sequence step by step on paper and, for each step of it, in a separate column, to analyze whether or not technical recommendations used by farmers exist. The resulting column, which includes possible technical recommendations, plus farmer practices for those cases in which new knowledge does not exist, constitutes in itself an improved production model, although it is of a theoretical type and will surely need field tests. Each field test is thus an integral part of a whole that should be assembled afterwards in a logical total sequence, under farmer management.

The testing of technology components should be done on representative farms and with farmer participation. This corresponds, in most cases, to what is commonly known as onfarm research.

Once one has a group of technological components that have turned out to be successful in controlled onfarm tests, it is important to test their goodness of fit in the overall production process. That is, the logical sequence of production steps should be repeated, but this time applying all the positive results of trials that were made to test technological components. This sequence of steps would be very similar to the initial improved and theoretical production model. Tests are conducted under complete farmer management, and they should necessarily be more extensive than trials as such.

Literature and experience normally indicate the suitability of conducting tests on surface areas larger than 1/4 ha, if the land is available of course. Such large plots cannot be submitted to experimental comparison due to their size. It is hoped, however, to compare their final results with those of other nearby commercial lots that are cultivated with the same cropping arrangement. The purpose of these large plots is mainly to evaluate the reaction of the farmer vis-à-vis each technological innovation, and to show some interactions on larger sized plots that cannot be identified clearly on small plots.

These plots have been given the name of "pre-production plots," since in reality they are the basis for production plans for a more or less homogeneous given area. They should not be confused with demonstration plots as such, although if they turn out successfully they could be used for those ends. Demonstration plots are established instead for the purpose of serving as a discussion and extension piece of certain already well-tested technology components directed toward farmers.

If these pre-production tests turn out successfully in the sense that the improved system is manageable by the farmer and really constitutes a significant advance over the existing situation, they should serve as a basis for structuring production plans for the target area of an integrated program for improving cassava production.

Chapter 7

EVALUATION OF CASSAVA CLONES WITH FARMER PARTICIPATION

Luis Alfredo Hernández R.*

Introduction

Agricultural research programs usually include the evaluation of a large number of alternatives in order to solve farmers' problems. These alternatives include selection of plants that are high yielding and resistant to pests and diseases, cultural practices, and other factors. During identification of promising options, some alternatives can be discarded: farmers are then confronted with limited options which have already reached advanced stages of research, that is, only those alternatives that seem to be the best from the researcher's point of view.

With this approach, the researcher may often exclude technologies that could be promising from the farmer's point of view. To develop useful new varieties of cassava, it is not only necessary to obtain productive lines but also to assure that these varieties will be adopted by farmers. Evaluations with farmer participation constitute a method that can obtain knowledge on farmers' perceptions of proposed technological innovation, independently from assumptions of researchers (Ashby and Pachico, 1987).

Incorporation of Farmers' Criteria in Technology Generation

A breeding program selects plants that are, among other things, high yielding, high quality, and resistant to the important pests and diseases. Then, it evaluates the plants at the local level and, in advanced stages of research, delivers them to the farmer so that they will be used as varieties. While this selection process takes place, the farmer has been "selecting" his varieties based on his own criteria to adopt or reject a new technology.

Experience demonstrates that mere varietal selection with a view toward obtaining high yields and resistance to pests and diseases does not necessarily

---

* Research associate in plant breeding, Cassava Program, Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia.

guarantee rapid adoption of a variety among farmers. In fact, there are widely grown varieties with productivity inferior to that of some of the materials offered by research programs. For example, in the traditional system of regional tests in Colombia, the variety P 12 (or Verdecita) was never evaluated as very good, but nevertheless farmers began to plant it widely, and it was eventually released as a variety (Cock and Lynam, 1986). This makes it evident that farmers use other "selection criteria" for varieties in addition to yield and resistance. Therefore, incorporation of farmers' selection criteria is required as an important factor in the methodology of technological development.

The previous analysis suggests that farmers should participate in the generation of technology before the release of materials. This participation will allow information feedback to researchers and extensionists on the potential of acceptance of a new variety and on modifications in design or selection criteria that the breeder should incorporate.

Several advantages are derived from incorporation of the farmer's point of view in varietal improvement. When producers actively participate, it is possible to evaluate experimental lines under farmers' conditions at multiple locations and to obtain information on stability. Furthermore, time is gained in obtaining results, tailored to local needs, that can be applied directly by the extensionist (Ashby, 1986). On the other hand, the risk of releasing a variety that would later be a disaster is minimal because resistances to diseases are usually of a horizontal type and the multiplication rate is so low that the farmers themselves will discover the defects of a variety before it is planted in large areas (Cock, 1985). Finally, research in which farmers participate fosters good relations between researchers and farmers, by giving the latter a more important role within the research process (Ashby, 1981).

Methodology of Participatory Research

Participatory research seeks to test a new methodology with farmers and researchers together. This methodology, applied to clones in advanced stages of evaluation, will increase the possibility that these clones will be adopted. The methodology is oriented toward establishing feedback among the transferrer, the farmer, and the breeder, for the purpose of identifying selection criteria that should be incorporated into breeding programs.

This methodology rests solidly in the design of an effective system to capture and interpret the information necessary for varietal selection. The methodology covers several stages described in detail in another document

(Ashby, n.d.). The first and second stages, respectively, consist of selection of the farmer and the explanation of the trial to him. This includes discussion about purposes, benefits, and risks implicit in trials, the responsibilities that both farmers and researchers assume, and the form of farmer participation. The third stage is farmer selection of the trial site. Fourth, the researcher and farmer together proceed to locate and mark off plots for planting. The fifth stage consists of gathering data on crop establishment and development. In the sixth stage, forms are used to record data, which are later analyzed in the seventh stage. Finally, in the eighth stage, records are designed for monitoring of clones that the farmer decides to continue testing.

Figure 1 presents a tentative model that outlines the procedure. The figure describes a cycle that originated in the supply of clones to be tested at the regional level. High-potential clones are selected first by the agronomist/breeder to then be tested in individual production systems with farmers (selection A). Once a system of information feedback and consultation between the researcher and the farmer is established, it is possible to arrive at a new selection (selection B) to satisfy specific local needs. In addition, the gathering of information (instructions, forms) would allow the identification of selection criteria that farmers use, so as to use these criteria in a breeding program.

A Case Study in Colombia

In a preliminary attempt to obtain farmer input into cassava variety evaluation, in May and June of 1986, CIAT distributed three or four promising cassava clones to farmers in the Atlantic coast of Colombia, to be evaluated under the conditions of each farm. This experience demonstrated the need for a more systematic approach to obtaining information that could be interpreted more clearly. In the following year, several trials were set up in coordination with national organizations such as ICA (Instituto Colombiano Agropecuario), the Ministry of Agriculture, CORFAS (Corporación Fondo de Apoyo a Empresas Asociativas), and SENA (Servicio Nacional de Aprendizaje), among others (Table 1).

Initial Results

Three types of information were obtained: agronomic information, qualitative information (farmer-researcher feedback), and information on initial descriptive profiles for some clones. The information includes the list of expressions and glossary of terms used by farmers to describe clones from their perspective, as well as calculations and frequencies of use that are then

Breeding program

↓

Regional evaluation of experimental clones by researchers

↓

Clones selected according to criteria of researchers. Selection A

↓

Evaluation of clones in farmer systems. Farmer and researcher give each other information feedback

↓

Refining of selection criteria

↓

Clones selected according to farmers' criteria. Selection B

↓

Adoption and diffusion

Figure 1. Proposed model for the evaluation process with farmer participation for promising cassava varieties.

Table 1. Geographical distribution of trials and participating institutions (1987-1988), in Colombia.

Department	Number of trials	Participating institutions
Cesar	4	CIAT-ICA*-DRI-CORFAS-SENA
Magdalena	5	CIAT
Atlántico	5	CIAT-ICA
Bolívar	10	CIAT-ICA-Ministry of Agriculture
Sucre	5	CIAT-ICA
Córdoba	7	CIAT-ICA
Cauca	24	CIAT-ICA
Meta	4	CIAT-Ministry of Agriculture
Santander	2	CIAT-ICA
Putumayo	3	CIAT-MISEREOR Project
Total (1980)	56	
Total (1987-1988)	69	

* ICA = Instituto Colombiano Agropecuario; DRI = Fondo de Desarrollo Rural Integrado; CORFAS = Corporación Fondo de Apoyo a Empresas Asociativas; SENA = Servicio Nacional de Aprendizaje.

related to quantitative agronomic aspects. Taking into consideration consistency, degree of dispersion of information, and tests of harvested cassava, it was possible to develop a list of criteria in three departments of Colombia, with basic information from 116 observations (Table 2). In addition, a preliminary descriptive profile for each clone, based on the selection criteria of most importance to farmers, was generated (Table 3). The comparison of qualitative information with some quantitative parameters (dry matter and yield) could be used to great advantage in future analyses on the possible degrees of correlation between farmer preference and the quantitative information taken by researchers. These preliminary data indicate overall high farmer acceptance for experimental clones such as CG 1141-1, CM 3306-4, CM 3306-9, and CM 3555-6.

Projection

The initial exploratory phase has allowed improvements in methodology to better capture and interpret the farmers' evaluations. It is advisable to obtain a glossary of terms per site, then "select," with the farmer's help, those expressions that may indicate the same concept (synonyms) or the opposite (antonyms) in each case. In this way, one attempts to improve the quality of information for the determination of frequencies. In the Atlantic coast of Colombia, for example, farmers use the expression **floury cassava** to describe a root with high dry-matter content. Thus, the expressions **flour, dry matter, dry,** and **starch** are used interchangeably. At the same time, the qualifier **glassy** is an antonym of the previous expressions. Farmers also talk about **good color** to refer to a cassava root whose peel is dark. The expressions **production** and **number of roots** are used to refer to yield. Finally, producers talk about a cassava root suitable for the market. The term **market** describes the root from the point of view of its size, form, color, and dry-matter content, among others.

Future Plans

Results from previous tests have provided very important elements for the design and preparation of recording forms, which will simplify test management and interpretation. In the future, new forms of data collection will be tested at the different sites to simplify this task during the production and harvest phases. Similarly, modified record forms frequently used in variety selection as well as new forms designed to record additional information will be tested, in coordination with national organizations such as ICA, the Ministry of Agriculture, CORFAS, and SENA, among others.

Table 2. Selected criteria based on frequencies and degree of dispersion of the information base[a] (Córdoba, Bolívar, and Magdalena departments, Colombia).

Criterion no.	Description of criterion	Frequency[b] (%)
1	Ease of harvest	70
2	Yield, load, production	70
3	General evaluation	64
4	Dry or wet (dry matter)	43
5	Seed (preparation of stems)	38
6	Color of peel	35
7	Size of root	31
8	Presence of starch and/or flour	31
9	Better than the Venezolana variety	26
10	Bitter or sweet	26
11	Flavor (simple or tasty)	20
12	Market acceptance	18
13	Color of pulp	16
14	Fibrous heart	7
15	Earliness	6

a. 38 initial expressions.

b. 116 observations, two sites per department.

Table 3. Selection criteria of greatest frequency mentioned in tests with farmers for Córdoba, Bolívar, and Magdalena departments, Colombia (early harvest (H-1) and normal harvest (H-2), 1987-1988); relating them to dry matter and yield evaluations by researchers.

Clone	Ease of harvest[a]		Yield of roots[b]		Dry matter[c]		Starch content[d]		Stake production[e]		Color of peel[f]		Farmer prefer-ence[g]		Cooking quality[h]		Dry matter[i]	Yield[i]
	H-1	H-2	H-1	H-2	H-1	H-2	H-1	H-2	H-1	H-2	H-1	H-2	H-1	H-2	H-1	H-2	%	t/ha
CG 915-1	1.0	1.0	1.0	1.0	3.0	2.0*	2.0*	1.0	--	3.0	1.0	1.0	1.0	1.0	2.0	1.5	32	12.5
CG 1141-1	3.0	2.0	1.0	1.0	1.0	1.0	1.0	--	1.0	1.0	1.0	1.0	1.0	1.0	1.0	2.0	37	13.5
CM 523-7	--	3.0	1.0	2.0	2.0	3.0	--	3.0	1.0	1.0	--	1.0	1.5	1.0	2.2	2.0	36	16.5
CM 962-4	1.0	1.0	1.0	2.0	--	--	--	--	1.0	3.0	1.0	1.0	1.0	2.0	3.0	4.0	22?	14.0
CM 3281-4	2.0*	3.0*	2.0*	2.0*	3.0	2.0*	3.0	1.0	--	1.0	3.0	3.0	1.7*	--	2.2	3.5	31	11.5
CM 3306-4	1.7*	1.0	1.0	1.0	3.0	--	3.0	--	2.0*	1.0	1.0	1.0	1.0	1.0	2.0	2.0	38	16.0
CM 3306-9	--	2.0	1.0	1.0	--	1.0	1.0	1.0	--	2.0	1.0	2.0*	1.0	--	2.5	2.5	36	15.0
CM 3320-4	1.0	1.0	1.7	1.0	3.0	3.0	3.0	--	1.0	1.0	1.0	1.0	1.5*	1.0	2.0	4.0	29	18.0
CM 3372-4	2.0	3.0	--	1.5	3.0	3.0	1.0	--	1.0	1.0	1.0	1.0	1.0	2.0	2.0	4.0	33	16.0
CM 3408-1	1.8	1.7*	2.7	1.5*	3.0	1.0	--	1.0	1.0	1.0	3.0	1.7	1.7*	1.3	2.3*	2.7*	34	11.0
CM 3435-5	2.5*	2.0*	1.7*	2.0*	1.0	3.0	--	--	1.0	1.0	1.0	1.0	1.0	2.0	1.2	2.0	35	10.5
CM 3555-6	2.0	2.0	2.0	2.0	--	3.0	1.0	1.0	--	1.0	--	1.0	1.0	2.0	2.0	4.0*	33	8.0
CM 3624-1	2.0*	2.0*	2.0*	2.0	--	3.0	1.0	--	1.0	1.0	--	3.0	2.0	2.0	2.5	2.5	35	16.5
CM 3750-5	--	--	2.0	--	--	--	--	--	--	--	1.0	--	1.0	--	3.0	--	--	--
M BRA 191	2.0*	3.0	3.0	2.0*	--	3.0	1.0	--	--	1.0	--	1.0	--	2.0*	2.5	2.5	34	7.0
M COL 2054	1.0	2.0*	1.7*	1.0	1.7	2.3	1.7*	1.0	1.0	1.0	1.0	2.0*	1.0*	1.0	1.5	2.0	32	14.5
M COL 2215	1.0	3.0*	2.0*	2.3	1.0	1.0	1.0	1.0	--	3.0	1.0	1.0	1.5*	2.0*	1.5	2.0	36	10.0
M COL 2237	1.0	--	2.0	--	3.0	--	--	--	3.0	--	--	--	3.0	--	4.0	--	--	19.0
M COL 2253	1.0	1.0	2.7	1.0	1.0	1.0	--	--	3.0	1.0	--	1.0	1.3	1.0	2.0	2.0	28	12.0
MCOL 72	3.0	1.0	--	1.5	1.0	--	--	3.0	--	2.0	--	--	1.0	3.0	2.0	3.0	33	11.0
M CUB 18	3.0	1.0	--	1.0	1.0	1.0	1.0	--	1.0	2.0*	--	1.0	2.0	1.0	2.0	3.0	31	7.0
M CUB 49	1.0	1.0	2.5*	2.5*	1.0	3.0	--	--	--	--	1.0	--	3.0*	2.0	3.0	3.5	30	8.5
Venezolana	1.0	3.0	1.0	3.0	1.0	--	1.0	1.0	--	3.0	--	--	1.0	1.0	1.5	1.5	37	6.0

a. 1 = easy harvest, 3 = difficult harvest. Criterion frequency, 70%.

b. 1 = good, 2 = average, 3 = bad. Criterion frequency, 70%.

c. 1 = high, 3 = low. Criterion frequency, 43%.

d. 1 = good starch content, 3 = low starch. Criterion frequency, 31%.

e. 1 = good production, 3 = poor production. Criterion frequency, 38%.

f. 1 = dark, 3 = light. Criterion frequency, 35%.

g. 1 = good acceptance, 2 = average acceptance, 3 = is not accepted. Criterion frequency, 64%.

h. 1 = excellent, 2 = good, 3 = average, 4 = bad, 5 = very bad.

i. Researcher evaluations.

* Data with high variability.

-- No information.

Currently, each researcher adapts these forms to his region. In the medium term, an attempt will be made to establish a network of participants with an information storage center for the combined analysis. The success of this work will depend to a great extent on the participation of national institutions.

Farmer participation in the evaluation of experimental cassava clones has shown a high potential to increase the probability of new varieties being accepted by farmers. While the specific details of the methodology will need to be adapted to the specific situation (production, processing, marketing) of each region, the general principles should be broadly applicable.

References

Ashby, J. A. 1981. Applied research on farmers soil fertility and fertilizer adoption. Report to the Rockefeller Foundation, IFDC/CIAT Phosphorus Project.

_________. 1986. The effects of different types of farmer participation on the management of on-farm trials. Agric. Admin. Ext. 25:235-252.

_________. n.d. Establecimiento de ensayos de evaluación (estudio de análisis combinatorio). Proyecto IPRA. (Unpublished.)

_________ and Pachico, D. 1987. Evaluación de tecnología por agricultores: Un manual. Revisiones. Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia. p. 8-10. (In mimeograph.)

Cock, J. H. 1985. Cassava: New potential for a neglected crop. Westview Press, Boulder, CO, USA. 191 p.

_________ and Lynam, J. K. 1986. Potencial futuro e investigación necesaria para el incremento de la yuca. In: Domínguez, C. E. (comp.). Yuca: Investigación, producción y utilización. Programa de las Naciones Unidas para el Desarrollo/Centro Internacional de Agricultura Tropical (PNUD/CIAT), Cali, Colombia. p. 1-25.

Chapter 8

ESTABLISHING THE DRY-CASSAVA INDUSTRY ON THE ATLANTIC COAST OF COLOMBIA

Rupert Best, Helberth Sarria, and Bernardo Ospina*

Introduction

This chapter examines institutional relationships and interactions within a rural development project in which one of the principal activities has been to establish an alternative market for cassava by introducing small-scale technology for chipping and natural drying of the roots. In the period 1981-1990, 50 farmer cooperatives have been set up, each one with its own infrastructure for processing cassava. The cooperatives, which directly benefit more than 1300 farmers and their families, produced 9500 tons of dry cassava during 1990, a product that is sold as a carbohydrate source for preparing concentrated feed for animals. One of the most important factors that contributed to the project's success has been the process by which the technology was introduced and adapted to local conditions. This was achieved by a pilot project that provided a scenario for interaction among researchers, development agents, and cassava farmers. Execution of the project ensured that the drying process was technically, economically, and operationally viable before promoting the technology among a large number of farmers. Additionally, the project provided information on institutional and financial resources required for its diffusion.

Background

The farming sector of Colombia's Atlantic coast region is characterized by a very uneven land distribution; 80% of the farmers own less than 20 hectares and occupy barely 10% of the land available. In addition, the rural areas of the six departments that make up the region are among the poorest in the entire country. Since its creation in 1976, the Colombian Integrated Rural Development Program (DRI) has channeled resources and coordinated

---

* Respectively, Leader; research assistant in the Cassava Utilization Section and Plan Nacional de Rehabilitación (PNR), stationed in Villavicencio, Colombia; Senior Research Fellow stationed in Fortaleza, Brazil; Cassava Program, Centro Internacional de Agricultura Tropical (CIAT), Cali,

activities designed to improve the well-being of small farmers and the marginalized rural population in general of this region.

Edaphoclimatic conditions in the region, characterized by a 4-5-month dry period and relatively poor soils, do not offer the small farmer many opportunities to increase his income. The principal farming activities are raising intercrops (cassava/maize and cassava/maize/yams) and dual-purpose cattle. Farmers consider cassava, a crop that is well adapted to marginal conditions, to be the least risky and most productive crop among their production alternatives, especially in bad years. With respect to utilization, cassava is an important staple food in the region, being consumed fresh in both urban and rural areas. Because of its high perishability, per capita consumption of cassava in urban areas is considerably less than in rural areas. With the rapid process of urbanization that has taken place over the last twenty years, the absolute demand for cassava in urban markets has been falling. As a result, cassava farmers, especially those with poor access to urban markets, are facing a situation in which demand for one of their principal products is decreasing, with negative repercussions on their income.

DRI, seeking ways to increase the income of these farmers, made subsidized credit available for production at the end of the 1970s. The greater supply of cassava resulting from this initiative brought about a drop in prices as the fresh cassava market became saturated, and was not able to absorb all of the increased production. This situation, which was particularly acute in the departments of Córdoba and Sucre because of the distance to market outlets on the coast, led DRI to consider identifying and developing alternative markets for cassava.

Among the most promising markets was the use of dry cassava as a carbohydrate source in balanced diets for animals. Colombia, in the 1970s, imported up to 200,000 tons of sorghum annually to satisfy the demand of the concentrated feed industry. Local production of raw material could not completely fill the needs of this industry since intensive production of broilers, eggs, and hogs was growing at the rate of 5% to 10% per year.

The experience of the European Economic Community, which each year imports more than 5 million tons of dry cassava from Asian countries for its incorporation into balanced feed, had demonstrated the technical feasibility of partially substituting dry cassava for coarse grains in feed rations. What was not known was the economic and operational viability of producing dry cassava in Colombia. The Centro Internacional de Agricultura Tropical (CIAT), from the time when its Cassava Program began in 1972, had been working on improving cassava natural-drying systems employed in Asian countries, and was therefore well placed to support DRI when, in 1980, it requested CIAT's collaboration on a project whose objective was to develop the new cassava market on the Atlantic coast.

The Dry-Cassava Project

Preliminary analyses indicated that producing dry cassava could be an attractive economic activity as long as it was carried out near production areas to minimize transportation costs for raw material sent to processing plants. In addition, DRI's policies favored creating farmer groups as a way to facilitate marketing small-farm crops and to generate added value in the rural sector. The project was thus based on establishing small processing units managed by groups of cassava farmers. The project, which is in its tenth year, has passed through three different phases, which are described below.

Experimental phase: 1981

This phase consisted of selecting a group of 15 farmers with which a cassava natural-drying pilot plant was built, the processing technology was adapted, and an operational scheme was developed in accordance with local conditions. During this stage, seven tons of dry cassava were produced and distributed among several balanced feed industries to obtain initial feedback on their interest in buying this nontraditional product, as well as the price that they would be willing to pay for it. As a result, one of these industries committed itself to buying the entire production of the following campaign.

Demonstration phase: 1982-1983

After the experimental phase, the project entered a phase during which the pilot plant was operated semicommercially, with the farmers themselves taking full responsibility for managing the plant. This period provided reliable data on the working of the plant and consolidated the market for the product. Based on this information, a technical-economic feasibility study was prepared. The positive results of this study prompted DRI to create a line of promotional credit for establishing additional drying plants. The pilot plant itself expanded its capacity and was used as a demonstration model to train other farmer groups that were showing interest in the drying process. Dry-cassava production in this phase was 138 tons.

Replication phase: 1983 onward

The third phase of the project has involved the replication of drying plants at other sites on the Atlantic coast. In the period 1983-1990, more than 40 farmer cooperatives began drying activities, and another 10 plants were installed by private individuals. The drying technology is already being spread to other parts of the country, such as the departments of Santander, Norte de Santander, Meta, and Cauca. Currently, annual dry-cassava production is estimated at 15,000 tons in all of Colombia.

The project initially sought to solve a problem of surpluses that were being produced beyond the requirements of the traditional market. Establishing drying plants has provided a base price under which the cassava price does not drop, thus avoiding large price fluctuations that used to occur. This situation is stimulating an increase in cassava production and creating a demand for improved technology that will make it possible to increase productivity and reduce the crop's cost. This is a critical factor since the project's success over a medium term will depend on dry cassava maintaining its competitiveness with other carbohydrate sources commonly used to prepare balanced feed.

Drying Technology

A cassava natural-drying plant has three principal components: the concrete floor, a chipping machine, and a storage area. To build the infrastructure, local human resources are used, ones belonging to the group of farmers who will later operate the drying plant. Farmer participation in constructing the drying installations is considered an important factor in group cohesiveness. The drying plant also has a chipping machine with a gasoline, diesel, or electric motor, plastic covers, carts, shovels, rakes, and a weighing scale. Table 1 shows the investment costs for a plant with a 1000-m^2 concrete floor.

For carrying out the drying process (Figure 1), farmers join together in working groups and each group is responsible for the overall processing of a batch of fresh cassava. The cooperative establishes a purchase price for the cassava received at the drying plant, and producers are responsible for harvesting and transporting the roots to the plant on mules or in vehicles. Once at the plant, the cassava is weighed and then chipped. The chipping machine produces small cassava chips and has a capacity of 8-12 tons per hour. After chipping, the chipped cassava is spread out on the drying floor at a loading rate of between 10 and 12 kilograms of fresh chips for each square

Table 1. Investment costs for a cassava natural-drying plant with a 1000-m^2 concrete floor.

Item	Amount (US$)
Construction[a]	
Patio (1000 m^2)[b]	5,042
Storage area (60 m^2)[b]	2,857
Chipping area[b]	420
Subtotal	8,319
Equipment	
Scale (500 kg)	252
Plastic covers	269
Chipping machine	629
Hopper	67
Motor for chipping machine	269
Wooden pallets (4)	101
Carts (3)	101
Funnels (2)	168
Metal shovels (6)	30
Wooden rakes (10)	92
Sisal sacks (250)	168
Subtotal	2,146
Incidental expenses (5%)	523
Total	10,988

a. It is assumed that the land is donated by the cooperative.
b. It is assumed that the cooperative supplies labor.

meter of drying floor. The cassava chips are turned over every hour or two by using a wooden rake, and this provides a faster and more uniform drying.

Farmers begin processing a batch of fresh cassava between 4 and 6 o'clock in the morning, and the cassava chips remain exposed to the sun during all of the first day and on the second day up to 4 or 5 o'clock in the afternoon.

Harvest

↓

Weighing

↓

Chipping

↓

Spreading of chips

↓

Turning over of chips

↓

Collecting and packing

↓

Storage

↓

Dispatch

Figure 1. The cassava natural-drying process.

When the cassava has reached less than 14% moisture, the farmers collect it, pack it, and store it. On the average, the dry cassava is stored for eight days before being sent to the concentrated feed plant. One of the project's fundamental elements has probably been the fact that now the farmers manage a stable product that offers them a marketing system in which they are less vulnerable (Figure 2). Previously, they marketed fresh cassava, a highly perishable product that was unsuitable for human consumption after only two days.

Cassava natural drying is an activity that generates employment. On the average, one man-day is required for each ton of fresh cassava that is processed. Between 2.4 and 2.6 tons of fresh cassava are required to produce one ton of dry cassava, that is, a yield between 38% and 42%.

A drying plant with a 1000-m^2 floor, on which 12 kilograms of fresh cassava are placed on each square meter, can process 12 tons of cassava, and two days are needed to complete the drying. Under these conditions, the plant has the capacity to process three lots per week for a total of 36 tons of fresh cassava chips. On the Atlantic coast, there is a 4-5-month dry period, and it is estimated that there is a minimum of 20 weeks per year that have favorable conditions for cassava natural drying. The annual capacity of a drying plant with a 1000-m^2 floor is 720 tons of fresh cassava, that is, around 280 tons of dry cassava. Considering local cassava yields (8 tons/ha), a 1000-m^2 drying plant will require around 90 hectares of cassava annually to operate at full capacity.

The economic viability of drying cassava depends on the potential of the dry cassava to compete with sorghum in the balanced feed industry for animals. Dry cassava is a good carbohydrate source but it has a relatively low protein content; in comparison, sorghum has a similar carbohydrate content but a larger proportion of protein and, consequently, greater nutritional value. The difference in nutritional value results in the price of dry cassava being discounted by a factor that can fluctuate between 10% and 20%. However, the price of dry cassava must be sufficient to cover production, processing, and transportation costs, and should leave some profit margin for the dry-cassava producer.

As the market for dry cassava has been consolidated and the product has gained acceptance among consumers, prices have evolved and farmers' profit margins have improved. Likewise, farmers have easily assimilated and

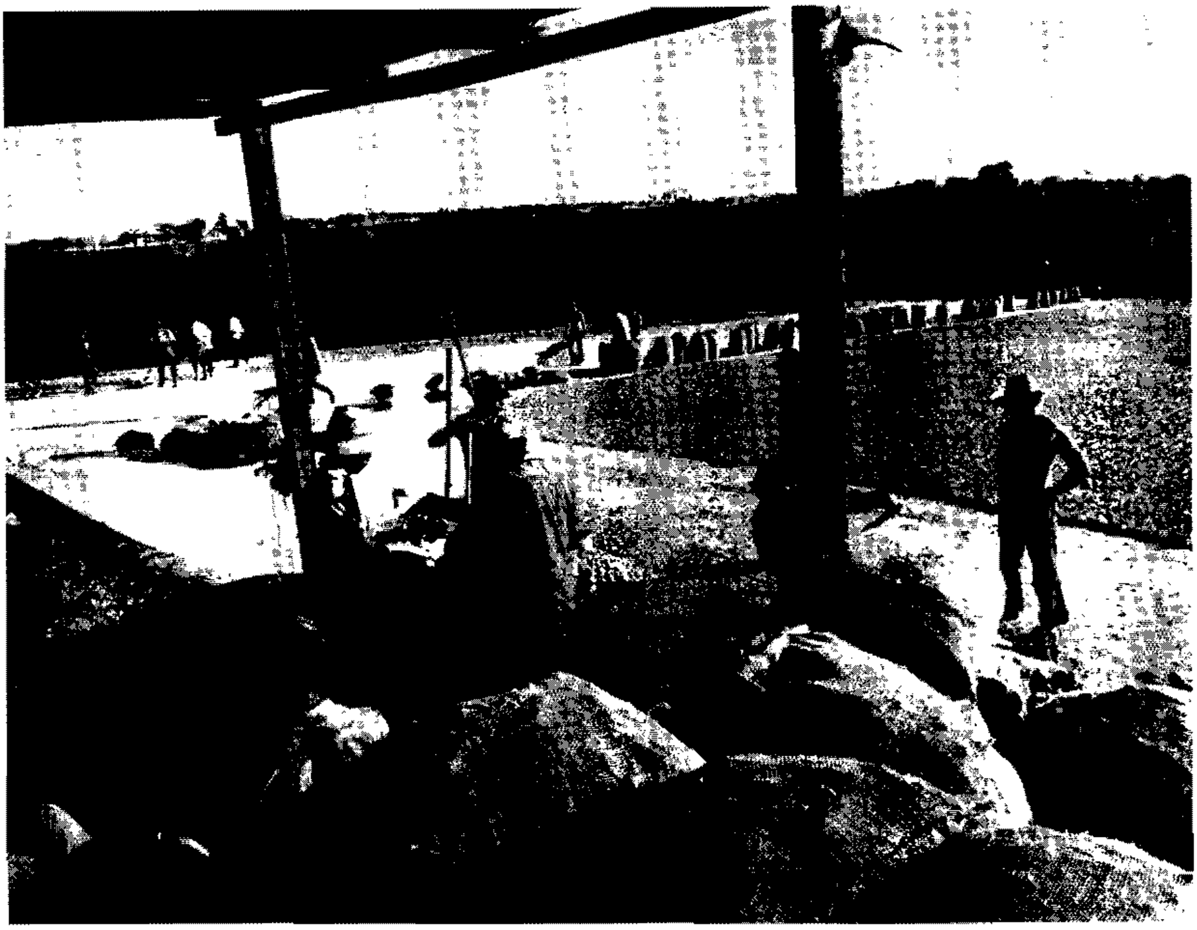

Figure 2. Cassava natural drying done by farmer groups on Colombia's Atlantic coast.

dominated the technology, and they feel motivated to increase the installed capacity of the drying plants, thus improving yields and reducing processing costs (Table 2).

Participants in the Project and Their Role

The successful adoption of the processing technology by farmer cooperatives on Colombia's Atlantic coast was made possible because of close cooperation and interaction between development agencies and research institutions, and between the latter and farmers involved in the project. A description of the role and responsibility of the different institutions participating in carrying out the project's principal components is presented in the following sections.

Project coordination

Since DRI's functions are to outline policies and coordinate, finance, and evaluate interinstitutional activities oriented toward improving the well-being of the rural population, it was natural that that entity would be responsible for coordinating the project. In this role, it played a very important part by obtaining support from different institutions and ensuring that the necessary components for technology adoption (technical assistance, credit, training, etc.) were available opportunely. With funds provided by DRI, a single technician was hired (a specialist in cassava drying) to work full-time on the project. DRI, in turn, was supported by the Canadian International Development Agency (CIDA), the organization that financed DRI's activities in the departments of Córdoba and Sucre and provided funds for setting up the pilot plant. At the departmental level, DRI headed the technical team made up of representatives from the participating institutions.

Organizing the farmers

The project was based on the formation of farmer groups (associations and cooperatives). The National Apprentice Service (SENA) was responsible for motivating and providing the training necessary for these groups to become solid organizations capable of managing the drying plants. SENA and the National Department of Cooperatives (DANCOOP) were particularly active in developing practical teaching tools in the areas of management and bookkeeping.

Table 2. Evolution of the DRI-CIAT cassava project.

Year	No. of plants	No. of members	Drying area (m^2)	Dry cassava production (t)	Ratio of fresh cassava/ dry cassava ($/t)	Purchase price of fresh cassava[a] ($/t)	Production cost[a] ($/t)	Sales price of dry cassava[a] ($/t)
1981	1	15	300	7	2.70	16,327	52,657	49,480
1982	1	15	300	38	2.61	14,584	49,547	50,453
1983	7	187	4,000	98	2.59	13,349	47,622	49,196
1984	7	187	4,000	1,100	2.53	14,131	46,006	51,915
1985	20	394	18,238	3,006	2.38	12,448	40,577	50,646
1986	35	790	28,800	2,980	2.43	13,558	39,882	47,511
1987	35	801	29,490	3,851	2.57	12,484	41,276	51,509
1988	37	1,129	35,364	5,484	2.46	13,518	41,887	57,489
1989	41	1,323	45,845	5,601	2.40	13,618	52,078	61,247
1990	52	2,044	66,801	9,500	n.a.	15,584	n.a.	n.a.

a. Constant 1988 Colombian pesos (US$1.00 = Col.$299.17).

n.a. = not available.

Technical assistance and credit for setting up plants

In the experimental and demonstration phases, the specialist in cassava drying, hired by CIAT with funds provided by DRI, worked together with the farmers on adapting the processing technology and developing a model scheme for operating the drying plant. This knowledge was then transferred to local staff members of the Organization of Agrarian Reform Cooperatives (CECORA) in order to replicate plants at other sites. Over the years, several courses on establishing and operating drying plants have been organized, with participation from institutions that, besides lending technical assistance to farmers, provide credit for building plants and working capital needed to operate them. These institutions are the Support Fund for Associative Enterprises Corporation (CORFAS), the Cooperative Financing and Development Institute (FINANCIACOOP), and the Colombian Agrarian Reform Institute (INCORA).

As was mentioned earlier, using the pilot plant as a demonstration model was essential for introducing to new farmer groups the technology for building plants and techniques for operating and managing the drying process. This "farmer-to-farmer" training element was a key factor in the rapid expansion of the project into new areas.

Technical assistance and credit for growing cassava

Current and potential cassava production anywhere is a critical factor in determining the economic viability of a drying plant. In this sense, the Colombian Agricultural Research Institute (ICA) plays an important role, first in providing technical information for preparing feasibility studies, and then in promoting better crop production techniques among farmers. With the opening of a profitable alternative market, many farmers behind in paying their debts have been able to pay them, and they are once again eligible for credit provided by the Farming and Mining Credit Bank. In addition, the modality of associative credit, in which the cooperative acts as a cosigner, has been introduced, allowing many member farmers, who normally do not fulfill the requirements for obtaining credit, to finance their plantings.

Organization of dry-cassava commercialization

In the first years of the project, a single concentrated feed industry for animals absorbed the entire dry-cassava production. As the volume of dry cassava produced increased, it became necessary to promote its sale among a larger number of buyers. Initially, this task of identifying markets and negotiating prices was handled by CECORA. Later, the National Association of Cassava Producers and Processors (ANPPY) was created, made up of the cooperatives linked to the drying project. This association gradually became responsible for negotiating the product.

Research support

A project of this nature requires constant research support, and it has been necessary to prepare socioeconomic and market studies around the project to define and orient research activities in the areas of both production and processing. For processing, improvements in equipment have been introduced in order to increase drying efficiency and ensure a high-quality product, free from molds and insects. In addition, ICA, with collaboration from CIAT, has formed a network of researchers and extensionists for carrying out onfarm trials and doing complementary research on experiment stations in the region. Currently, two technological packages developed for the cassava/maize and cassava/maize/yams systems are being tested on pre-production semicommercial lots, that is, on areas of 1/2 to 1 hectare per farmer. Without a doubt, the project has improved the approach to research, with greater orientation toward solving real problems of farmers.

Elements That Contributed to the Project's Success

The development project for establishing the dry-cassava industry on Colombia's Atlantic coast demonstrates fully the complementarity that should exist between entities responsible for development and those responsible for research. DRI identified a problem that arose from a deficiency in the existing cassava production and marketing system and, in this case, CIAT had a technological solution to the problem. The correct definition of the problem and the selection of a viable solution in itself does not guarantee that farmers will adopt the technology. It is considered that the pilot project approach was the key mechanism that made it possible to transfer the technology to a large number of farmers.

The pilot project provided the focal point for close interaction among development agencies, research institutions, and farmers. For all of them, it was an experience in "learning by doing," in which two basic achievements were made: (1) testing and modifying the technology according to the socioeconomic and cultural conditions of the region, and (2) developing methods for replicating the technology at other sites. However, within the pilot project concept, two fundamental elements stand out in its success: the project structure and leadership.

The project structure

The fact that activities were structured within a concrete project with well-defined goals and objectives meant that the different entities involved understood their respective roles. In addition, the availability of donor funds to finance the experimental and semicommercial phases was important since it reduced the risk to farmers who were committed to the project. Also, the project sought to integrate production, processing, and marketing aspects, and it was not a question of a partial solution for only one of these components, which in many earlier projects had led to failure.

Leadership

Leadership refers in the first place to institutional leadership provided by DRI. The project was able to exploit DRI's experience, accumulated over several years, to achieve real interinstitutional action with the project. The DRI concept ensured that all the components needed for the project's success would be present. In addition, during the critical period between the pilot project and the expansion phase, DRI had, at both the regional and central level, visionary and decisive leaders. At another level, there was the leadership of the project itself. As was mentioned earlier, the pilot project had only one technician working full-time. This person, because of his leadership qualities, dedication, and charisma, inspired respect from farmers and project personnel. His enthusiasm motivated all those associated with the project, thus creating a certain working mysticism that made it possible to overcome the difficulties that sometimes arose.

Conclusion

In conclusion, carrying out the pilot project has brought important benefits to the three principal groups of people involved.

The farmers felt themselves to be participants in the technological development process and direct beneficiaries of the economic advantages brought about by adopting the technology.

The pilot project also allowed development agents to contribute to the technological development process by not only being intermediaries in transferring technology from the researcher to the farmer. The creation of viable solutions to problems that they themselves have identified is an important source of motivation.

For the researcher, the pilot project becomes a fundamental element in the methodology that he or she should apply to ensure that his or her work will have a basis in reality. Besides providing the researcher with an environment for testing and modifying the technology developed, it is a source of new ideas and opportunities for research.

The project that has been presented in this document has served as a model for carrying out similar projects in other Latin American countries. The positive results achieved up to now demonstrate the effectiveness of the pilot project concept as a means to ensure that researchers and development agents responsible for generating and transferring technology will work together with the farmer to generate viable solutions to their problems.

Bibliography

Best, R. (comp.). Plan piloto para el desarrollo agro-industrial del cultivo de la yuca en algunos departamentos de la Costa Atlántica de Colombia. Proyecto Cooperativo DRI/ACDI-CIAT, tercer informe, junio 1983-junio 1984. Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia. 126 p.

_________ and Ospina, B. (comps.). El desarrollo agro-industrial del cultivo de la yuca en la Costa Atlántica de Colombia. Proyecto Cooperativo DRI/CIAT, cuarto informe, tomo I, julio 1984-junio 1985. Centro Internacional de Agricultura Tropical/Fondo de Desarrollo Rural Integrado (CIAT/DRI), Cali, Colombia. 42 p.

_________; Alonso, L.; and León G., A. 1986. Procesamiento de la yuca para pequeños productores: Adaptación y mejoramiento de una máquina picadora de yuca para el uso de cooperativas de agricultores. Paper presented at the conference on the formation of a Regional Mechanization Network for the Small Farmer held at Campo Experimental Cotaxtla, Veracruz, Mexico, 10-15 November 1986.

CIAT (Centro Internacional de Agricultura Tropical). 1982. Plan piloto para el desarrollo agroindustrial del cultivo de la yuca en algunos departamentos de la costa norte de Colombia. Proyecto Cooperativo DRI/ACDI-CIAT, primer informe, noviembre 1981-junio 1982. Cali, Colombia. 45 p.

_________. 1987. Guía de estudio: Secado natural de raíces de yuca en pisos de concreto. Series 04SC-07.02. Cali, Colombia. 48 p.

_________. 1988. Yuca y cultivos asociados: Resultados de algunas investigaciones realizadas por diversas instituciones en la costa norte de Colombia, y resúmenes de discusiones técnicas. Documento de Trabajo no. 01. Cali, Colombia. 249 p.

_________. 1990. Yuca y cultivos asociados: Resultados de investigaciones realizadas por diversas instituciones en la costa atlántica de Colombia. Documento de Trabajo no. 02. Cali, Colombia. 183 p.

CIAT/DRI (Centro Internacional de Agricultura Tropical/Fondo de Desarrollo Rural Integrado). 1987. El desarrollo agro-industrial del cultivo de la yuca en la Costa Atlántica de Colombia. Proyecto Cooperativo DRI/CIAT, quinto informe, julio 1985-agosto 1986. Cali, Colombia. 46 p.

_________. 1988. El desarrollo agro-industrial del cultivo de la yuca en la Costa Atlántica de Colombia. Proyecto Cooperativo DRI/CIAT, sexto informe, diciembre 1986-noviembre 1987. Cali, Colombia. 31 p.

CORFAS (Corporación Fondo de Apoyo a Empresas Asociativas). 1987. Proyecto de secado natural de yuca, costa atlántica: La asistencia técnica y seguimiento al proyecto. Bogotá, Colombia. 49 p. (In typescript).

Gómez, G. (comp. and ed.). 1983. Plan piloto para el desarrollo agroindustrial del cultivo de la yuca en algunos departamentos de la costa norte de Colombia. Proyecto Cooperativo DRI/ACDI-CIAT, segundo informe, julio 1982-mayo 1983. Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia. 53 p.

Janssen, W. 1986. Market impact on cassava's development potential in the Atlantic Coast region of Colombia. Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia. 357 p.

MacGillivray, I. C. 1984. Mission-end report: Integrated rural development, Córdoba and Sucre, Zone 4, Colombia. Canadian International Development Agency, Bogotá, Colombia.

Pérez S., R. 1989. Experiencias sobre la agroindustria de la yuca en Colombia. In: Pérez Crespo, C. A. (ed.). Metodologías aplicadas a proyectos integrados de yuca: Memorias del Congreso Latinoamericano celebrado en Villahermosa, Mexico, 26-28 October 1987. Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia. p. 21-42.

Vásquez V., F. and Cuero O., J. L. 1987. Manual actualizado de la fabricación de la máquina trozadora de yuca tipo Tailandia. Sección Utilización de Yuca, Centro Internacional de Agricultura Tropical (CIAT), Palmira, Colombia. 46 p.

Chapter 9

SOCIOECONOMIC IMPACT OF THE CASSAVA PROJECT ON THE ATLANTIC COAST OF COLOMBIA

Paul Bode*

Introduction

When analyzing cassava projects, one should not only examine their capacity for stimulating cassava production but also their contribution to the rural development process and the impact they have on small-farmers' standard of living. On the Colombian Atlantic coast, most of the rural population depends on production of subsistence crops (cassava, maize, yams) and the income that this production generates. In this chapter, the impact that a cassava project has had in this region is analyzed with regard to increasing income of farmers and their families who live in the project's area of influence. The impact of a cassava project is basically manifested at the level of small-farmer organizations and the small-farmer family that carry out the project. The development of cassava drying is generating income directly through cassava that is purchased for processing, labor that is utilized in drying plants, and profits from the process. The drying plants also generate some indirect income such as that coming from commercialization of cassava for the fresh market, income because of labor utilized in the production of fresh cassava, and income related to other cooperative activities that cassava drying organizations have carried out. Finally, the project produces an impact of a qualitative type through development of local and regional small-farmer organizations and through improvement of access of those farmers to production factors (land, credit), infrastructure, etc.

Integrated cassava projects have become a new strategy for rural development. Projects have been carried out as an integral part of national rural development programs. Activities directed toward cassava production, processing, and commercialization have been accompanied by other policies (credit, training, small-farmer organization) for the purpose of achieving

* Anthropologist and visiting researcher, Cassava Program, Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia; currently, sub-director, Foster Parents Plan International, stationed in Sucre, Bolivia.

improvement in the standard of living of the small-farmer population. The Project for the Agroindustrial Development of Cassava on the Colombian Atlantic coast is not an exception to these principles. Together with activities directed toward growing cassava (drying plants, seed production and distribution, supplying of inputs), this project undertook a series of activities within the framework of a rural development program, such as marketing of farm products, road construction, and financing of farm machinery, among others.

The way in which benefits generated at the organizational and family level can be increased and how those benefits can be directed toward the poorest sectors of the population will be analyzed in this chapter. The Colombian Atlantic coast cassava project will be described for such a purpose by analyzing the most important limiting factors in each phase of its development. Afterwards, the impact that the project has had both on cassava production as well as socially and economically will be examined. Lastly, factors that contribute to improving this impact will be analyzed. External circumstances in which the project has been carried out will be described, along with factors related to organization of the project in small-farmer cooperatives and cassava production factors at the farm level. Before entering fully into the discussion about the cassava project, however, the context of the project on the Colombian Atlantic coast and the characteristics of cassava production in this region will be described.

The Colombian Atlantic Coast and Its Cassava Production

The Colombian Atlantic coast is made up of the departments of Córdoba, Sucre, Bolívar, Atlántico, Magdalena, and Guajira. It consists of low and flat areas formed by the valleys of the Magdalena and Cauca rivers and more mountainous areas, the so-called savannas. Two large capital cities (Barranquilla and Cartagena) are found in the region, along with four cities of lesser importance (Montería, Sincelejo, Santa Marta, and Valledupar). The socioeconomic structure of the region is characterized by a high inequality. On the one hand, there is a small group of large landholders. They own most of the land and dominate political, economic, and social life, while, on the other hand, there are small-farmer families whose access to land is very limited and in many cases insecure under land-tenure systems such as renting. The social structure was formed through a process of settlements in which small farmers cleared the land, raised crops for a few years, planted land in pasture, and finally turned it over to a large landholder either by force or by selling. Most Atlantic coast land was cleared by this process, and this land has become concentrated in a few hands, leaving small farmers with limited land resources (Fals Borda, 1976). This situation has led to social tension expressed in violent takeovers of land on the part of small farmers. In some areas, these takeovers have resulted in the intervention of the national government through its entity for agrarian reform (INCORA). INCORA has purchased lands in dispute and has redistributed them among small farmers. Although this situation was especially common at the beginning of the seventies, a notable increase in land purchases on the part of INCORA in the region as a response to a peak in land invasions during the last few years is currently noted. However, these agrarian reform activities have generally been insufficient to be able to change land distribution substantially.

Extensive cattle farming is the most important economic activity on the Atlantic coast, occupying the largest part of big farms. Part of these lands is also dedicated to commercial crops such as cotton and sorghum. The small-farmer sector, on the other hand, dedicates its lands almost completely to the growing of subsistence crops (cassava, maize, yams, plantains, sesame) and to small-scale cattle farming, if the land resources allow it. Part of this production is directed toward urban markets in the region or to the market in the interior of the country, such as the case of maize that is sold in the wholesale market of Medellin. Only in some specific areas are small farmers involved in the production of commercial crops (cotton, tobacco).

Cassava has been grown on the Atlantic coast since precolonial periods, and it was a part of production systems for native villages. During the settling of new lands, cassava was planted in the recently opened lands through "slash and burn" systems, directing production toward home consumption by settlers. During the last century, different socioeconomic developments have changed the nature of cassava production. In the first place, the availability of virgin lands diminished considerably at the same time that the population has increased. The resulting scarcity of land for the small farmer brought about the already mentioned occupations of land in the seventies and a high emigration to cities and to Venezuela. In the second place, the growth of the two largest capitals of the region, Barranquilla and Cartagena, created an important urban market for farm production. Within this context, cassava production systems were transformed from systems based on slash and burn, in which both land preparation as well as weeding were done by hand (and whose production was almost completely directed toward home consumption), toward production systems that include mechanization and application of herbicides, and whose production is directed in a lesser or greater extent toward sales in urban markets. In some isolated areas, systems based on slashing and burning of virgin lands still persist.

The most important limiting factor for cassava production for small farmers of the Atlantic coast is related to land tenure. Most cassava producers work under insecure forms of land tenure, and the average size of land in tenure is small (Janssen, 1986). This situation has limited the possibilities of increasing cassava production through an increase in area planted. During the seventies, before the cassava project began, area planted in cassava dropped considerably as a consequence of precarious land tenure and high insecurity in product commercialization, as is demonstrated in Table 1 with regard to the department of Sucre. This limited and insecure access to land can influence the possibilities of technological development.

In general, three forms of land tenure under which cassava is being produced can be distinguished: ownership of a small area, beneficiaries of agrarian reform, and renting. For renters, cassava production in intercropping systems (maize, yams) in combination with day labor makes up the largest source of income. Landholders and agrarian reform beneficiaries normally combine their farm production with small-scale cattle farming. Landholders have developed cattle farming more than agrarian reform beneficiaries, however, because the latter have suffered from a scarcity of economic resources, leading to an underutilization of their plots. Most of the land is rented by payment. However, in some areas the traditional manner of "renting for pasture" still exists, in which the renter settles the land, cultivates it for a limited time, and afterwards returns it to the owner planted in pastures.

Several groups of people who rent land for growing cassava can be differentiated (Bode, 1984). First, there are small- and medium-sized landowners, who rent land to relatives and friends, who, in turn, produce mainly for home consumption. Second, there are agrarian reform beneficiaries with limited resources, who, as a result, rent part of their underutilized lands to other small farmers. Third, there are medium landowners whose main activity is cattle farming and who rent land as part of a rotation system between farming and cattle raising, in order to maintain soil fertility. They rent lands under pasture that need to be mechanized and cleared of secondary vegetation (stubble). The large landholders normally do not rent lands for small-scale farming, for fear of invasions, but they do rent lands for commercial production of cotton and sorghum. In the case of the "renting for pasture" system, large landholders' holdings are important.

In general, labor use intensity in cassava production should be taken into account in the social impact analysis of integrated cassava projects. Demand for labor can vary as a result of the development of such projects. Drying plants create a direct demand for labor, and the expansion of area planted in

Table 1. Area planted (ha) in different crops, Sucre, Colombia, 1976-1982.

Crop	Year						
	1976	1977	1978	1979	1980	1981	1982
Cassava	17,000	17,300	17,200	14,000	11,000	8,000	9,700
Maize	8,000	9,000	12,340	11,510	10,700	9,850	8,200
Yams	4,500	4,800	3,800	3,700	2,700	3,300	7,000
Tobacco	2,100	3,100	2,800	2,400	1,800	1,800	2,750

SOURCE: Banco de la República, Investigaciones Económicas, Sincelejo, Colombia, 1981.

cassava increases that demand even more. Thus, the need to introduce technologies that will save labor in order to overcome labor scarcity in certain production phases can arise.

At present, cassava production on the Colombian Atlantic coast shows two peaks in labor demand that can create an obstacle for the increase in area planted. The first occurs in weeding, which has led to the rapid adoption of herbicides in some areas. The second takes place in the harvesting process, especially in regions where soil texture does not allow harvesting cassava throughout the dry period because the soil becomes very hard. A high labor demand occurs at the beginning of the rainy period (April to July) when most small farmers must leave their land in order to be able to plant again, which makes the harvesting process coincide with land preparation work. This labor scarcity is especially important in areas where "renting for pasture" is the main form of land tenure, since land preparation in this nonmechanized system needs much labor. The labor scarcity also occurs due to the demand for labor from other farming activities. This is the case of areas where the cassava harvest coincides with the manual harvest of cotton.

Cassava production on the Colombian Atlantic coast shows high variation. Although most of the cassava is planted intercropped with maize and yams, there are important differences in the production systems (Table 2). In the department of Córdoba, maize and yams are the most important crops from the point of view of farmer income. Given the distance to the main cities on the coast, the cassava market for human consumption is less developed (Table 3). Maize is sold chiefly for the industrial market of Medellín,

Table 2. Arrangements of cassava intercropped with other crops in selected regions of the Colombian Atlantic coast (percentage of area planted).

Region	Crop						Number of farmers
	Maize	Maize/ Yams	Maize/ Millet	Sesame	Monocrop	Other	
Sucre	88.2	2.3	0.0	0.0	9.4	0.1	106
Córdoba	79.8	10.0	0.0	1.8	7.5	0.9	55
Atlántico	5.4	0.0	83.2	0.0	11.4	--	26
Magdalena	51.2	0.0	0.0	9.8	39.0	--	13

SOURCE: Survey, 1989.

Table 3. Relative importance of income from sales of different products (expressed as a percentage of families indicating the product that is most important for them) in selected regions of the Colombian Atlantic coast.

Region	Crop					Number of farmers
	Cassava	Maize	Yams	Millet	Other	
Córdoba	28.8	42.6	28.6	0.0	0.0	66
Sucre	73.3	25.2	0.8	0.0	0.6	58
Atlántico	62.3	13.9	0.0	23.2	0.6	25
Magdalena	82.1	17.4	0.0	0.0	0.5	15

SOURCE: Survey, 1989.

a city whose demand for cassava has traditionally been low. Within the production system in this area, maize and yams are planted first, when the first rains arrive around April, while the planting of cassava is pushed back until June and July (Table 4). In addition, cassava is planted in low densities. Due to late planting, it is not profitable to begin to harvest cassava before

Table 4. Percentage of farmers who plant cassava per month of planting on the Colombian Atlantic coast.

Region	Month					Number
	March	April	May	June	July	of farmers
Sucre	4.1	52.1	21.9	19.8	2.2	96
Córdoba	1.6	7.9	15.8	68.3	6.4	63
Atlántico	--	84.6	11.5	--	3.8	26
Magdalena	7.1	--	35.7	14.3	7.1	14

SOURCE: Survey, 1989.

entering the dry period in December. Therefore, many farmers leave part of the cassava until the next rainy period and they thus have fresh seeds for the next planting. For renters, this situation can be difficult because they have to vacate the land and turn it over before the full year is completed in March or April.

In the department of Sucre, cassava is produced mainly in the savanna area, where the duration of the dry period and soil quality impede leaving the cassava in the ground during the dry period because high losses of dry matter can occur. Most people plant when the first rains arrive (April), which allows them to harvest and sell cassava early (September/October), when prices in the fresh market are at their highest levels. Within this production system, cassava is the most important crop and it is planted in greater densities than in the department of Córdoba. Yams are produced in small quantities and they are used above all for home consumption in the months when cassava is not being harvested (April to September), for which the product can be stored at home. Normally, cassava stakes have to be stored for some time, especially in the case of farmers who have to vacate their rented land at the beginning of the dry season. When the owner needs the land for pasture, conflicts may arise between the renter and the landowner, which result in losses of cassava when the owner lets cattle enter the land without the renter having been able to vacate it. The main characteristic of cassava production in the departments of Bolívar and Atlántico is the importance of the fresh market because of the nearness of Barranquilla and Cartagena, leaving only low-quality cassava for processing. In Bolívar, yams are an important export product for the United States. Thus, continuous production of yams throughout the year occurs in some areas. In Atlántico, cassava is mainly grown intercropped with maize and millet, especially under the form of "renting for pasture" landholding.

Cassava production as a crop of nonmechanized settling predominates in Magdalena and Cesar, producing little commercial surplus. The commercialization of fresh cassava is made difficult because of long distances and the poor quality of road infrastructure. The most important planting period is at the beginning of the rainy season; however, a second planting of less importance takes place later in the year.

Development of the Cassava Project on the Colombian Atlantic Coast

The development of the cassava project on the Colombian Atlantic coast will be described in this section, focusing on changes that have occurred in the project model and the consequences of these changes on the impact of the project. When the project began, the general idea was that cassava drying organizations would form a closed system by processing only cassava from the organizations' members. It was estimated that project benefits would not come about so much from processing but from the expansion of cassava production on the part of farmers affiliated to the organizations. Therefore, the first plants were founded as nonprofit associations that would provide services to their affiliates in the processing of surplus production.

In truth, it turned out that the drying plants bought most raw material from farmers not affiliated to the organization, and processing resulted more profitable than was originally estimated. The organizations were achieving significant profits with only a limited number of members (15 to 25). These profits were used to develop new activities and, in part, to distribute profits among the affiliates. Because of this, the legal structure of the organizations had to be changed to convert them into cooperatives.

The development of the cassava project took place in four phases, namely, the pilot project phase, expansion, consolidation, and the second phase of expansion. Each phase varied in terms of the level of small-farmer organization, institutional participation, the most important limitations, benefits produced, and the general working of the project.

Pilot phase

From 1981 to 1983, the cassava project on the Colombian Atlantic coast functioned as a pilot project with only a small number of plants established within a limited geographical area. The small-farmer organizations that were managing the project were structured more or less informally. During this phase, important knowledge was obtained with regard to the application of drying technology within the local organizations. The technology was adapted, allowing a greater rationality in labor use through a better utilization of installed drying capacity. In addition, the farmer organizations developed methods for managing the drying process on days that were climatically adverse for drying. Because the industry was not familiar with the product, the market for dry cassava was still not very developed. Economic benefits from the project in this phase were still low given the limited installed capacity and low quantities of fresh cassava processed. Institutional participation in the project was very high, especially in areas such as technical assistance, training, and research, above all with regard to processing and commercialization. The first control parameters for the project began to be developed, especially in terms of control of processing itself.

First phase of expansion

A rapid expansion of the project took place in 1985-1986, with an increase in the number of plants from 7 to 34. Several limitations for the good working and growth of the project arose in this phase. Plant efficiency fell rapidly due to delays in the formation of the new organizations, construction of new plants, and the setting in motion of the drying process. The limited institutional capacity for providing necessary technical assistance in the start-up process of a drying plant was one of the most important causes of delays. In order to overcome these limitations, technical cassava teams at the departmental level began to be formed, made up of employees involved directly in project execution, at the farm level, at the farmers' organization level, and at the regional management level. In addition, technical assistance within the project began to be expedited through the elaboration of a technical assistance handbook, allowing greater homogeneity in assistance. A large number of employees were trained in this phase on aspects of cassava production, processing, and commercialization. Most of the cassava drying associations became cooperatives, opening the way for the distribution and reinvestment of profits, and creating greater access to different kinds of credit (farm machinery, commercialization, production, etc.). The new organizations that were formed were also founded as cooperatives under the initiative, in most cases, of the national entities. In some cases, existing organizations were restructured for the purpose of developing cassava drying.

Most of the organizations began to work with a relatively large number of members. However, as only small quantities of cassava were processed in the first years, due to the delays mentioned, producing only minor profits, the number of members fell rapidly until each organization reached between 15 and 25.

For the marketing of dry cassava, the distance between the drying plant and the final market turned out to be an important limitation because of high transportation costs, considering the high volume of dry cassava in relation to its weight. Parameters for evaluating the drying process efficiency and its production costs were established. The optimal size of a drying plant could be established by comparing results from different plants during several campaigns. The location of a drying plant turned out to be the decisive factor for project success, as it affects the availability of cassava for drying. The ideal location was determined by local production circumstances (area planted, planting and harvest period) and the dynamics of the fresh cassava market. Failures occurred in regions where cassava production was too low or competition with the fresh market was too strong. The hypothesis that building a drying plant would give sufficient stimulus to cassava production to assure the supply of cassava to the plant was not valid. On the contrary, the best place for the development of cassava drying turned out to be areas where cassava production already existed and farmers sold part of their production to the fresh market, but where, during the dry season, fresh market demand was not sufficient to absorb all the cassava produced, bringing about unprofitable prices to the farmer, or where the quality of cassava dropped too much, restricting its sale in the fresh market.

Consolidation phase

In the consolidation phase of the cassava project on the Colombian Atlantic coast (1987-1988), the number of drying plants established was not increased, although most of the organizations increased their drying capacity. A significant and constant increase took place in the quantity of dry cassava produced, from 2980 tons in 1987 to 5483 tons in 1988. In some regions (Córdoba, Magdalena), cassava drying outside the dry-period months began to develop, creating a demand for artificial drying technologies.

Most of the organizations were able to consolidate their social base, making the entry of new members difficult through the introduction of high affiliation fees. With the increase in dry cassava production, the benefits produced increased rapidly, and they not only reached the organizations through higher profits but they also reached farmers in general through a rapid rise in prices paid for fresh cassava. The effective demand for dry cassava increased rapidly with the entry into the market of one of the most important producers of concentrated feed in the country. However, high transportation costs and low storage capacity for dry cassava at the level of the organizations, together with other factors related to the commercialization process (inopportune delivery of packaging, lack of capital because of delay in payments, among others) caused temporary paralyses in the plants.

By utilizing profits and infrastructure set up for cassava drying (drying floor, warehouse, etc.), most of the organizations developed secondary activities, which consolidated their economic and social base and gave greater continuity to their activities during the year. A second-degree organization was formed. However, the weak economic base of this second-degree organization made its successful working impossible, and it was thus unable to achieve an important role in the commercialization process, still leaving government entities with an important role to play in commercialization.

A rapid growth in the number of employees working within the project came about, especially reflected in the growth of the credit and technical assistance organization. Technical assistance to organizations began to direct itself less toward technical aspects of cassava drying and more toward administration and bookkeeping of the cooperatives.

The integrated nature of the project (production, processing, commercialization) was expressed more by the increase in activities directed toward promoting production within the framework of the project. Thus, activities such as the production and distribution of high-quality stakes, the distribution of inputs through cooperatives, and the introduction of a new cassava variety were carried out. The small-farmer organizations played an important role in these activities. Several organizations obtained associative credits for cassava production. However, the growth of credits to individual farmers seemed to lag behind.

Second phase of expansion

The project entered what is considered as a second phase of expansion in 1989. The number of cassava drying plants is increasing, both within the area of the original project as well as in other areas. This expansion is the result of private initiatives both from low-income producers as well as private entrepreneurs. Some of the new plants have been established directly by groups of farmers, which has diminished the importance of government entities in the formation of groups. In addition, it seems that the new organizations work with a greater number of members than the old ones as a result of the fact that the profitability of cassava drying has been proven sufficiently in previous years. At the level of the old organizations, cases have been observed in which several drying plants in an area tend to integrate themselves in order to allow greater investments. This is the case of three cooperatives in Sucre that joined together to obtain a credit for the construction of a supply center.

Other existing plants were founded through initiative of private entrepreneurs. It seems that these plants represent significantly less benefits for the small farmer than the plants managed by cooperatives. The private entrepreneurs tend to produce all the raw material by themselves and they use the final product on their own farms, dedicated chiefly to cattle raising. Clearly, cassava drying in private enterprises differs socially from cassava drying managed by cooperatives. Although perhaps one can hope for a rapid adoption of improved production technology within the group of entrepreneurs, the process will probably not lead to an increase in the income of the neediest small-farmer families of the region.

Impact of the Project on Cassava Production in the Region

With the integrated cassava projects, one aspires to improve the standard of living of small-farmer families, through improving cassava production, processing, and marketing. Therefore, it is necessary to analyze the impact of the project on fresh cassava production, with regard to area planted and crop productivity. However, to restrict the analysis of impact only to crop production would be insufficent since the increase in cassava production is only a means to improve the standard of living of the poorest sectors of rural society. Consequently, the impact of the integrated project on the income of small-farmer families and the socioeconomic structure of the region should also be taken into account. The impact of the cassava drying project on the Colombian Atlantic coast will be discussed in this section with regard to production, while in the next section the socioeconomic impact will be analyzed.

The greatest benefit produced by the integrated cassava projects is related to raw material production. The size of the benefits produced and their long-term distribution depend on the capacity of different groups of farmers to increase their cassava production. Increases in cassava production can be achieved through an increase in area planted in the crop, or through increases in productivity. Increases in area planted result in increases in farmer income (with a profitable price assured by the drying plants) and demand for labor needed for crop production. An increase in the total area planted can be brought about by augmenting the area planted per farmer or by an increase in the number of producers.

In the Colombian Atlantic coast, farmers have different possibilities for increasing the area planted in cassava. Farmers who work on their own land or who have land distributed to them by the agrarian reform institute, INCORA, have more opportunities than farmers who work on rented land. An alternative for increasing the area planted on the part of small landowners and beneficiaries of agrarian reform is to reduce the area left fallow. This arrangement is especially appropriate for farmers who have their farms under utilized, but it may increase the use of fertilizers in order to maintain soil fertility. It is more feasible to reduce the area used in pasture and to lower the number of cattle. However, cattle raising has many advantages for small farmers as opposed to growing cassava. Cattle farming provides a stable income during the year, along with high security, and it serves as a capital fund for financing a crop (Boering, 1984). For these reasons, small farmers prefer to increase the number of cattle per hectare, which generates a demand for pasture management technology and an increase in the demand for rented pasture, especially in the dry season.

As can be observed in Table 5, in the area of influence of the cassava drying plants, area planted in cassava has increased by almost 40% during the last four years. This increase has come about chiefly among farmers who work on lands obtained through agrarian reform and that are linked to cassava drying cooperatives. It is important to note that in 1987, average area planted among these farmers reached 4 hectares per person. This was not repeated the following year due to scarcity of stakes in some of the main areas of agrarian reform. It is also noted that the increase in area for cassava planted in holdings of small landowners has been relatively low. This group is more dedicated to small-scale cattle farming. For example, in the department of Sucre, where there is a greater concentration of lands redistributed in the agrarian reform process, the beneficiaries have an average of 1.5 head of cattle for each hectare of landholding, while for small owners in the region this figure climbs to 2.6.

Farmers who produce cassava on rented land seem to have fewer possibilities for increasing their area planted. An increase in production on

Table 5. Changes in area planted in cassava according to kind of farmer.

Kind of farmer	Year						Change		
	1985			1988					
	(1)[a]	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Agrarian reform									
Nonmembers	758	312	2.4	726	330	2.2	-4.3%	5.6%	-9.3%
Members	168	81	2.1	270	93	2.9	61.1%	14.3%	41.0%
Renter									
Nonmembers	2131	1319	1.6	3486	1937	1.8	63.6%	46.9%	11.4%
Members	519	330	1.6	778	432	1.8	50.0%	31.0%	14.5%
Owner									
Nonmembers	1125	482	2.3	1294	563	2.3	15.0%	16.7%	-1.4%
Members	291	132	2.2	378	145	2.6	30.0%	10.0%	18.2%
Total	4991	2657	1.9	6931	3500	2.0	38.9%	31.7%	5.4%

a. (1) = total area planted in cassava (ha); (2) = number of farmers; (3) area planted per farmer (ha).

SOURCE: Data extrapolated from Survey, 1989.

the part of this group has a high social impact since these farmers make up part of the poorest strata of the rural population on the Atlantic coast. The option of increasing the area planted in cassava at the expense of other crops almost does not occur because the rented land is normally completely occupied by cassava production systems. Most of the renters do not have cattle, and cannot use land occupied by cattle to plant cassava. Those who do have cattle cannot use this land for planting either since the pasture is rented per head of cattle monthly, and the farmer does not obtain the right to use the land for any purpose desired. The owner of the land can even have cattle from different people on the same terrain. The only possibility that the renters have for planting more cassava is to rent more land. This is rather difficult due to inequality in land distribution, the fear of the landowners of invasions, the reduced size of the lots in which cassava is produced, the long cassava production cycle in comparison with other small-farmer crops (sesame, maize), and the attractiveness of renting land for other more profitable crops (cotton, sorghum).

Besides the scarcity of land, the absence of capital limits renters in extending area planted in cassava. Most renters do not have credit or cattle, and they thus suffer from a scarcity of capital for crop financing, especially when they only have a small amount of family labor and should mainly utilize paid labor in planting. A labor scarcity may come about with renters who work on virgin lands or in mountainous areas, where land preparation is done manually, requiring much labor.

The development of the drying project induces new renters to produce cassava. For these farmers, labor scarcity is less because of their small production areas, so they still have sufficient family labor available. As can be observed in Table 5, the increase in area planted in cassava in rented lands has occurred chiefly as a result of farmers not associated with cooperatives. Area planted per person has only increased slightly.

As was stated earlier, several cassava drying cooperatives have increased cassava production through collective plantings of relatively large lots (between 5 and 15 hectares). It seems easier to find land in this manner than individually, in small lots. In this case, the landowner has to deal only with the cooperative and not with a large number of farmers. Owners with more land tend to rent more land for the planting of cassava in this modality, opening new land resources for production. A massive expansion of production under this form could limit the benefits of cassava drying to a relatively small group of farmers, who are members of the cooperatives.

It is hoped that the development of product commercialization in integrated cassava projects will bring about changes in production technology used by farmers. The availability of different production factors (land, labor, capital) determines the type of technology to use. The farmer should define the principal market of his cassava production: concentration on the fresh market, sale of surplus cassava to drying plants, or principal concentration of sales toward drying plants. In addition, independently from the strategy that will be adopted, the farmer has to take into account home consumption needs. Preference for any of the strategies depends on farmer access to the fresh market and the rate at which security in the commercialization of cassava through drying plants will have been established.

Farmers choose among intensive systems in the use of labor, by intercropping three different crops, or less intensive systems, especially cassava planted in monocrop or intercropped with maize. The planting density of the crops that are intercropped varies in accordance with the relative importance of each one of them for the farmer. A greater planting density of cassava will increase its yield, but the arrangement will proportionally reduce the quantity of cassava suitable for sales in the fresh market. Therefore, greater planting density is an attractive option, mainly for renters with poor access to the fresh market, who direct their production completely toward drying plants, and who have to vacate their land early. They therefore try to achieve the highest possible yield in a limited time period.

In the department of Córdoba, members of a cassava drying cooperative experiment with two different production systems. In the traditional system, cassava occupies a secondary place in comparison with intercrops (maize and yams). Cassava is planted in low densities starting in June and July, and an important part of the crop is not harvested until one year after planting. The cassava produced under this system is used chiefly for domestic consumption, and to a lesser degree for sales in the fresh market. In the nontraditional system, cassava is intercropped with maize, by planting the cassava earlier, in higher densities, and commencing the cassava harvest at the beginning of the dry period. Cassava produced under this system is used principally for sale to the cooperative. To choose which production system to adopt, the farmer considers the period in which he wishes to harvest, the relative importance that he gives to intercrops, access that he has to the fresh market, acceptable labor use intensity, and expected yields.

Normally, farmers plant a mixture of varieties, but most plant the regional variety Venezolana due to its high yields and good characteristics, both for home consumption as well as for sale in the fresh market. When evaluating varieties, farmers take into account characteristics such as yield, yield stability, earliness, starch content, starch stability during the harvest period, taste, shape of roots, acceptable color in the market, and quality of stakes. Not all farmers give the same relative importance to all these characteristics. Earliness is more important in regions where cassava is planted for the fresh market in the last months of the rainy season. It is also more important for renters who have to leave their land early. Stability in starch content is especially important in the departments of Sucre and Atlántico where marked deficiencies in dry matter content occur when the dry season is prolonged. Characteristics related to fresh market sales may be less important for farmers who have poor access to the market, especially when yields and prices paid by drying plants assure crop profitability to the farmer.

Quantity and quality of planting material have been identified as some of the greatest limitations on cassava production on the Atlantic coast both with regard to the increase in area planted in cassava as well as yields obtained. In order to overcome these limitations, farmers and cassava drying cooperatives could work on stake production, and develop technologies for stake treatment and storage. The adoption of one alternative or another will depend on three factors: first, the cassava production system; second, type of land tenure; and, third, farmer affiliation with the drying cooperatives.

With respect to the production system, it has been observed that in the department of Sucre, farmers have to store stakes over a rather long period since most of the cassava is harvested early in the dry season. In Córdoba, on the contrary, one can easily leave a special lot for the production of stakes, avoiding their storage. Consequently, the problem of stake scarcity is specific to some regions (Table 6).

The second factor that is related to the availability of stakes for planting cassava is the form of land tenure under which the farmer is working. In many cases, renters have to leave their land early and store stakes for a long time. On many occasions, all the stakes are lost for the new planting. Renters depend to a great extent on purchased and/or gift stakes, especially in regions where the problem of cassava planting materials is more pronounced, as in the department of Sucre (Table 7). The scarcity of stakes, because of a long dry season or the presence of pests, affects renters more than farmers who work on their own land.

Affiliation with cassava drying cooperatives is the third factor that influences the management of cassava planting materials by the farmer. At the time of cutting stakes for the next planting, the farmer needs to seek an outlet for the harvested cassava. In some cases, it is utilized for home consumption. However, if the farmer wants to plant a large cassava area, a market has to be sought for the roots. The members of cooperatives have their sales of cassava assured and they can delay more than nonmembers before cutting stakes for seed. Thus, they avoid a long storage period. It has been observed that cassava offered by members is processed chiefly in

Table 6. Percentage of farmers who suffered from a scarcity of seed per department on the Colombian Atlantic coast.

Result	Department				Total
	Sucre	Córdoba	Atlántico	Magdalena	
No	54.4	88.8	62.5	30.8	62.6
Yes	45.6	12.0	37.5	69.2	37.4

SOURCE: Survey, 1989.

Table 7. Source of seed according to region and type of land tenure (expressed as percentage of seed).

Region and type of land tenure	Origin of seed			Number of farmers
	Own	Purchased	Gift	
Sucre				
Agrarian reform	88.6	11.4	0.0	35
Renting	68.1	27.6	4.3	35
Ownership	87.2	9.4	3.5	32
Regional average	81.1	16.3	2.6	102
Córdoba				
Renting	99.6	0.0	0.4	24
Ownership	91.9	1.9	6.2	26
Regional average	95.6	1.0	3.4	50
Atlántico				
Agrarian reform	100.0	0.0	0.0	1
Renting	82.0	13.0	5.0	20
Ownership	66.7	0.0	33.3	3
Regional average	80.8	10.8	8.3	24
Magdalena				
Renting	66.7	5.6	27.8	9
Ownership	68.8	0.0	31.3	4
Regional average	67.3	3.8	28.8	13

the last months of the dry season, while in the first months a greater quantity of cassava from other farmers is processed.

It can then be concluded that technologies for stake storage are especially suitable for renters in the departments of Sucre, Magdalena, and Atlántico, while technologies for stake production on the land of individual farmers themselves are more appropriate for the members of drying plants in Córdoba, especially in areas where a concentration of small holdings is found. Production of planting materials on common lots is what is most advisable for the cooperatives in Sucre in order to be able to avoid long storage periods. In addition, this allows stakes to be produced for sale to farmers who have to leave their land early and who lose all of their planting material.

In all of the Colombian Atlantic coast, cassava is harvested manually and up to now there is no alternative technology available. The most important decision that the farmer has to make for the cassava harvest refers to time, the quantity of cassava to harvest, and the outlet for the cassava harvested. Three different situations arise: first, the cassava may be harvested before the rainy season in which it was planted ends; second, the cassava is harvested in the following dry period; and third, the cassava is harvested more than a year after being planted in the rainy period. Several factors influence making a decision. The cassava is harvested early especially when it is for home consumption and when prices in the fresh market are high. The farmer has to choose between delaying the harvest to obtain a higher yield or obtaining a higher price through sales in the fresh market, even with lower yields. The cassava is harvested in the dry season due to the need to vacate the land, to pay for credit, and to acquire planting material, and also because in some areas cassava can show high losses of starch content when the rainy period begins again. Farmers are only capable of leaving the cassava more than one year and obtaining a high price in the fresh market when they have sufficient land to be able to plant somewhere else, and if sales of other products provide sufficient income to pay for credits and satisfy household needs.

Socioeconomic Impact of the Project

The impact of an integrated cassava project can be analyzed at the level of small-farmer families within the project's area of influence, small-farmer communities involved in the project, regions where the project is carried out, or at the national level. The impact of the cassava project on small-farmer families and communities affected by the project is analyzed in this section. The purpose is to estimate the capacity of cassava projects to contribute to the process of rural development. At the regional and national level, the project's impact has still been limited, although it is increasing. However, a rapid increase in the impact at the national level is foreseen because of the interest that the project has created on the Atlantic coast. In fact, experience has brought about the formulation of a national development plan for growing cassava, in which the development of cassava projects in other regions of the country is contemplated. In addition, a growing interest in cassava drying on the part of private producers has been noted. It is estimated that half of the dry cassava in Colombia is currently produced outside the context of the cassava project on the Atlantic coast.

As was stated earlier, the objective of integrated cassava projects is to improve the standard of living of the poorest sectors of the small-farmer population who receive their income as cassava producers or processors. It is thus necessary to analyze the amount of money generated and the way in which it is generated, the distribution of income generated among the population, and the cost of achieving this income.

The cassava project on the Colombian Atlantic coast is generating several kinds of income. First, the project generates some important income through the cassava that the farmers sell. This benefit reaches both members of cooperatives as well as nonmembers, but members benefit more because of the higher prices that they receive and because they are selling, on the average, a greater quantity of cassava per person. High production costs and low yields reduce net income received through the sale of cassava. During the 1987-1988 campaign, some 3500 farmers sold cassava to drying plants on the Atlantic coast, which gave an average net income per small-farmer family of US$60.93. As can be observed in Table 8, the 670 members who sold cassava to the plants obtained, on the average, a higher income than the 2830 nonmembers. In this analysis, differences in production costs and yields were not taken into account.

The second income that is being generated within the cassava project on the Atlantic coast is through employment generated by the cooperatives related to the drying process. This income is derived through the use of labor in the drying process itself and the administration of the cooperatives. This income chiefly reaches the small-farmer families affiliated to the cooperatives, mainly the members, or their children, doing the work in the plants. However, some 25% of this income benefits people not affiliated to the cooperatives. Income from administration benefits a limited group since in each cooperative few people have been named (one to three) to dedicate themselves full-time to this activity.

Table 8. Income generated at the small-farmer family level (1987-1988 campaign) in US dollars.

Factor	Number of families	Total benefit	Benefit per family
Sale of fresh cassava	3500	213,243	60.93
by members	670	75,905	113.29
by nonmembers	2830	137,338	48.53
Workdays in drying	525	45,373	86.43
by members	394	34,030	86.43
by nonmembers	131	11,343	86.43
Wages of members	88	22,549	256.24
Profits of members	700	158,113	225.88
through capitalization	700	94,868	135.53
through distribution	700	63,245	90.35
Workdays in production	9000	157,616	17.51
Farmer	3500	78,808	22.52
Day laborers	5500	78,808	14.33

SOURCE: Data bank, monitoring of cassava project.

Earlier, it was observed that cassava production is highly labor intensive, in some cases exceeding 100 workdays per hectare. Thus, income is generated indirectly by the cassava project through increased demand for labor in the production of cassava. The size of this income will depend on the quantity processed and the production systems under which it was produced, especially the intensity in labor use and the manner in which the necessary labor is obtained. If family labor is mainly used, this income is added to the family income obtained through the sale of cassava. If one turns to contracting day laborers in production, the income reaches the poorest sector of the small-farmer population, which depends in part or totally on income as day laborers. It is estimated that some 50% of this labor-related income reaches the farmers themselves and the rest goes for payment of day laborers.

The last type of income that the cassava project is generating is in the form of profits from drying plants. Members of cooperatives are the beneficiaries of these profits in a direct manner, when there is redistribution of profits, or in an indirect manner, when profits are used to pay for cooperative credits or to invest in other activities, thus increasing the organization's patrimony.

All the small-farmer families do not benefit to the same extent from the cassava project. Table 9 presents an estimation of the benefits received by different groups. The people who have benefited the most have been those who have occupied a position within the cooperatives, such as manager, treasurer, or head of production. Their total salary per campaign reaches almost six times the monthly legal minimum wage rate. Most of the members receive a net benefit per campaign equal to almost three times the monthly legal wage rate. In addition, they participate in the capitalization of their organizations. These amounts are considered to be significant in the rural environment of the Colombian Atlantic coast region.

The benefit received by nonmember families is significantly lower than the benefit that member families receive. However, the group of nonmembers that sells cassava to the plant is rather large (around 80 people per cooperative), and they are receiving an appreciable net benefit within the context of the small-farmer economy.

Besides income generated, the cassava project has had an important impact in several ways. First, small-farmer organization has been strengthened, locally, regionally, and, to some extent, nationally. By utilizing profits obtained in cassava drying, most organizations have increased their activities. At the local level, the organizations have pressured political sectors for the construction of necessary infrastructure for the proper working of the cooperatives (roads, electricity, water systems, etc.). The cooperatives have acted as middlemen between their members and credit entities to facilitate the provision of production credit. Finally, they have pressured for the provision of credits for the purchase of farm machinery and land.

Table 9. Direct benefits derived from the cassava project of members and nonmembers (in US dollars).

Type of farmer	Number of families	Family benefit
Total members	1129	276.84
Receiving a wage and selling cassava	88	527.57
Selling cassava and working in drying	168	357.76
Selling cassava and not working in drying	502	271.33
Not selling cassava but working in drying	226	221.95
Not selling cassava or working in drying	145	135.53
Total nonmembers	8461	34.05
Selling cassava	2830	71.05
Working in drying	131	62.86
Day laborer	5500	14.33

SOURCE: Data bank, monitoring of cassava project.

Mechanisms for Increasing the Impact of Cassava Projects

It has been observed that project success depends to a great extent on the selection of specific regions and areas for the development of activities. The level of development of the fresh market in the region is important, and cassava drying projects have to be located in intermediate regions with regard to the demand of the fresh market for human consumption. Drying plants located in regions with a strong demand from the fresh market suffer difficulties in the supply of cassava for the plant because of competition from these markets. This has been the experience of plants established in the departments of Atlántico and Bolívar. Plants established in regions where a demand for cassava in the fresh market does not exist previously also suffer from a scarcity of raw materials for supply to the plant. A low level of initial production is an important limitation for the development of a drying plant, especially when it is accompanied by a lack of credits and limitations in access to land.

The best sites for the development of a cassava drying project are regions in which demand for the fresh market during certain periods of the year exists, but in which prices fall to unacceptable levels for the farmer during the period of greatest supply. These areas are especially suitable for cassava drying if the period of its greatest supply coincides with the dry period. This is the case of the department of Sucre, where the most rapid development in the dry cassava industry has occurred. Within these regions, areas which offer the best infrastructure to facilitate the transport of fresh cassava to drying plants and the transportation of dry cassava to the market have to be selected.

One should also consider the geographic dispersion of production. In the Colombian Atlantic coast project, it has been observed that the drying plants with greatest success have bought a large part of the fresh cassava within a limited area around the plant (Romanoff, 1986). The plants that have had to purchase cassava from farther away have suffered more because of a lack of raw material. Therefore, cassava drying plants should be located in areas with a high concentration of cassava plantings. In regions where there is sufficient production, but with relatively scattered production, one has to seek other drying methods, such as drying on the farm, with later storage of the already dry product at a central place, to thus lower transportation costs.

The organization of the cassava drying project on the Colombian Atlantic coast in small-farmer cooperatives has been an important mechanism for achieving a broad socioeconomic impact. Members of these organizations are the major beneficiaries of the project. They have received high incomes through the sale of fresh cassava, participation in profits generated in the drying process, and, to a lesser degree, employment in cassava drying. Nevertheless, the project has also benefited a large number of farmers who find themselves indirectly linked to the plants, especially through the sale of cassava. Other farmers have been benefited by the stimulus to production, which generates an important demand for employment. The organizational model consists of small cooperatives of 15 to 25 members. Each one carries out drying activities and assures the supply of cassava up to a minimum level necessary for profitability of the process. Members receive a proportionally greater benefit as compensation for their efforts and risks taken. To assure the profitability of drying plants, cassava production in a cooperative form can be financed up to the point in which there will be a sufficient cassava supply so that the plant can cover its costs. It is not advisable to finance all the supply of fresh cassava for drying in a cooperative form since this would limit the benefit of the project to the group of cooperative members.

References

Bode, P. 1984. Peasant cooperation: A self-interested behavior. M.A. thesis. University of Amsterdam, Amsterdam, Netherlands. 83 p.

Boering, S. 1984. The role of cattlekeeping in the extension of cassava production by small farmers in the Atlantic Coast of Colombia. Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia. (In mimeograph.)

Fals Borda, O. 1976. Capitalismo, hacienda y poblamiento en la Costa Atlántica. Punta de Lanza, Bogotá, Colombia. 70 p.

Janssen, W. G. 1986. Market impact on cassava's development potential in the North Coast region of Colombia. Ph.D. dissertation. Agricultural University of Wageningen, Wageningen, Netherlands. 369 p.

Romanoff, S. 1986. Beneficiarios de las plantas secadoras de yuca. In: Best, R. and Ospina, B. (comps.). El desarrollo agro-industrial del cultivo de la yuca en la Costa Atlántica de Colombia. Proyecto Cooperativo DRI-CIAT, cuarto informe, tomo 2, julio 1984-junio 1985. Centro Internacional de Agricultura Tropical/Fondo de Desarrollo Rural Integrado (CIAT/DRI), Cali, Colombia. p. 15-29.

Chapter 10

FARMER ORGANIZATIONS IN INTEGRATED CASSAVA PROJECTS[1]

Steven A. Romanoff*

Background

Social scientists and development experts hold that farmer organizations make development projects more efficient, even though many groups have failed because they were poorly designed or promoted (Esman and Uphoff, 1984; Byrnes, 1988). Organizations also contribute labor and resources to reduce the costs of investment, and they cooperate with extension, supervision, and even research activities. Moreover, farmer organizations can guide project benefits to small-scale producers in marginal environments, to women, or to poor consumers.

This paper reports experiences with such organizations in integrated cassava-based projects and provides guidelines for viable organizational alternatives. All of the benefits just mentioned are found in the cassava projects of one or more countries, as are cases of problems that might be avoided. This paper will show that,

> "Organizing farmers for processing activities is even more important than providing them with infrastructure. Motivated farmers have dried cassava in small make-shift patios, whereas expensive patios have remained underutilized because there were no operators" (Pérez-Crespo, 1988, 29).

---

1. This chapter is based on work conducted under CIAT's agreements with INIAP (Instituto Nacional de Investigaciones Agropecuarias) of Ecuador and DRI (Fondo de Desarrollo Rural Integrado) of Colombia. The author gratefully recognizes the financial support of the Rockefeller Foundation and FUNDAGRO (Fundación para el Desarrollo Agropecuario) in Ecuador.

* Anthropologist, FUNDAGRO/CIAT Project, Cassava Program, Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia, stationed in Quito, Ecuador.

Types of Organizations in Integrated Cassava Projects

There are some general considerations for choosing the form of organization for a project; the first is simply the purpose of the investment. There have been four basic goals for investing in integrated processing projects: to benefit small-scale farmers; to demonstrate new technology; to produce an agroindustrial product; and to improve technology among existing processors. If the objective is to organize existing processors, then perhaps a loose association for protecting their interests is appropriate. If, on the other hand, the project is searching for an economically viable activity for land reform groups, then small, tightly integrated farmer-owned companies may be best. If demonstration is the goal, one might choose a government-owned facility. It should be noted that goals may change as projects evolve, so the type of organization that is appropriate at the start of a project may be different from that of later phases.

It is also important to consider potential external constraints on the success of an organization, such as transportation routes and government policies. Are large factories feasible, or are small facilities located near dispersed producers more viable? Does the technology allow for several layers of organization (e.g., local drying, town milling, state feed production, and national lobbying)? Are there bottlenecks in the flow of the product to consumers that an organization might control? In general, what production and processing tasks or stages would the organization undertake? There may also be cultural and political factors that favor one form of organization--entrepreneurial, cooperative, state farm--over others. Finally, project planners may be under financial constraints, since the cost of supporting and subsidizing a farmers' organization can be very high. Therefore, a feasibility study should take all these aspects into account.

We now turn to a description of the specific types of farmer groups that process cassava.

Types of Farmer Groups

Local-level farmer organizations have been a prominent part of integrated cassava projects in such Latin American countries as Colombia (36 cooperatives and associations), Ecuador (19 associations), Brazil (15 semiexperimental groups in Ceará State), and Panama (3 groups). Less common forms have been large cooperatives, private companies, government-owned factories, the Mexican ejidos (landholding units), state farms, demonstration facilities, and regional federations or unions. Their functions are summarized in Table 1.

It is worth noting that some kinds of organization are **not** found in cassava projects. Highly informal farmer groups organized for information-sharing, labor exchange, and marketing have been found in Zimbabwe, but they are simpler and less formal than those typical of cassava projects in Latin America (Byrnes, 1988, citing a manuscript of Michael Bratton). At the other extreme, the characteristic traits of agroindustry in enclave economies (e.g., plantations in Asia, contract farming, and transport over considerable distances to processing plants) are absent from cassava projects in Latin America to date.

Local groups

The most common type of farmer organization in integrated cassava projects in Latin America is a village-level cooperative or association. Typically, the group has from 12 to 30 members drawn from farmers living in a 3-km radius. The group, dedicated primarily to processing and marketing, dries chips in the sun, using a modest level of investment in drying floor, warehouse, chipper, and operating capital. The members, but not the group as such, usually produce fresh roots (except in Mexico, where emphasis is on production). These groups strive to increase their production of cassava derivatives, buy members' and neighbors' cassava, accumulate tools, and distribute profits to members. Noneconomic activities tend to be secondary.

The maximum authority is the general assembly, which in fact works on the basis of consensus rather than formal voting, though there may be legal provision for votes. Members, not professionals, assume administrative roles, and the general assembly often discusses operating decisions. The group keeps simple records of production and expenditures, but not double-entry accounting. Unassisted, the group could not prepare a balance sheet.

Given the informality of these local groups, the differences between "cooperatives" and "associations" are not salient. Empirically, the actual meetings, organization of work, and division of profits appear to be similar (nevertheless, see sections on large and regional cooperatives). Some groups begin operating before obtaining government recognition.

Government technical assistance, supervision, and funding are an integral part of the typical group. Extension personnel do influence operations; however, at this local level, they are rarely successful in implementing the principles and technologies they sometimes espouse, whether these be the

Table 1. Types of processor organizations in cassava projects.

Function	Organization
Processes cassava for onfarm use (single farms)	Small-farm producer-consumers (e.g., for pigs); large-farm processor-consumers (for cattle); state farms
Sells cassava without processing	Network of farmers organized around buyers or intermediaries
Processes cassava without selling	Village "farinha" processing facility
Processes and sells cassava derivatives	Small-farmer local association or cooperative; second-order cooperative or association; artisan starch extractor; entrepreneur; large cooperative
Marketing board; does not process	National or regional association
Educates farmers and officials	Investigation-demonstration unit
Represents farmers' interests	National association, congress, or federation

Rochdale principles of cooperativism, parliamentary rules of order, ideals of community service, political activism, or complicated accounting systems.

Farmer-operated cassava processing plants or local cooperatives are appropriate where there are concentrations of small-scale farmers, adequate government support, and low-interest credit for investments, as well as necessary climatic and marketing conditions (e.g., for cassava drying projects, four months dry weather during the harvest, a 1:4 price ratio for cassava roots versus maize at the farm gate, and fresh cassava marketing problems). These plants are most appealing where the project is attempting to raise the incomes of marginal farmers.

Nevertheless, adjustments can be made for different kinds of farmers. Large farmers may be interested in professionally operated plants. Scattered farmers might concentrate on functions that can be managed without frequent meetings. In Africa, for example, it was found that "nucleated settlement is not a prerequisite for mutual assistance, cooperation, self-reliance, or participation--the basic requirements for participatory development" (Green and Isely, 1988, 165). Farmers in favored environments might emphasize cassava for export or for urban supermarkets (Romanoff, 1988).

The Colombian, Ecuadorian, and Panamanian groups have been profitable (**see also** Pérez-Crespo, Chapter 3, this volume). An experienced trainer, called on to evaluate the Union of Associations of Cassava Producers and Processors (UAPPY) in Ecuador, wrote the following, which applies to the Colombian groups as well:

> "Without actually being a cooperative, the UAPPY has adopted some cooperative principles, adapting them to its reality. The associations are really becoming an original kind of business, with characteristics that cross the best and most applicable of cooperativism and of corporations" (Ramadan, 1988a, translation by the author).

Second-order aggregations of local groups

It is advantageous for small, local groups to be united in larger organizations in order to achieve economies of scale, justify the high costs of promotion, and undertake specialized functions. Esman and Uphoff (1984) report a modest correlation between such integration (i.e., a local group's "vertical" and "horizontal" linkages, in their terms) and successful operations. Based on the cumulative experience of American Cooperative Development International (ACDI), Fledderjohn suggests "regional cooperatives" that work in the area served by a single market town, uniting village committees or local groups without cooperative status. He contrasts this to community development, on the one hand, and larger, commodity-based cooperatives on the other (Fledderjohn, 1988, 25-34).

Second-order aggregations of small local groups (cooperatives or unions) are found in Ecuador (UAPPY), Colombia (the National Association of Cassava Producers and Processors, ANPPY), and Mexico (the Collective Interest Rural Association of the Savanna of Huimanguillo, ARIC). However, there is no consensus as to the appropriate relations among local groups.

ANPPY, which has no permanent facilities, has a commercialization committee and participates in yearly evaluations. It tried to unite nearly 40 groups from across the Atlantic coast of Colombia; however, as distances are great and markets and costs vary, it has fissioned into regional groups. State-level federations would probably be more advantageous. Recently, in the state of Sucre, an experimental aggregation of three plants was established under the DRI project to build a small animal-feed mill. In addition, one state-level group marketed part of the last harvest, retaining 1% of the values of sales.

In Ecuador, the relatively extensive functions of UAPPY include milling and selling chips produced by local associations; sales of other products (starch and conserved cassava); providing credit to associations for investment, operations, and onfarm production; training courses; communication among associations; promoting new groups; running special projects (seed production, trials); and maintaining relations with outside institutions. UAPPY has a two-room central office in the city near the associations, two vehicles, four cassava mills, three maize degrainers, a peanut sheller, and assorted minor equipment. It is constructing a central training and demonstration center, for which it is acquiring starch-processing equipment, a modest diesel drier, a sifter for flour for human use, workshop equipment for machinery repairs, and 3 ha of farmland. The office is staffed by exceptionally capable farmers, their more educated children, and a nonfarmer accountant. After deducting costs and distributing rebates to participating local groups, UAPPY keeps about 10% of the gross sales prices of the flour.

In Mexico, where the first base group had been operating since 1981, an association of producer groups (both colonists and **ejidos**) was formed in 1986 by agrarian reform officials. One-third of the local groups are in the Huimanguillo ARIC. This organization, which operates two industrial plants and coordinates sales of dried chips, sets support prices, makes bulk shipments, and establishes contracts with buyers. The cassava ARIC has its own office and a truck. It charges a very low service tax on sales (Pérez-Crespo, 1988, 30; personal communication[2]).

---

2. Personal communications cited include those of Paul Bode, Jesús Reyes, Bernardo Ospina, Rafael Orlando Díaz, and Carlos Pérez-Crespo of CIAT's Cassava Program, as well as Napoleón Chávez and Aníbal Mosquera, economists of INIAP's Roots and Tubers Program.

Second-order groups are probably appropriate wherever there are cooperatives or associations. Organizations at the market-town level are indicated, and 20 to 30 base groups with 500 members is a good size. The groups should not be divided by marked class, ideological, or interest differences, nor should they be too scattered if frequent meetings are planned. The second-order group should be formed at the same time as the base groups, even though its functions would be limited at first.

Third-order groups, federations, and congresses

Although no third-order organizations have emerged, the Colombian ANPPY and the Brazilian National Cassava Congress fill some of the needs for lobbying, communications, evaluation, and policy recommendations, common for national-level institutions, which might be third-order groups or federations in the cooperative scheme. Price-setting, for example, was an especially important function for the ANPPY until it fissioned. In Mexico, a group of politicians and technicians have formed a National Development Committee for Promoting Cassava, which lobbies, evaluates, and recommends policy. This somewhat top-down approach contrasts with the federation approach (C. Pérez-Crespo, personal communication).

If there is no economic need for a third-order group, then it should limit its activities to public relations, coordinating groups, and other activities that do not require frequent interaction or regional proximity. Thus,

> "The federation approach to cooperative development has been attempted in many parts of the world--Ecuador (FENACOOPARR), Paraguay (UNIPACO), Panama (COAGRO), Honduras (FECOAGROH), Egypt (UCS) and Indonesia (PUSPETA)--because it combines the benefits of both solidarity and scale. Although conceptually sound, this approach is difficult to implement. Many federations have either had difficulty or failed because of an insufficient business rationale for their creation" (Magill, 1985, vol. 2, 50).

Large cooperatives

Large (more than 100 members in the Latin American agricultural context), first-order cooperatives (i.e., not composed of several smaller units), which are common for export industries, savings-and-loan operations, or modern milk processing, are rare for cassava processing. The minimal technology needed for the cassava drying does not usually require major investments, volume of sales, or professional management that form the basis of such large cooperatives. For example, the Latin American projects do not use high-volume pelletizers, operated by middlemen in Thailand. One project in Costa Rica (Unión Campesina Agroindustrial de Pequeños y Medianos Agricultores) is a federation with a plant for freezing and paraffining cassava for export. It is said to have several hundred affiliated farmers; workers at the plant said that they have to invigorate local groups to increase farmer participation.

Since many existing agricultural cooperatives have almost all the infrastructure needed for cassava processing, it was thought that they might add this activity as a sideline. Three cooperatives in Brazil did so, one coffee cooperative in Ecuador discussed it but later decided not to pursue it, and cooperatives were both producers and consumers in a German/Costa Rican flour mill. Two of the Brazilian cooperatives dropped the activity because they had problems securing the participation of small-scale cassava-producing farmers, and the Costa Rican flour mill was economically unviable. Large cooperatives may be appropriate where large investments in starch extraction or flour for human consumption are contemplated. There is, for example, a large starch-producing cooperative in Argentina (Cuéllar, personal communication). So far, however, local groups are more common and more successful.

Public facilities at the village level

In northeast Brazil, the state affiliates of the federal technology transfer agency EMBRATER and the Father Cicero Fund helped villages establish small facilities to grate, press, and toast cassava to make the popular gritty flour, farinha. The project's main goal has been to eliminate the fees charged by owners of traditional processing facilities. Individual producers organize their own processing in the village plant, paying a minimal charge, and the only administrative tasks are scheduling and maintenance.

The public facility model, similar to the **casas da farinha**, was used for some of the first cassava chipping plants in Ceará State. Farmers used the facility to dry their own cassava, administration was minimal, and no attempt was made to expand efforts. Consequently, production was low. In Mexico, the first government-constructed facilities were expected to run on similar lines; again, production was low, several plants were not used, and there were maintenance problems. This model may be appropriate where low-intensity production is feasible, marketing is not a problem, subsidies are available, and capital accumulation out of profits is not a goal.

The associations and cooperatives that have been successful work with only a part of the population, while, in theory, the community facility is for all residents. In corporate villages that have effective social sanctions against accumulation of wealth, the village facility may be necessary, but its use should be monitored to see if all do in fact use it. In most villages of lowland Latin America, with the exception of some indigenous settlements, private property, economic stratification, and occupational diversity are prevalent. Thus, the goal of equity requires that poorer residents participate, not that the facility be held in the name of all.

Farmer processors: the coffee model

Coffee farmers usually dry their beans on a small concrete floor before selling them to a merchant. In the area of Bucaramanga, Colombia, some farmers who grow coffee and cassava have begun chipping and drying the roots, but this practice is not yet widespread. In the Philippines, farmers dry cassava at the farm level using a bicycle-driven chipper, and they sell the chips to a cooperative that processes them for animal feed.

Entrepreneurs

Artisan starch producers. The integrated cassava projects have dedicated little effort to small-scale starch extraction. In Colombia, CIAT and the French development agency, CIRAD (Centre de Cooperation Internationale en Recherche Agronomique pour le Développement), are studying fermentation technology to make the popular "bitter" starch. In Ecuador, several minor improvements are being tested, principally involving cleaner water and marketing innovations. In Nicaragua, there are many family-owned operations, which used to export to other countries until high root prices and the war disrupted operations. The Nicaraguans are presently working on a medium-sized, state-owned starch factory (C. Pérez-Crespo, personal communication).

In Cauca, Colombia, and two regions of Ecuador, artisan starch producers sometimes produce cassava flour. Instead of chipping the roots, they grate them as for starch extraction, and then dry the grated roots in the sun. This activity is of considerable interest because these artisans process much more cassava than any of the integrated projects. Moreover, their growth has not required either extensive technical assistance or subsidies.

Any small-scale entrepreneur already having relations with cassava producers may be an appropriate participant in an integrated project. He might adopt drying cassava as a new activity, or the project might improve existing processing technology. This is the strategy used by CIRAD in several African countries where they are improving the machine used by men who walk from farm to farm offering to grate cassava for **gari** (similar to the Brazilian farinha). The **casas da farinha** might be interested in drying as a sideline.

Although there are development projects to support small industries in many countries, the conditions under which it would be feasible to work specifically with cassava-processing artisans are not yet known.

Companies. Enterprises started for the sole purpose of making cassava flour have done poorly in Colombia, Ecuador, and Venezuela. They fared better in Brazil only when government regulations required a proportion of cassava flour to be mixed with imported wheat. (Starch factories, on the other hand, are found in many areas, among them southern Brazil--Santa Catarina, Minas Gerais--, the Argentine Chaco, and northern Colombia.) In addition, plants started in Mexico and Costa Rica in the 1970s failed. Larger-than-expected investment expenses, a predilection for excessively complex technology, high production costs, and uncertain markets, as well as problems with raw material supply, have been major problems.

Companies that already have appropriate drying facilities have been able to add cassava drying to fill seasonal lulls. One such company in Ecuador has done well in its first year, but another found that its costs for artificial drying are almost double those of solar drying by small-scale farmers; and for milling, 25% higher.

Given the frustrations in dealing with small-scale farmers and government agencies, it may seem easier to work with entrepreneurs who seek technical assistance at their own initiative. However, there are three problems. First, their failure rate has been high because some of them were too enthusiastic, working in inappropriate areas, or working with costly technology. Second, it is easy to devote too much time to companies that later decide not to invest. Third, one must consider how to choose the appropriate beneficiaries for an integrated project.

Association of large farmers. In Santo Domingo, Ecuador, an association of large-scale farmers is being formed by 15 cattlemen who decided to grow and process cassava after finding that their farms (located on the acid soils of what had been a tropical rain forest) were becoming unprofitable. The group faces significant environmental constraints; only time will tell if their relatively greater resources and infrastructure can overcome the factors that have favored local groups of poor farmers.

Processor-consumer farmers. Large cattlemen in Brazil have adopted cassava chipping technology with little outside stimulus, since semiarid conditions make pastures seasonally unreliable. By 1987, 1200 cassava chippers had been sold in Ceará State, with small-scale farmers providing most of the roots (B. Ospina, personal communication). Benefits have not been quantified but must be substantial. In the dry north coast of Colombia, cattlemen have begun to request technical information on cassava drying from extension services (P. Bode, personal communication).

The thousands of small-scale producers who grow cassava for onfarm use (e.g., as pig feed) also fall into this category of processor-consumers.

Government owner-operators

Institutional owners. In several countries, the first plants were built or owned by an agricultural research and extension agency. Except for research and demonstration units, pilot plants have been turned over to farmer groups. In Mexico, the project depended on an experimental plant, which in fact experienced technical problems. If farmers are to be involved, projects should buffer them from such hazards. On the other hand, once the technology is proven, farmers should not be denied the experience of building their own facility, which is a very effective way of creating group solidarity.

State farms. Cuban state farms have a substantial program for producing planting material, which satisfies internal demand. Cassava drying is just now beginning; there are 15 chippers built for use on military farms. Policy now supports the development of feed grains by state industries in an effort to reduce cereal imports, which amount to 70% of consumption (J. Reyes, personal communication).

Other organizations

Some types of farmer organizations have been important for project development although they have not had an official role in it.

Matrix organizations. A matrix organization provides members for a new processing group without becoming a processor itself. The matrix organization may also choose to provide goodwill, funding, facilities, or other resources for the new group. Examples from Ecuador include a land-reform commune in

Esmeraldas Province, several groups from an agricultural credit program in Manabí Province, and a maize-marketing project. An indigenous town was the matrix for one Colombian group (P. Bode, personal communication).

Organizations created for other purposes. It is easier to start farmer organizations than to sustain them. They have been a popular form of organization for both government and nongovernment projects in agrarian communities in areas such as marketing, wholesale purchasing, land reform, and technology transfer. Perhaps they have been too popular because they frequently fail for lack of an economically viable activity or because the central activity does not require members' participation.

Several faltering groups have received technology and funding from integrated cassava projects, and they have responded well. In Colombia, various land reform groups, formed to facilitate administration and in hopes of fomenting collective production, found that group postharvest processing was more feasible than collective agriculture. Some marketing groups discovered that storing semiperishable crops is riskier than processing cassava. After developing cassava processing, several of these groups began to market their original crops as well, this time using the experience and infrastructure gained from drying cassava (P. Bode, personal communication). In Ecuador, two women's groups joined the project because they were interested in technology, credit, and marketing assistance.

Having seen the value of working with already established groups in Colombia, I thought that the Ecuadorian project might adapt cassava technology to existing groups. This suggestion was rejected by the Manabí UAPPY, which required new groups not only to reorganize themselves with cassava processing as their principal activity but also to change their name to a standard form. It was felt that powerful cooperatives, such as coffee marketers, would divide or subvert the UAPPY. The newer Esmeraldas UAPPY allowed a cooperative to join, but still insisted that it be specialized in cassava and adopt a new name. This reasoning exemplifies the standard cooperativist norm of associating individuals with similar interests.

As established groups have links to institutions, care must be taken to keep good relations with such sponsors, perhaps bringing them into the interinstitutional committee that supports the project, lest there be cases of rivalry between institutions, leading to division and vacillation in potential cassava-processing groups.

Social networks among farmers. Local-level associations are often formalized versions of farmers' social networks, with members united by ties of kinship, neighborhood, or clientelism, as is the case of Colombian groups. The existence of networks can jeopardize a group if it is dominated by a single extended family. Sometimes networks are important in unexpected ways. Surveys have shown that new varieties of cassava diffuse along networks as farmers get planting material from friends and neighbors, rather than stores or institutions. Thus, in one community, two individuals were ultimately responsible for introducing new varieties (R. O. Díaz, reporting results of a CIAT survey). This is not the case for other crops, such as maize.

Processor-provider networks. The relations between a processor and a set of providers constitute a social network characterized by its size (number of providers), geographic distribution, and internal connections (existence of intermediaries, etc.). At the center of such networks, one may find a cooperative, a company, some other type of processor, or even an apparently unrelated person.

This type of network grows naturally and the links on which it is based often solve important problems--getting goods to market, supplying informal credit, providing inputs, solving disputes, linking people to centers of power, and so on. Therefore, it is not always easy to introduce more formal organization. For example, about half the cassava consumed in Guayaquil, Ecuador, is delivered by only 11 farmer-intermediaries who own large farms and trucks and who make only prearranged deliveries (A. Mosquera, personal communication, reporting results of an INIAP/CIAT survey). It would not be easy to replace these intermediaries with a cooperative. Moreover, simply installing a cooperative will not necessarily obviate intermediaries, increase the number of beneficiaries, double the distance farmers are willing to travel, or eliminate marketing margins. Unsubsidized cooperatives often come to look remarkably like the intermediaries they displace.

A basic understanding of provider networks allows managers to make administrative decisions that benefit the project. How close processing plants can be located, for example, depends on the spatial distribution of providers; in Colombia and Ecuador, 90% of the production comes from within a radius of only 5 km. The strategy for increasing production also depends on the nature of the provider network: projects typically work with nearly 100 small-scale providers per plant, each of whom augments his planting by a small amount. Also, the strategy for directing benefits to small-scale farmers, rather than to intermediaries, may arise from understanding the role of middlemen for the network of providers. Intermediaries enter only when raw material comes from a distance of more than 10 km, so a strategy of many small processing plants close to production areas is appropriate.

Traditional sociocultural forms of organization. Village councils and traditional leaders often make decisions about agricultural production, though the cassava projects in Latin America have been most active in areas that do not have corporate villages or large social groupings. In one case in Colombia, however, members of an indigenous tribe have begun processing cassava. In Ecuador, two communes of Quichua Indians have sent representatives to see the Manabí Province project. If integrated projects have to involve the villages as units, traditional sociocultural forms of organization should be taken into account and built upon.

Here ends the catalogue of organizational forms found in cassava projects. The nearly 20 types that have been described show that projects have many options. We now turn to a description of the activities, membership, and issues for the most popular kind of organization in cassava projects.

Membership in Farmer Organizations: The Importance of Small-scale Farmers

For cassava processing associations to be feasible, they must involve substantial numbers of small-scale farmers. Motives for joining groups have been of interest to social scientists (Bode, 1986; Byrnes, 1988); however, no theory predicted that small farmers would join the integrated cassava projects in such numbers nor that they would be so enthusiastic. In Ecuador and Colombia, the projects are located in areas where large numbers of traditional producers faced a declining market for fresh cassava and experienced problems with their agroindustrial buyers. The integrated projects answered a "felt need" to unload excess production, and thus farmer interest was not a constraint.

Even more striking than the number of beneficiaries is the degree to which poorer farmers have joined the project. The monitoring data from Colombia show unusual participation by land reform beneficiaries, as well as a significant minority of participants who rent or borrow land to produce cassava. In Colombia, the most active members were smallholders having about 12 ha of land, but so many **minifundistas** (fewer than 5 ha in the dry Atlantic coast region) and landless people joined the associations that these groups now contribute more raw material and labor than larger farmers.

One reason for the influx of small farmers is the nature of cassava, a rustic, unmechanized crop, usually produced in small lots. Data from Colombia indicate that the equilibrium size of planting for integrated projects is 3 ha. In Ecuador, plots in the project area are still smaller. In a Costa Rican project, an associated agricultural technician reported that plots are 1 to 4 ha. Even in Thailand, the world's largest producer of dried cassava, plots average only 3 ha. Farmers have indicated that even if constraints were removed, they would not expand their plantings beyond 4 ha (Janssen, 1986, 119; N. Chávez and R. O. Díaz, personal communication). In colonization projects such as the Mexican Tabasco State project, where farm size is substantial, artificial drying of cassava (subsidized) and silage for pig feed (10,000-metric-ton capacity for each silo) have been implemented. Even here, with substantial credit and pressure to increase production, the mean size of planting has been only 7 ha (Pérez-Crespo, 1988, 21).

Administrative restrictions in Colombia's Integrated Rural Development (DRI) project has limited participation to farmers with fewer than 20 ha of land. However, in Ecuador, even though there is no legal limitation, most members still have fewer than 5 ha.

Perhaps only small-scale producers find the benefits of association membership very attractive. Data from Colombia showed that 52% of the members received as much benefit from wages and profits as they did from sales of cassava. Such benefits are attractive to people who need off-farm employment.

Turning to other characteristics of members, the entry of **women** into associations has been limited. In both Ecuador and Colombia, there are some female members and administrators, and, in the former country, there are two groups comprising only women, who specialize in higher value, lower bulk products. Members typically range in **age** from 30 to 60, in part because younger people have not yet acquired land, or because the mix of activities whereby they earn their living includes migratory activities not compatible with the demands of producing cassava and participating in groups. The Colombian and Ecuadorian members are more likely to be **literate** than the general rural population, especially if they have leadership roles, but substantial numbers of illiterate members are found.

Cassava-processing groups thus include smallholders, women, land reform beneficiaries, and other marginal producers--an important consideration for donors, government officials, and other participants. Although the main benefit from the groups has been economic, not political, they assume some of the functions of what Esman and Uphoff (1984) call "interest associations," intended to defend the interests of a given group.

Activities Undertaken by Farmer Organizations

What is it that farmer organizations do in cassava projects? What can project planners reasonably expect them to undertake? The answers to these questions are addressed within the framework of the most common type of organization found in the projects--cooperative style, local organizations linked in a second-order union--with occasional comments on other types.

Central activities

Production of fresh roots. The groups of cassava producers (as opposed to their individual members) in Ecuador, Panama, Mexico, and Brazil do not grow large amounts of cassava. In a few cases they do; some land reform beneficiaries in Panama have sought credit for limited communal production, and the main activity of the Cuban state farms is production. Some Colombian groups have started producing on company plots for the season when local supplies are lowest, especially as they increase their drying floors and need more raw material. Collective production also has a function in technology testing and production of planting material (P. Bode, personal communication). Some groups do provide production services (in Colombia, some have a tractor for plowing members' fields), but, in most cases, individual farmers produce the roots.

Processing. The most common group processing activity has been drying cassava using a chipper and a concrete drying floor or trays. In Ecuador, some groups have also combined preservation of fresh roots with drying--a powerful combination because what is rejected for conservation is used for drying. Two groups in Ecuador also produce starch, and they chip very small roots. In Mexico, the second-order group operates a drier, which requires a subsidy.

Marketing. In Colombia, the ANPPY, together with government officials, undertakes marketing. It negotiates sales with factory representatives, while the local-level groups are responsible for getting the product to market. In Ecuador, second-order organizations mill chips into flour and then market it; they have even marketed products of entrepreneurial producers. In Mexico, the ARIC coordinates marketing.

Transport. Base groups usually assume responsibility for transport. They typically hire trucks to carry their product to buyers, while in Ecuador, the responsibility again lies with the second-order group. The UAPPY and the ARIC own trucks.

Utilization. In the state of Sucre, Colombia, several associations in the DRI project have explored utilization. They have a trial processing plant for making balanced animal feed. In Mexico, cassava silos are attached to pig stalls run by the project. In general, utilization by farmer organizations is an interesting possibility for the future.

Support activities

Local-level associations receive credit of several kinds: agricultural production loans (to members), operating loans, the basic investment loan, and loans for capital improvements. In one case, the second-order union manages a rotating fund. Only rarely have the groups pursued activities common to agricultural service cooperatives.

Credit. Credit for investment and plant operations is essential for most projects. Perhaps the most attractive credit has been for agricultural production, which is subsidized; it is also the most dangerous form of credit for cassava organizations, used to attract farmers and support unsustainable practices.

In Colombia, some groups obtain production credit for all their members at once from a special integrated rural development window of the Agrarian Bank, whereby the group and members guarantee individual subloans. This arrangement is advantageous to the bank because the loans are repaid (versus high default rates on individual loans). The group assumes some of the administrative burden for the bank, and the bank avoids confrontations with borrowers. The groups have gone so far as to lend members money to pay off prior bad debts so that the group can receive credit. The rationale for this system from the group's perspective is that interest rates on the loans are below the inflation rate, thus obtaining credit is highly desirable.

In Mexico, a land-holding unit or **ejido** obtains credit to be distributed internally among cassava producers. If even one member fails to pay, the **ejido** is excluded from credit, and credit default is a major reason for farmers dropping out of the project (Pérez-Crespo, 1988, 19). In Panama, some land reform groups now considering processing benefit from subsidized loans.

In Ecuador, the UAPPY operates a small rotating fund that loans to the base groups, which pass the money on to individual members, who receive only enough to pay about one-quarter of the costs of a hectare of cassava. The purpose of the fund is to teach farmers and organizations to manage credit so that they can finance inputs and new technology; however, members see the program as simple agricultural credit. This is a losing proposition for UAPPY.

Where inflation advances at the high rates characteristic of many Latin American countries and where governments offer agricultural credit at rates below the inflation rate, it is practically impossible for a cooperative to offer credit at rates that protect its capital. It may pay to receive loans and retail them to farmers with a small differential to cover costs. Except in rare circumstances to remove a bottleneck, a group should not subsidize loans or lend its own money. "Indeed, to be more blunt, credit is more like a nagging headache for the cooperative manager, a necessary evil, a losing proposition that constantly threatens the life of the enterprise" (Fledderjohn, 1988, 61).

Groups generally manage subsidized operating loans from development institutions to cover purchase of raw material, labor, gasoline, transport, maintenance, small tools, and other direct variable costs. As sales of dried cassava are in units of about 10 metric tons, a good rule of thumb is to provide sufficient credit to produce 20 metric tons--enough to produce another load while awaiting payment. Fortunately, most projects usually pay cash for raw cassava as the practice of paying after it has been processed or sold is a sure cause of resentment, which happened in the Mexican project (Pérez-Crespo, 1988, 20). An unfortunate practice that has occurred with operating credit, particularly during the group's first year, has been its use for investments, which causes a problem at the end of the year when the group is expected to return its operating loan.

Subsidized loans for investment come from government-sponsored development projects, government agencies, special cooperative banks, and bilateral international assistance. Farmer associations do not normally have access to regular commercial credit. Loans vary in the degree to which the investment is expected to be repaid and to whom. The Colombian DRI projects expect some repayment, but funds are to be used for local projects. In Ecuador, the UAPPY has a rotating fund so that repayments are recycled to member groups. Feed mills have funded at least two entrepreneurial processors, but this is not a normal practice.

In Ecuador, UAPPY has been operating a rotating credit fund for all three kinds of credit since 1985. Nominal interest rates do not cover inflation, but the union retains part of the profits of selling flour, which serves to replenish the fund. Since loans are guaranteed by sales of flour produced by base groups, there have been no problems of repayment.

Bulk purchase of inputs. In Colombia, at least one group has used its profits to buy backpack sprayers for its members, and in Ecuador, construction materials are sometimes bought for union associates. In general, however, cassava producers have not established cooperative stores. The use of agrochemicals and other purchased inputs is not common for cassava production, so the need for group purchase has not been great; indeed, use of systemic agrochemicals would cause problems for groups selling to shrimp farms.

Production of planting materials. The Cuban state farms are active in multiplying virus-free planting material, and the government has adopted a strategy to produce three varieties with different harvest dates. In Ecuador, cassava associations became interested in maize seed multiplication, and in 1988, two associations produced certified seed. In 1989, two associations built high-humidity chambers for rapid multiplication of promising cassava varieties. Using traditional technology, farmers obtain 10 cuttings from each plant harvested after one year, where the chambers can produce thousands. While onstation testing and multiplication of promising varieties would take seven or more years to reach farmers in economically important quantities, by putting evaluation in the hands of farmers (participatory techniques, see Hernández R., Chapter 7, this volume), and by allowing them to control multiplication, this time can be cut to four years.

Machinery loans. Several Colombian groups own tractors and prepare members' fields for a fee. According to a survey, members consider this service to be more important than any other, including purchase of cassava; however, because of high import taxes, the tractor is not self-financing, and the cooperative's other activities subsidize it (P. Bode, personal communication). In Ecuador, UAPPY owns maize degrainers and a peanut sheller, which it plans to rent to associations for members' use.

Production/storage/marketing of other products (see **Diversification** below).

Internal aspects of the organization

Administration. Organizational affairs are typically managed by the general assembly of members, its officers, and the plant manager, with significant influence exerted by project staff. Meetings tend to be held more frequently during the processing season. Despite elaborate rules, they tend to be long discussions of pending issues, with decisions made by unanimous consent, or, at least, when opponents become exhausted. Factions may develop within the groups, but even then they rarely resort to voting.

The manager determines the amount and quality of the cassava that is processed. When the duties of this position became too onerous, Colombian groups established a junior "production leader." The manager is the critical person in relations between producers and the processor. He schedules deliveries, has a great deal to say about prices, and makes many other decisions that affect farmers.

Accounting. Almost all groups have some accounting system, but it may be only a notebook with lists of expenses. Donors and project staff insist that records be kept, and the Ecuadorian UAPPY has been forced, perhaps to its eventual benefit, to implement an elaborate system to satisfy their requirements. This aspect of management is a serious problem for all cassava projects as the accounts are often incomplete and sometimes disorganized or badly stored. Members, many of whom are functionally illiterate, rarely attempt to understand the accounts. Technical assistance and training are costly and only modestly effective. Isolated cases of misuse of funds have appeared; but, relative to other kinds of problems, they seem rare.

Distribution of benefits. Farmers benefit when they sell cassava, work for wages, receive a share of profits, use plant facilities for storage or drying, own a share of the investment, and have access to programs such as credit channeled through the group. The relative importance of these benefits can be manipulated by setting the purchase price of cassava, along with the daily wage and hiring policy, making it possible for groups to direct benefits to particular types of people. A policy to benefit landless laborers, for example, would raise wages, distribute profits equally among members, and reduce the price paid for cassava (Romanoff, 1989b).

Both members and their nonmember neighbors benefit from the plants. Typically, only half the fresh cassava is from group members. When small farmers are the majority of members, they and their sons tend to work in the plant, whereas workers are more likely to be hired in plants owned by larger farmers. The question of who works in the plant is always a lively one in the groups' first years. Monitoring data show that workers tend to be people who live nearby. If the plant is near members' homes, they may come to evening sessions and their children may help out.

In Colombia and Ecuador, the rules of dividing profits are roughly the following: 40% for members, 40% for capital investment, and 20% divided among various areas, such as education, members' emergencies, community uses, and administration. The members' portion may be divided in different ways--equal shares, according to cassava sales, according to days worked, etc. In Brazil, the **casas da farinha** set their prices just to cover costs, while other countries are only now reaching the point of generating profits.

The best way to direct project benefits to small-scale farmers is to build processing plants that do not need more raw material than is found in the immediate area. Monitoring data from both Colombia and Ecuador showed that intermediaries and large-scale farmers only entered the project when it was necessary to obtain roots from more than 10 km from the plant. If the plant can be supplied locally, there is no incentive for intermediaries (Romanoff, 1986b).

Goals, norms, and values. During meetings that I attended in several countries, members have emphasized the financial rewards to themselves or their families. Statements about long-term benefits have been important in the context of various decisions: to pay back loans or not, to invest or distribute profits, to maintain relations with a government official, or to express a grievance. Sometimes members discuss restricting membership and benefits to small farmers, their neighborhood, or women. On the other hand, in meetings with donors, higher level government officials, and trainers, statements about general benefits are more common.

Social and ceremonial events. Plant inaugurations in Colombia and such events as the annual UAPPY dance in Ecuador should not be overlooked as devices for creating solidarity among members and for making contacts between government officials and farmers. Groups typically extend formal invitations, and even quite high bureaucrats are expected to attend or send a delegate. Their very presence makes it more likely that the group will obtain more services in the future.

Training and extension

Farmers' organizations are capable of organizing and participating in technology transfer activities (Romanoff, 1988). In Ecuador, UAPPY employs a rural secondary school teacher to organize almost 50 events per year, often in conjunction with the national agricultural research agency, the ministry of agriculture, or CIAT. The teacher also organizes the participation of UAPPY farmers in events run by other agencies.

Farmer-to-farmer technology transfer. The use of paraprofessional agents of technology transfer is not uncommon in development projects (Esman, 1983). In Colombia, Ecuador, and Panama, experienced groups, with the backing of development organizations, have taught new groups how to process cassava. In Ecuador, farmer-to-farmer technology transfer began in 1985, when an experienced Colombian farmer taught local groups how to dry cassava. In 1987, Ecuadorian farmers began to function as promoters, though with modest success. In 1988, UAPPY formalized its activities and its supervision, and seven experienced farmers successfully formed six new groups. This case is particularly interesting because the promoters made it possible to form the groups with less assistance from local notables (merchants, middle-range farmers, etc.), the preferred contacts of official extension personnel. In Panama, the InterAmerican Foundation funded a technical assistance visit by a Colombian farmer in 1987 to improve management and processing technology in a near-crisis situation; this visit permitted a tenfold increase in production. In later phases of the Colombian project, new groups have arisen as a result of farmers' initiatives, and these new organizations have been very successful (P. Bode, personal communication).

Farmers can also contribute to publications. UAPPY has brought out two numbers of its bulletin in Ecuador, receiving technical assistance from the national farmer training institution (INCCA). Members of the Esmeraldas Province groups have been trained as radio reporters for a church-sponsored station; they typically attend events with a tape recorder, and several shows have aired.

Nonagricultural services

In part because they are new and in part because they are focused on economic benefits, most groups have not made much effort to set up family disaster funds, community services, communal stores, literacy training, etc.

External linkages

Relations with cassava planters. The greatest advantage of the associations is that as members are both producers and processors, they understand the problems of each activity and make adjustments accordingly when they decide how much cassava to plant and make investment decisions. Less resentment builds up about promotional trickery, underweighing, delays in receiving cassava, payment delays, or quality discounts.

Relations with factories. Relations between farmer groups and buyers in Colombia, Ecuador, and Panama have been characterized by bargaining on price, with some intervention by government/project officials. Most of the production has gone to larger factories. There have been few major cases of bad faith on either side, that is, failure to pay, short-weighing, or massive adulteration; but, delayed payments are common. Buyers do control quality, particularly moisture content, a salutary check on producers' practices. Projects should not indulge in unrealistic expectations of gratuitous assistance or high prices from the entrepreneurial sector, but they should not shun them either, as this sector creates the demand that benefits small farmers.

Relations with government. Organizations have the potential for representing farmer interests to the government, projects, and the general public. Where there are official prices or support prices, as in Brazil and Colombia, these are of primary interest. Private producers are represented in Brazil's cassava congress, an unusual accomplishment. In Colombia and Ecuador, there is an annual large-scale meeting with government officials. In Ecuador, the second-order group is included in the provincial-level monthly sessions of the interinstitutional committee.

At the local level, groups have frequent contacts with lower level extension personnel in the projects of Colombia, Ecuador, Panama, Brazil, and Mexico. To varying degrees, the groups make their needs and opinions known; this feedback, both positive and negative, is very valuable.

Relations with researchers. In Colombia, several organizations have collaborated with CIAT and ICA on studies; in Ecuador, INIAP and UAPPY frequently trade services. UAPPY has collaborated on production, processing, marketing, and socioeconomic studies for the project (Romanoff, 1988).

Secondary projects. Village-level cassava groups in Colombia were considered as potential implementing agencies for a community tractor project. The second-order UAPPY of Ecuador is assisting a church group to implement a community water project. A second-order organization, employing a bookkeeper and administrator, has considerable capacity for implementing small projects when they are of interest to the organization and the funder. Such activities, however, must pay for themselves and must not overburden the administrative capacities of the group.

Issues for the Organization

Cassava-processing organizations have encountered the same issues, problems, and risks as other farmer organizations.

Relations with outsiders

External support. All the associations have been linked to government institutions. In fact, at the outset, so many decisions are made jointly or by government officials that the true implementing agency is not the association alone but rather a network that includes government officials and select members of the group. The positive and negative effects of such links are a standard topic of discussion (e.g., Esman and Uphoff, 1984).

Farmer groups do sometimes resist recommendations, with mixed results. In Colombia, officials were unable to dislodge an administrator who was stealing from the group (not uncommon if theft is kept within tolerable limits; see Tendler, 1981). In Ecuador, UAPPY successfully resisted an international adviser's recommendation about pricing to accumulate capital, and one group expelled several relatives of government officials who had been slipped in as members. Other cases of resistance were noted earlier.

Cultural differences are also important. On returning from a commission to Colombia, the representatives of the Ecuadorian UAPPY reported that they had spoken in defense of Colombian government officials, whom they perceived to be mistreated by farmers. In Colombia, militance is seen as a sign of independence and legitimacy, whereas, in Ecuador, the norm is more decorous and deferential.

Outsiders' ideals versus local realities. Idealized notions about farmer organizations can become a significant problem for both government officials and farmers if the ideal is not feasible, if the outsiders try to change group structure, or if they disagree about the ideal. One unresolved issue has been the appropriate size of groups. Some government officials have wanted to increase group membership to meet beneficiary goals, while interested farmers try to maintain or even reduce their size. In fact, group size is relatively uniform and not very flexible, given their nature, form of organization, and tasks. In this case, outsiders must adapt their ideals to the realities of the organization and the work.

Sociopolitical factors. All the communities in which cassava projects are located are stratified, in the sense that some people have more land and income than others. Members are drawn from most strata, with large numbers of poorer individuals. Still, there has been some debate in Ecuador about the strategy of forming new groups by working through local landlords or merchants, with many government officials in favor of this.

Alignment with political parties has been rarer, and many groups have rules against political speeches. A Colombian group reportedly expelled an individual for repeatedly making campaign speeches. Clientelism is another issue. Groups usually have goodwill toward government officials with whom they have daily contact, and they support most of the institutions that have helped them. On the other hand, a certain antipathy can develop for some officials, for example, if the government bank presses for prompt payment of loans.

Relations with nonmember farmers. About half the cassava processed by a group comes from the farms of nonmembers. For some, this makes the groups "intermediaries," a term of opprobrium; for others, it is a result of the fact that not all individuals want to join a group with its duties to attend meetings, provide labor, pay quotas, plant cassava, etc.

Sometimes relations with nonmembers are not harmonious. When associations are being formed, one should expect strongly stated opinions about advantages and disadvantages of the group. The skeptics may win the argument, or the debate may become so heated that forming a group is impossible. Once groups are formed, relations tend to be more amicable.

Internal issues

Internal stratification. The degree to which benefits are equally distributed varies, and some plants are more egalitarian than others. Studies of the Colombian groups, for example, showed that some farmers sold no cassava to their plant, while others sold several hectares' production. Farmers with little land specialized in working for the plant, while large farmers did not. The Gini index of inequality calculated for total benefits (sales, wages, and profits) to members of three Colombian associations showed an index of .32 for one (i.e., relative equality of participation), while another had an index of .67 (highly unequal participation).

In small associations, the ideal of completely equal participation is unlikely. Monitoring data have identified several factors enhancing differential participation. For example, some members plant more cassava for sale than others. The plant manager, motor operator, and one or two enthusiastic workers usually work many more days than the bulk of the membership and earn exceptional wages. When people from more than one town are involved, those who live where the plant is located work more.

Diversification. Noting the potential problems of an excessive number of services, Fledderjohn recommends that cooperatives look for complementary activities that pay their way and that concentrate on the group's primary area of concern; they should also add services gradually (Fledderjohn, 1988, 23-24). Cassava drying is a seasonal activity, so there is ample opportunity for diversification. A mix of processing cassava derivatives, marketing two other seasonal crops, credit management, and minor activities in support of production may be a good mix. In Colombia, the cooperatives have developed a mix of activities, which they ranked (Table 2).

It is necessary to determine whether a proposed activity will affect the functioning of the group's main activities. Some are risky (marketing perishable products), some difficult to manage (community stores), and many are simply irrelevant. Others use existing resources with little additional investment or risk (complementary processing of nonperishables) or keep members involved in the group (credit programs, which are risky). Analysis of potential new activities is frequently needed.

Sustainability. What can be done to ensure that organizations continue to benefit farmers when they no longer have substantial subsidies? This is a critical area for social science research as it is not really known why small, highly successful projects sometimes disappear, decline, or stagnate, nor why they rarely turn into large development projects of the kind normally funded by international development banks (see Tendler, 1981, for keen observations on several Bolivian cooperatives). There is no consensus on how to include local organizations in development projects (see Paul, Alexander, Cernea, and Tertiainen in Davis and Schirmer, 1987).

Where cassava-based associations and local cooperatives of small farmers have been set up in a viable manner, they have been hardy, with a low failure rate, though turnover has been a problem in Mexico (Pérez-Crespo, 1988). The sustainability issue for cassava associations is whether they will become self-replicating. The autonomous diffusion of the technology among Brazilian cattle farmers and artisan starch manufacturers is still too limited a phenomenon to declare that the technology and associated groups are viable.

Table 2. Ranking of cooperative activities by members.

Activity	Rating[a]
Tractor operation for members	6.5
Support in obtaining credit	6.2
Cassava buying	5.9
Labor for cassava drying	5.3
Cooperative store	4.0
Cash advances	3.9
Maize commercialization	3.6
Sale of herbicides	2.3

a. 6.5 indicates most positive, 2.3 indicates least positive.

SOURCE: van der Hoeven, 1988, as reported by P. Bode.

Balance between production and processing. Imbalance between cassava production and processing capacity is a major cause for such potentially fatal problems as insufficient raw material for a large processing facility or promotion of excessive planting that processing facilities or markets cannot absorb. Processing capacity should not be confused with purely physical facilities; it is also determined by investment levels, financial viability, organization, and administrative aspects.

There are several cases of production/processing imbalance. A private starch processor in Ecuador promoted cassava production, only to find that technical problems caused him to delay purchases and to lower prices. When farmers reacted by curtailing production, the plant could not obtain sufficient raw material and had to close. In Panama, several groups of farmers mortgaged their land for production credit; having already delayed their harvest, they approached the processing season with weak organizations and inadequate processing capacity. Some new funding and timely technical assistance has helped them. In Brazil, the Mato Grosso alcohol plant had problems with supply of raw materials. In Mexico, a project energetically promoted cassava planting, only to find that it had caused overproduction; cassava planted in 1981 was finally harvested in 1983, and the initial group of 20 farmers stopped producing cassava (Pérez-Crespo, 1988, 7-8). In

Colombia, a drying plant was established in an area where cassava was grown only for home consumption. It was assumed that the plant would stimulate production, allowing the processing to take off, but this did not occur (P. Bode, personal communication, 1989).

Economic viability. Although governments are often willing to fund farmer groups initially, they must eventually become self-sufficient, except in the case of government-owned facilities or those plants founded for research and demonstration. Magill (1985, 60) maintains that a cooperative whose primary goal is social, political, or welfare will not produce a self-sustaining organization. However, it is not essential to work with large-scale farmers or entrepreneurs, nor do social services have to be eliminated completely. The precise beauty of the cassava projects is that they combine economic benefits with social functions.

When a project fails economically, who takes the loss? In the case of the large flour plant in Costa Rica, the participating cooperatives had the political influence to insist that the government subsidize production until farmers had sold what they planted for the project. In Mexico, subsidies assisted another flour plant.

Focus. The primary purpose of most groups that participate in integrated cassava projects--except for some entrepreneurs, networks, and villages--is to process and sell cassava. This is in accordance with the recommendation that cooperatives tend to be more successful when organized around a key resource (e.g., a key stage of the production or marketing process) that will benefit from economies of scale or technologies provided by the cooperative (Magill, 1985, 60). Some projects, such as the Mexican one, form groups to grow cassava with credit. Unless there is a strong market for cassava, such projects should include a postharvest component to avoid the aforementioned imbalances.

Clarifying organizational goals and strategies is critical to avoid operational problems. Scarce resources have been used to switch from associations to cooperatives, the desirable attributes of a private-sector association have not been clearly established, and the debate about the appropriate relationship between government and farmers continues. Officials have lost time debating with members about letting large numbers of new members into associations and in unrealistic attempts to have local groups live up to the accounting standards of large companies. It took several years to realize that groups of marginal farmers in cassava projects were feasible and more so than groups of larger farmers.

Impact of failure

Integrated cassava projects have been less risky than projects involving large, abrupt changes in farmers' lives or their environment. The major problem so far has been irresponsible promotion of planting, so that farmers could not sell all their production. Of course the risk to entrepreneurs who invest in cassava-processing equipment is substantial. Planners should consider these risks seriously (Table 3).

Ways for Institutions to Work with Farmer Organizations

Literature on working with organizations

Simplicity and realism are two themes in much of the literature on how to support cooperatives or farmer organizations. Another kind of literature reiterates the legal rules for forming cooperatives or the Rochdale principles, the guidelines for cooperation formalized in nineteenth-century England. Realism requires that those guidelines be modified according to the particular activities being undertaken and in light of empirical experience. Promoters should remember that an agroindustrial cooperative is not a production cooperative, a savings-and-loan, or a consumer cooperative. Planners must also recognize that small, struggling groups of marginal farmers, perhaps illiterate, will not hire professional management of the kind that might satisfy the many legal and accounting requirements of official cooperatives (see Fledderjohn, 1988; Tendler, 1981).

Dobyns (1969) notes that behavior within organizations is functionally linked to other kinds of social behavior, that promoters can make mistakes by not recognizing cultural differences, and that cooperativism presumes some values of the industrial society where it originated (e.g., efficiency or profit). He notes that rebelliousness has been part of cooperativism and should be expected by promoters, an assertion that might be challenged by some who see cooperatives as basically conservative. He also writes that homogeneity and unanimity characterize small groups, which can be fostered by choosing kin and members with similar beliefs and by allowing dissenters to leave the group. Finally, he notes that the cooperative must satisfy a need better than existing institutions; it must have a niche.

Many articles offer practical advice on how to form farmer groups (see Ramadan, 1988b, head of INCCA in Ecuador). Having worked with failed land reform groups that had attempted communal agriculture, he counseled promoters to adapt their expectations and practice to farmers' real needs and

Table 3. Risks to farmers and institutions if a project fails.

Group affected	Type of risk
Farmers	Time lost in meetings
	Unsalable cassava production
	Unpayable credit, possibly with mortgage
	Disillusionment with development efforts
	Loss of prestige
	Loss of equity in processing plant
	Factionalism, discord
	Friction with institutions
	Less subsistence production
Institutions	Unproductive use of staff, funds, etc.
	Loss of credibility

capacities. His recommendations to promoters were to teach farmers to identify their common interests and goals, to explain costs/benefits, to seek viable opportunities with the group, to arrange training in practical skills as well as general orientation, and to observe group dynamics as they occur--in short, to deal with real farmer groups, not ideal abstractions.

Financial viability, social homogeneity, attention to local social organization, and concern about accounting appear in many publications from very disparate political ideologies. Practical suggestions for construction, operation, and formation of groups can be found in the manuals developed in Colombian and Ecuadorian contexts (Ospina and Best, 1984, and Romanoff, 1989, respectively). Based on experience with cassava projects, it is possible to formulate some specific ways to support cassava-processing organizations.

Selecting groups

Geographic area and environment. In Ecuador, initial criteria for locating cassava drying associations were appropriate climate for both traditional rainfed production and solar drying, traditional cassava production, marketing problems for that production, relatively dense populations of small-scale farmers (preferably nucleated settlements to make communications feasible), absence of more profitable production or employment alternatives in the relevant months, acceptable transportation costs, and feasibility of institutional (public, private, farmer groups) support. Since then, ways have been sought to include less-than-ideal groups by reducing investment costs, decreasing the need for institutional support, modifying technology to meet the needs of special groups/environments, and decreasing the cost of a failure.

Prior social relations. Project staff tend to make initial contacts based on prior social or institutional ties, for example, a link to someone with whom a researcher had planted an onfarm trial. This can help the project proceed. However, there are several cases of projects that have chosen inappropriate sites because they wished to help a certain population. Several such groups have failed.

Membership. Each project has to decide on the characteristics to be required in a member: must each have land (as opposed to landless laborers, renters, housewives), derive primary income from farming (as opposed to teaching, taxi driving, government employment), live in the town where the plant will be located, be a member of the matrix organization? Who should be excluded as members: large- or small-scale landholders, merchants, the landless, government employees in general, politicians?

Membership in groups has tended to be self-selecting, depending on circumstances of individual farmers, their relation to matrix organizations, or their social ties to founding members. Individuals who come to the first meetings may or may not be those who form the organization, and membership may not stabilize for several years. Sometimes meetings with farmers have not resulted in groups, either because the farmers were not interested or because they did not fit the requirements of the project. Accepting this as normal would save government officials much lost effort, nor should they be upset if several members decide to leave. On the other hand, extreme instability of membership or participation is a cause for concern; in the Mexican case, it was said to indicate the farmers' disenchantment (Pérez-Crespo, 1988, 20).

Technical and organizational support

Adaptation of technology. The project and the organization need to choose which cassava derivative to produce (chips, meal for animal consumption, flour for human consumption, starch, conserved roots, silage), which drying technology to use (solar on concrete or on trays, artificial), and which investments to make first. Important factors in that decision are characteristics of the group (size, funding, membership, goals), of its individual members (experience, capacity, goals), and of the environment (insolation, cloudiness, riskiness, proximity to market, attitude of surrounding farmers) (Romanoff, 1988).

Technical support. For basic solar drying and construction techniques, the most efficient technical assistance is from one farmer to another, but trained extension personnel are needed to show farmers mill design and use, conservation techniques, rapid propagation methods, production of planting material, motor maintenance, and installation of new kinds of machinery, among other things.

Organizational support. Similarly, to organize a new group near an old one, the farmer-to-farmer approach is sound, but a government official and a representative of the second-order group should participate to clarify legal procedures, funding, and support, as well as to train farmer-promoters in the first years.

Assistance with accounting and management of funds is the most recurrent organizational task for institutions working with cassava processors. In Colombia, assistance is provided by financing institutions, the cooperative service center, and the national training service (SENA). In Ecuador, the Ministry of Agriculture provides an agricultural technician who checks the books of each group, and INCCA has given some courses. The books of the second-order UAPPY are checked by donors. UAPPY gives some assistance to base groups, especially in maintaining production records, and is experimenting with an accountant who can work with them. Despite considerable effort, institutional design for an effective accounting assistance program is a challenge that has not been met fully in any project.

Staffing. Esman (1983) has noted that despite the critical nature of staffing at the lower end of development projects, this aspect is largely ignored. One way to facilitate contact between extension agents and small-scale farmers is to choose as agents or promoters people of the same class as those to be contacted. In Colombia, the DRI project has employees from poor town backgrounds, while in Ecuador, UAPPY employs educated children of farmers in the central office, and farmers in the role of promoter. The contacts chosen by extension personnel of middle-class origin tend to be farmers of the same level. At the other end of the social spectrum, projects also need staff who have influence in the capital cities or with elites.

Cost and evolution of institutional support. Initially, institutional support for farmer groups is very expensive, but its cost declines with years of experience. In the first year of the project, formation of a farmer group in Colombia took 220 days of attention from different kinds of support personnel; in later years, this declined by half (Romanoff, 1986a). The groups will still have some government supervision into the forseeable future.

The institutionalization of successful cassava processing groups has been remarkably rapid. Within two years, they can operate with very little technical assistance, expanding their capacity each year. Starting with a drying floor of 400 m^2 (the minimum feasible size), by the third or fourth year they can be operating effectively on about 2000 to 2500 m^2, the maximum size manageable by nonprofessional farmer-administrators. However, they are not independent in the areas of accounting, crisis management, and dealing with relatively powerful institutions.

Evolution of the second-order UAPPY in Ecuador has also been rapid. In its first year, it was a forum for discussion among the presidents of the base associations and a checking account to receive and disburse funds. It met in one of the rooms of the Ministry of Agriculture, and it was dominated by technical assistance staff. By the second year, it had assumed the function of milling chips and opened an office. Still, its promoters were not successful in starting or supporting new groups. In its third calendar year (fourth drying season), it has a permanent staff, the office is established, production is routine, and the promoters have formed six new groups. An outside foundation still finances technical assistance, and many costs are subsidized. Complete autonomy may take about five years.

Reducing financial risk to farmer organizations. Loans for investment in processing plants can be designed to reduce the risk that the farmer organization will not be able to pay. Subsidies are the most common method used so far, but other no-cost measures can be taken.

The lender should comply with the basic rules of credit programs--feasible projects, honesty, regular oversight, adequate accounting systems, prudent selection of borrowers, on-time disbursements, etc. This does not mean that banks should continue their usual lending procedures, which are such that they often exclude the kind of small farmers who most benefit from cassava programs. It is more important for lenders to know their borrowers than to meet all normal requirements.

Credit should be delivered on time. Delays in credit or land preparation for construction are a major reason why first-year groups dry little cassava. One way to compensate is to have new groups start with drying on trays. Delays in working capital loans have caused reduced production and financial distress in Ecuador.

The group should spread investments over several years; a group might begin with a chipper, portable trays, a small cement floor, and a rented warehouse. In later harvests, it might obtain credit for more cement and, finally, a brick warehouse.

Interest rates should be adjusted to levels of production. The Ecuadorian groups pay a very low interest rate on their loans, but they also pay out a part of their profits to the revolving loan fund. In a year of low production, they pay little interest; in a good year, they pay much more.

A revolving credit fund should be established. If financing for the project involves donations, the donors should consider establishing a revolving credit fund instead of one-time donations or working through large financial institutions. With supervision, this assures that groups will have access to credit and that the lender will be responsive to their needs.

There should be a mix of suppliers and buyers. Because a large number of nonmembers provide half the cassava needed by a normal plant, these nonmembers effectively absorb the risk of lack of production, while the proprietary interest of the members guarantees a supply when market prices are high. The need for multiple buyers is evident because any buyer may refuse deliveries, reduce his prices, delay payment, etc. Groups should be careful that a single buyer, even the government, does not monopolize the market.

Institutional teams to support farmer groups

Working with farmer organizations requires the resources of an interinstitutional team characterized by collaboration and flexibility (Tanco, 1983; Korten and Alfonso, 1983). Not all government officials or agencies have the skills required to sustain the varied and flexible activities needed to work with farmer organizations (Ickis, 1983). Some prefer to maintain strict institutional integrity or areas of authority. An essential element in Colombia, Ecuador, and Brazil has been support of skilled mid-level managers capable of overcoming bureaucratic barriers (see Satia, 1983, on the crucial role of the middle manager).

Costs of institutional support

Technical assistance costs in Colombia are very great compared to the cost of hardware and operating capital, which amount to only 12% of the entire project cost (Romanoff, 1986a, 11). Even when excluding the high cost of international participation, support costs are 75% of the total project cost. Therefore projects should budget sufficient funds to support farmer groups adequately.

Some economies might be made. The government officials interviewed in a study of the project said that their workload could be increased if certain impediments such as lack of gasoline were removed; in fact, they became more efficient with experience. Lower level staff might be substituted for more costly functionaries, but certain highly trained professionals pay for themselves (Esman, 1983). More radical economies can be found in working with investors who need little assistance, and it may be possible to teach farmers to assume many responsibilities and/or to pay for services. The aforementioned farmer-to-farmer technology transfer has just this effect, and has produced significant economies.

Challenges for support institutions

Artisan producers. Thus far the integrated projects have made little progress in working with independent artisan producers. Such producers have their financial and technical ties to middlemen, and it may not be feasible or even desirable to displace such intermediaries. Still, a loose organization based on technical assistance, communication, and, perhaps, cooperative purchases of equipment could be a way to improve the quality of their product and their economic efficiency. It is likely that an institutional team working with them would have different skills and values from the one working with marginal farmers.

Accounting. Fledderjohn's (1988) suggestion that local groups leave accounting to a central cooperative office would not work with cassava groups having substantial sales and complex activities. Institutional accountants have been effective because local groups accept the responsibility for keeping production records and simple accounts; but they are scarce, and many members do not understand even simple accounts. A possible solution could be a semicommercial center that would, for a fee, provide services and training to farmers' groups, not only in the area of accounting but also in mechanics, metal working, complementary agroindustry, legal concerns, and other areas. Cooperative federations sometimes assume some of these tasks.

Diffusion of farmer organizations. The cost of promoting farmer organizations, the expectation that investments will be heavily subsidized, and the fact that most small-scale farmers are not eligible for normal credit has braked the spread of cassava drying technology in Latin America. This constraint can be overcome in two ways. The first has been noted: to make technology transfer more self-financing or at least make limited funds go further. The second is the adoption of cassava processing and related social organization as a main activity of a standard rural development project. This has not happened to date. The closest experience is that of Mexico, which illustrates the inherent difficulties (Pérez-Crespo, 1988). Projects are under consideration by DRI of Colombia and SUDENE (Coordinator of Development in the Northeast) of northeast Brazil. Support of viable farmer organizations by large projects is not the same as support by nongovernmental organizations or medium-sized projects; it is a challenge for development bureaucracies.

Nontraditional disciplines. An important challenge is to make more efficient use of social scientists to identify what is known about the appropriate organization of farmer groups, adapt this knowledge to new environments, and monitor results. Staffing at national institutions would have to include more social scientists, although Esman (1983) has noted that projects tend to consider forming these groups a secondary activity, delegating that task to untrained individuals. There is also an urgent need for more postharvest technologists to complement the more common agronomists. The financial success of processing organizations, and their ability to reach small-scale farmers, the landless, and women, can make the investment worthwhile.

Planning and studies for farmer organizations

Planning. The norms for including cooperative-style farmer organizations in project planning are summarized herein, and they should be adapted to each context. A single farmer group requires 12 to 30 small-scale farmers in a radius of 3 to 5 or fewer km; access to 10 to 15 ha of cassava in its first year (of which one-half or more should belong to members) and 30 ha within a year or two; from US$2,000 to US$12,000 for a drying plant (depending on design and what farmers can rent or borrow); and an appropriate team with, minimally, the funder, extension personnel (with organizational and marketing experience and experience in postharvest technology), a supervisor, and services of a farmer education institution. Between 120 and 220 person-days of direct assistance to the group (plus administration and studies) were required to start a group in Colombia although the level of effort in Ecuador has been less. Technical assistance, with at least two months of farmer-to-farmer contact, should be included.

For the purpose of planning, the plant may be expected to produce about 20 metric tons of chips in its first year if credit and other services are delivered on time, and 100 metric tons within a few seasons. At that point, the plant will benefit about 100 families by purchasing their cassava, paying wages, or sharing profits. The use of a second-order farmer group is highly advisable; it should be implemented with professional assistance and should focus very closely on practical, economically viable activities.

If the project is to expand, it will need additional personnel for monitoring and evaluation. The best strategy for expanding the group is to increase the number of small, localized groups rather than the size of any one group. Economies of scale and ease of administration can be secured by working with the second-order group. Later, the amount of technical assistance can be reduced as farmers become capable of assuming more responsibility.

The major danger encountered in planning projects has been an imbalance between cassava planting, processing capacity, and markets: for example, putting a processing plant where there is no cassava or where it cannot be dried profitably; promoting planting before processing/marketing investments are ready; or presuming that production of either roots or chips will instantly reach full levels. Therefore, the project should allow for a year of small-scale production, a year of semicommercial production, and then expansion. Starting with one or two plants, Colombia and Ecuador have reached 20 plants by the fourth year; this schedule could be shortened slightly in new regions. The main constraint to expansion is funding and technical assistance.

A second problem encountered has been inattention to the need for organizational and management assistance. This has left some projects frozen in embryonic state; in others, it has led to years of inefficient administration.

Organizational feasibility. Most projects conduct a minimal feasibility study for each new organization, which might be improved by incorporating factors specific to cassava. Some of the topics to be covered are shown below.

Factors for feasibility studies

Social factors

A town or dense population, but not a large town
A substantial number of small-scale farmers
Low income

Productive factors

Traditional rainfed cassava production
Prior sales of cassava
Commercial and marketing problems, declining sales
Few alternatives to cassava production and processing, at least seasonally

Fit between activities and form of organization

Climate

Dry months during the cassava harvest
Enough rain for cassava production

Institutional factors

Institutional capacity present (may be nongovernment)

Commitment of institution to the group

Process or feedback in early stages

Attendance at organizing meetings
Presence of small-scale farmers
Lack of evident schisms and excessive clientelism
Land available at a reasonable price
Donations of labor and tools

Needs assessment. Periodic group evaluations are advisable. ANPPY in Colombia and UAPPY in Ecuador meet annually to evaluate the project. In addition, SENA (Colombia) has sponsored workshops for farmers in which promoters help them diagnose problems, and in Ecuador, the annual cassava seminar includes results from socioeconomic studies.

Monitoring and evaluation. Project monitoring has been an important activity in both Colombia and Ecuador. It has been based on compiling sales slips and financial records of all associations or cooperatives, modified to include some social data on the people selling cassava. When these data are sorted and cleaned, they provide a list of all the people who have received financial benefits from the projects. This system is very inexpensive compared to surveys.

In determining measures of success, the criteria will vary given the fact that cassava technology can serve many ends (Table 4).

Conclusions

The feasibility of integrated cassava projects depends on organizational success. Choosing the wrong size, form, or characteristics of farmer organizations has been a cause of delays and failures in establishing cassava drying as a viable industry in some countries.

Several cassava drying projects working with local groups of small-scale farmers have been successful; if carefully done, this model may work in other countries. It appears that a viable second-order union of local groups has many advantages and more attention should be given to such regional groups.

Challenges for the future include working with artisans and, more generally, adapting technology to new kinds of producers and processors. A series of social science studies can contribute to the design of farmer organization, related institutional activities, and project monitoring.

The cost of extension and organizational support accounts for the largest part of institutional expenses in integrated cassava projects, surpassing the cost of investment in processing infrastructure. Institutions have become more efficient in working with farmer organizations. The groups themselves are showing that they can take on many functions handled by relatively expensive government or international agencies. Being economically and socially viable, local-level organizations and their second-order groupings may have the ability to continue after government support is removed.

Table 4. Examples of monitoring criteria.

Criterion of success	Indices
Feasibility of technology	Conversion ratio (fresh:dry cassava), drying time, production costs
Demonstration of technology	Persons attending/adopting
Gross production	Tons produced; value of production
Community service	External benefits; % population benefited
Community development	External benefits; community use
Self-perpetuating, expanding companies	Number of companies; profits; investments
Benefits to organization members	Sales + wages + profits; number of beneficiaries
Benefits to a special class of people	Benefits to women, farmers within land limit, etc.; Gini index
Benefits to consumers	Nutrition, production
Political organization	Other benefits obtained
Profitable production	Profits; investments
Macroeconomic impact	Imports foregone, jobs created, etc.
Project efficiency	Cost of investment; administration; technical assistance
Financial health of groups	Standard and special cooperative ratios

Cassava processing organizations have been successful on a scale that is small relative to the needs of Latin American countries. At most, a few thousand farmers have benefited in any country. The challenge is to replicate successes with many times as many farmers. That will require that the advantages of the local group/union form of organization be retained, that promotion be efficient and self-sustaining, and that new forms of organizations be created for new environments and technologies.

References

Bode, P. 1986. La organización campesina para el secado de yuca. Working document no. 11. Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia.

Byrnes, K. J. 1988. The potential role of farmer organizations in increasing the productivity and income-earning capability of small-farmer agricultural systems in the developing countries: A call for research. Paper prepared for the Office of Rural Development, Bureau for Science and Technology, Agency for International Development, Washington, DC, USA. (In mimeograph.)

Cardona, A. 1974. Formas de cooperación en comunidades indígenas de Colombia. Instituto de Educación e Investigación Cooperativa, Universidad Santo Tomás. Tercer Mundo, Bogotá, Colombia.

Davis, T. J. and Schirmer, I. A. (eds.). 1987. Sustainability issues in agricultural development: Proceedings of the seventh agricultural sector symposium. The World Bank, Washington, DC, USA.

Dobyns, H. F. 1969. Sociological and anthropological approaches to engineering successful economic organizations. In: Anschel, K. R.; Brannon, R. H.; and Smith, E. D. (eds.). Agricultural cooperatives and markets in developing countries. Praeger Special Studies in International Economics and Development, Praeger, New York, NY, USA. p. 163-188.

Esman, M. J. 1983. Paraprofessionals in rural development: Issues in field-level staffing for agricultural projects. World Bank staff working papers number 573, The World Bank, Washington, DC, USA. 55 p.

__________ and Uphoff, N. T. 1984. Local organizations: Intermediaries in rural development. Cornell University Press, Ithaca, NY, USA. 391 p.

Fledderjohn, D. 1988. Manuscript to be published by the American Cooperative Development International.

Green, E. C. and Isely, R. B. 1988. The significance of settlement pattern for community participation in health: Lessons from Africa. Hum. Organ. 47(2):158-166.

Ickis, J. C. 1983. Structural responses to new rural development strategies. In: Korten, D. and Alfonso, F. (eds.). Bureaucracy and the poor: Closing the gap. Kumarian Press, West Hartford, CT, USA. p. 5-32.

Janssen, W. G. 1986. Market impact on cassava's development potential in the Atlantic Coast region of Colombia. Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia. 357 p.

Korten, D. and Alfonso, F. (eds.). 1983. Bureaucracy and the poor: Closing the gap. Kumarian Press, West Hartford, CT, USA.

Magill, J. H. 1985. Cooperatives in development: A review based on the experiences of U.S. cooperative development organizations. Development Alternatives, Inc., Washington, DC, USA.

Ospina, B. and Best, R. 1984. Manual para la construcción y operación de una planta de secado natural de yuca. Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia.

Pérez-Crespo, C. 1988. Report on Mexico's cassava program, 1977-1987. Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia. (Unpublished manuscript.)

Ramadan, A. 1988a. Evaluación y capacitación organizativo-administrativa de las APPY y de la UAPPY. (Unpublished manuscript.)

________. 1988b. Organización y participación campesina. Instituto Nacional de Capacitación Campesina, Quito, Ecuador. (Unpublished manuscript.)

Romanoff, S. 1986a. Estimativos del apoyo institucional para las empresas campesinas productoras de yuca seca en la Costa Atlántica. In: Best, R. and Ospina, B. (comps.). El desarrollo agro-industrial del cultivo de la yuca en la costa atlántica de Colombia. Proyecto Cooperativo DRI-CIAT, cuarto informe, tomo II, Julio 84-Junio 85, Centro Internacional de Agricultura Tropical/Fondo de Desarrollo Rural Integrado (CIAT/DRI), Cali, Colombia. p. 2-14.

_________. 1986b. Beneficiarios de las plantas secadoras de yuca. In: Best, R. and Ospina, B. (comps.). El desarrollo agro-industrial del cultivo de la yuca en la costa atlántica de Colombia. Proyecto Cooperativo DRI-CIAT, cuarto informe, tomo II, Julio 84-Junio 85, Centro Internacional de Agricultura Tropical/Fondo de Desarrollo Rural Integrado (CIAT/DRI), Cali, Colombia. p. 15-29.

_________. 1988. Farmers' organizations for developing and transferring agricultural technology. Paper presented at the Rockefeller Foundation Conference on Farmers and Food Systems held in Lima, Peru, October 1988.

_________. 1989a. Manual de referencia para la promoción de asociaciones de productores y procesadores de yuca. Fundación para el Desarrollo Agropecuario and Centro Internacional de Agricultura Tropical (FUNDAGRO/CIAT), Quito, Ecuador. 186 p.

_________. 1989b. Social science monitoring as a management tool for directing the benefits of new agricultural technology to the poor. In: Groenfeldt, D. and Moock, J. (eds.). Social science perspectives on managing agricultural technology. International Irrigation Management Institute, Colombo, Sri Lanka. p. 193-206.

Satia, J. K. 1983. Development tasks and middle management roles in rural development. In: Korten, D. and Alfonso, F. (eds.). Bureaucracy and the poor: Closing the gap. Kumarian Press, West Hartford, CT, USA. p. 76-85.

Tanco, A. 1983. Mobilizing national commitment to a multi-agency program. In: Korten, D. and Alfonso, F. (eds.). Bureaucracy and the poor: Closing the gap. Kumarian Press, West Hartford, CT, USA. p. 56-61.

Tendler, J. 1981. What to think about cooperatives; a guide from Bolivia. The Inter American Foundation, Rosslyn, VA, USA.

van der Hoeven, R. 1988. Cassava en cooperatie: Een analyse van een boerenorganisatie in Colombia. CIAT and Rijksuniversiteit Utrecht, Cali, Colombia. (Unpublished manuscript.)

Chapter 11

MONITORING AND EVALUATION SYSTEMS FOR CASSAVA DRYING PROJECTS

Paul Bode*

Introduction

During the distinct development phases of integrated cassava projects, critical decisions have to be made that can significantly change the final results of the project, such as, decisions on the final market, processing technology to be used, social organization of the project, and timing and area of commercial expansion, among others. Most of these decisions cannot be made when beginning the project but only during its development. Therefore, the implementation of monitoring systems and continuous evaluation of project actions and results becomes necessary.

This chapter will describe a model for such systems that was developed and implemented in the context of the DRI/CIAT Cooperative Project, on the Atlantic coast of Colombia, for drying cassava through small-farmer cooperatives. This monitoring and evaluation system serves as a model for developing systems for other integrated cassava projects.

General Concepts for Monitoring of Cassava Projects

An increasing interest exists in the development of so-called monitoring and evaluation systems (e.g., Clayton and Pétry, 1981; Smith, 1985; Maddock, 1987; Staub and Koppel, 1986; Casley and Kumar, 1987; Dorward, 1988). Discussion on these systems has concentrated on the definition of objectives and activities to be carried out, along with the most adequate institutional organization for these activities.

Monitoring of a development project is defined in the literature as the analysis of the execution of that project related to previously established short- and medium-term goals. The objective of monitoring consists of detecting when project implementation differs from the initial plan, and providing

---

* Anthropologist and visiting researcher, Cassava Program, Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia; currently, sub-director, Foster Parents Plan International, stationed in Sucre, Bolivia.

information so as to be able to take any corrective steps needed. In this sense, monitoring is above all a tool for the short-term evaluation of the implementation of a project (Smith, 1985; Maddock, 1987). According to this definition, the analysis of project impact does not form part of the monitoring activity (Dorward, 1988). However, it seems to us that the analysis of project impact, especially of the benefits that it generates and their distribution among the target population, should form part of monitoring, especially if specific actions in implementation that contribute to increasing project effectiveness can be distinguished.

In the literature, project evaluation refers to project design. While monitoring is a part of project implementation, evaluation is a part of its planning. While monitoring analyzes whether planned actions have been implemented correctly and timely, evaluation considers whether these actions were the most suitable when looking at the objectives that the project pursues. Therefore, while monitoring is done during project implementation and its goal is to improve the performance of that project, evaluation is executed when the project ends, and its results serve to extract lessons for the design and planning of future projects. As monitoring and evaluation are based to a great extent on the same information, they have been considered as two opposing parts of the same system of information generation.

When defining the monitoring and evaluation methodologies to be used in a project, the indicators or parameters to be measured should be considered carefully. These indicators are related to the specific design components of the project (Maddock, 1987). Thus, monitoring activities can be related to decisions to be made at each step of implementation. Surveys are not always the most adequate method nor the only one to generate the necessary information. A large part of monitoring can be based on records of an administrative nature that the principal people who carry out the project already keep (Coleman, 1987). Together with these records, surveys can play a support role to analyze specific subjects (Staub and Koppel, 1987).

In the methodology of monitoring and evaluation systems, information analysis is carried out at the project level, and methods of feedback of results toward the people and entitites involved in project implementation and planning are developed. The manner in which feedback is given cannot be limited to a written report but should be adapted to the needs and requirements of the information receiver.

Discussion regarding the organizational form which the monitoring and evaluation systems should follow has centered on the rate in which monitoring forms part of project implementation. Monitoring can be done by the same employees involved in implementation, or it can be an activity of a special section or institution. Monitoring units have in many cases been implemented only at the request of the organizations that finance the project. In general, special monitoring units have not been very successful. Their work has been isolated from implementation as a consequence of their approach toward the general external objectives set up by the financing entity, and not toward the specific internal objectives of the projects (Maddock, 1987). In addition, it has been observed that giving the responsibility for gathering information for monitoring to employees in charge of project implementation can result in a secondary importance being given to this activity, thus making effective monitoring difficult (Staub and Koppel, 1986).

Because of all this, a monitoring and evaluation system for integrated cassava projects should have four characteristics. First, the system should be an integral part of the project. Second, it should use simple methods of information gathering and analysis that can be integrated easily, and at a low cost, into the project's daily activities. Third, it should examine the technical, economic, and social development of the project in accordance with previously established goals. Fourth, the monitoring and evaluation system should use feedback mechanisms that will allow a rapid and appropriate divulging of results among the different project levels. These characteristics should permit the results of the monitoring and evaluation systems to be used in project implementation, and in the planning of future and/or similar projects.

A Model for Monitoring and Evaluation Systems in Cassava Projects

The monitoring and evaluation system for the cassava project on the Atlantic coast of Colombia produced information in three main areas. First, it provided information on the project's daily working. The system supplied the information necessary for the suitable adaptation of processing technology to local circumstances of each project. Second, the system generated data on the project's impact on cassava production, with regard to area planted, technologies used, and yields achieved. Such information is of importance, since one of the basic hypotheses of these projects is that the development of cassava marketing channels serves as a stimulus to farmers to increase their incomes through improvements in production. Third, the monitoring system documented the benefits generated by the project, and their distribution among the population affected. It was thus possible to estimate the contribution of projects to the process of rural development.

To carry out these tasks, monitoring was conducted at three different levels, using different methodologies (Table 1). These levels were the data bank, the annual survey, and intensive monitoring. The first level consisted of the formation of a data bank with information on the small-farmer organizations that participated in the project. The information obtained thus served as a basis for comparison both to measure project impact as well as to evaluate the results of surveys that were conducted at the other two levels. The second level consisted of an annual survey with a relatively large group of farmers. The third level was an intensive monitoring of a selected group of farmers. The information stored in the data bank on farmers selling cassava to the processing organization formed the sample framework for the surveys used at the second and third level of the monitoring system. Moreover, the content of these surveys was based on the analysis of this information in the data bank. These three levels were directed toward different populations, and they differed among each other with regard to the objectives that they sought with the gathering of data, the areas on which they gathered information, and the methods they used in the gathering, analysis, and feedback of data.

The base of the monitoring and evaluation system used in the cassava project on the Atlantic coast of Colombia was the creation of a data bank on the development of the small-scale cassava drying industry. Information at this level referred directly to the activities of the small-farmer organizations that carried out the project, above all with regard to processing and commercialization. This level has been integrated into the activities of both the cooperatives/associations and the support institutions.

To gather information for the data bank, formats that are valuable for the good internal management of the cooperatives/associations were used, hence keeping the records was no extra burden to the associations. The system took advantage of contact between the cassava processing organizations and the farmer, at the time of the sale of fresh cassava to drying plants, to collect basic information on area planted with cassava, its location, the landholding system, etc. The majority of the formats used daily by the organizations were suitable for monitoring (e.g., recording of lots of dry cassava produced). In other cases, some simple adjustments were needed.

The nature of the information to be stored in the data bank is based on monitoring criteria described in the "Technical Assistance Handbook" used by support institutions (Benítez, 1987). At this level, monitoring and evaluation are an integral part of the technical assistance lent to small-farmer organizations.

Table 1. Model for a monitoring system for integrated cassava projects.

Factor	Data bank	Surveys	Intensive monitoring
Population	a. Organizations-cassava processors b. Farmers-cassava sellers	Population sample of cassava sellers in the data bank, structured according to region, landholding, and link to cassava processing organizations	Subsample for sample for surveys
Objective	a. Obtain basic information on the functioning of processing and beneficiaries of the project b. Create a sampling frame to extrapolate results from surveys and intensive monitoring	a. Obtain information on the impact of the project on cassava production b. Analyze the impact of the project at the level of the small-farmer economy	a. Obtain information with regard to production technology at the farm level
Areas	a. Purchased cassava: variety, harvest period b. Sellers: landholding, area planted, location c. Processing: production costs, labor, commercialization profits, credits	a. Landholding b. Intercropping systems c. Availability of labor d. Commercialization of cassava e. Yield f. Landholding	a. Farmers' production technology b. Availability and use of resources in production
Method	a. Collection of data for monitoring is based on needs of processing groups b. Information is centralized in data bank for its later systematic analysis	a. An annual survey with 300 farmers based on a stratified sample	a. Repeated visits to a group of selected farmers

The development of a monitoring system through a data bank consists basically of three actions: defining the project evaluation criteria according to control parameters already used; designing control forms; and designing the reports in which the results of the analysis of the stored data will frequently be presented. In some cases, the control parameters already exist, but in others they should be developed, especially when the project begins to work in new areas.

Technical, economic, and social parameters can be distinguished. Technical parameters refer to the manner in which processing is carried out and the efficiency of use of the installed drying capacity. These parameters indicate the need for technical assistance to be given to the small-farmer organizations involved in the project, and give indications for improving technology adaptation to local circumstances. Economic parameters analyze the project's economic profitability. They constitute the basis for technical assistance that is given to administrative/financial management of small-farmer organizations. They also serve as an evaluation measure of the project in terms of its capacity to generate income for the rural population.

Social parameters express project impact on distinct groups of farmers, and serve to evaluate the effectiveness of different organizational forms. They also allow an evaluation of the working of technical assistance institutions. Thus, by analyzing this information, the work areas of these entities can be defined, facilitating an optimal use of their human resources.

The second step in the development of a monitoring and evaluation system is to define formats to be used, at the level of cooperatives, to obtain information. Ideally, formats are defined before the project starts; however, in most cases, formats already in use should be standardized and made suitable for the purpose of monitoring. To design forms, the needs of the small-farmer organizations with regard to the administration of their activities must be considered. It is likewise important to attend to the specific needs of each one of the different entities participating in the project. Finally, the type of information required for monitoring and evaluation of the whole project should be defined. Therefore, it is very important to have a coordinating mechanism among the entities carrying out projects and the small-farmer organizations, where one can reach an agreement on formats to use.

The monitoring system exploits visits from technical assistants to cooperatives to compile information facilitated by the managers and/or heads of production of the drying plants. This information is centralized, analyzed, and fed back to the beneficiaries and technical support institutions.

Monitoring assumes an analysis repeated monthly or annually with different levels of detail. In addition, it requires timely processing of information. The use of a computer program is therefore justified. Analysis is thus not only faster but it also facilitates the production of reports. Monitoring, however, requires not only the availability of microcomputers and human and financial resources for execution but also a good coordination among the technical assistance employees to achieve a continuous flow of information. Bottlenecks because of a lack of capacity to process the information supplied, and/or because of irregularity in the supply of information on the part of technical assistants, should be avoided. Again, to define reports, the participating entities and the small-farmer organizations have to reach agreement on the content of the reports to be produced, their frequency, and their distribution.

The formation of an electronic data bank is an important feedback mechanism for results from monitoring in view of the flexibility and speed that the process offers. In the Atlantic coast project, however, two other feedback methods were used. In the first place, meetings of the so-called technical teams were exploited, in which the different entities involved in the project met to present results from monitoring. Thus, based on the monitoring and evaluation system, critical decisions for project development could be made. In the second place, reports based on the information provided by monitoring were elaborated annually. An efficient monitoring of the project and centralization of information in a data bank allowed the timely elaboration of such a report, so that recommendations formulated could be applied as soon as possible.

As could be observed in Table 1, small-farmer organizations are the object of analysis at the level of the data bank, although information is also gathered on the individual farmers who sell cassava to the drying plants. Surveys and intensive monitoring allow an analysis of the impact that the project has on individual farmers, both from the perspective of their production of cassava as well as their socioeconomic conditions.

The project should serve as a stimulus to increase area planted in cassava and yields through technological changes. Thus, it should permit farmers and their families to improve their standard of living through an increase in their farm income. A cassava project can be quite successful in terms of the development of processing. However, if that development does not lead to greater income for farmers, it is not meeting the project's fundamental objective.

Basic information has been collected in the data banks on farmers who have sold cassava to the project's organizations. This information serves as a sampling framework for monitoring at the second and third level. For this purpose, the definition of groups of farmers with characteristics in common that need measures and/or special technologies to be able to benefit from the project to a greater extent is especially important. Using stratified sampling methods, limitations in cassava production for different groups of farmers can be analyzed. The information in the data banks allows extrapolating this analysis toward the whole population affected by the project. Information from the surveys and intensive monitoring, in turn, permits validating the information from the data bank.

In the second level of monitoring, an annual survey is made with a relatively large group of farmers. The size of the sample depends on the rate of stratification that will be required. This survey should be repeated annually to be able to detect changes in cassava production and income of farmers over time.

Organization of the survey and intensive monitoring differs from establishment of the data banks. In the survey and intensive monitoring, one seeks to improve the project's impact over a medium and long term, while analyzing information in data banks serves to make decisions that affect the project's performance daily. Therefore, feedback on results from the survey and intensive monitoring can take place by means of annual reports.

Planning of Processing Projects

One of the first tasks of a monitoring system for integrated cassava projects is to assist in the selection of areas and sites to include in the project, and in the planning of actions to be undertaken within these areas. Already in the first years of the Colombian Atlantic coast project, criteria were defined to select the areas where one could establish dry cassava industries (Janssen, 1984). The criteria were defined taking into account the potential of the area to increase the growing of cassava, along with the potential and possible socioeconomic impact of the project. When those criteria were defined, they were based on an **ex ante** analysis of the project. However, later, the criteria were adjusted and redefined based on results from the project's monitoring, especially during its pilot phase and first commercial expansion.

In the **ex ante** evaluation, potential cassava production is an important factor for selecting areas. Through monitoring, it has been possible to analyze the supply of cassava for drying plants by different kinds of farmers, especially with regard to their form of landholding, their area planted in cassava, distance from the plant site, and their relationship to the cassava processing organizations (i.e., members versus nonmembers). Based on this information, the potential supply of cassava for a drying plant that would be established in similar regions can be estimated. As an evaluation parameter for this supply, it has been determined that potential members should provide sufficient cassava so that the plant can at least reach an equilibrium point that will assure its profitability. In this way, investment size can be adjusted, which, in the case of drying cassava, is manifested in the size of the floor to be constructed, according to the expected supply of cassava.

In the initial analysis of the factors for selecting areas, much importance was given to the potential increase of productivity in cassava cultivation. In project planning, these criteria with regard to current profitability and the possibility of increasing this profitability in the future should be considered. To determine the current profitability of cassava, differential prices paid by drying plants should be considered, taking into account the higher prices paid to members of the processing organizations in comparison to prices paid to nonaffiliated sellers. In addition, differences in production costs among farmers should be considered; for example, those costs brought about by differences in forms of landholding (ownership versus renting). Thus, the percentage of farmers for whom the drying plants will form a viable alternative of commercialization can be estimated.

The potential for increasing productivity by means of technological changes should be contemplated. In planning, technological production problems identified by farmers as the most urgent should be examined, in addition to analyzing in what phase the research and extension process is found in order to find possible solutions. These should be a joint effort from the group of farmers who wish to set up a plant and the technical assistance entities.

An important factor for judging the potential for establishing a drying plant is the extent of small-farmer organization. The number of members should be estimated to measure the potential supply of cassava for the plants. It is important to monitor the potential of the number of members during the planning and setting-in-motion phase of the project, to avoid the number of members falling below a minimum limit (15 members) that would place the execution of the project in danger. The optimum number of members for a small-farmer organization of good quality dedicated exclusively to drying cassava has been set between 20 and 30 members (Bode, 1986).

Together with the analysis of the social base of the organization, some organizational characteristics should be considered. These include the nature of leadership, prior experience that exists in agroindustrial projects and in their administration, and the possibility of using local organizations in the training process. In addition, it is very important to know if the initiative for setting up the plant comes from the group of farmers itself or if it is the result of an external intervention. Finally, the possibilities of developing other activities with the organization in order to extend its economic base and assure its viability should be analyzed.

A final factor for judging the potential of an area to establish a cassava drying project is the manner in which necessary institutional support exists. Institutional support is needed in four areas: credits to finance the processing project, and also for production; technical assistance in different aspects of the project (production, processing, commercialization, organization); training; and interinstitutional coordination, especially when different tasks are carried out by several entities.

In summary, one needs to analyze factors related to project planning within monitoring and evaluation. Monitoring provides a large part of the information for judging the possibilities of replicating a project in other regions. Information should be gathered by using the knowledge present within the group of potential members and entities in the region. Information on potential supply will help to calculate the size of investment necessary.

Monitoring of the Start-up Process of a Cassava Project

One of the most important causes of low levels of profitability of integrated cassava projects in the first years of operation is the delay in starting up processing due to a series of activities that should be carried out before the project takes off. A monitoring system needs to offer control methods that will allow the timely performance of those tasks. A suitable method for such monitoring is the so-called "Critical Path Method (CPM)," through which the chronological order of tasks to be carried out is analyzed in order to identify the critical tasks in the process (Smith, 1984). The application of this method in the case of constructing a cassava drying plant was analyzed by Ospina (1986).

The start-up process of a cassava drying project consists of several subprocesses, and their corresponding tasks. Some of these subprocesses can be executed at the same time, while others require completion of prior tasks. Several subprocesses can be distinguished when constructing a drying plant: the decision on whether or not to build the drying plant, the organization and training of a group of small farmers, project financing, and construction of the physical infrastructure. These processes can be charted in order to analyze the tasks to be faced and the duration of each one (Figure 1). In this example, a group of small farmers presents a request to set up a drying plant to the competent entities. The first subprocess that has to be faced is the analysis of the request and the corresponding decision. That subprocess takes place above all at the level of entities and requires a study of the region. During this phase, emphasis should be on the economic and social feasibility of the project under the terms outlined above. In Figure 1, a ficticious duration for this process is presented. The duration of this subprocess, however, varies from case to case, depending on the information already available for the analysis of the request.

When the entities approve the request from a group of small farmers, one turns to the subprocesses of organization and training and to financing. The duration of organization and training depends on the prior experience of the group and its organizational status. The duration of the financing subprocess depends on experience at the institutional level in the elaboration of cassava drying project proposals, and agility in their approval. During this phase, emphasis should be on the analysis of the financial feasibility of the project. In centralized administrative systems, project approval can take a considerable amount of time.

Only when one has finalized the financing subprocess with the delivery of funds to the small-farmer group can the final subprocess of construction be begun. Within the first construction tasks, several can be executed at the same time, and their duration depends above all on the availability of construction materials and machinery for preparation of the project site. When all the materials have been obtained, and the terrain has been prepared, construction itself can be started, provided that the subprocess of training and organization has resulted in the formation of construction working groups. The duration of the construction subprocess depends mainly on the size of the floor and the warehouse to be built.

When construction is finalized, once again one enters in the training subprocess, this time directed toward technical and administrative aspects of

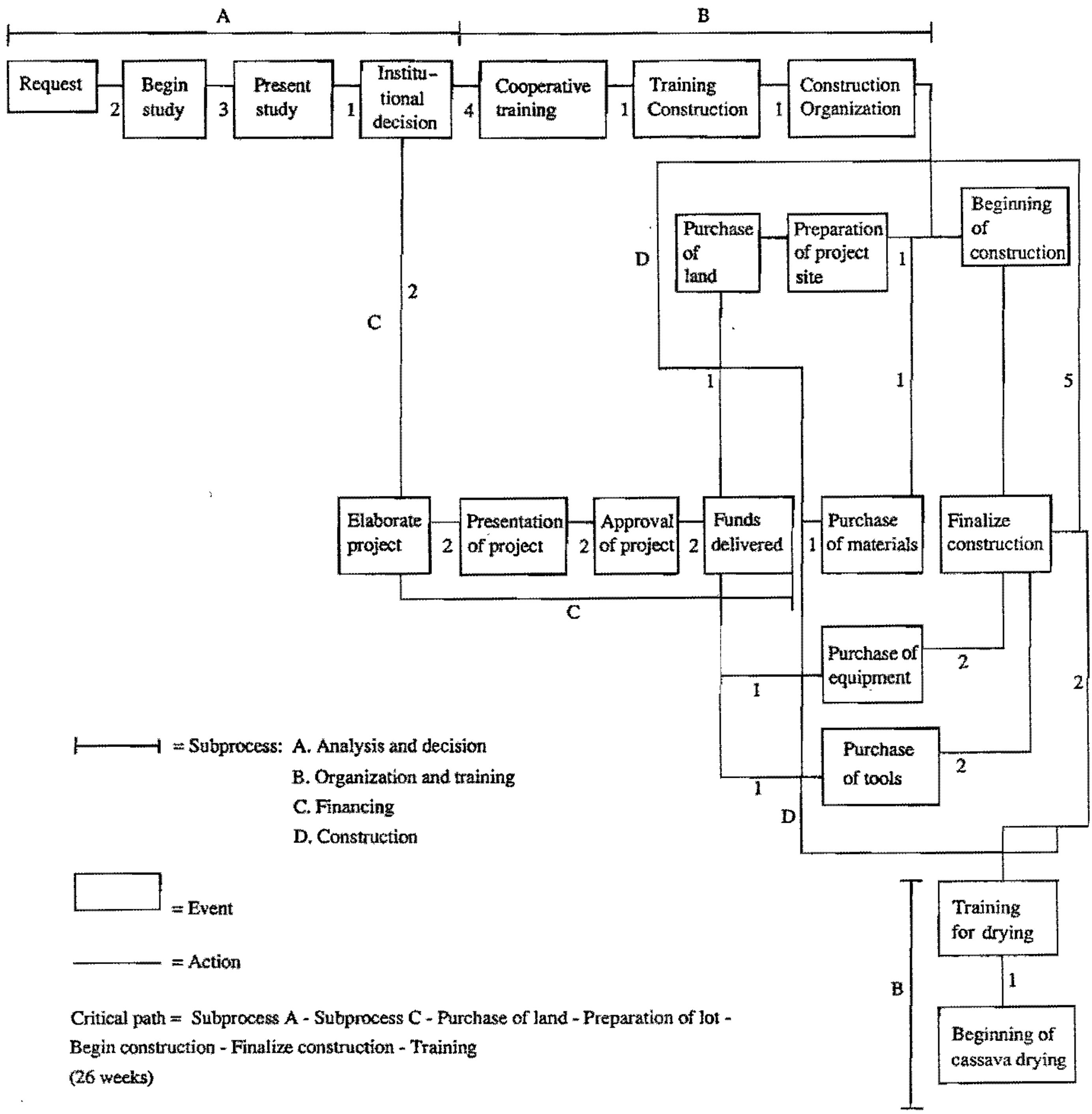

Figure 1. Analysis of critical path to set in motion a cassava drying project. (Adapted from Ospina, 1986.)

drying cassava. Upon finishing training, the drying plant can be started up.

In monitoring the start-up of a cassava project, an analysis of the critical path can be carried out, such as the one presented. Starting from this analysis, one can write up a list of tasks to be performed (Table 2), with the dates at which they should be completed. Monitoring can be done at weekly meetings of employees in charge of the project. Setbacks, consequences of those setbacks, and solutions for them can be analyzed at the meetings.

Monitoring of Daily Work in Processing

An important task of a monitoring system within integrated cassava projects is to provide control for the performance of small-farmer organizations in the processing activity, and point out when the project is not achieving previously established goals, in order to take corrective actions. This monitoring is based on the information gathered at the level of small-farmer organizations that are carrying out the project. The information is centralized in the data bank and a comparative analysis is carried out using simple parameters (Table 3).

For a cassava project to work efficiently, a timely supply of fresh cassava is needed. The Atlantic coast cassava drying project showed that the cassava came from a limited area around the drying plant (Romanoff, 1986a). Later, monitoring demonstrated that middlemen took on an important role in the cassava supply if it came from longer distances, because they lowered the benefit that reached the farmer directly.

The distance between the farmers' farms and the plant and the percentage of the cassava brought by middlemen indicate whether the plant has been established at the correct site. If the cassava comes from far away, the feasibility of promoting cassava production in the area of the plant's direct influence should be analyzed, in order to decide on the future of that plant. In addition, the supply structure should be analyzed by village. For example, in the case of a village with a relatively high supply of fresh cassava, but located outside of the area of direct influence of already established plants, the feasibility of setting up a processing project in such a village should be analyzed. If supply turns out to be disperse geographically, that is, inadequate for the establishment of a drying plant, one could attempt to dry cassava directly on the farm, and later store the dry product at a central point, thus lowering transportation costs.

Table 2. List of activities to follow according to the analysis of the critical path.

Week	Activity (underlined: tasks of the critical path)
0	Request
1	--
2	Begin feasibility study
3	--
4	--
5	Present study
6	Institutional decision
7	--
8	Elaboration of the project
9	--
10	Presentation of the project
	Cooperative training
11	Training in construction
12	Approval of the project
	Organization for construction
13	--
14	Delivery of the money
15	Purchase of the lot
	Purchase of materials
	Purchase of equipment
	Purchase of tools
16	--
17	Getting lot ready
18	Begin construction
19-22	Construction
23	Finalize construction
24	--
25	Training in drying
26	Begin cassava drying

a. Maximum delays allowed:

Training in cooperativism + training in construction + organization for construction: 5 weeks
Purchase of materials: 2 weeks
Purchase of equipment: 6 weeks
Purchase of tools: 6 weeks

Table 3. Parameters for monitoring.

Supply of fresh cassava		Processing (chipping and drying)		Commercialization	
Origin	Distance to the plant	Utilization of capacity	Overall efficiency	Availability of packaging	Number of packaging materials
	% brought by middlemen		Floor use efficiency		
					Dried cassava stored in warehouse without packaging
	Supply by village	Product quality	Degree of humidity	Utilization of warehouse	Dry cassava in warehouse in relation to capacity
	Supply of members in relation to equilibrium point		Conversion factor		
		Production	Cost structure		
				Rotation of capital	Days of delay in payment
Quality	Dry-matter content		Costs in relation to selling price		
	Variety			Value of inventory in relation to working	
	Planting period				
Regularity	Quantity processed by lot				
Value	Purchase price				
	% of remainders				

The quality of the fresh cassava utilized determines to a great extent the quality of the final product. In the case of drying cassava, an important variable is the dry matter content of the fresh product. Although dry matter content has not been measured directly in the Colombian Atlantic coast cassava drying project, monitoring was done on the planting period of the fresh cassava purchased and the variety used, factors that can influence dry matter content. Monitoring of varieties purchased also allows analyzing the acceptance of new varieties on the part of farmers.

In order to assure an optimal use of the capacity for drying cassava, one needs to have a more or less homogeneous supply during the processing campaign. If a high fluctuation in supply occurs, the profitability of processing goes down. This is due to the fact that in a certain period, processing capacity is not utilized completely, while in other periods it is possible that not all of the fresh cassava supplied can be processed because of a lack of capacity. To measure the regularity of supply, variance in the quantity of fresh cassava processed per day should be analyzed. A high variance indicates that the supply of cassava is irregular, and measures tending to regulate supply need to be taken, for example, through a system of advance payments, processing of members' cassava in periods of low supply, or using cassava produced by the same organization in order to regulate supply.

The cost of the raw material purchased is the most important item in the production cost structure of a cassava drying plant. A record of prices paid by the plants is kept during monitoring in order to indicate when one is paying prices that are too high within the planned cost structure. In addition, prices paid are evaluated in relation to the farmer's production costs. Furthermore, in the monitoring system, a record is kept of the quality of raw material purchased in relation to the price paid for it. If the plant is successful in purchasing a high percentage of noncommercial roots that are left after the selection of fresh cassava for sale to the fresh market, the cost of the raw material goes down considerably. A high supply of noncommercial roots indicates that significant quantities of fresh cassava are sold into the fresh market for human consumption in the region. This would indicate the possibility of organizing small farmers to enter into this market.

The parameters for monitoring supply of fresh cassava are valid for all kinds of cassava processing, since a timely supply of cassava is important for any kind of project. The parameters for the monitoring of processing itself, on the contrary, are more specific, depending on the case. In the first place, the use of the installed processing infrastructure is evaluated. In the case of drying cassava, the parameter of overall efficiency is used for this purpose, and it indicates the percentage of dry cassava produced in relation to production that is theoretically possible. The analysis of overall efficiency serves to decide on possible expansion of plant capacity. As a rule of thumb, a drying floor should be expanded if the overall efficiency of the plant exceeds 80% during the month of greatest production. On the other hand, the use of the drying floor is measured in terms of the amount of fresh cassava per unit surface area, which is expressed as "use efficiency." In this case, 100% indicates that fresh cassava has been spread on the floor in accordance with what is technically possible. Analyzing this parameter allows evaluation of the application of drying technology at the level of the small-farmer organization. In addition, it gives an indication of the management of the drying process in adverse climatic circumstances, when the amount of fresh cassava spread on the floor should be reduced.

In the Colombian Atlantic coast cassava drying project, occasional losses have occurred, caused by returns of dry cassava on the part of purchasing enterprises because of deficiencies in product quality. In reality, it is difficult to monitor final product quality simply and effectively. Quality control is based on the small-farmer organization's empirical experience in processing. These organizations execute the project with limited resources, often under difficult circumstances (heat and dust), and with people with low levels of formal education. It is thus impossible to use advanced laboratory methods for quality control. Monitoring should be based on the information supplied by purchasing enterprises. In this regard, a rapid feedback of information to organizations is critical in order to be able to correct deficiencies rapidly, and thus reduce economic setbacks to the organization. At the level of the cassava drying organizations in the Atlantic coast, only two control parameters were used to indicate quality of the dry product. These were: first, the conversion factor, calculated by dividing the amount of fresh cassava processed by the amount of dried cassava produced, indicating the quality of the raw material and the efficiency of the drying process; second, the moisture content of the dried cassava, which is measured in a rather empirical way through rubbing the dried cassava on the plant's concrete floor.

Production costs are the last aspect of processing analyzed by the monitoring system. The cost structure is analyzed in comparison with what was planned to detect whether differences that need adjustments occur, such as changes in prices paid, payment for workdays, and/or administrative expenses, etc. In addition, the level of production costs is analyzed with regard to the selling price of the dry product, as a control for profitability of the process.

With the exception of the lack of raw materials, the most important causes for interruptions in cassava processing in the Atlantic coast project have been related to problems in commercialization of the final product. These problems are related to availability of packaging, excess of inventory in warehouses, and lack of liquidity of the organizations.

The project monitors the number of packaging materials available within the small-farmer organization. Those cases in which dry cassava is stored without being packed are observed, since this practice causes deterioration in product quality and a rise in labor costs as the cassava must be packed later. The weight of the bags of dry cassava dispatched is also recorded in order to measure the use efficiency of the packaging and the means of transportation used in dispatch. Since commercialization of the final product can paralyze a drying plant when the product storage warehouse becomes filled, the rate at which warehouse capacity is being used related to its total capacity is recorded. The information thus generated serves to determine the need to expand facilities.

In the cassava processing organizations, problems of liquidity have arisen because of delays in payment for dry cassava dispatched. An evaluation of the time that goes by between the moment of dispatch of dry cassava and the moment in which the corresponding payment arrives in the hands of the organization is made in the monitoring process. According to these data, the best purchasing enterprises can be selected. The value of final product inventory is also analyzed in comparison with the amount of working capital given in the form of credit. Thus, recommendations with regard to the amount of working capital to be delivered can be formulated.

Monitoring of the Impact of a Cassava Project on Cassava Production

The development of integrated cassava projects does not have as its final objective to process a certain quantity of fresh cassava but to increase income and general well-being of producers and their families. It is expected that development of cassava processing will motivate the producer to increase cassava production through the adoption of improved technologies. Consequently, the impact of a cassava project on the cassava production system and the socioeconomic structure in general should be analyzed.

Information collected in the data bank allows an analysis to be made with regard to the area planted in cassava, based on information provided by each seller. In this manner, an estimation of the percentage of cassava that the farmer commercializes through the project can be used as a measure of the importance of this project within the small-farmer economy. This estimation can be improved by using the information on yields that is gathered at the second level of the monitoring system in the surveys. When one has information from several years in the data bank, changes presented in the area planted in cassava, and the quantity of cassava sold by farmers with different socioeconomic characteristics (such as landholding, affiliation to the project, access to production credit, region, etc.), can be analyzed. Based on these factors, groups of farmers for whom the project has had a differential impact are identified. The comparison of the information obtained through the record of the farmers in the data bank and the surveys allows identification of the causal factors for changes in area and limitations on credit, land, labor, seed, etc.

To measure the impact of the cassava project on production technology used by farmers, the information collected on all farmers who have commercialized cassava through the project (data banks) and the information gathered through a sampling of this population can be combined. Changes with regard to planting period and varieties planted can be analyzed using the information from the data banks. According to the need of each project, production technology indicators can be included, provided that it is feasible to gather the information at the moment in which the farmer sells his product to the small-farmer organization. For example, at the moment of the cassava sale, a farmer may be asked if he has mechanized his production, data which can be easily recorded on the sales slip. But it will be impossible to get information on, for example, the number of workdays used in production, which is a subject more apt for a survey.

The combination of the information gathered at the moment of selling fresh cassava and the information collected through surveys with farmers is valuable for estimating yield obtained by farmers, which is an important measurement of technological change motivated by the project. As the farmer is harvesting cassava almost daily during a relatively long period (from 5 to 12 months), for several uses (self-consumption, home processing, animal consumption, the market for human consumption, drying plants, etc.), it is difficult to estimate total yield. It is possible to estimate this yield if the information from the data bank on the quantity of fresh cassava sold by the farmer to the drying plants (which is measured with a scale at the moment of selling) is used, and it is combined with the measurement of the lots of land where the cassava was harvested for sale to the plants, information which may be obtained through surveys. It is clear that this method can only be used when the farmer can identify well the lot where he harvested the cassava for sale to the project, and supposedly the producer has not harvested from this lot for other uses. An even more exact yield measurement can be obtained through repeated visits to a small group of farmers during the harvest period.

One of the changes that is expected as a result of the projects is that cassava will acquire a growing importance within the production systems in which it is produced. Through the use of surveys repeated annually, one tries to detect changes in planting period, intercropping, and other factors. Repeated visits to a small group of farmers can be used to analyze changes in aspects that need a more precise observation, such as planting distances. The aspects to include at each level (data banks, survey, monitoring of a small, intensive group of farmers) depend on the rate at which one requires representative information from farmers in the area of the project's influence (levels 1 and 2) or, instead, a detailed description of cassava production at the farm level is required (level 3). One should consider how feasible it is to measure certain aspects at each level (Table 4). At the first level, simple information can be collected with a high degree of representativeness, while at the third level, complex information with a low representativeness is gathered.

The last aspect that is analyzed in relation to production in the monitoring system is related to the harvest process and final destination of the cassava. It is expected that integrated cassava projects will reduce the farmer's production risk through the development of an alternative market. This motivates an increase in cassava production. However, a greater production will not always be destined for processing within the context of the project. It is hoped that the farmer will be able to exploit periods of high demand and competitive prices in alternative markets such as the market for human consumption.

The monitoring system should analyze project impact on the whole process of cassava commercialization. It collects information on demand and prices in the fresh market at the local level and, through a survey at the moment in which the farmer decides to harvest, on the amount of cassava that he harvests each time and the destination that is given to the product.

Monitoring of Socioeconomic Impact

A cassava project can be quite successful from the point of view of volume of cassava processed, area planted, and yields achieved. However, if the project does not lead to an improvement in the socioeconomic position of the

Table 4. Production aspects to be included in the Absolute Social Impact (ASI).

Factor	Data bank	Surveys	Intensive monitoring
Complexity	Low	Medium	High
Representativeness	High	Medium	Low
Land preparation	Mechanization	Costs of mechanization	Mechanization technology
Planting	Varieties	Order of planting in intercropping systems Preference for varieties	Planting distance
Seeds		Availability of seeds	Management of seeds at the farm level
Weeding			Application of herbicides Number of weedings
Harvest and marketing	Quantity sold to drying plants Fresh market prices and demand	Sales with different destinations	Analysis of decisions in commercialization Decisions in the cassava process (moment, quantity, destination)
Labor		Availability of labor	Utilization of labor in distinct phases of production
Area planted	Area in cassava	Changes in land utilization	Rotation systems

poorest rural families, the project is not considered to be meeting its objectives. Therefore, within a monitoring system, income generated by the project and its distribution among the target population should be measured. Likewise, project impact should be evaluated with regard to improvements in the level of education, small-farmer organization, its relative political weight, and other social benefits.

Project impact on the generation and distribution of income can be evaluated at the aggregate level or at the level of individual small-farmer households. The data bank supplies information for the analysis of aggregate benefits. For such an analysis, three parameters have been developed: Absolute Social Impact (ASI), Relative Social Impact (RSI), and the Social Impact Indicator (SII).

Direct income generated by a cassava project is that which is generated in cassava processing. This income can result from cassava sales to plants, compensation to personnel that works in the processing and/or administration of the plants, and profits generated. Based on data (available in the data bank) on purchases of cassava by plants, farmer gross income can be calculated, without taking into account his production costs. Later, information is obtained on cassava production costs and yields, to thus calculate the net benefit received.

In order to calculate income from labor used in the plants, data are obtained at the first level of the monitoring system on the number of workdays paid to workers in the plants and the value of the workday. In addition, one needs information on the wages paid to plant administration (the manager, treasurer, head of production, etc.). Plant profits are calculated based on their variable and fixed costs and income obtained from the sale of dry cassava.

Indirect farmer income is varied and difficult to estimate. For effects of analysis of social impact, the most important indirect income, that is, what is related to cassava production, should be considered. In the first place, the greater demand for cassava as a consequence of the existence of the drying plants has stimulated an increase in area planted, which, in turn, generates greater demand for labor. Income from labor in cassava production sold to drying plants is thus an indirect result of the project. To estimate this income, information is needed on the amount and cost of labor used by the farmer in cassava production, which is gathered by means of surveys and intensive monitoring of farmers.

Absolute Social Impact (ASI) is defined as income derived from the project, divided by the amount of the investment in resources. Table 5 summarizes the methodology for estimating the ASI. The ASI serves to evaluate project income as related to its costs. There are two kinds of costs in this context: financial costs and investment in human and institutional resources. Cassava projects have been financed in many cases through soft development credits (with low interest and grace periods), which are used for construction of the drying plants and as working capital for processing. In some cases, the installations are partially built, by using donations from international development entities. For effects of making calculations, this cost is defined as the difference between the value of the credit, reduced by inflation during the existing period of credit, and the total amount reimbursed by the small-farmer organizations.

In the establishment of cassava projects, different entities participate in areas such as credit, technical assistance, training, research, coordination, etc. The quantifying of this institutional participation is difficult because staff involved dedicate only part of their time to the cassava project, and the small-farmer organizations that carry out the project have other parallel activities such as commercialization of other products, community stores, farm machinery, etc. The calculation of institutional costs is based on information from the entities with regard to the number of personnel linked to the project and the time dedicated to it (Romanoff, 1986b).

As was already mentioned, one hopes that income generated by the project will reach the poorest sectors of the population, for which socioeconomic information is required from the beneficiaries. A basic socioeconomic indicator in the rural context of cassava projects is the size of land on which some form of holding is exercised (ownership, renting, sharecrop arrangements, etc.), because family income tends to be correlated to this factor.

At the first level of the monitoring system, detailed information is collected on the farmers that sold cassava to the project. In order to analyze the distribution of this benefit, different indicators can be used. One of them is the percentage of beneficiaries that form a part of the target population segment of the project, which, in the case of the Colombian Atlantic coast project, was defined as those farmers with less than 20 hectares of land in their holdings. Another indicator is the proportion of beneficiaries that belong to the poorest sectors of the population. Although a large proportion of the beneficiaries may be within the segment sought, it is possible that the greatest portion of the benefits will reach very few people.

Table 5. Absolute social impact.

$$\text{Absolute social impact} = \frac{\text{Income generated by the project}}{\text{Costs of resources invested}}$$

Income generated	Formula	Information required	Source
1. Cassava purchased	(kg purchased x price per kg) - fresh cassava production costs	Cassava purchased	Level 1
		Purchase price	Level 1
		Fresh cassava production costs	Level 3
		Fresh cassava yield	Levels 1, 2, 3
2. Labor in processing	(workdays paid x value of workday) + wages paid	Number of workdays	Level 1
		Payment of workday	Level 1
		Wages	Level 1
3. Profit in processing	Income for sale of dry cassava - dry cassava production costs	Dry cassava production costs	Level 1
		Dry cassava sold	Level 1
		Price of dry cassava sales	Level 1
4. Labor in production	(kg cassava purchased/yield per ha) x no. of workdays per ha x value of workday	Kg cassava purchased	Level 1
		Yield per ha	Levels 1, 2, 3
		Workdays per ha	Level 3
		Value of workday	Level 3
<u>Costs of resources invested</u>			
1. Financial resources	(credits delivered + increase because of inflation) - (capital + interest paid)	Credits delivered	Level 1
		Repayment of credit	Level 1
		Interest	Level 1
		Inflation	Statistics
2. Institutional resources	Σ (salary of employee x portion of time dedicated to the project)	Employees in the project	Entities
		Time of dedication to the project	
		Wages	

For this reason, the number of people benefited and the distribution of benefits among these people according to hectares in their holdings should be known. This relationship can be expressed with the Gini coefficient. When the Gini coefficient is equal to 1, benefits are distributed in an equitable manner; if it is greater than 1, benefits reach people with little land in a greater proportion; and if it is less than 1, they reach people with a larger amount of land more.

Based on the concepts presented, the parameter of "Relative Social Impact" (RSI) can be defined, which indicates the number of beneficiaries in relation to the distribution of benefits to the target population.

RSI = (proportion of beneficiaries with less than 20 ha) x beneficiaries with less than 5 ha/proportion of beneficiaries with less than 20 ha x Gini x number of beneficiaries.

The RSI is equal to the number of beneficiaries when all the benefits reach people with less than 5 ha, and the benefits are distributed equitably.

Finally, starting from the two parameters formulated earlier, the "Social Impact Indicator" (SII) can be formulated in the following manner:

SII = ASI x RSI

The SII gives a relative indication of the income generated by the project and its distribution among the population benefited in relation to costs incurred upon carrying out the project. This parameter can have different applications in the execution of projects. For example, the effect of certain development measures can be estimated, such as emphasizing associative credit for production versus individual credits. One can also know which have been the most determining factors of the social impact of a project and, based on this analysis, proceed to strengthen this impact in the chosen population segment. Finally, a comparative analysis of cassava projects (drying cassava, commercialization of fresh cassava, etc.) can be made to define which is the best option for rural development in a specific situation.

The project also measures the impact on income of individual small-farmer households. It includes within the surveys for households questions on the relative importance of income related to the project in comparison with remaining income of the small-farmer family. An analysis is also made of whether a change in the standard of living of the family occurs.

Some simple indicators such as improvements made on the house, nutrition, educational level, among others, are used for this.

The Contribution of the Monitoring and Evaluation System in the Colombian Cassava Project

The monitoring and evaluation system developed for the Colombian Atlantic coast cassava project has contributed in several ways to the making of decisions in its management and planning (Table 6).

By using the information generated by the system, the critical factors for the successful establishment of cassava drying plants were identified. The system is supplying information useful for the selection of sites for new plants. First, the system establishes levels of potential fresh cassava supply that allow an analysis of the feasibility of a drying plant in a certain area. Second, it permits an analysis to be made of the cassava supply based on socioeconomic characteristics of farmers in the area of the project (landholding, affiliation to small-farmer organizations). Third, the system identifies geographic areas with a high fresh cassava supply. Based on these three factors, new drying plants have been established, ones that have shown levels of dry cassava production significantly superior to those of the previously established drying plants.

A second area where monitoring contributes has been the utilization of processing technology.

Now, the Atlantic coast cassava project has entered into a second phase in which the so-called second generation processing technologies (milling, artificial drying, flour production) are going to be tested and transferred. The selection of sites where pilot projects are going to be established for the purpose of testing the technical, economic, and social feasibility of the technologies is based on information supplied by the monitoring system. Pilot projects are located in areas where the first phase of the project showed a greater impact in terms of volumes of dry cassava produced, area planted in cassava, and organizational development. These areas could be identified based on the monitoring data. With regard to the artificial drying of cassava, cassava areas with production during the entire year were identified, where it is expected that such technologies will solve climatic limitations on the drying process.

The monitoring and evaluation system has contributed to analyzing project impact on cassava production and on the socioeconomic environment. In this way, it has been verified that the development of commercialization

Table 6. Contributions of the monitoring and evaluation system to the Atlantic coast cassava project.

1. Site selection	a. Identification of regions with large supplies of fresh cassava for processing.
	b. Establishment of fresh cassava production levels to assure sufficient supply to the drying plant in specific areas.
	c. Analysis of the potential supply to a drying plant in terms of socioeconomic characteristics of farmers in the area.
2. Implementation of processing technology.	a. Analysis of utilization of installed processing capacity during the campaign.
	b. Analysis of utilization of labor within distinct organizations.
	c. Simple monitoring of product quality control in drying.
	d. Site selection for pilot projects of "second generation" technologies.
3. Impact of the project	a. To test the principal hypothesis of the integrated cassava projects.
	b. Calculation of benefits as related to project costs.
	c. Definition of forms of social organization and potential functions of cooperatives and associations.
	d. Description of specific groups of producers based on socioeconomic characteristics and production technologies.
4. Training and promotion	a. Seminars of self-evaluation of small-farmer organizations.
	b. Institutional training events.
	c. Visits from outside national and international officials.

effectively opens opportunities for increases in production, bringing significant benefits to the small-farmer sector. This verification has justified the expansion of the project on the Atlantic coast and its replication in other regions of the country. Monitoring showed that the small-farmer organizations (15-30 members) that purchase a large part of the cassava to process from nonaffiliated farmers are economically viable, and they are an important mechanism to direct benefits toward poor small-farmer families.

The monitoring system in the Atlantic coast cassava project has been used in the training of staff and small-farmer organizations, and in promoting the project toward external entities. Monitoring data are used both in self-evaluation events in which small-farmer organizations that execute projects participate as well as in courses in which personnel that is going to work in this project or in similar projects in other regions is trained. This allows a combination of a general perspective of the project with a deeper analysis of the special activities of some organizations. Monitoring information has been presented to personnel from different national and international entities that have visited the project on short missions.

Costs of a Monitoring System for a Cassava Project

In the development of the model for the monitoring systems, an attempt has been made to reduce costs through the incorporation of monitoring activities into the normal activities of project execution. Especially at the first level of the system (data bank), information gathering has been incorporated within the management of cooperatives and as a part of technical assistance. In this aspect, monitoring does not imply additional costs. An example of the costs of each level of the monitoring system in the case of the Colombian Atlantic coast cassava project is given in Table 7. Resources necessary for a staff member to be able to dedicate himself full-time to the development, organization, and coordination of the system's execution have been included. In truth, this arrangement seems to be only necessary during the first years of the project when the system should be developed. Afterwards, this staff member would be responsible for coordinating the execution of the monitoring and evaluation system that would already be a part of project implementation. In addition, given that monitoring is essentially an interinstitutional activity, it should be organized at the level of a unit of institutional coordination. In the case of the Colombian cassava drying project, this unit has been the departmental technical teams, in which all the entities linked to the project are represented. Thus, monitoring costs can be distributed among these institutions according to their specific interest in the results of the exercise.

In the example given in Table 7, first-level monitoring of 36 drying plants that functioned during a 4-month campaign was carried out. At the second level, an annual survey was conducted with 230 farmers. At the third level, monitoring of 50 farmers was performed, by making 8 visits per year to each one. As can be observed, the total cost of this monitoring system was about US$10,300 annually, including the salary for one fully employed staff member, which corresponds to 2.4% of the net benefits generated by the project.

Table 7. Annual costs for the development of a monitoring system for integrated cassava projects (in US dollars).

Factor	Cost	
Level 1 (36 organizations, 4 months of campaign)		
Processing of information from:		
Purchase of fresh cassava	218	
Processed lots	109	
Commercialization of the final product	29	
Packaging	36	
Members of the organization	46	
Organization	2	
Credits delivered	2	
Credits applied	2	
Printing of reports	97	
Subtotal Level 1		541
Level 2 (230 farmers, 1 survey)		
Reproduction	209	
Execution	666	
Processing	226	
Subtotal Level 2		1,101
Level 3 (50 farmers, 8 visits per year)		
Reproduction	61	
Execution	1,182	
Processing	152	
Subtotal Level 3		1,395
Coordination (1 full-time employee)		7,272
Total costs		10,309
Total annual benefit of the project: US$424,000; monitoring costs as a percentage of the annual benefits of the project, 2.4%		

References

Benítez, R. 1987. Manual de asistencia técnica del Proyecto DRI/PMA para el desarrollo agro-industrial del cultivo de la yuca en la Costa Atlántica. CORFAS, Bogotá, Colombia. 28 p.

Bode, P. 1986. La organización campesina para el secado de yuca. Cassava Program working document no. 11, Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia.

Casley, D. and Kumar, K. 1987. Project monitoring and evaluation in agriculture. A joint study: The World Bank, International Fund for Agricultural Development, Food and Agriculture Organization of the United Nations. Johns Hopkins University Press, Baltimore, MD, USA. 159 p.

Clayton, E. and Pétry, F. (eds.). 1981. Monitoring systems for agricultural and rural development projects. FAO Economic and Social Development paper no. 12, Rome, Italy. 261 p.

Coleman, G. 1987. Monitoring a rural credit project in Ethiopia. Agric. Admin. Ext. 24(2):107-127.

Dorward, A. 1988. The classification and organisation of monitoring and evaluation activities in agricultural development projects. Agric. Admin. Ext. 30(3):163-175.

Janssen, W. 1984. La selección de sitios para el establecimiento de plantas de secado natural de yuca. In: Best, R. (comp.). Plan piloto para el desarrollo agro-industrial del cultivo de la yuca en algunos departamentos de la Costa Atlántica de Colombia. Proyecto Cooperativo DRI-CIAT, tercer informe, junio 1983-junio 1984. Centro Internacional de Agricultura Tropical/Fondo de Desarrollo Rural Integrado (CIAT/DRI), Cali, Colombia. p. 112-120.

Maddock, N. 1987. On the monitoring and evaluation of agricultural development projects. Agric. Admin. Ext. 25(3):177-188.

Ospina, B. 1986. Presentación en seminario interinstitucional: Desarrollo de un plan de capacitación para el proyecto de yuca en la Costa Atlántica. Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia.

Romanoff, S. 1986a. Beneficiarios de las plantas secadoras de yuca. In: Best, R. and Ospina, B. (comps.). El desarrollo agro-industrial del cultivo de la yuca en la Costa Atlántica de Colombia. Proyecto Cooperativo DRI-CIAT, cuarto informe, tomo 2, julio 1984-junio 1985. Centro Internacional de Agricultura Tropical/Fondo de Desarrollo Rural Integrado (CIAT/DRI), Cali, Colombia. p. 15-29.

_________. 1986b. Estimativos del apoyo institucional para las empresas campesinas productoras de yuca seca en la Costa Atlántica. In: Best, R. and Ospina, B. (comps.). El desarrollo agro-industrial del cultivo de la yuca en la Costa Atlántica de Colombia. Proyecto Cooperativo DRI-CIAT, cuarto informe, tomo 2, julio 1984-junio 1985. Centro Internacional de Agricultura Tropical/Fondo de Desarrollo Rural Integrado (CIAT/DRI), Cali, Colombia. p. 2-14.

Smith, P. J. 1984. Agricultural project management: Monitoring and control of implementation. Elsevier Applied Science Publishers, London, England. 190 p.

_________. 1985. Monitoring and evaluation of agricultural development projects: Definitions and methodology. Agric. Admin. 18(2):107-120.

Staub, W. J. and Koppel, B. 1986. Monitoring and evaluation of benefits in agricultural and rural development. Asian Dev. Rev. 4(1).

Chapter 12

SOME KEY ELEMENTS IN ESTABLISHING AN INTEGRATED CASSAVA PROJECT

Carlos A. Pérez-Crespo*

An integrated cassava project normally begins with the establishment of a council composed of agricultural researchers, rural development program administrators, and farmers. This chapter will discuss some of the subjects that members of these bodies should keep in mind when establishing and operating an integrated cassava project.

What Is the Mission of Integrated Cassava Projects?

The mission of an integrated cassava project is to catalyze a series of institutional interventions, with a final objective of improving farmer income and, in addition, generating socioeconomic development of a region. These interventions are of a technical and financial nature. They usually include technical assistance services for cassava production and the operation of rural cassava-processing industries, agroindustrial credit, and infrastructure of services such as drying patios, warehouses, storage centers, and commercialization, and sometimes access roadways. Interventions also include assistance for the development of trades and skills, technical and financial assistance for the formation of cooperatives and similar organizations, and, occasionally, services for providing fertilizers and pesticides.

An integrated cassava project is necessarily intersectorial and multidisciplinary. The project takes advantage of opportunities that agroindustrial exploitation of cassava offers for empowering farmers and processors economically, socially, and, as a last resort, politically. It combines and synchronizes contributions of state entities, nongovernmental institutions, and producer groups, besides technical personnel with different specialties.

---

* Anthropologist and senior research fellow, Cassava Program, Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia; currently, field research associate of the Institute for Development Anthropology of Binghampton, New York, USA, and adviser to the Program for Alternative Development of Cochabamba, Bolivia, stationed in Cochabamba.

An integrated cassava project is a rural development program based on the exploitation of agricultural resources. Development is defined as permanent economic growth combined with the ability of producers to assume control over their lives and solve their problems. Thus, a project combines the contributions of technology generation and transfer centers and financial and social development entities to mobilize human and financial resources, to form local leaders, and to spread new knowledge. It is less important to measure the success of a project in relation to accomplishing a specific task over a particular period of time (technology adoption, increase in cassava production or commercialization, including improvement in farmers' income and nourishment) than to measure it in relation to the autonomous capacity of producers to create and maintain future profitable activities and organizations that will represent their interests. In this way, the impact of a successful integrated cassava project is extended beyond activities directly related to this crop.

Integrated Projects Are Participatory

Integrated cassava projects adopt a participatory style of administration because the active participation of cassava producers and processors in the planning and execution of activities increases the economic and technical efficiency of the projects, and it guarantees their long-term durability. Basically, projects are oriented toward solving problems and taking advantage of opportunities. The goal is to benefit farmers and, indirectly, consumers, especially those of limited resources. If farmers are not consulted, program administrators and technicians cannot correctly and completely define problems and opportunities. It is necessary to take into account the producers' knowledge about local conditions to decide how and where to invest technical and financial resources with better results. Producers should define program priorities as it is very likely that these priorities will differ from those formulated by technicians. Farmer participation is needed so that the project will respect the cultural values of its communities, respond to their needs, and guarantee an equitable distribution of benefits. It is essential to know the local political and socioeconomic context, and no one knows it better than producers. It is not enough to know that technically it is possible to produce, process, and sell cassava in a particular area. It is important that producers accept and support the form in which the project will invest in the area. Although the project may be technically correct, technology adoption and its continuous use require that farmers perceive its value and usefulness. It is much more likely that producers will support projects that they consider important if they have the opportunity to negotiate project design. Finally, the long-term impact of the project depends on the ability of producers to autonomously assume the operation and maintenance of services created by the project when outside institutions cease giving aid. Producers can only develop these abilities gradually and through daily experience in solving problems, organizing themselves in associations, and training new members of their associations.

For these reasons, one of the most important tasks in the planning and operation of cassava projects is to assure active participation of farmers and rural communities. The project should identify limitations and opportunities by taking into account the perspectives of producers together with those of their administrators and technicians. In order to decide upon project objectives, the nature of the product line, and market segments with which it will operate, an administrator should include perspectives of farmers, their felt needs, and their organizational abilities, with the same seriousness given to biotechnical feasibility and economic profitability analyses. Likewise, the possible geographic location of a cassava project should be decided by taking into account whether the agroecological and socioeconomic conditions exist, on the one hand, for cassava production, processing, and commercialization; and on the other hand, whether there are producer groups with interest in the project, capacity to work with it, and market access. These issues should be considered in this order of importance.

Administrators should carefully analyze what kind of incentives will allow them to gain the participation and active support of farmers: under what conditions and for what purposes farmers are willing to produce, process, or commercialize cassava, and how much they are willing to sacrifice to obtain these objectives. This consultation is necessary, because the opportunity costs for farmers not only cover economic costs but also include social and political ones.

As a general rule, one should be careful in promoting the launching of an integrated cassava project with arguments that may emphasize the enormous potential cassava has for satisfying national-type needs. Indeed, the benefits that the project could contribute to nations are many and varied. They go from the reduction of grain imports and the flight of foreign exchange upon producing cassava-based substitutes to the generation of multisectorial dynamics that will put a brake on rural emigration, will increase the efficiency of farming as a motor of development, and will respond effectively to demands for feeding an increasingly urban population. These strategic macroeconomic arguments, however, must adequately emphasize the promotion of a cassava project first and foremost in relation to direct benefits for farmers and their communities. In all cases, the benefits expected for farmers participating in the projects, and for their communities, should be made explicit. In this way, once projects are implemented, it will be easy to measure and guarantee the effectiveness of regional projects or national plans because there will be locally operationalized goals.

Ways to Increase Participation

There are several methods for increasing producer participation in the planning, operation, and control of an integrated cassava project. First, producer participation should be gradual and based on practical experience. Participation is a learning process. For producers to be able to take control of services, they need many abilities. These include public speaking, leading a meeting, favoring democratic leadership, discussing constructively, decision making, being familiar with technology and markets, knowing how to administer resources and keep accounts, investing efficiently, and planning future activities. No one is born with these skills and, therefore, projects should encourage producers to learn them through daily practice and by organizing courses on group dynamics and technical and administrative management. The responsibility for organizing practical opportunities and courses should be gradually transferred from project employees to producer and processor associations.

Second, producers will be more interested in participating in a project if they are enthusiastic about it. They will have enthusiasm if the project shows easily identifiable success (we all wish to be part of a winning organization) and provides direct benefits for producers as a result of their participation. It is important for project administrators to favor distribution of benefits as soon as possible. It is likewise necessary to have an open and democratic administrative system, in which all producers are able to review accounts and understand the bookkeeping mechanism.

Third, a project should be small and simple. Large projects tend to favor participation of technicians more than producers. In a larger project, projects of infrastructure acquire more importance, the mixture of planning and administration is more complex, and there is greater temptation to control all those processes. In addition, there is less room for producer learning and less flexibility for adaptation. It is also more difficult for farmers to take full responsibility for services. As a result, the project administration continues to depend on employees indefinitely. Likewise, one should begin with a single function (such as processing or production) and take on another one only when producers become efficient at the first one.

Fourth, producers should be encouraged to make small-scale experiments with technology, commercialization systems, organizational models, and mechanisms of administration. These experiments should be on a reduced scale in order to limit risks caused by structural factors or by those arising from the situation. The scale of the experiments also facilitates the participation of producers with limited resources. Technical, administrative, or organizational recommendations totally adapted to the conditions of each region will never exist. Producers should experiment with them in order to adapt them to their own local conditions.

Fifth, projects should avoid depending on outside funds, above all on large quantities of financing. If much outside money or easily obtainable outside benefits exist (subsidized land preparation for all members of a cooperative, for example), this could encourage producers to participate in the project, but they will not be committed. It is preferable to have producers contribute whatever resources they can for the construction or maintenance of infrastructure, negotiation of contracts, renting of land, or any other necessary activity. Producer contributions can be in quotas of money, work, farm products, or construction material. Participation plus contributions stimulate producers to take interest in the project's working, and they will feel that they have a right to require efficient operation of services. It is also good for producers to gradually learn to control capital. For a project's operation, too much outside money can be more prejudicial than the total lack of financing.

Sixth, project administrators should plan on phasing out outside personnel when the project will officially end, and when farmers will take over all the project's services. Although the transfer of employee responsibilities to producers should be gradual, it is important to set a date beforehand for the complete removal of outside support to avoid prolonging project dependency. During this process of gradual removal, teams composed of producers capable of supervising the project and training other producers to take over these tasks will be created.

Integration in Projects

Independently from the manner in which integrated cassava projects will be developed, they should be conceived and carried out integrally. The integration of a project is manifested at several levels, among them the joining of its functional components, along with administration and leadership that bind the project together.

The sectorial integration of the project emphasizes the simultaneous treatment of production, processing, and commercialization processes. As a general rule, one should begin by defining the limitations on the commercial expansion of the crop. In many cases, the limiting factor is market demand: expansion is facilitated through the transformation of cassava into a less perishable product with greater demand. In other cases, when elasticity in demand exists, improvements in the production or commercialization systems of the roots or their derivatives are needed.

Increases in production or productivity require changes in the manner of utilizing or commercializing cassava. Likewise, improvements in the transformation systems or sale of cassava require adaptations in the volume or quality of the raw material produced. The way in which production, processing, and commercialization are linked chronologically may vary, but what is important is that in the end these components will be part of a single process.

The functional integration of a cassava project also takes in linking the technical, financial, and entrepreneurial assistance systems of the project. The quality of assistance depends on a good general strategy and clear features for guiding, adjusting, balancing, and evaluating daily project management. This strategy and its features are particularly necessary because multiple organizations with different resources, loyalties, and objectives frequently take on technical assistance.

Integration and coordination take place on the basis of common objectives and schedules. The general administration of the project determines action plans and the way in which technical assistance components are joined. The more those responsible for the technical assistance components, including producers, participate in project planning, the greater the coordination of the project during implementation will be.

A project's integration depends on its ability to carry out its activities timely and adjust them in time. It is essential that administrators avoid delays and breaks between project phases. For that, a plan is needed that clearly defines the sequence in which activities will be carried out. Thus, it will guarantee that the distribution of services and inputs will be orderly and efficient, that technology transfer will back up and will be backed up by technology generation, and that local capacity for project administration will grow over time. An implementation plan with clearly marked phases allows administrators to anticipate needs of production factors and possible delays in the delivery of necessary inputs, including credit.

Integration, therefore, depends on the administrators' ability to foresee possible obstacles and to identify possible opportunities for the project. For this purpose, a constant and adequate flow of information among the different administrative levels is required. Administrators should pay close attention to details. PERT techniques, the critical path, and Gantt charts are particularly valuable as aids for foreseeing many contingencies. The value of these techniques does not lie so much in the operational plan that will result from their application as in the awareness of all the elements that should be combined in order to successfully implement a project.

Administrative coordination of components usually is facilitated if the general administrators of the project also exercise an economic or political control over institutions in charge of the components. Thus, one encourages participation linked through compensations and stimuli. Nevertheless, the most important incentives for coordination are of a moral type, and these incentives are based on the leadership of an institution or of an employee of that same institution.

The Leader of the Integrated Project

The leader plays an important role in the planning and operation of an integrated cassava project. He or she should establish the most efficient way to utilize existing human resources, identify areas in which there are unsatisfied needs of personnel, and accede to this personnel, whether it be by incorporation of institutions within the project or through training of existing personnel. The leader should define monitoring and control systems for project activities. He or she should establish when and in what sequence the production, processing, and commercialization processes should be integrated, and the institutional interventions to support them. Finally, he or she should contemplate clearly a plan of activities that will allow not only the autonomous survival of projects once the infusion of financing and technical support has been reduced to a minimum but also the way in which the project will multiply its effect in similar projects or related economic and social activities.

The project leader transmits a vision and some objectives to the group, and confidence that these are achievable. The leader interprets demands of those involved and makes them compatible with the tasks of the project's administration. Those involved are producers, rural communities, industries that use cassava, urban and rural consumers, private entrepreneurs, assistance services, and political leaders.

The leader also constantly serves expectations and positive and negative collateral effects that the project creates. Among the collateral effects, employment opportunities and local economic activity can be included, along with improvements in nutrition in the project's area; improvements in the economic and social position of groups at risk, particularly women and young people; the increase or decrease in soil erosion; the increase in the use of commercially acquired chemical products; changes in the conditions of small-farmer incorporation into the market economy; the need to increase technical-managerial knowledge among farmers; and improvements in the regional and/or national balance of payments.

An integrated project's leader should have an entrepreneurial vision: he or she should effectively combine a strategic vision, creativity, initiative, and ability to take risks and adopt new solutions. The leader should show flexibility and adaptability, characteristics that are often found in administrators who are generalists. The leader should be capable not only of tending to routine program administration (definition of objectives, control of budgets, definition of calendars of activities, and planning the flow of information) but also to maintaining staff morale, promoting staff development, having a vision of the future, encouraging links to complementary organizations, and expanding project resources. Finally, the leader should actively favor orientation of the project toward being accountable to producers and increasingly incorporating their participation.

The Strategic Emphasis of an Integrated Cassava Project

An integrated cassava project operates as a matrix organizational structure within which specific development subprojects are carried out on the basis of one cassava product. Thus, it is possible to conceive the project as a portfolio with different emphases, although in its first phases, a project only concentrates on one subproject.

Before beginning the project, the administrators conceptually define the type of cassava-based product that the portfolio will be made up of. Administrators should consider several options besides the most obvious portfolio products and emphases. It is important to avoid defining the portfolio only in accordance with what the project staff knows how to do best. It is possible that a large part of the initiative of promoting cassava development may come from groups of technicians who are production specialists. This notwithstanding, it is important that an exaggerated bias does not develop toward promoting production while overlooking processing and commercialization.

An open approach should be adopted, based not only on what the project knows how to do best (supply factors) but above all on opportunities that exist for developing the crop (demand factors), even if training existing personnel or integration of personnel or institutions with different specialties in the project will be required in order to take advantage of these opportunities. Among the socially and technically acceptable options, the one with the greatest commercial demand is adopted.

It is recommended that the market be defined in general terms until the product line has become strongly consolidated in the market. Thus, instead of thinking about the market for roots, one thinks about the market for industrial additives for human or animal food, for example. Generic markets allow more flexibility and greater capacity for adapting oneself to consumers' requirements. When determining project strategies based on generic markets, the open opportunities for cassava are considered not only from the perspective of the crop and its physical conditions but also from the point of view of already existing or possible products in which cassava could be introduced as a component.

As a general rule, integrated projects should carry out a rigorous analysis of markets and products in which cassava could compete, products in which it could be "camouflaged," and the demand volumes. This analysis should be made before beginning the implementation of the project, and it should also be made periodically once the project is in operation in order to serve changing conditions.

There is a consensus among projects that it is not enough to define the potential market for cassava based on general estimates. A rather precise quantitative definition of demand volumes, and of the levels of profitability expected given a particular level of investment, is increasingly sought. Estimates are used more and more for costs necessary to operate the project, analysis of the requirements appropriate to the stages in which the project will be developed, and for calculations on the maximum costs and minimum prices for the cassava-based product to be competitive.

Through market analysis, it becomes possible to justify the creation of an integrated cassava project only when this project clearly has comparative advantages vis-à-vis other possible actions that could generate economic and social development. The systematic measurement of demand also allows placing a series of possible projects in perspective. Thus, pipedreams are differentiated from projects in which investment is worthwhile, and, among the latter, those projects in which the investment of resources can be converted into greater results in a shorter term are identified.

From project to project, the methods for estimating demand and the amount of detail in information that is obtained with them vary enormously. Up to now, time series have mainly been used to estimate cassava demand, to identify the market for a product that the crop's raw material could totally or partially substitute, and to perform estimates of price and income elasticity of demand, the number of potential users, and their rate of purchase. The method is rather effective, above all when little time is spent employing it, and when it explores the potential of some markets where it is obvious and where it is not so obvious that cassava could be competitive.

Because the purpose of these analyses is to define strategies for new products or new markets for cassava, it is necessary to measure demand volume, and also to suggest in detail the form and conditions under which such demand could be made effective. For these reasons, complementary methods have been used. For example, factors that are highly correlated with market potential (number of mills and bakeries, production volume of balanced foodstuffs, among others) are used. Likewise, the use of small-scale market tests for the evaluation of new products or to measure the elasticity of new markets is increasingly becoming popular. These tests, together with surveys of intent to purchase, and estimates and predictions from producers, industrialists, and dealers of cassava or other products, strongly complement the methods of time series for estimating demand.

Technology in Integrated Projects

It is important for the project to rely on a production and processing technology and a commercialization system that will overcome limitations on crop expansion. Certainly, it is not necessary to generate all the production or processing technology in each country where a cassava project is created. International technology generated in part at CIAT and in part by research or development programs in other countries can be modified. These conditions allow individual projects to benefit in the short term from years of research and development of experimental prototypes achieved in different geographical areas. Over the medium and long term, however, the integrated project will need the constant support of a native research and development system. Creation, strengthening, or integration of this technological research and development system within the project should be contemplated in the project strategy.

Project administrators should evaluate how many technological options are appropriate for a region's particular conditions and which ones among them are available. The critical factor in the evaluation of the technology consists of having up-to-date and correct information on all the options available. Therefore, it is necessary for administrators to have access to sources of information that will facilitate decision making.

The integrated project needs a technology that will be economically efficient and socially workable. Instead of waiting for users to reach the level of the requirements of the technology, technology that is at the level of users' needs and resources should be generated and promoted. The simpler and the more divisible the components of a technology package are, the greater the possibility is that users can accept them rapidly, altogether or in parts. As a corollary, the integrated project will require research on ways to produce technology that is adaptable and economically and socially beneficial to the producer.

The design and implementation of technology appropriate for farmer conditions are very important. Strengthening and/or building the social, economic, and administrative institutions for efficient project implementation and evaluation are, however, equally important. One should start with existing organizations, but these organizations should not limit possibilities for generating new structures and functions.

The Project as a Unit of Experimentation and Learning

Outlines and diagrams equally applicable to all the integrated cassava projects cannot be generated. Cassava production and transformation technology and the strategies of commercialization and formation of institutions are necessarily specific to a project and a region. They require constant experimentation and adaptation to temporal and spatial changes in the circumstances of a cassava project. For these reasons, administrators and researchers can and should utilize integrated cassava projects productively in order to test elements that form part of the project experimentally, as well as possible combinations among them.

Among the possible areas of comparison and experimentation are the chronology and spectrum of activities in which farmers can participate in project administration, designing technology (size, specifications, organization of production), systems for commercializing cassava (storage or centralization centers, advertising campaigns), and methods for technology transfer (diverse means of mass communications, courses, case studies, visitors). One can also experiment with credit systems for production or processing (state or private capital, sums of credit, payment in cash or in kind), methods for improving the flow of information for project control (bimonthly reports, meetings, recollection of information by farmers or extensionists), and systems for evaluating farmer needs (group or individual interviews, key informants). Additionally, it is possible to experiment with methods for the training of institutional employees and producers to make project administration more efficient.

Administrators of integrated projects can take advantage of the opportunities that they have to experiment. A methodical attitude will be needed to measure a population systematically under a treatment together with control populations. The limits for obtaining inferences under these conditions are tremendously broad. This approach should be used to design strategies for program planning, operation, and evaluation. With great advantage, it can also be used to define the benefits that the project provides to those who directly and indirectly participate in it.

Institutional Benefits of the Project

In addition to economic improvements for small farmers and rural regions, the project contributes important institutional benefits. Participation in integrated cassava projects strengthens both producer organizations as well as those of project personnel. These transformations will not only impact on the cassava project's area but will also contribute to rural development in general.

Integrated projects give new vitality to groups of farmers who have often operated with many setbacks but who now gain confidence in their own resources. This has been translated not only into the formation of a new generation of small-farmer leaders but also into a greater ability of these leaders to more competitively confront society in general.

The institutions that form part of the project also benefit. The complexity of the factors involved in rural development determine that for institutional solutions to be effective, they should be based on the use of interdependent multisectorial interventions. This complexity makes organizations lose perspective of the overall vision and of the specific contribution for which they are called in achieving a common objective. Very often, even when an institution contributes efficiently in its area of competence, the ineffectiveness of another organization can nullify or considerably reduce the positive impact of the overall interventions.

The integrated cassava project contributes strongly to institutional consolidation by providing relevancy and rationale for participating organizations' interventions. The project encourages institutions to feel proud of their work. The researcher who carried out trials whose results few people knew about (or much less used for producing more and better) finds a critical but receptive audience in the project that utilizes his or her knowledge and creates new questions and challenges. The extensionist sees the vicious circle broken of promoting technology that is not appropriate for farmers, who are not interested in adopting it, regardless of how much he or she promotes it. The credit agent sees capital that he or she lends grow productively and benefit many people. Finally, the promoter goes from the passive position of seeing what can modestly be done to the active attitude of turning into reality that which he or she did not dare to dream.

ACRONYMS MENTIONED IN THE TEXT

Acronym	Institution	Country
ANPPY	Asociación Nacional de Productores y Procesadores de Yuca	Colombia
APROBE	Asociación de Productores de San Juan de Betulia	Colombia
ARIC	Asociación Rural de Interés Colectivo de la Sabana de Huimanguillo	Mexico
CECORA	Central de Cooperativas de la Reforma Agraria	Colombia
CGIAR	Consultative Group on International Agricultural Research	USA
CIDA	Canadian International Development Agency	Canada
CIRAD	Centre de Cooperation Internationale en Recherche Agronomique pour le Développement	France
CORFAS	Corporación Fondo de Apoyo a Empresas Asociativas	Colombia
DANCOOP	Departamento Nacional de Cooperativas	Colombia
DRI	Fondo de Desarrollo Rural Integrado	Colombia
FUNDAGRO	Fundación para el Desarrollo Agropecuario	Ecuador
ICA	Instituto Colombiano Agropecuario	Colombia
IDRC	International Development Research Centre	Canada
INCCA	Institución Nacional de Capacitación de Agricultores	Ecuador

INIAP	Instituto Nacional de Investigaciones Agropecuarias	Ecuador
ODNRI	Overseas Development and Natural Resources Institute	England
SENA	Servicio Nacional de Aprendizaje	Colombia
UAPPY	Unión de Asociaciones de Productores y Procesadores de Yuca	Ecuador
USAID	United States Agency for International Development	USA