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removing constraints to small farm production:

The Caqueza Project

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Removing Constraints to Small Farm Production: The Caqueza Project*

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*This report is a modified version of a paper presented at the annual meeting of the Canadian Agricultural Economics Society, Brandon, Manitoba, 22–25 June 1975.

Abstract

In collaboration with the Colombian Agricultural Institute (ICA), the IDRC rural development team has been studying problems in agricultural production faced by small farmers. Over a 4-year period, several studies were conducted in the Caqueza Rural Development Project. These dealt with existing crop production patterns, the development of new technology, the analysis of the credit system, and an evaluation of the marketing structure. The specific findings of these studies showed that:

- 63% of the small farm crop acreage is in corn production; 27% is in potato production; 66% is in legumes associated with the former two; and only 12% is in horticultural crops.
- The application of fertilizer, new seeds, and pesticides could increase corn yields threefold. This was, however, at an additional cost of 200% for material inputs and a doubling of the risk from production and price variations.
- The new technology in corn production could increase net returns to total investment by over 50% above returns from traditional corn production.
- Labour employment and returns to labour could increase 80% with the adoption of the new corn technology.
- Net return to total investment in horticultural production alternatives found in the area ranged from 90 to 190%, compared with returns for traditional corn of 30%.
- Material input costs for horticultural production ran from $100 (U.S.) to $300 per hectare compared to traditional corn at $50 per hectare.
- Labour employment in horticultural production was at least three times that of traditional corn.
- Price-production risks in horticulture increased directly with costs of material inputs, ranging from 100 to 400% above the risk level of traditional corn.
- The government bank's interest rate was 13%. When imputed values for legal costs, time spent, travel, and bribes were included, the real cost of credit to the farmers averaged 43% per year. Of all credit sources analyzed, bank credit only accounted for 27% of the loans.
- Marketing margins to intermediaries were low but overcapacity in vehicles and marketing agents suggested the existence of an "atomistic" market structure.

Several conclusions were drawn from these studies. First, modern technology substantially increases risk to capital expenditures and, at his subsistence wealth level, the small farmer can ill afford this. Secondly, cash for investment in new farming activities is severely limited and very costly; almost double the opportunity cost of local capital. Thirdly, the anarchic "atomistic" marketing structure jeopardizes the attainment of the potential economic opportunities from adopting modern technology in agriculture.

This analysis of the small farm situation in Caqueza has led to the formation of three major action programs. The first was to continue the development of new agricultural technology adapted to the region. The second was to initiate, on an experimental basis, a credit-insurance investment scheme for corn and onion producers who apply the new technology. The third was to create a farmers–retailers voluntary chain for the two-way marketing of fresh produce, farm supplies, and staple foods. All three aim toward the generation of integrated support structures for small farmers' production. Preliminary results appear to indicate economic feasibility of these programs, but their ultimate success will be measured by future increases in small farm incomes and well-being.

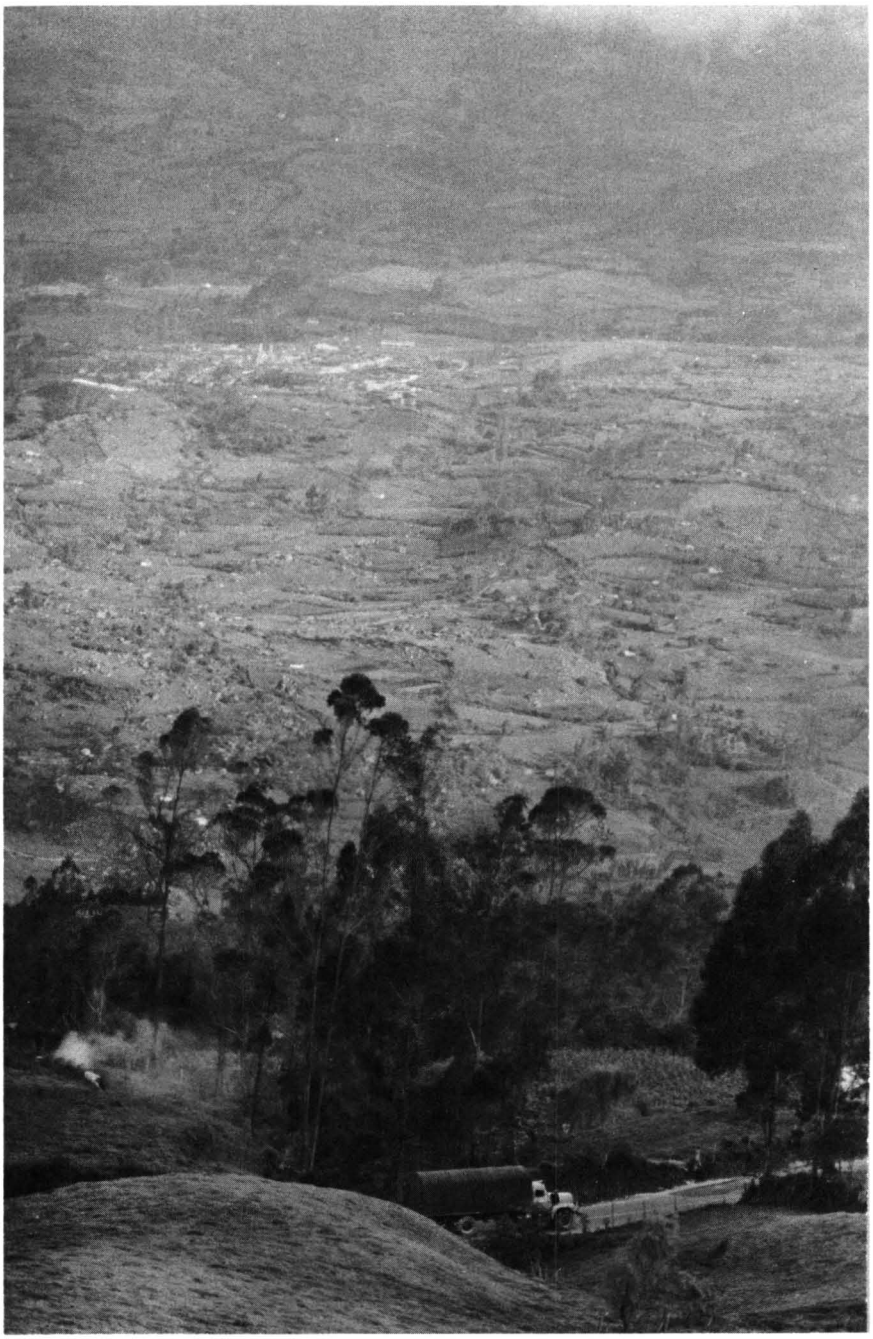
Résumé

L'équipe du CRDI oeuvrant dans le domaine du développement rural a étudié, en coopération avec l'Instituto Colombiano Agropecuario (ICA), les problèmes de production agricole auxquels se heurtent les petits fermiers. Pendant plus de quatre ans, de nombreuses études poursuivies dans le cadre du projet de développement rural de Caqueza et traitant de modèles actuels de production culturale, du développement d'une nouvelle technologie, de l'analyse du système de crédit, et d'une évaluation de la structure de commercialisation, ont démontré en particulier ce qui suit:

- 63% de la superficie des petites fermes est consacrée à la production de maïs; 27% à la production de pommes de terre; 66% aux cultures maraîchères, y compris la pomme de terre et le maïs; et 12% à l'horticulture.
- L'utilisation d'engrais, de nouvelles semences et de pesticides pourrait tripler les récoltes de maïs. Ce rendement requérerait, cependant, un débours additionnel de 200% pour les entrées de matériel et doublerait le risque encouru suite à des variations de prix et de production.
- Les nouvelles techniques de culture du maïs pourraient augmenter les rendements nets par rapport à l'investissement total de plus de 50%, de ce que l'on obtenait par la culture traditionnelle du maïs.
- L'adoption de nouvelles techniques de culture du maïs pourrait augmenter de 80% l'emploi et le revenu.
- Le rendement net de l'investissement total obtenu par diverses techniques d'horticulture trouvées dans la région s'est chiffré de 90 à 190% comparativement aux rentrées de 30% que produit la culture traditionnelle du maïs.
- Les coûts du matériel servant à la production horticole se sont élevés de $100 à $300 (américains) par hectare comparés à $50 par hectare pour les techniques traditionnelles de production de maïs.
- On embauchait trois fois plus pour la production horticole moderne que pour les méthodes traditionnelles de culture du maïs.
- En horticulture, les risques prix-production augmentaient directement en fonction des entrées de matériel, excédant de 100 à 400% le niveau de risque encouru en production traditionnelle de maïs.
- Le taux d'intérêt de la banque d'Etat s'élevait à 13%. Toutefois si l'on ajoute les sommes versées en frais juridiques, le temps, les déplacements, et les pots-de-vin, le coût réel du crédit aux agriculteurs était, en moyenne, de 43% par année. Après analyse de toutes les sources de crédit, le crédit bancaire ne rend compte que de 27% des prêts.
- Les faibles marges de commercialisation aux intermédiaires ont été minimes mais le pouvoir centralisateur des manoeuvriers et des agents de commercialisation laissent entrevoir l'existence d'une structure de marché "atomistique".

Lesdites études ont permis de tirer plusieurs conclusions. Premièrement, que les techniques modernes augmentent sensiblement le risque par rapport aux capitaux investis, ce que peut difficilement se permettre le petit agriculteur à peine capable d'assurer sa subsistance. Deuxièmement, que les fonds destinés aux investissements dans de nouvelles opérations agricoles sont très limités et fort coûteux — soit presque le double de la première mise de fonds. Troisièmement, que la structure anarchique de commercialisation "atomistique" compromet la réalisation des possibilités économiques qu'on retirerait par l'adoption de techniques agricoles modernes.

Cette étude de la situation de la petite exploitation agricole à Caqueza a mené à la formulation de trois principaux programmes de travail. Le premier consistait à poursuivre le développement de nouvelles techniques agricoles adaptées à la région. Le second, à créer, à titre d'essai, un programme de placements crédit-assurance pour producteurs de maïs et d'oignons utilisant les nouvelles techniques. Le troisième, à créer un réseau volontaire agriculteurs-détaillants pour la mise en marché, dans les deux sens, de produits frais, de denrées et d'aliments de base. Ils visent tous les trois à créer des structures favorisant l'aide destinée aux petits agriculteurs et leur production. Des résultats préliminaires semblent indiquer que ces programmes sont économiquement réalisables, mais le succès définitif ne saurait être démontré qu'en fonction du relèvement économique et du bien-être des petits fermiers.



View of highlands.

Foreword

After an extensive study of integrated rural development programs in other parts of the world, the Instituto Colombiano Agropecuario (ICA) decided early in 1971 to restructure its own activities in this field, based on the model being used in the Puebla project in Mexico. The Colombian approach differed somewhat from Peubla, where most of the emphasis was on corn production, in that the Colombian areas selected for the first integrated rural development projects all involved complex intercropping systems on small farms. In addition to the emphasis on agronomy, the Colombian program incorporated inputs in animal science and home economics.

The Colombian program commenced with four pilot projects and in the last 4 years the number of projects has expanded to 22, covering a significant part of the small farming area in the country. In mid-1971, IDRC was invited by ICA to collaborate in this program by providing a small team of specialists to assist in developing the methodology and evaluation techniques for the program.

This report by the IDRC team, which is a modified version of a paper presented at the Canadian Agricultural Economics Society annual meeting at Brandon, Manitoba, in June 1975, describes some of the progress made during the 4 years of the program to date. The report represents the collective efforts of the small IDRC team and a large number of Colombian coworkers. Because the program has moved very rapidly and the pilot projects have been used to train staff for the expanded program, there has been a substantial movement in the local staff and a very large number have made inputs to the work described in the study. Furthermore, the program has a linkage with the postgraduate program operated jointly by ICA and the National University and with the programs of other universities. Over 20 students have conducted their field research for postgraduate degrees in the project. The list of persons collaborating in the program has been, therefore, very large. However, particularly enthusiastic support and assistance has been received at all times from Dr Rafael Mariño, the director general of ICA and Dr Josué Franco, the deputy director specifically responsible for integrated rural development. At the level of the project itself much of the work described could not have been carried out without the backing of Ciro Villamizar and Roberto Gonzalez, former project coordinators now promoted to ICA regional coordinators, and to Alfonso Chudt the project evaluation officer who is largely responsible for the progress made in the marketing activities.

In collaboration with the World Bank, ICA is now embarking on the preparation of a sizeable expansion in its rural development activities. As part of the preparatory work for this program the experiences of the pilot project at Caqueza are being recorded in greater depth and it is anticipated that during 1976 this material will be available in both English and Spanish so that the lessons of experience gained in the project can be used for the purpose of planning and developing projects of this nature elsewhere.

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View of corn fields.

Introduction

In the last 20 years several efforts have been made to accelerate rural development in the Third World through the introduction of new techniques in agriculture and animal production. This approach has been stimulated by the encouraging progress made in the last 15 years in the development of new technology that increases agricultural production capacity. Nevertheless, although the adoption of this new technology by small farmers has been a major rural development goal, in practice the success achieved has been rather limited. Recent thinking has suggested that low adoption rates may result from the new technology being inappropriate for small farm situations. In particular it may be erroneous to seek only to maximize production per hectare, and to consider that other production factors exist in unlimited quantities and at fixed prices. Such an approach assumes that the economic, social, cultural, and political infrastructure can and will automatically adjust to the requirements of the new technology. In practice this does not often occur.

More recently, an alternative approach has gained some acceptance, namely that of adjusting production technology to the social and economic systems currently encountered in rural areas. This approach has emerged as a result of the recognition that modern production technology (especially fertilization and mechanization) (Urrutia Montoya 1974) may increase the disparity in welfare levels between commercial and traditional farmers, rather than close the gap.

The present study examines this second approach. It deals primarily with the agricultural sector, and in this sense suffers from an inherent weakness since the work shows clearly that successful rural development involves many nonagricultural activities in fields such as rural infrastructure, education and health systems, and institutional organization.

Most of the material presented here is based on experiences gained during 4 years of work in the Rural Development Project of East Cundinamarca (Caqueza Project), directed by the Colombian Agricultural Institute (ICA), a component of the Ministry of Agriculture. The demographic, agricultural, and economic characteristics of the project area are summarized in Appendix 1. The project was established early in 1971 with the objective of developing mechanisms for rural development through the analysis of the impact of specified action programs. It was postulated that an increased impact should be obtainable if the action programs were continually redesigned on the basis of the evaluation of their initial results so the lessons of experience could be continuously built into the project activities.

The second section of this paper describes the relationships between the present Colombian national objectives for development and the production and consumption systems of the typical small farmer. The third section, which is based on research results obtained by ICA through action programs and special research studies, examines the production systems used by the small farmer. This examination attempts to interpret the behavioural responses of the small farmer confronted by various production alternatives; it evaluates his reactions to changes in production factors such as credit, labour, prices, marketing mechanisms, and risks. The final section relates current production systems to governmental activities intended to bring about changes such as the formulation and implementation of agricultural research policies, the provision of technical assistance and production credit, and the improvement of marketing. Such activities are generally considered to be integral components of government services for rural development activities.

Corn combined with legumes.

Government Objectives and Their Relationship to Small Farmers' Systems of Production and Consumption

Colombia's development policy emphasizes the need to achieve a more equal distribution of incomes, to increase agricultural production and productivity, to create employment, to increase exports and industrial development, and to overcome malnutrition.

These policies are designed particularly to improve the welfare of the lower-income half of the population. Of these people, 65–75% are rural inhabitants, many of them small farmers (700,000 families) producing mainly for family consumption. To reach these people any official rural development activities need to be related to the production and consumption system of the small farmer (the traditional[1] rural sector).

Small Farmers' Production and Consumption

The traditional sector, which produces more than half of the nation's food supply, must play an important role in any rural development scheme based on increasing agricultural production. Substantial increases in small farm production can be used to improve local nutritional levels, increase exports, and supply the food manufacturing industry.

Studies by the National Institute of Nutrition and the nutrition study carried out in the Caqueza Project area (Shipley and Swanberg 1974) clearly indicate that malnutrition seriously affects a substantial percentage of small farm families. The study in the Caqueza Project showed that calorie and protein consumption were closely correlated to family income. However, deficiencies in some other nutrients (calcium, riboflavin, and vitamin A) were not dependent on income levels. Nutrition education programs could, therefore, help to solve these latter problems but they would probably not substantially influence calorie and protein intakes that need to be tackled by increasing rural incomes.

Small Farm Income

Census data show that the lowest income group in Colombia is mostly rural (Urrutia Montoya 1974). This means that to achieve a more even distribution of income at the national level, it will be necessary to increase rural incomes.

Small farm incomes consist of two basic components: monetary income from product sale or off-farm income, and income in kind from production for home consumption (80% for the Caqueza area). Monetary income and income in kind (which can also be expressed in monetary terms) can be represented by the following equations:

$$\text{Monetary income} = \sum_{i=1}^{n} \alpha_i Y_i (P_i - C_i) + I_f \qquad \ldots\ldots(1)$$

$$\text{Income in kind} = \sum_{i=1}^{n} \beta_i Y_i (P_i - C_i) \qquad \ldots\ldots(2)$$

where: i = each of the production activities;
n = the total number of production activities;
α_i, β_i = the proportion of each product that is destined for sale or consumption respectively, so that $\alpha_i + \beta_i = 1$;
Y_i = the production of the ith product;
P_i = the unit price of the ith product;

[1]The term "traditional" is used without any derogatory connotation. It is employed in the same way as it is used in the federal government, defined as the noncommercial subsector of the agricultural sector.

To achieve a substantial improvement in nutrition and well-being, the small farmers' production must increase without any decrease in their monetary income.

C_i	= the unit cost of the inputs of the *i*th product excluding land and family labour[2];
I_f	= any income obtained outside the farm.

Supposing for the moment that off-farm income remains constant, total income can be increased as follows:

(*a*) by increasing the difference between unit price and unit cost ($P_i - C_i$), so that income per unit of product increases without requiring production increases;

(*b*) by increasing production and either keeping the price–cost ratio constant or increasing it.

Increasing the price–cost ratio without varying the quantity produced will increase the total income of small farmers. However, to the extent that their consumption and that of their families are largely a function of their own production, the amount consumed will not increase and the effect on the nutritional state of the families will be negligible. This means that to achieve a substantial improvement in the nutritional status of the rural family, the second option, namely that of increasing production, must be selected. However, to obtain the desired nutritional and income effects, such an increase in production must take place without any decline in the farmers' monetary income.

[2]Family labour and land are not included as costs because they are factors that the small farmer owns, and hence returns to them are part of gross income.

The Small Farmer's Production System

Use and Availability of Production Factors

One way of increasing production is to increase all production factors proportionally, while keeping production techniques constant. This possibility, although theoretically acceptable, is in reality unattainable, as the possibilities of the small farmer increasing the size of his farm are usually negligible. Consequently, the land factor is a constant. Therefore, to increase production the productivity of the land factor must be increased. This can be done either through increasing productivity per se or by changing the product mix, or both. To allow a better understanding of the difficulties associated with changing land productivity, we shall consider the situation of the small farmer in Eastern Cundinamarca, emphasizing the reasons for his present land-utilization practices.

Land use and availability

Although the ecology and topography of the region are not ideal for agricultural production[3] the present land-use frequencies (Table 1) indicate the existence of considerable agricultural activity.

The region can be classified according to altitude into three zones. The high altitude zone (more than 2200 metres above sea level) is characterized by a great variety in agricultural and animal production activities. The main crops are potatoes, in association with beans and peas, as well as red beets and lettuce. Dairy cattle are also important in this zone.

In the medium altitude zone (between 1800 and 2200 metres above sea level) corn is grown in association with several vegetables, especially onions, under a traditional system of intercropping.

The low altitude zone (less than 1800 metres above sea level) is distinguished for its production of corn in association with beans and kidney beans. Vegetable crops such as green beans and tomatoes (Escobar P. 1973) are also grown.

To understand the reasons for this pattern of land use, the farmer's use of other production factors and their availability in the region must be examined.

Table 1. Land use in the Caqueza Project area.

Land use	Frequency (%)		Surface area (hectares)	
Annual crops		30		7034
Corn	66		4642	
Potato	26		1829	
Legumes[a]	89		6260	
Horticulture crops (beets, onions, lettuce, cabbage, etc.)	13		914	
Cassava and other root crops indigenous to the area	6		422	
Permanent crops		3		622
Fallow soil		9		2145
Pasture land and woods		58		13974
		100		23775

[a]Most of these crops are sown with corn and potatoes.

Source: *Preliminary Report of the Frequency Study in Land Use and the Agricultural Census of 1970.* Bogota, Colombia, DANE, 1972.

[3]According to the soils classification presented in the diagnostic report of the Caqueza Project, most of the surface area in the region is rated as class III and IV soils. These soils, although quite steeply sloped, are very appropriate for several crops if they are handled well agronomically (Escobar P. 1973).

Labour utilization and availability

The region has a complex labour situation. During certain periods, there is an excessive work load and day labourers are scarce. In contrast to this, analyses of labour use showed that a considerable portion of the economically active population does not have constant work throughout the year. These observations coincide with national statistical data, which show that taking the year as a whole there is a surplus of labour.[4]

Different crops in the region vary substantially in their labour requirements (Table 2), with the most common crops — corn and associated crops — presenting the lowest absorption of labour, and horticultural crops showing the highest labour demands. The labour requirements for a traditional cropping pattern (corn–beans) are greatly increased when a recommended set of inputs is applied, although even then this crop association has a lower requirement than that of most vegetables.

Capital use and availability

Although the availability of capital for investment is generally low, it varies considerably within the region. In the low altitude zone, the amount of available investment capital is estimated to vary from $80 to $160 per hectare, but in the other

The labour requirements for a traditional cropping pattern (corn-beans) are greatly increased when a recommended set of inputs is applied.

[4]The monthly labour requirements of the important crops in the region and estimates of off-farm employment are used to compute these statistics.

Table 2. Use of capital and labour in agricultural production in the Caqueza Project area (1973) (per hectare).

	Capital for material inputs ($/hectare)	Labour (man-days per crop)		
		Salaried	Family	Total
Corn–bean (traditional)	51	48	12	60
Corn–bean (recommended)	128	81	30	111
Beet	118	97	86	183
Tomato	236	140	81	221
Onion	312	105	66	171
Potato–pea (2nd semester)	353	126	26	152

two zones this sum increases to $240 to $320 per hectare per year.[5] The reason for this difference is that the per capita income in the higher zones is approximately 20% greater than it is in the lowest zone, principally because crops in the higher zones are generally more profitable.

Although crops with a high labour demand also require a high cash investment (Table 2), given the substantial unemployment in the region, the present crop distribution pattern is most probably a result of the lack of cash for investment in production materials. An alternative, but weaker, explanation could be related to the efficiency of use of the existing resources, which will be analyzed next.

Efficiency of Resource Use

The average returns to the production factors of land, capital, and labour are in most instances greater than their respective costs (Table 3). This is, however, not the case with the marginal returns to labour (VMP) in the production of corn. Although the estimated VMP of seeds and pesticides was greater than its price, the VMP obtained for labour was half the local wage rate (Narvaez H. 1974). This analysis suggests that the scarcity of cash restricts the use of purchased inputs to well below the optimum level, while the abundance of labour has led to a situation of overemployment of labour, so returns to farm family labour are below the currently prevailing agricultural wage rates in the area.

In the light of the scarcity of the cash resource, it becomes important to understand the credit situation in small farm regions as well as the impact an increase in the availability of working capital could have on the present production system.

Credit

Availability of credit

The Caqueza Project (Villamil O. 1974) identified four main sources of credit in the rural sector. Banks only provided 30% of the total credit in 1973. The other sources were: relatives (26%), friends or local lenders (34%), and local merchants (9%).

The credit study revealed that there was a positive relationship between the level of indebtedness and the wealth of the producer. Farmers lacking a certain minimum level of assets[6] could not obtain credit. The existence of a linear relationship between indebtedness and assets implies that the creditworthiness of a region is associated with its degree of wealth. Alternatively it might imply that the small farmer limits his indebtedness to avoid risks. However, the credit study indicated that this was not the

[5]Estimated on the basis of annual family income and food expenditure and from actual production investments by 85 families studied in the region.

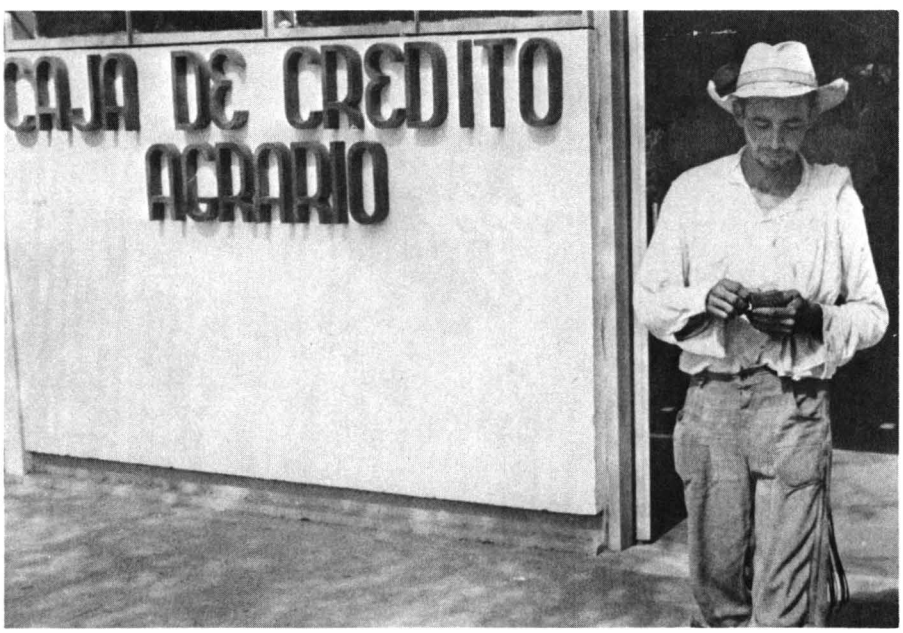
[6]It is necessary to have at least $1000 to obtain $200 credit, and $10,000 to obtain $2000 credit.

case. As a matter of fact, more than 70% of the rural community studied considered that the availability of credit was very limited and more than 50% of them felt that it was extremely difficult to obtain.

Cost of credit

Institutions such as private banks and the government-controlled Agrarian Bank (Caja Agraria) charge a nominal annual interest rate of 13%. In fact hidden costs amounting to 9% for stamps, legal fees, and hospitality expenses, and a 14% cost for time lost and travel on the part of the small farmer, pushed the total real cost up to 36%. In comparison, credit from relatives involved costs of 22% for nominal interest, 5% as overpricing,[7] and 14% for time lost and travel, for a total cost of 41%. "Friends" charged 26% nominal interest, which together with 0.5% as overpricing and 21% for time lost and travel amounted to a total cost of 47.5%. The cost of credit obtained from store owners is even higher, adding up to a total rate of 59%.

Recommended production activities should produce returns to capital invested that are higher than the weighted average (over the different sources) of the total cost of credit to the farmer (estimated at 43%).[8] Studies of production costs for various crops (Table 3) show that corn associations produced without the application of the new technology recommendation[9] do not provide returns to capital at its average cost in the region (43%). Aside from the traditional corn production,[10] however, the returns



More than 70% of the rural community studied considered that the availability of credit was very limited and more than 50% of them felt that it was extremely difficult to obtain.

[7]This term applies to two situations: (1) the lender fixes an amount of product to be paid at the end of the loan period at a certain price when he knows that the market price will actually be higher; (2) a lender stipulates a price for a product obtained as part of the loan above the actual market price at that time.

[8]These costs include the rate of inflation.

[9]Technical recommendation based on 3 years of experimental work by the project.

[10]The case of traditional corn is not very relevant as the cash requirements are so low that the small farmer can grow his corn without depending on credit.

to total investment in agricultural production (see examples in Table 3) can easily absorb the real cost of credit and therefore compete with any other economic activity for the necessary capital.

An in-depth analysis of the costs of credit in the project area yielded the following results. The nominal interest rate (fixed by the lending institution) was not related to the quantity of credit applied for. On the other hand, the imputed interest (representing the extra expenditure required to obtain credit) was negatively related to the quantity of credit applied for by the small farmer (the majority of the imputed costs are fixed costs, independent of the amount of credit received). What this means then is that the farmer with the least assets pays the highest interest rates.[11]

This analysis suggests (*a*) that small farm production does offer returns to invested capital greater than the cost of the capital; and (*b*) that the small farmer will readily absorb more credit for agricultural production if this is made available to him. Nevertheless, the close positive relationship between the farmer's assets and the credit he can obtain, and the negative relationship between assets and the total costs of credit, together make it very difficult for farmers with little economic backing to change their technology or their present patterns of low-profit crops. This appears to be one of the most important reasons why the small farmers in Caqueza are sowing so much (66%) of their land to a cropping system that does not give a high return (traditional corn and associated crops without new technological inputs).

This analysis tends to reinforce the notion that one way of improving the income of the small farmer lies in facilitating his access to production credit. However, ICA's experiences in East Cundinamarca do not totally support this hypothesis. On the contrary, project studies on the adoption of new technology for corn (Escobar P. 1972) indicated that the farmer readily adopted new techniques that did not increase his production costs or his need for cash inputs, but he did not adopt those that required greater cash costs, even when credit was available.

Table 3. Average returns to production factors in the Caqueza Project area (1973).

	Length of productive cycle (months)	To capital[a] in material inputs (%)	To total labour[b] ($/man-day)	To land[c] ($/hectare)	To total investment imputing all costs[d] (%)
Corn–bean (traditional)	8–10	85	1.81	73	30
Corn–bean (recommended)	8–10	194	3.25	277	91
Beet	5	401	3.50	515	145
Tomato	5	198	4.18	746	143
Onion	5	317	6.75	1031	191
Potato–pea (2nd semester)	5	146	4.38	551	93

[a]Returns to capital in material inputs $= \frac{VP - VT - CMO - CI}{CI}$.

[b]Returns to labour $= \frac{VP - VT - CI}{MO\ (By\ day)}$.

[c]Returns to land $= \frac{VP - CMO - CI}{T\ (hectares)}$.

[d]Returns to total investment $= \frac{VP - VT - CMO - CI}{CT + CMO + CI}$.

where VP is the production value ($); T is the quantity of land (hectares); VT is the value of land rent ($); MO is the quantity of labour (man-days); CMO is labour costs ($); CI is the capital in material inputs ($).

[11]For example, a producer with assets of $20,000 pays a total interest of 46.5%, whereas another producer with assets of $30,000 pays a total interest of 32.7%.

One of the factors associated with this behaviour, apart from the problems of the credit itself, was the risk associated with the adoption of new technology (ICA–CIID 1974).

Risk

The farmer is always confronted with a number of uncertainties that lie largely outside of his control. These uncertainties are attributable to a lack of knowledge regarding: (*a*) the quantity of the product to be obtained; (*b*) the price of the product at the moment of sale; (*c*) institutional uncertainty.[12]

Based on his own experience and that of his parents, as well as the information at hand, the farmer attempts to evaluate these uncertainties in defining his production policy. In doing this he appears to consider two aspects. One is the net gain he expects to derive from the different production activities. This was estimated by the average net gain for each activity. The other consideration relates to the variance of the net gain to be obtained, as this determines the probabilities associated with lower profits or higher losses for each alternative. Given the same variance, the farmer will undoubtedly select the alternative showing the highest average profit. Where variances differ, which is generally the case, and particularly where the types of distributions are not similar, the farmer's choice becomes more difficult to simulate (Anderson 1974).

As a criterion for comparison of risks of different production activities we have selected the value of the expected loss (Dyckman et al. 1962) and the expected loss per investment for the following reasons:

(1) Because of the very limited wealth of the majority of small farmers, the disutility of any loss is very high and a substantial reduction in the slope of the utility function is expected beyond the break-even point.[13] For this reason the lower end of the profit distribution curve is of major importance.

(2) The expectation of the loss generally increases for high input–high return alternatives, so higher average returns are closely associated with high expected losses. Unless one alternative presents a higher average profit (mean) at a lower expected value of the loss, no simple dominance of one alternative can be established.[14]

(3) The expected value of the loss is in monetary units, and allows easy comparison of the same enterprise in different regions. The additivity of expected losses also allows the comparison of combinations of enterprises and the inclusion of this measure of risk in linear programing problems.[15]

In this report, "expected loss" is, therefore, regarded as being synonymous with "risk." Interviews of farmers in Caqueza suggest that: (*a*) the producer assigns little or no cost to the use of his labour or that of his family; (*b*) the landowning producer assigns little or no cost to the use of his land in the productive process; (*c*) the producer does consider as costs those inputs that must be paid in cash upon receipt.

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[12]Institutional uncertainty includes all factors beyond the producer's control, which he evaluates in his attempts to answer such questions as: Will there be seed? Can I get fertilizer? Will there be trucks to transport my produce? etc.

[13]Inability to pay for credit will severely limit future production possibilities or lead to great additional costs for refinancing the credit.

[14]Comparing incomes (Table 3) and risks (Table 4), the potato-pea association is in this case stochastically inefficient in relation to onions and tomatoes. This is probably because of the exceptionally low potato prices during the survey year (1972). Except for rare cases of intersection of cumulative density functions (CDF) below the break-even point (net loss = 0), the combination of the expected loss and average profit allows similar selectivity for efficient alternatives as does the concept of stochastic dominance. Because of rare intersections below the break-even point (net gain = 0), some alternatives will be included in the efficient set that are, strictly speaking, not stochastically dominant. This may, however, prove to be an advantage as it avoids the problem of low probability CDF intersections discussed by Anderson (1974).

[15]Similar to the approach used by Boussard (1971).

Consequently, the producer is thought to evaluate his expected loss primarily by what he considers to be his costs — those inputs or production factors that were paid in cash — and the probability that yields and prices will be so low as to not cover these costs. This value determines the "risk" related to each production possibility.

An analysis of the cropping patterns found in the area of the Caqueza Project that related risk to net earnings (value of product less cost of materials) showed that the absolute value of the risk increased rapidly when low investment crops were changed for those with high production costs (Table 4).

Table 4. Expected value of the loss (risk) and its relation to total investment for selected crops in the Caqueza Project.

Crop	Risk[a] ($/hectare)	Risk[a] / Total Investment
Corn-bean (traditional)	24	0.16
Corn-bean (recommended)	50	0.18
Beet	55	0.17
Tomato	108	0.22
Onion	132	0.25
Potato-pea (2nd semester)	141	0.25

[a]Calculating the expected value of the loss function (value of product less cost of materials < 0).

Considering risk as a proportion of the total investment, or the risk per dollar invested, corn production presented the lowest risk (16 cents per dollar invested), and the risk per dollar invested increased with increases in the absolute value of risk (25 cents per dollar invested for onion and potato-pea crops).

Apart from production risks, the farmer has to take into account variations in the price received for his product and the availability and costs of the inputs required for its production. All these uncertainties cumulatively increase the total risk the farmer must take. This probably explains why he sows the safest crop — traditional corn — in so much (66%) of the area that he cultivates in the project region.

So far, ideas about production risks have been discussed from the standpoint of the farmer. Fortunately, he does have a limited capacity to assume risks. As mentioned earlier this appears to be a function of his wealth (land, fixed personal property and machinery that belong to him) and of his expendable income at the time of decision-making (discounting his consumption requirements). Again, as in the case of credit, the small farmer with little wealth faces a difficult situation. He is caught in a vicious circle, in which he cannot increase his income or wealth without taking risks, but due to his limited economic strength, he cannot afford to take these risks. Thus, he finds himself caught in "the small farmer's low productivity trap."

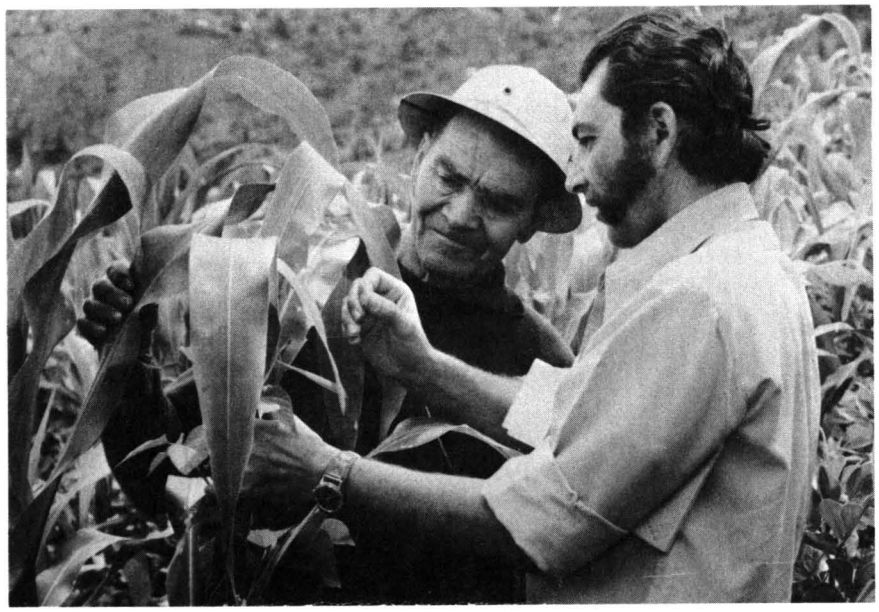
The Application of Agricultural Production Programs in Regional Rural Development Projects

This section attempts to define what must be done to increase small farm production according to the criteria previously established with respect to returns to production factors, risk, and credit. This includes the generation or identification of high-yielding technologies, the technical assistance farmers require to apply these technologies, the establishment of a system of credit that adequately covers production risks, and the creation of an infrastructure to supply agricultural inputs and produce marketing services.

Generation of Technology

Having determined that the small farmer knows how to allocate his production resources efficiently within the prevailing structural and ecological limitations, the task of introducing new technology or production alternatives, or both, raises some new questions. For example, would a change in the established system of production lead to a decrease in efficiency if it is accepted that the small farmer is operating efficiently within the existing limitations? This problem does not arise only with respect to applied research at the project level, but also for all agricultural research and its subsequent dissemination to the small farmer (Gonzalez Gomez and Zandstra 1974).

Research beneficial to the small farmer must focus initially on his production system and identify structural limitations, particularly those that could be advantageously modified or removed.



Technical assistance might be more successful if, as well as specifying the highest-yielding technology, a comprehensive assistance program were designed to take into account reducing risk and providing credit, inputs, and marketing services that meet the small farmers' needs.

For this reason, research beneficial to the small farmer must focus initially on his production system and identify the structural limitations with which he is faced, particularly those that could be advantageously modified or removed. Agricultural research per se must operate within the existing limitations, identifying those adjustments required to generate the greatest benefits from the present or potential production systems.

The selection criteria for alternative production systems should go further than simply generating a production package that maximizes kilograms per hectare or net gain per hectare. It should also include an analysis of risks, input costs, and labour requirements of the new technology vis-a-vis the traditional system. Returns to capital, land, and labour, calculated per hectare and per family also need to be considered and to be compared with those of the current production system. This will then identify which adjustments the small farmer should make if he is to adopt the new technology successfully, and will also permit an estimate to be made of the benefits he will receive from adoption of those changes.

Technical Assistance

The analysis presented in previous sections raises some important questions about the validity of conventional technical assistance techniques with small farmers in Colombia. The small farmer does usually seem to be aware of existing modern technology (ICA–CIID 1974b) and, in most cases, to recognize its possible benefits. For these reasons, technical assistance should, perhaps, concentrate less on the *communication* of production technologies and more on the *interpretation* of the situation of the small farmer and the *limitations* hindering his adoption of new technology that should lead to more profitable production systems (ICA–CIID 1975). Technical assistance might be more successful if, as well as specifying the highest-yielding technology, it were committed to the design and establishment of a comprehensive assistance program that also takes into account reducing risk and providing credit, inputs, and marketing services that meet the small farmers' needs.

Credit System

The intensive, high-yielding production activities that have been identified as satisfying national production objectives do seem to require a level of investment in inputs usually out of reach of the small farmer's own resources and hence force him to seek credit (ICA–CIID 1974b).

The credit study discussed in the previous section indicated that:

(*a*) a large number of the small farmers in the Caqueza area use credit from four major sources — banks, friends, relatives, or commercial outlets (local shopkeepers);

(*b*) the average real cost of this credit is equivalent to 43% per annum;

(*c*) the total cost of credit is substantially greater than the stipulated nominal rates;

(*d*) the amount of credit received is directly proportional to the farmers' assets;

(*e*) the highest total costs are paid by the producers with the lowest assets;

(*f*) production capacity is not considered when granting credit.

The real cost of credit the small farmer incurs exceeds the current inflation rate (25%) and the opportunity costs of capital (30%) in Colombia. Although these rates are high, productivity is still high enough to justify the use of credit at 43% for most crops and cropping associations. In other words, the production system of the traditional small farmer is still able to compete favourably in the capital market. This means that low nominal interest rates are not necessarily required because of the low yields of the small farmer's production system, but are primarily needed to compensate for the lack of efficiency of the institutional credit system. This inefficiency has a high social cost and implies, in most cases, a loss to the national economy.

Given that credit to the small farmer is closely tied to government technical assistance, the granting of credit for agricultural production according to the economic potential of each activity under consideration appears to be justified. Such a measure should allow for a reduction of the close current tie between the amount of the credit per loan and the farmer's wealth, thereby increasing the availability of credit to the smaller and poorer farmer. Moreover, the selection on a regional basis of production activities or technologies, or both, that generate higher returns to credit capital would also achieve economic benefits at the national level.

To use the economic efficiency of the small farmer's production system as a basis for granting him credit, however, does not necessarily guarantee that he will use this opportunity to shift toward more profitable production processes. As previously discussed, it is often impossible for the small farmer to accept the additional risks such changes imply. For this reason, the design of credit systems for the small farmer needs to take into account those aspects of risk that affect his production decisions.

Fortunately, in most cases, and provided that an adequate technical assistance program exists, returns to invested capital are sufficiently high to cover the following conditions:

(*a*) a satisfactory return for the producer to pay for his investment in land and labour;

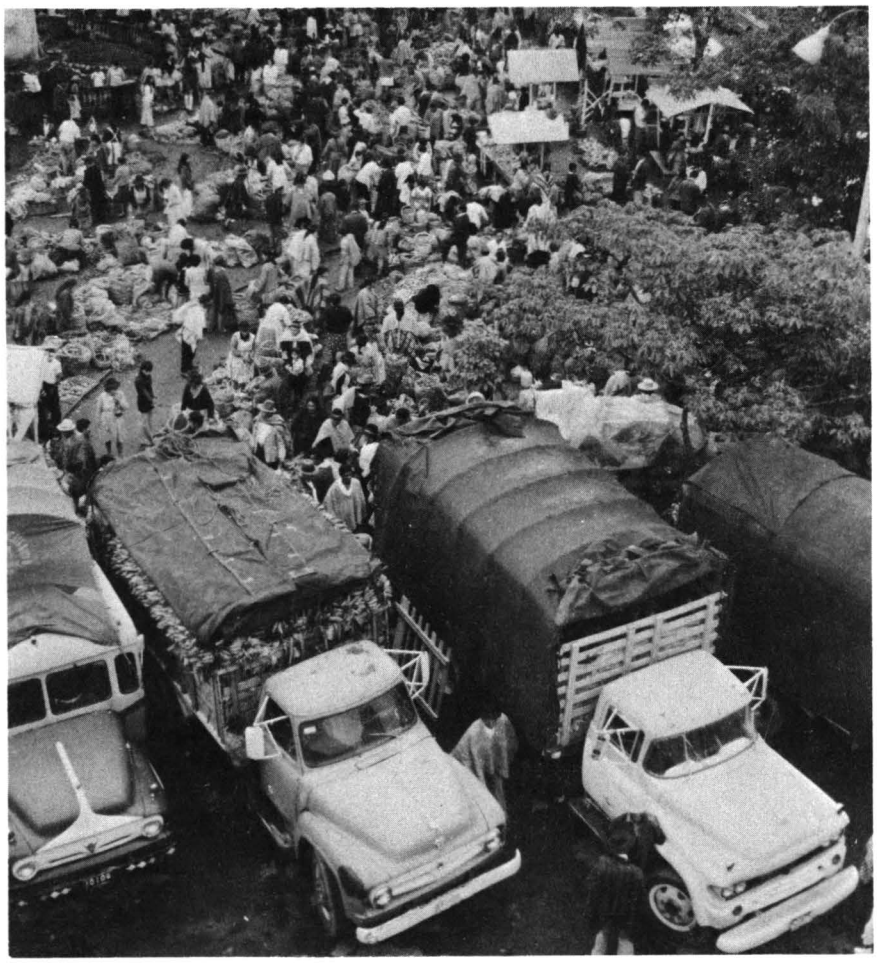
(*b*) an adequate return to the credit furnished by the loan or technical assistance agency, or both, to cover inflation plus total interest on capital;

(*c*) an additional income to the producer for having applied an improved technology or for having changed his cropping pattern.

In general, returns from new technology are high enough to support production programs that cover the farmer against the risks associated with the application of this new technology (or changes in cropping patterns) and that, at the same time, generate a return to the invested capital sufficiently high to pay for its real cost.

Experimental plan of the Caqueza Project

To test the above hypothesis the Caqueza Project staff designed an experimental credit and risk-sharing plan that would reduce the risks associated with the adoption of high-input recommendations for corn production (Appendix 2). Furthermore, the plan tried to reduce the cash requirement of the farmers to a level to which they were accustomed in their traditional production system (Zandstra and Villamizar 1974).



Competition among individual wholesalers forces prices up because it results in trucks, personnel, etc., being badly underutilized.

In 1974, 27 farmers collaborated with the Caqueza Project staff in carrying out this plan on an experimental basis. An analysis of the results showed that the plan realized its expected potential for increasing corn production and profitability. In turn, this suggested that production plans for crops with higher returns to invested capital (such as horticultural crops, see Table 4) could be even more attractive, and could provide even greater benefits to the farmer as well as to the loan agency.

Nevertheless, the execution of the corn production plan, or similar plans for horticultural crops, requires further refinements in design and management to reduce personnel inputs on the part of the loan or technical assistance agencies. These problems notwithstanding, the encouraging results obtained in 1974 indicate that, with the formulation of such a production plan and through the distribution of risks that this plan implies, a possible mechanism has been found to reduce the limitations the small farmer faces with respect to cash requirements and risk associated with the adoption of high-yielding production technologies.

Marketing

Another source of uncertainty concerning small farm income is the extreme variability in product prices. This is especially true for horticultural crops. Studies carried out in the project area show that, contrary to much accepted theory, produce

wholesalers have not created an oligopolistic market structure. Competition among individual wholesalers forces prices up because it results in trucks, personnel, etc. being badly underutilized (Chudt et al. 1973). This means that, although the costs of intermediary services are high, individual intermediaries do not earn excessive profits. A possible way around this situation is through vertical integration, or rather through addition to existing intermediary channels of active participation of producers as well as final retailers. Such participation could be achieved through the establishment of distribution warehouses in urban areas. These warehouses would be owned by groups of producers and storekeepers and would receive the farmer's produce, perform the tasks of classifying and repackaging, and would ultimately distribute these products directly to final retailers.[16] This system offers the double advantage of allowing the producers and retailers to participate in the profits of marketing activities. It would also improve the relationship between production and demand, since a much closer linkage would have been established between producers and retailers. This would allow the reduction of many uncertainties in estimating demand. Over a period of time this type of vertical integration, as it would lead to changes in production patterns, should tend to diminish seasonal fluctuations in product price.

Finally, this same market structure might be used to supply inputs to the producers in accordance with existing production plans and taking into account the input requirements of the specific technology being recommended. This supply of inputs is an indispensable activity of the market structure that should partially lessen the institutional risks the farmer incurs. Without this agricultural input service the producer, in the face of the uncertainty of acquiring seed, fertilizers, pesticides, etc., appears to prefer to continue with his present low input production system instead of adopting crops or technologies that could substantially improve his income through the use of more productive material inputs.

In 1974 the Caqueza Project started an experimental marketing plan (Appendix 3) (Swanberg et al. 1974). The experiences acquired in this plan to date are sufficiently encouraging to suggest that this type of plan has a role to play as part of an integral support structure for agricultural production.

Integral Support Structure for Agricultural Production

The small farmer's dependence on an institutional structure for credit, marketing, and technical assistance leads to uncertainties that in earlier chapters were called "institutional risk." If the farmer is fortunate enough to own his land or if he has obtained a cosigner for his credit (at a certain cost), he will receive the credit with which he can buy the required inputs, provided these are available in the area. The entity supplying the credit is not considered responsible if the necessary inputs for production are unavailable, nor is it considered at fault if the farmer is not offered adequate technical assistance. Even though the availability of inputs and technical assistance determines yield levels and, therefore, the small farmer's income, historically the agricultural support structure in Colombia (and elsewhere) has not assumed responsibility for these aspects.

It has been shown (see page 13 and Table 3) that the returns to capital invested in agricultural production are sufficiently high to compete for existing capital in other sectors of the economy. In addition these returns may be sufficiently high to justify investment by government required to obtain adequate technical assistance.

Production cost studies carried out by the Caqueza Project estimate that the returns to invested capital for corn grown with associated crops (averaging corn associations such as corn-beans, corn-broad beans-beans, corn-broad beans, and corn-peas) are 26% without using the technical assistance recommendations developed by the project and 70% when following the project staff's recommendations. For a potato-bean crop the estimate was 69% when not following recommendations and 151% with the application of the recommendations. Taking into account that the frequency of corn associations in the region is 66% and that of

[16]The final retailers can include neighbourhood stores, consumer cooperatives, supermarkets, etc.

potato associations is 26%, the weighted average for returns to invested capital is estimated at 38% without recommendations and at 93% with the recommendations obtained from technical assistance.

The amount of agricultural credit for the region was estimated at $400,000 in 1971 (Escobar P. 1973). Assuming that the amount has now reached $500,000, the estimated returns to this investment without technical assistance would be $190,000 and $465,000 with technical assistance. Each agent of technical assistance can generally manage recommendations equivalent to at least $10,000 a year, so the technical assistance personnel needed to attend to $500,000 would be 50 agents, mostly subprofessionals. With the yearly cost of such personnel, including administrative costs, estimated at $150,000, $125,000 annually would remain for the benefit of the country. This does not include the other benefits, already mentioned, of an increase in agricultural production and a substantial absorption of labour in rural areas.

These higher returns to investment in agricultural production can only be obtained if the granting of credit is conditional on:

(*a*) a knowledge of the economic benefits of the production process;

(*b*) the ensured availability of the necessary inputs to realize this production;

(*c*) the presence of a suitable system of technical assistance;

(*d*) the existence of a marketing service responsive to the farmer's production.

This requires that the agricultural support structure has an adequate knowledge of the economic potential of the different agricultural activities in the area, as well as of their market possibilities. On this basis it is possible to formulate production plans (such as the project's corn plan) through which the farmer receives credit, preferably in the form of inputs, and is assured a minimum yield. Such a service — which combines credit, the provisions of inputs, the guarantee of a minimum yield, the selection of viable production processes, the teaching of technologies, and an orientation in market requirements (all these services being offered in the form of production or marketing plans as previously described) — will enable the small farmer to intensify his production and increase his total income.

Institutionally there are many possible ways this integrated service can be formulated. ICA has obtained excellent results with interdisciplinary groups responsible for specific local areas. Their experience suggests that this model should be broadened to include within the interdisciplinary group representatives of the Agrarian Bank, a marketing institute, and farmers' groups, with the aim of unifying activities toward the establishment of an integrated support structure for agricultural production. This is similar to a so-called "work in commission" structure in which one institution makes personnel available to another institution, which in turn contributes the necessary funds and evaluates the finished work. In addition to linking representatives of various institutions, the responsibilities of each entity must be defined very clearly so the interinstitutional group will cover the whole production process, both from the market (inputs) to the field and from the field to the market (products).

In actual fact, existing institutions in rural areas are not easy to organize in this way. The branches of the Agrarian Bank, ICA's rural development projects and agencies, local private banks, other agencies involved in technical assistance, the Colombian marketing institutes, rural stores, as well as organizations of producers and cooperatives are all isolated in their work patterns and lack central coordination at the regional level. As long as this lack of coordination continues, the possibility of formulating strong plans as a basis for integrated support to production is remote. Unfortunately, the required coordination is unlikely to be obtained by the creation of informal agreements between various parallel or sister institutions, such as those that presently exist between the ICA and the Agrarian Bank.[17] For effective coordination, it appears necessary to designate or create, at the national and regional levels and also

[17]The problems related to the lack of coordination between ICA and the Agrarian Bank are discussed in *National Analysis of the CAJA-ICA Agreement,* Bogota, Colombia, Ministry of Agriculture, August 1974 (Spanish).

in rural areas, an entity with definite responsibility for the "coordinated execution" of integrated production support activities. This institution should be responsible for implementing production plans in collaboration with all participating institutions, with the latter being responsible to the executing agency. This agency should also be responsible for the distribution of the funds necessary to carry out the plan.

Any production increases achieved by the small farmer should significantly improve his contribution to the national economy.

Conclusions

The Colombian government has defined its objectives for rural development; these imply changes in the present production system of the small farmer. Studies carried out by the ICA rural development programs on the adoption of technology, rural credit, and risk show that it is necessary to identify and then to remove or reduce several constraints that currently limit small farmer production and income before these can be changed.[18] These constraints are seen in the uncertainties of production and prices, the uncertainties inherent in the institutional structure, and limitations encountered in the credit system, the existing market structure, and the knowledge of the performance of new production technologies at the regional level.

Although the small farmer is "caught up" in a system of low cost, low risk, low income — "the small farmer's low productivity trap" — the studies described herein indicate that high returns to capital invested in agricultural production are feasible. These returns justify the formulation of production plans offering support in the form of credit, inputs, technical assistance, and marketing, and also guaranteeing a minimum yield to the farmer.

Any production increases obtained by the small farmer should significantly improve his contribution to the national economy, create employment in rural areas and increase the average income of the rural population and their consumption of agricultural products. To bring this about, it is necessary to increase selectively (according to production potential) credit to the small farmer, lessen his production risk and the uncertainty due to the institutional structure (inputs and markets), and provide him with adequate technical assistance. Granting credit without assuring the availability of inputs, technical assistance, and markets creates an economic imbalance for the small farmer and carries with it a high cost because of misallocation of resources.

[18]The small farmer, efficient in his decision-making, has adjusted his method of production to existing conditions, achieving an equilibrium between possibilities and limitations. As long as the limitations are not substantially changed, there will be no significant changes in the production system of the small farmer.

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Appendix 1

General Area Description of the Caqueza Project

The data for this area description are based on secondary data obtained for the nine municipalities (counties) the project area covers and a survey of 623 households in eight of those municipalities that the project staff conducted in 1971 in collaboration with the Agrarian Bank. Some of the information has been updated by cost and production figures provided through experimental work and a further survey of 400 farm households in 1972.

The People

In 1970 the population of the project area was 89,000, of which 82% lived in the rural areas. In 1970, 30% of the population were under 10 years of age and 58% under 20 years of age. Over 80% of the population were born in the municipality in which they currently live.

Average family size was 7.5 persons and population density was 101.5 per square mile. The rate of net population growth was 1.0% per annum from 1954 to 1964. The age structure of the population suggests the existence of heavy migration (probably to Bogota). There also appears to be some migration to the larger towns in the project area, probably from the remoter areas where population has increased very little in the last 20 years. In 1972, 22% of household heads migrated temporarily at some time during the year, 46% of these to the Llanos and 40% to Bogota. Most such migration was for 6 months or less.

The Land

Eastern Cundinamarca is composed of nine municipalities covering an area of 672,000 acres. Four of these municipalities, Caqueza (26,400 acres), Chipaque (31,000 acres), Ubaque (29,000 acres), and Une (41,500 acres), have been the initial foci of the rural development effort to date. Four more municipalities have since been integrated into the operational area of the project. Forty percent of the total area in the region is not suitable for agriculture due to limitations of topography. Slopes range from 10 to 50% across the area and altitude above sea level ranges from 3300 to 12,800 feet. Of the area 42% is above 9200 feet and 33% is between 3300 and 7600 feet.

Soils in the area are rated as classes III, IV, V, and VII in the usual land-use capability classification, all having one or more of the following limitations: erosion, poor internal and/or external drainage, rocks, and claypan. Rainfall and minimum temperatures are also limitations for crops in some areas.

Farm sizes in the region vary although most of the farms are very small. Sixty-five percent of the farms covering 28.5% of the land are in units of less than 12 acres, 23% are between 12 and 25 acres and cover 11% of the land area. Only 4% of the farms are over 75 acres, but these units account for 42% of the land. However, much of this is upland and mountain grazing, which is unsuitable for cultivation. Seventy percent of the farmers own their own land, 18% are renters, and 12% both own and rent land.

Roads

The region is covered by a sparse network of roads, most of which are concentrated in the better agricultural areas. In total there are 242 miles of road of various types, or one mile of road per 4.3 square miles of area. The principal road crossing the region leads from Bogota to Villavivencio, a city of over 50,000 people on the edge of the Llanos. This road is paved and carries almost all the traffic and merchandise passing between the two areas. It passes through both towns of Caqueza and Chipaque, which are 26 miles and 16 miles respectively from Bogota. All the nine municipality centres are connected by road and further neighbourhood roads are being constructed and maintained to improve farmer access to local market towns.

Water

A number of rivers rise in the nearby mountains and flow eastward towards the Llanos. Due to uneven rainfall, the regime of these rivers varies considerably according to the season. Rainfall records are available for seven of the municipalities for a period of 20 years during which time the yearly average rainfall has been between 38 inches in the driest municipality, Chipaque, and 88 inches in the wettest one. Monthly rainfall averages from 0.4 – 2.1 inches according to the municipality in January to 4.3 – 14.4 inches in July.

Education

In 1970, 20,986 persons or 23.6% of the total population in the area were of school age. Of these, 15,095 or 72% were actually attending schools. There are 224 official primary schools in the area and three private ones; 36 of these are in towns and 191 in rural areas. Secondary schools are found only in the towns and, of the 18 existing, six are government schools and 12

are private. There is a teacher training school in Caqueza and an agricultural technical school in Fomeque. In 1971, the ratio of students to teachers was 30:1.

The latest survey of school levels was done in 1964 and the situation has changed somewhat since then. Some estimates of present conditions made by the project staff show that approximately 62% of the total population have attended only primary school, 27% have no schooling, 8% have attended secondary school, and 3% have attended university or some other type of higher training. It has been estimated that about 80% of the population over 7 years of age is literate.

Health

Health services in the region are based principally on hospitals in the municipalities of Caqueza and Fomeque, plus 4 health centres and 5 health posts. The hospitals each have a doctor as director and 3 assistant paramedics, the health centres each have a doctor 3 days a week plus paramedical assistants, and the health posts are manned by public health nurses. Medical attention is not within reach of all inhabitants in the region since for each health service unit there are 8160 people to be served and these units are not evenly distributed. Medical attention in 1971 at the centres included 18,321 consultations involving 1189 patients. Despite the fact that health service facilities are limited, the utilization of hospital bed-days was only just over 60%.

A nutrition and hygiene study was carried out in 366 homes. It was found that corn and potatoes were the principal components of the total diet and, along with milk, vegetables, and various types of beans, formed 74% of regular diets. Little meat and few eggs are eaten. Flush toilets were found in 8% of the houses, 12.5% had latrines, and the remaining 79.5% had no sanitary facilities.

Housing

Of the total population, 48% live in houses with less than 2 persons per room, 34% with 2 persons per room and 18% with 3 or more per room. Forty percent of the population live in houses with only 2 rooms and 47% of the houses have earthen floors. In 70% of the houses pigs and chickens run loose around the house and kitchen, creating further health hazards.

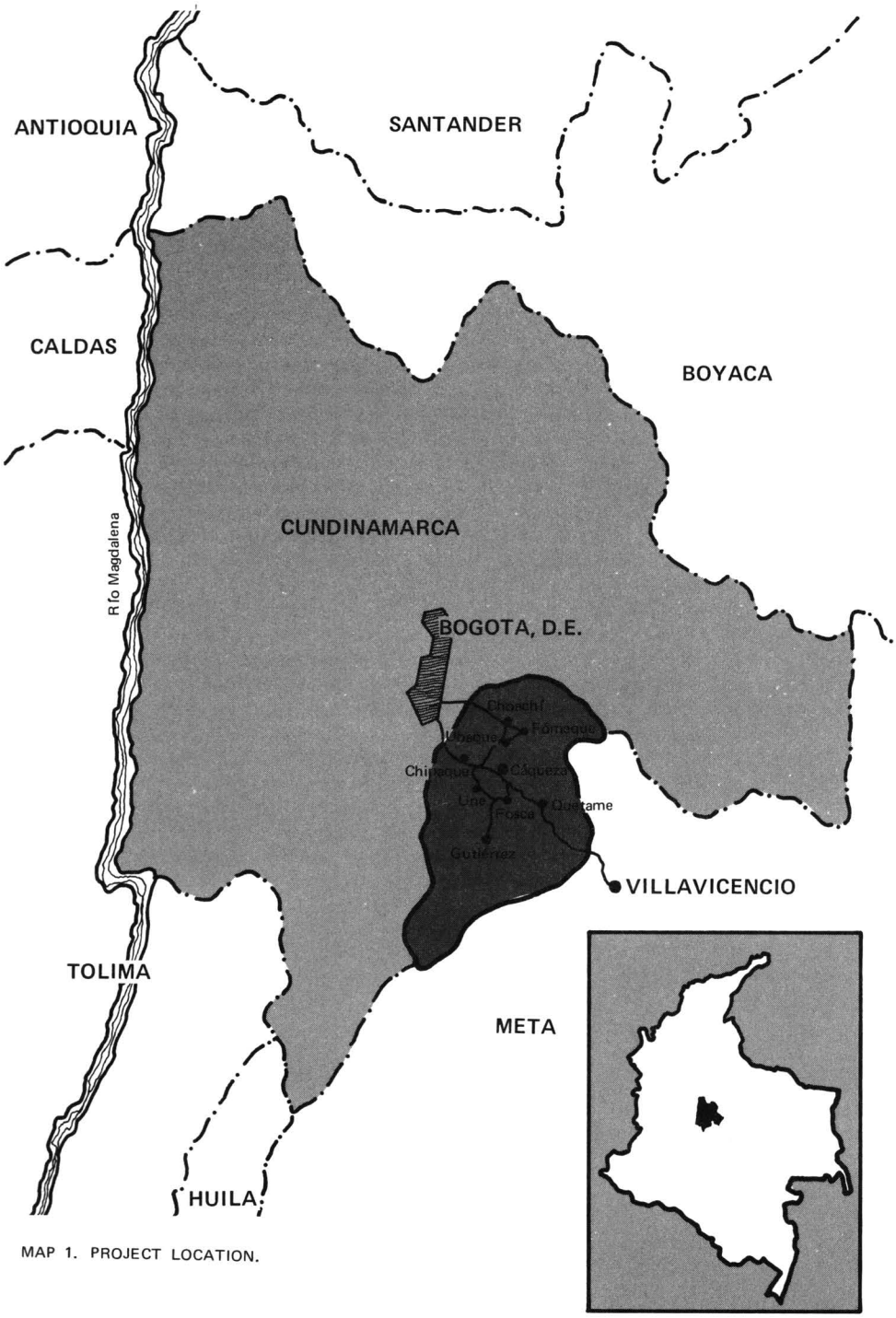
Public Utilities

Public utilities are poor in most of the region. Electricity is sporadic but all municipality centres are connected to the power network. Plans are afoot to improve the service over the next 2 years. All municipality centres have water delivered either by open canal or pipe from rivers and streams up to 6 miles away. All are gravity systems and no water treatment is provided. In the whole area, however, 82% of the population are not reached by such water systems and must carry water from local streams.

All municipalities have post offices, long distance telephone, telegraph, and radio reception. Three have local telephone systems, one a local radio station, and four receive television broadcasts. Only three municipalities have market buildings, the rest hold their markets in the open central square of the town. All but two have a municipal slaughterhouse where, for a small fee, farmers can bring their animals to be slaughtered.

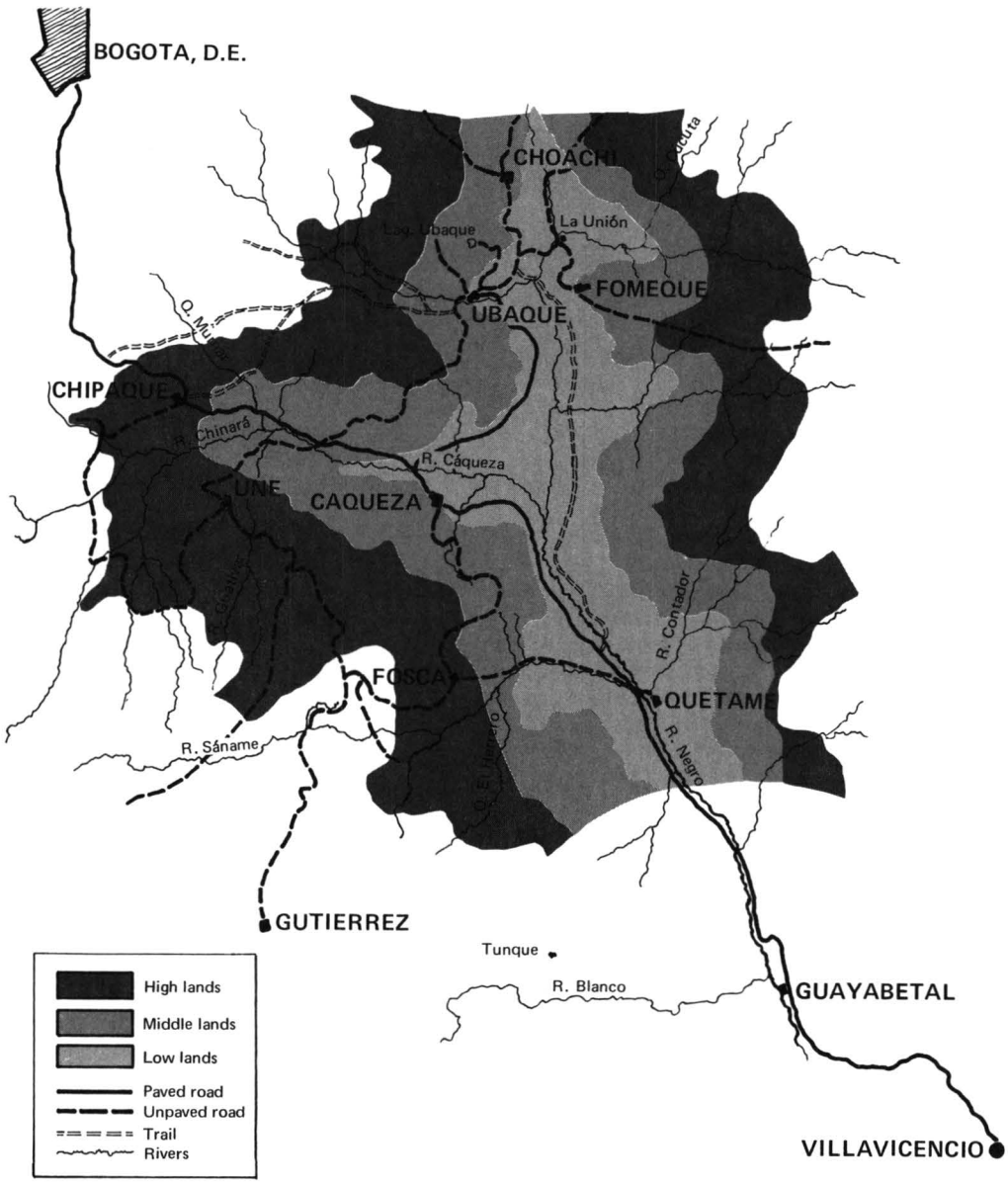
Income

Per capita income estimates were calculated in 1972 at $86 (Canadian). These estimates were based on cost account surveys of the major cropping patterns (the corn and potato associations); field staff estimates of multiple cropping arrangements; the project veterinarian's estimates of animal production earnings; and calculations of off-farm income derived from the household survey.



MAP 1. PROJECT LOCATION.

MAP 2. CHARACTERISTICS OF THE AREA



Appendix 2

Corn Production Plan

In 1974 the corn production plan operated in the following way: farmers interested in the plan specified the area they wanted to seed and supplied information about soil type, topography, and history of the field to be seeded. They also paid an entry fee of $10/ha (Appendix Table 1). Personnel of the Caqueza Project then visited the farm and together with the farmer formulated recommendations as to which variety or hybrid to seed and which type and quantity of fertilizers and insecticides to apply. The farmer received from the project an authorization to receive these inputs from the cooperative. The cooperative gave the farmer the seed, fertilizers, and insecticides required at planting time and at the time of side-dressing. The farmer signed a contract according to which he was to share equally with the cooperative any yield in excess of 800 kg/ha. If he were to break the contract, the farmer was required to pay a fine of $10/ha, and to reimburse the costs of the inputs he received from the plan.

Comparing the corn production plan with the actual production system and the project's recommendation (Appendix Table 2) it can be seen that the plan increased cash requirements by $10.00 (cost of entry). The cash requirement for a farmer participating in the plan is however, much less than for those who are applying the recommendation on their own. As for risks, the proposed plan is advantageous because the probability of obtaining low or zero yields is greatly reduced; the risk to the total investment is similar to that of the actual production system; and the risk to cash investment is substantially less than that which the farmer actually accepts with his present production system (Appendix Table 2, last three lines).

Appendix Table 1.
Basic characteristics of the corn production plan in the Caqueza Project (1974 prices (U.S. $) projected for 1975).

Entry fee	$ 10
Total investment by farmer	$107[a]
Total investment by plan	$111[b]
Minimum yield for the farmer	800 kg/ha
Expected yield for the farmer	1770 kg/ha
Expected yield for the plan	970 kg/ha
Net earnings of the farmer	$175
Net earnings for the plan	$ 50

[a]Total cost of land preparation, land, and labour.
[b]Total cost of fertilizers, seed, and insecticides.

Appendix Table 2.
Cash (U.S. $) requirements, returns to land, labour, and cash, and risks to the farmer under the existing production method, the corn production plan, and the method recommended by the Caqueza Project (all calculations are on a per hectare basis).

		Actual production system	Corn production plan[a]	Recommended production system
Cash investment by farmer:		$22.00	32.00	149.00
Net gain of farmer:		$61.00	175.00	214.00
Returns to total investment	per	$ 1.68	3.42	1.90
Returns to cost of land	per	$ 3.07	4.12	5.10
Returns to cost of labour	per	$ 2.61	5.33	6.69
Returns to cash	per	$ 3.75	6.03	2.44
P (yield of 800 kg/ha)		0.44	0.05	0.05
Risk on total investment[b]		$39.00	41.00	82.00
Risk on cash investment[b]		$ 3.40	0.50	55.00

[a]According to expenditure and income of the farmer.
[b]Calculating the expected value of the loss.

The production plan was formulated to reduce cash requirements and risks, as well as to avoid the possibility that returns to invested cash would be smaller than those obtained from the farmer's present production system. With respect to this, the returns to cash were increased from $3.75 to $6.03 for each dollar invested. This implies that the farmer pays $39 per hectare for insuring his minimum income when he participates in the plan (Appendix Table 2). Obviously, the farmer who is economically capable of accepting the risk associated with the application of technology will have greater gains if he himself finances the production process. Nevertheless, studies in the Caqueza project and experiences of project personnel indicate that the small farmer generally prefers to lessen his income slightly in exchange for security.

Appendix 3

Marketing Plan

The marketing plan was designed in response to several expressed problems of institutional risk presented by the small farmer. The plan attempted to establish a system of vertical coordination for the marketing of perishable products, staple goods, and agricultural inputs. Since supply and demand relationships determine the prices of perishable products at any given moment, these prices should be the determining factors for the selection of type and time of crop production. Therefore, a knowledge of the demand is of great importance to programs designed to increase income and returns to the small farmer.

The laws of supply and demand show that when the supply offered in the market is high the prices are low, and vice versa. Given that production is seasonal and that many products cannot be stored for long periods, price fluctuations will continue throughout the year, especially for onions, green peppers, lettuce, and potatoes. These fluctuations are much less marked for storable products, such as corn and rice. Under these circumstances, the seeding time of corn may be of little importance (the best physical-climatological moment could be chosen). The seeding time for very perishable products is, however, of great importance because a greater net income is possible if one can select the seeding time so the harvest coincides with a period of high prices, even though this may mean lower yields.

Since consumer demand in the retail market has been observed to remain constant throughout the year, a system must be established that provides the same volume of products, daily, throughout the year.*

The market plan was designed as a result of the above analysis. The plan started experimentally in September 1974 with the minimal capital of $2000 (U.S.) as a rotating fund, buying products in the area of Caqueza, Arbelaez, and La Mesa, and after sorting and repacking, distributing them to independent retail stores in Bogota.

During September and October sales reached an average of $500 per week. Due to lack of experience, gross margins during this period were negative, and operating costs relatively high. During November and December, however, sales increased and the gross margin was positive at 16%. But operating costs remained relatively high because of the small scale of operations.

At present, the plan has increased its working capital to $5000. In addition, affiliated organizations are obtaining lines of credit for staple goods and farm inputs. The plan will manage the major portion of this credit. Weekly capital rotation will be approximately $5000 in total volume of sales. Costs are estimated at $1000 per month. Cash working capital will be expected to turn over every 2 or 3 weeks. This operation will attend to approximately 10 rural producers' organizations and 20 retail stores. As earnings increase, prices will be adjusted, so that the plan will cover both its expenses and its capital costs, and not show a profit (the farmers-retailers association that should evolve from this experiment could elect to operate with a profit and distribute these earnings as patronage refunds before taxes.) This second phase of the marketing plan will run for 5 months.

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*The market plan organizers carried out a seminar with the participation of farmers and wholesalers in which the former understood the position of the latter and agreed that they have to plan their production in such a way as to be able to offer a constant quantity of produce throughout the year. Moreover, since the farmers know that each area has a favourable season for each crop, they themselves undertook to collaborate with producers in other areas, with different production schedules, to be able to offer jointly a constant supply.

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