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The feasibility of introducing Opaque-2 Maize for human consumption in Colombia

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Centro Internacional de Agricultura Tropical

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July 10, 1969
Dr. Per Pinstrup-Andersen
The Agricultural Economics Program
CIAT

Dear Dr. Pinstrup-Andersen

The Plant Sciences Division is planning to evaluate the productivity of the high lysine Opaque-2 corn hybrids developed through the breeding efforts of ICA and CIAT.

This project contemplates establishing evaluation plots with ten farmers in each of six Colombian regions important or potentially important for corn production.

The study will be carried out cooperatively between ICA and CIAT. ICA will provide technical assistance and administrative support, and CIAT will provide the services of six field assistants who will be in charge of the field activities involved in the evaluation. Also, CIAT will provide the inputs and travel expenses required.

This project will provide a good opportunity to study the technical, economic and social variables which may bear on the future acceptance of this corn by farmers and consumers. In addition, such data will be useful in attempting to expand the production of these high quality protein corn hybrids.

We hope that the agricultural economists can participate in this study to help identify and interpret the economic and social problems that may be relevant.

Sincerely yours,

Eduardo Alvarez-Luna

Eduardo Alvarez-Luna
Assistant Director
Plant Sciences, CIAT

Acknowledgments

A number of agencies and individuals collaborated in this study, including the Instituto Colombiano Agropecuario (ICA); Cresemillas, Palmira; the Instituto Colombiano de Bienestar Familiar; the Universidad del Valle and the Maizena and Quaker Corporations.

No attempt has been made to list all the individuals who contributed to the study. The major collaborators were Daniel Sarria, ICA; and Eduardo Alvarez-Luna, Francis Byrnes, Charles Francis, and Gerald Trant, CIAT.

The assistance of the six agronomists who carried out the CIAT-ICA field trials of Opaque-2 maize was essential to the collection of information among maize producers. These agronomists are Rafael Barreneche, César Augusto Bonilla, Carlos Escobar, Juan Darío Gómez, Hernán Sánchez and Gustavo Vera. Rafael Barreneche also assisted with the marketing survey and Colombia Molina conducted the consumer survey interviews. Finally, Camilo Alvarez processed a large part of the data.

The collaboration of the above-mentioned agencies and individuals and others who assisted in the study is acknowledged. The author has full responsibility for errors in the study.

Summary and conclusions

The objectives of this study were to identify the major social and economic obstacles to the introduction and expansion of the production, marketing and human consumption of Opaque-2 maize in Colombia, to determine under what circumstances such an introduction and expansion might be feasible, and to suggest possible roles for science, government and private enterprise in such a program.

Two ways to introduce and expand the human consumption of Opaque-2 maize were considered: (1) consumption of the product by maize-buying consumers, i.e., consumption based on commercial production, and (2) consumption on the farm of home-grown Opaque-2 maize.

It may be concluded that a rapid expansion of commercial production of Opaque-2 maize for direct human consumption is not feasible at the time of the study without considerable government subsidy. Promotion of Opaque-2 maize for home consumption among small farmers may be successful at low costs to the government.

The obstacles to a rapid expansion of commercial production and consumption of Opaque-2 maize are primarily associated with its softness and appearance. Hence, research emphasis is needed to develop a flint type high lysine maize.

Seven potentially key factors which might influence the results of efforts to introduce and expand the production and consumption of Opaque-2 maize were considered in the study. Furthermore, a number of alternative public policy measures which could be applied by the Colombian government with respect to Opaque-2 maize were outlined.

Five surveys carried out among maize producers, marketing agencies and consumers furnished basic data for quantitative analyses to estimate the importance of each of the potential key factors and how they might be varied to create conditions favorable to the production and consumption of Opaque-2 maize.

Production

Three factors are likely to inhibit efforts to encourage farmers to produce Opaque-2 maize: (1) low yields of Opaque-2 maize relative to other available hybrids, (2) farmers' adverse attitudes toward Opaque-2 maize, and (3) difficulties in storing Opaque-2 maize on the farm.

While experimental yields of the yellow Opaque-2 maize are about equal to the yields of the best normal hybrid, the yield capacity of the present white Opaque-2 maize is apparently low.

Recent field trials show that an introduction of white Opaque-2 maize either alone or as a part of an input package is likely to increase maize yields among farmers who do not presently grow the best hybrid.

Likewise, if Opaque-2 maize is introduced as an ingredient of a complete input package, the farmer presently growing the best hybrid at low levels of technology may improve his yield. In both cases, however, the yield increase is likely to be higher if the best normal hybrid is introduced instead of the Opaque-2 hybrid. Alternatively, if the farmer grows the best hybrid at high levels of technology, the yield of Opaque-2 maize is likely to be less. Thus, the commercial farmer who is prepared to apply new technology to increase maize yields would find it more profitable to choose the best normal hybrid if the market price of Opaque-2 maize is equal to or less than the price of normal maize. If the maize is produced primarily for home consumption, awareness of the high nutritional value of the Opaque-2 may lead him to plant it.

Efforts to introduce Opaque-2 maize among producers may be handicapped by its lighter weight and lack of resemblance to the maize most familiar to the farmer. A large majority of the farmers interviewed preferred ordinary flint types to Opaque-2 maize.

Farmers reported that insect damage during storage was much more severe for Opaque-2 maize than for flint types. It was indicated that on-farm storage, even for short periods, without the use of insecticides would result in a great or complete loss.

The farmers' attitudes about and ability to change and the approach and competence of the change agent are other important variables to be considered in any introduction program.

The level of technology currently used by the farmers was found to be low. Less than half of the farmers interviewed used improved seed, one-third used fertilizer on maize, and one-half used insecticides. The major barriers for a rapid expansion in the use of these inputs were lack of credit and lack of knowledge about how to grow maize.

Data from this study lead to the conclusion that it is not feasible to promote commercial production of white Opaque-2 maize unless the producer price is above the current price of normal maize. Larger, semi-commercial field trials are needed to determine the relative yields of the latest back crosses of yellow Opaque-2 maize before any decision can be made about promoting yellow Opaque-2 maize.

It may be feasible to promote the production of Opaque-2 maize among small farmers for home consumption. But the acceptance of Opaque-2 maize by the farmers' wives tends to be low unless they are aware of and appreciate the higher nutritional value. Considerable effort may be needed to inform and educate farm families on this point.

Furthermore, the introduction of Opaque-2 maize to farmers must be accompanied by an effective educational effort with respect to cultivation and storage practices. Heavy losses during storage, unexpected low yields and reduced protein value because of cross fertilization with local varieties or hybrids grown nearby, are but some of the risks the farmer faces unless precautions are taken.

Efforts to promote commercial production of Opaque-2 maize without a price differential to offset the effect of lower yields on total sales revenues would likely fail.

Marketing

Lack of willingness among wholesalers to buy Opaque-2 maize may be a serious barrier to sustained production. Only

8 percent of those interviewed said they would buy Opaque-2 maize at a price equal to that of ordinary maize.

Under perfect market conditions preferences at the wholesale level are determined by consumer preferences. Considering its low consumer acceptance it is not surprising that wholesalers are unwilling to buy Opaque-2 maize. Results from the marketing survey indicate, however, that the wholesalers were unaware of the present or potential level of consumer acceptance of Opaque-2 maize.

Because of limited communication between consumers and wholesalers in the Colombian maize market it is not certain whether or how fast the wholesalers would respond to greater consumer acceptance.

The marketing survey indicated that a farmer producing Opaque-2 maize may have severe difficulties selling it unless he grows on contract for processors. In addition to the earlier mentioned price differential, the farmers, or the wholesalers, must be assured a market for Opaque-2 maize if efforts to introduce and expand its commercial production are to be successful.

Consumption

Low consumer acceptance was identified as the most important barrier to a rapid expansion of the consumption of Opaque-2 maize, which is disliked primarily for its floury texture. Furthermore, consumers generally considered it inferior to the flint type, as well as to other floury maize, because of its appearance. The majority of the homemakers interviewed reported differences between Opaque-2 maize and ordinary flint type maize in preparation and cooking quality.

These differences are associated with the softness of the endosperm. While the majority of the homemakers said that Opaque-2 maize was easier to prepare because it was soft, they also assumed that it could only be used for certain products or dishes. The majority said that they would buy ordinary flint type maize instead of Opaque-2 maize if both were available at the same time.

Homemakers were considerably aware of prices Given the low preference of Opaque-2 maize, it would not seem feasible to introduce it at a retail price above that of ordinary maize. Even if a considerable preference differential did exist, lack of purchasing power would likely prohibit rapid replacement of present varieties by Opaque-2 maize at a higher retail price.

The belief that Opaque-2 maize cannot be used for certain products or dishes may be well-founded. If traditional cooking methods are used, the results of using Opaque-2 maize may be a failure. However, if cooking methods were changed slightly, Opaque-2 maize could be used with satisfactory results. Efforts to increase consumer acceptance should include an educational campaign explaining how to modify the cooking methods presently used.

The majority of the homemakers knew that foods of animal origin have a higher nutritional value than most plant products, although most of them did not know why. Promotion of Opaque-2 maize using the higher quality protein as the argument will probably not be successful unless preceded by an educational campaign through which consumers learn the importance of protein in the diet. Opaque-2 maize might be successfully promoted by a campaign which equates its nutritional value to that of meat or milk.

A promotional campaign to introduce Opaque-2 maize should be directed not only to the homemakers but also to the head of the household. In a large proportion of low-income families, it is the husband who buys the maize and maintains a strong position as decision maker.

The results indicate that to reach the low income groups, Opaque-2 maize should be available in the central market place as well as in certain grocery stores and with grain dealers.

Most of the families studied did not obtain sufficient high quality protein. The primary reason was lack of purchasing power. To what extent might Opaque-2 maize be able to fulfill the protein deficiencies among these families? The weekly consumption of maize was found to be 0.6 and 1.0 kilograms per capita for each of the two consumer sub-samples, re-

spectively. If, as pointed out by Clark, the daily adult requirements of essential amino acids can be fulfilled by 250-350 grams of Opaque-2 maize, the families in the two sub-samples could receive almost one-third and one-half, respectively, of their essential amino acid needs from maize if they shifted to Opaque-2 and maintained the present level of consumption.

While replacement of ordinary maize by Opaque-2 maize is likely to reduce considerably the present high level of malnutrition among low-income families in Colombia, such replacement will not occur under free market price determination except perhaps among the producers themselves. A rapid expansion of the consumption of Opaque-2 maize among maize-buying consumers is likely to come about only if a flint type lysine maize can be developed, or the present floury Opaque-2 maize can be sold at a retail price below that of ordinary maize. Because of the lower yields, the commercial producer would not have any incentive to produce Opaque-2 maize unless the farm price were above that of ordinary maize. A subsidy would thus be necessary if the commercial production and human consumption of the present Opaque-2 maize were to be rapidly expanded. In addition, an intensive promotional campaign would be necessary among consumers as well as producers.

Assuming that the consumer would shift from ordinary to white Opaque-2 maize at a price differential of 10 percent, the size of the government subsidy necessary to promote the present floury Opaque-2 maize would be determined by 10 percent of the farm price (the yield of white Opaque maize is approximately 10 percent below that of ordinary maize)and 10 percent of the retail price, plus promotional costs. Present farm and retail prices are around Col. $1.70 and Col. $ 2.20 per kilogram, respectively. Hence, the subsidy would be Col $ 0.39 per kilo. The total human consumption of maize in Colombia is about 560 thousand tons annually. 1/ Hence the total government cost of replacing ordinary maize by Opaque-2 maize would be Col $ 218 million annually plus the cost of the promotional efforts among producers, consumers and marketing agencies.

1/ Total production for 1968 was estimated as 845 thousand tons (L. Jay Atkinson, Changes in Agricultural Production and Technology in Colombia, U.S. Department of Agriculture, Foreign Agricultural Economic Report No. 52, 1969). About 67 percent of the quantity produced is utilized for human consumption (Manual de Costos, Caja de Crédito Agrario, Colombia, 1967).

If the farm yields of the present Opaque-2 maize could be brought up to the yields of ordinary maize, only a small, if any, producer price differential would be needed to replace the production of ordinary maize by Opaque-2 maize. The necessary retail price differential, however, would remain unchanged. Government costs would be Col.$123 million annually plus promotional costs. If a flint type Opaque-2 maize is developed, it appears that no retail price differential would be needed. In this case, government costs might be limited to those associated with the promotional campaign.

Recommendations

It is recommended that major emphasis be placed immediately on research to develop within the shortest time possible a flint type high lysine maize with a yield capacity equal to that of normal hybrids. 2/ As soon as a commercial hybrid with these characteristics is available, it should be introduced, accompanied by sufficient promotion among producers, marketing agencies and consumers, to obtain a rapid replacement of normal maize.

When it is known that the flint type high lysine hybrid has a competitive yield capacity and consumer acceptance, it may be considered to terminate all production and sale of seed of normal hybrids, thereby accelerating the adoption of high lysine maize. Such action cannot be recommended on the basis of the present Opaque-2 maize.

Furthermore, it is recommended that, while waiting for a flint type high lysine maize, the present Opaque-2 maize be promoted for production and home consumption among low-income farmers. Such promotional efforts should only be attempted as a part of a complete input package including credit and technical assistance extended to the farmer, perhaps using a regional approach similar to that of the Puebla Project in Mexico. It is essential that the farmer obtain seed of Opaque-2 maize (for planting aimed at home consumption) as well as

2/ Preliminary results from chemical and biological analyses at CIAT, ICA and CIMMYT suggest that this type of maize can be developed.

seed of the best hybrid (for planting aimed at sale). Given the present market situation for Opaque-2 maize, it cannot be recommended to extend to the farmer Opaque-2 seed for commercial production unless some arrangement is made that will establish a market for Opaque-2 maize at a price above that of normal maize. Such an arrangement could consist of contracts with the processing industry or government production and/or price subsidies.

The decision as to whether such subsidies are provided rests with the government of Colombia and should be determined on the basis of priorities as related to the urgency of reducing the level of malnutrition, the social cost involved, and alternative public investment opportunities. While the public subsidy might allow for an immediate rapid expansion of the consumption of Opaque-2 maize at a relatively high public cost, attempts to develop a flint type high lysine maize might allow for a rapid rate of expansion of its consumption at a relatively low public cost, but postponed 3-5 years.

Promotion of the present white Opaque-2 maize for commercial production aimed at human consumption cannot be recommended without special market arrangements. The results would likely reduce farm income and generate a lack of confidence in the agencies promoting new technology.

It is recommended that research by industry to incorporate Opaque-2 maize into complex products such as baby foods be continued and supported.

It is further recommended that research aimed at determining social and economic relationships relevant to the production, marketing and consumption of Opaque-2 maize be continued and supported. Major attention should be placed on obtaining more specific market information. In particular, it would be important to obtain information on the relationship between consumer preference, relative retail price of Opaque-2 maize, and quantity purchased in order to determine the maximum price of Opaque-2 maize relative to the price of normal maize at which the consumer would shift from normal to Opaque-2 maize. It is important to consider both regions where the soft type maize is consumed and those where flint type maize is the most important maize.

Introduction

The development of maize hybrids with a high content of essential amino acids presents new ways to reduce the extensive protein deficiency which prevails among low income families in the developing world.

While the production of rice and maize has increased rapidly in many developing countries in recent years, little increase has been made in the production of foods containing high quality protein. Measured on a calorie basis, the price of traditional high quality protein commodities, such as meats and milk, is high relative to the price of commodities containing lower quality protein, i.e., maize. Hence, while low income families may be able to satisfy their needs for calories, they often do not have the purchasing power to satisfy their protein requirement.

Other less costly food commodities, such as soybeans and fishmeal, which contain high quality protein, are available. But most consumers do not readily accept these products. Processing, often complicated and costly, may be needed before the products are accepted as human food. Even then it may be difficult to develop a considerable demand for such products among low-income families, because the products are not customarily eaten.

An ideal solution to reduce or eliminate protein deficiencies among low-income families seems to be to improve the protein quality of a staple commodity which these families traditionally consume in large quantities.

Maize is one of the most important staple foods for low-income families in Latin America. Improvement of the quality of maize protein thus offers a unique opportunity to reduce protein deficiencies among the people of Latin America.

Maize protein is normally deficient in the essential amino acids lysine, tryptophane, and methionine. Opaque-2 maize, which is the best known high lysine maize, contains from 70 to 100 percent more lysine and about 70 percent more tryptophane than normal maize. Recent research indicates that reasonable quantities of Opaque-2 maize can fulfill the adult human requirements for essential amino acids and thus eliminate protein deficiency. 3/

Seed of Opaque-2 maize was first brought into Colombia in 1964. Succeeding breeding efforts by the Colombian Institute of Agriculture (ICA) and The Rockefeller Foundation in Colombia have resulted in two commercial Opaque-2 maize hybrids suited for Colombian conditions at altitudes between 600 and 1,200 meters above sea level. 4/

The prominent place of maize in the Colombian diet, particularly among low-income groups, and extensive protein deficiency among these families, seem to justify an introduction and expansion of the production and consumption of Opaque-2 maize in Colombia. Before the production and consumption of Opaque-2 maize is promoted, however, answers should be sought to two basic questions:

1. Under what circumstances would it be economically feasible to introduce and expand the production and human consumption of Opaque-2 maize in Colombia? 5/

2. What might be the roles of science, government and private enterprise in promoting and accelerating the production, marketing and consumption of Opaque-2 maize?

This study is an attempt to supply information from which tentative answers to these questions may be obtained. Furthermore, specific needs for further analysis are indicated. On this basis, these tentative answers may be verified and more detailed information obtained.

3/ Clark reports that 250-350 grams of Opaque-2 maize was found to satisfy the daily protein and essential amino acid requirements of young adults (H.C. Clark. "Opaque-2 corn as a source of protein for adult human subjects." Purdue University, Indiana 1966).
Bressani estimated that the quality of Opaque-2 maize protein was about 90 percent of that of skim milk when consumed by children (R. Bressani. "Protein Quality of Opaque-2 Maize in Children." Corn Industries Res. Fdn., Washington, D. C., 1966). Pradilla and Harpstead found that children suffering from Kwashiorkor (severe protein deficiency disease), recovered on a diet in which Opaque-2 maize was the only source of protein (D.C. Harpstead and A. Pradilla. "High Lysine Corn Human Nutrition ".Simposio sobre Milho Opaco .Voscosa, Minas Gerais, Brazil, 1968 and unpublished data from A. Pradilla).

4/ The two hybrids are I C A H-208 (yellow) and I C A H-255 (white).

5/ Whether the project is economically feasible depends on social costs and benefits which may or may not be equal to private costs and benefits.

The specific objectives of the study are:

1. To identify the major social and economic obstacles to the introduction and expansion of the production, marketing and human consumption of Opaque-2 maize in Colombia.

2. To determine, on the basis of the results obtained in (1), the circumstances under which an introduction and expansion of the production and human consumption of Opaque-2 maize in Colombia may be feasible and what might be the roles of science, government and private enterprise.

Theoretical framework

As a first step, it is useful to establish a frame of reference concerning the following three factors:

1. The possible ways by which the production and human consumption of Opaque-2 maize might be introduced and expanded.

2. The key factors determining the outcome of such an introduction and expansion.

3. The courses of action that may be taken to accelerate this introduction and expansion.

An introduction and expansion of the consumption of Opaque-2 maize may take place among the maize-buying consumers, or among the maize producers themselves.

Expanding the consumption of Opaque-2 maize based on commercial production

The commercial farmer must have as an economic incentive expected higher net returns before he will change from the production of present maize to Opaque-2. If yields as well as cost of production per unit of land are equal for Opaque-2 maize and the variety presently produced, the expected producer price of Opaque-2 maize must be slightly higher than that of the variety presently produced. Lower yields or higher cost of production of Opaque-2 maize must be compensated by a higher price.

Under free market price determination, the producer price is derived from the consumer price less the marketing margin. Opaque-2 maize can be sold at a price higher than the prevailing price of ordinary maize only if consumers prefer Opaque-2 maize and if they have additional purchasing power.

If there is a strong desire on the part of society to expand the consumption of Opaque-2 maize, the government may intervene in the price formation. A price subsidy may result in higher producer prices and/or lower consumer prices than those obtained with free market conditions. Likewise, the government may directly subsidize the production of Opaque-2 maize, thus reducing the cost of production of Opaque-2 maize relative to the cost of producing ordinary maize.

Expanding the consumption of Opaque-2 maize among producers

The majority of subsistence and marginal market farmers in Colombia grow a small acreage of maize primarily for home consumption. A replacement of their present maize, whether local varieties or hybrids by Opaque-2 maize, might be a significant step toward reducing or eliminating protein deficiency among rural residents.

The decisions subsistence farmers make about the crops and varieties they grow may be, at least to some extent, independent of the relative market prices of the products. Traditions, consumption preferences and needs may influence the choices. The success or failure of efforts to introduce and expand the production and consumption of Opaque-2 maize among subsistence and marginal market farmers may thus depend less on the market price of Opaque-2 maize relative to the price of ordinary maize and more on other factors.

The farmer's attitudes toward and ability to change, and the approach and competence of the change agent, are key variables to be considered in any introduction program. His attitudes are determined primarily by the strength of tradition, his level of education, and his confidence in the new technology. His ability to change is determined primarily by the quality and quantity of resources available to him as well as his managerial ability.

Efforts to introduce Opaque-2 maize must also deal with the family's maize consumption pattern and preferences.

Differences in cost of production and yields may be important. Given his resource constraints, the farmer will probably sustain little interest in Opaque-2 unless it yields considerably more than his present maize, which in most cases is non-hybrid. The question also arises as to the yields of Opaque-2 maize relative to other available hybrids. If channels of communication can be established through which new technology can flow to the small and disadvantaged farmers, the choice of which maize to use may be determined by relative yields of the varieties and hybrids available. However, if the farmer and his family prefer Opaque-2 to ordinary maize, he may decide to produce it even though other higher yielding hybrids are available. Finally, low yields or high cost of production of Opaque-2 maize may be compensated by government production subsidies.

Apparent key factors

The key factors influencing the results of efforts to introduce and expand the production and consumption of Opaque-2 maize, whether commercially or for home consumption, appear to be:

1. The yield of Opaque-2 maize relative to the varieties presently grown and the best hybrids available.

2. The relative costs of production and farm storage of Opaque-2 maize versus other maize.

3. The farmers' attitudes toward and ability to change.

4. The government policy with respect to production and price subsidies.

In addition there are three key factors which apply only in the case of commercial production:

5a. Consumer preference and the available purchasing power.

6a. The relative cost of marketing.

7a. The marketing agencies' willingness to handle Opaque-2 maize.

In the case of production of Opaque-2 maize for home consumption, one factor should be added to the above four:

5b. Consumption preferences among producers.

Courses of action

A campaign to introduce and expand the production and consumption of Opaque-2 maize must be based on changing the magnitudes of the above factors to a point where they, in combination, contribute to a set of conditions more favorable to Opaque-2 maize than to present varieties and hybrids. The choice of strategy to accomplish these changes should be determined by their contribution to social welfare and can be justified only if they improve it.

There is no unique measure of social welfare. One measure which might be used in the case of Opaque-2 maize is the impact on human nutrition per unit of resources used. The cost of obtaining similar impacts on human nutrition using other acceptable means and the impact of the various policies on employment, incomes, and income distribution are parts of the measure.

The courses of action open to science and government in the case of Opaque-2 maize include the following:

1. At the input level:

   a) Making seed of Opaque-2 maize available at a price equal to or slightly above its cost of production and marketing.

   b) Subsidizing the production of seed of Opaque-2 maize, hence reducing its price to the farmer.

   c) Making a direct subsidy available to the producers of Opaque-2 maize. The size of the subsidy may be determined by:

(1) The acreage on which Opaque-2 maize is grown.
(2) The quantity produced, or
(3) The quantity of purchased input used, e.g., a two-price scheme for fertilizer.

This course of action may be combined with either (a) or (b).

d) Introducing massive efforts to expand the use of improved technology among the farmers with major emphasis on the introduction of seed of Opaque-2 maize. By introducing seeds of Opaque-2 maize as an ingredient of a complex input package, possible yield handicaps may not be noticed because of the larger increase in yields resulting from the other components of the input package. This course of action may be combined with (a), (b) or (c).

e) Withholding the present Opaque-2 maize seed from the market, while concentrating on the development of seed with higher yields and/or more acceptable quality, e.g., flint type seed.

2. At the output level:

a) No interference. Free market conditions prevail.

b) Carrying out educational and/or promotional campaigns with the objective of shifting consumer preference among maize-buying consumers and/or producers towards Opaque-2 maize. Such campaigns may be carried out by public agencies, private firms or both.

c) Introducing price support for Opaque-2 maize to reduce consumer prices and/or increase producer prices. This course of action may be combined with (b).

d) Introducing marketing subsidies with the objective of reducing the cost of marketing Opaque-2 maize. This may be combined with (b) or (c).

e) Carrying out promotional campaigns aimed at an improvement of the attitudes of marketing agencies toward Opaque-2 maize. This may be combined with (b), (c) or (d).

The following sections of this study attempt to determine the present stage of each of the earlier-mentioned key factors and to point out the most feasible courses of action to change their relative magnitudes to create conditions favorable to an introduction of Opaque-2 maize.

Data sources

Primary data were obtained from five surveys carried out among maize producers, marketing agencies and consumers. Sampling procedures and certain sample characteristics are discussed in the Appendix.

The producer surveys

In three producer surveys, data were sought on the following seven major topics: Present stage of technology in maize production; attitudes and ability to change; utilization of the maize produced; certain facets of marketing and storage; present nutritional stage; level of knowledge with respect to certain aspects of human nutrition; and acceptability of Opaque-2 maize. The surveys covered 154 farmers in 12 departments of Colombia (Figure 1).

The Marketing surveys

Twenty-five wholesalers of maize in five towns in the Department of Valle were interviewed to determine their attitudes towards Opaque-2 maize. 6/

The survey was limited to Valle because of the greater awareness of Opaque-2 maize in this Department. This awareness is associated primarily with the efforts of two companies, Maizena and Quaker, in Cali, along with the experimental work of ICA at Palmira. 7/

6/ Five wholesalers were interviewed in each of the following towns : Cali, Palmira, Buga, Tuluá and Cartago.

7/ Colombian breeding work with respect to Opaque-2 maize has been done primarily at the ICA Station in Palmira. The work done by Maizena and Quaker will be discussed in a later section.

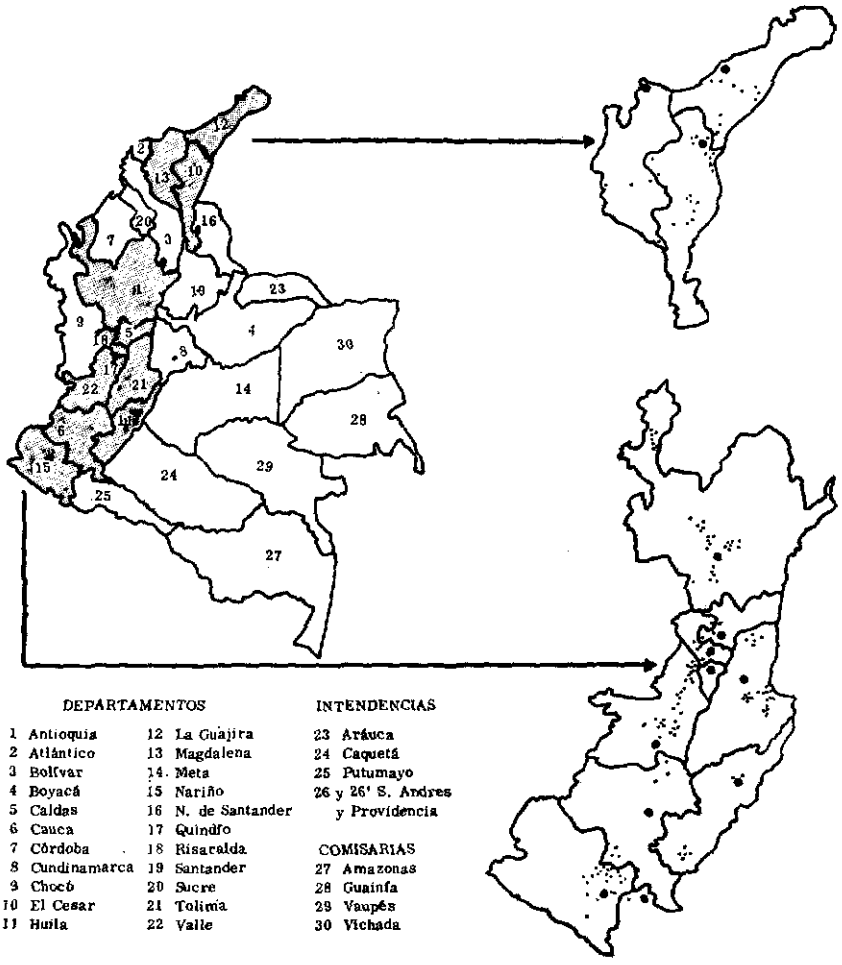

Figure 1. Illustration of the geographical location of the farmers interviewed (the two islands San Andres and Providencia are not shown in the map).

Although little Opaque-2 maize had been handled by the wholesalers, their opinions and attitudes toward the product might be significant factors to consider in an introduction program..

The consumer survey

In the consumer survey 50 homemakers were interviewed on maize consumption and purchasing patterns, their knowledge of certain aspects of human nutrition, and their reaction to Opaque-2 maize. Thirty of the homemakers lived in a low income section of Cali, while 20 lived in a low income rural town near Palmira, Valle. Each of the homemakers received two one-pound bags of maize, one with white Opaque-2 maize and another with ordinary white flint type maize. They were asked to cook the two types of maize on different days, and to decide for themselves the method of cooking and the end products.. Three days later their reactions were obtained in a follow-up interview.

Other data sources

Secondary data were obtained from several sources, including ICA, Quaker and Maizena.

Relative yields and costs of production

The yield capacity of Opaque-2 maize is analysed by means of three yield comparisons:

1. The relative yields obtained at the ICA experiment stations.

2. Those obtained from field trials among commercial as well as subsistence farmers using various levels of technology.

3. Those obtained by commercial farmers using a high level of technology.

Experimental yields

ICA has incorporated the Opaque-2 gene into the two high-yielding normal hybrids H-207 (yellow) and H-253 (white), the resulting products being named H-208 (yellow) and H-255 (white), respectively. The experimental yields of these two Opaque-2 hybrids and the two normal hybrids during six growing seasons are shown in Table 1.

Table 1. Experimental yields of basic material, simple crossing and backcrossing of two Opaque-2 hybrids.

Hybrid	Description	Number of growing seasons	Average yields kg/ha.	Index com. hybrid = 100
H-207	Normal yellow hybrid	6	6.821	100.0
H-208	Simple cross between normal and Opaque-2	5	4.627	67.8
	First backcross	3	5.573	81.7
	Second backcross	3	5.792	84.9
	Third backcross	2	6.648	97.4
	Fourth backcross	1	7.557	110.8
H-253	Normal white hybrid	6	7.565	100.0
H-255	Simple cross between normal and Opaque-2	5	4.679	61.8
	First backcross	3	5.637	74.5
	Second backcross	3	5.906	78.0
	Third backcross	2	6.116	80.8
	Fourth backcross	1	6.717	88.7

Source: ICA, Palmira.

Remarkable increases have been obtained in the yields of the two Opaque-2 hybrids by recurrent backcrossing. The yield obtained from the fourth backcross is almost twice that obtained from the first simple cross. 8/

8/ For a discussion of the breeding efforts carried out in Colombia with respect to Opaque-2 maize see: Daniel Sarria V. and Clímaco Cassalett D, " Transformación de Maíces Normales A Maíces con el Gene Opaco-2," Revista ICA, Vol. IV, No. 4 Diciembre 1969.

Results indicate that the yellow Opaque-2 hybrid has reached a yield capacity equal to that of the yellow normal hybrid, while the yield capacity of the present white Opaque-2 hybrid is somewhat below that of its normal counterpart.

Yields from field trials

A joint CIAT-ICA project was launched to test the performance of Opaque-2 maize under actual farming conditions at various altitudes. Each field trial included five treatments. White Opaque-2 maize was grown at two levels of technology: that currently used by the farmer, and that considered optimal for the location. The maize traditionally used by the farmer was also grown at the same two levels of technology Finally, the best normal hybrid for that region was grown at a high level of technology. Average yields and yield differences are shown in Table 2.

Opaque-2 maize yields were greater than those of the varieties and hybrids currently grown by farmers participating in the trials. Yields were 12 percent above those of current varieties under current technologies, and about 20 percent above those with an optimal level of technology. Replacing the maize currently grown with Opaque-2 would thus appear to increase farm yields.

Introducing Opaque-2 maize as part of an input package to improve present technology among participating farmers could increase yields by 80 percent. The impact on the individual farmer's maize yield would depend on his present level of technology, including type of seed used. Farmers presently growing the best hybrid under high levels of technology would experience a yield decrease of about 10 percent if they changed to Opaque-2 maize.

The Opaque-2 maize seed used in these field trials was a fifth generation backcross white Opaque-2 hybrid. Although the yield capacity of this backross has not yet been reported by ICA, the yield capacity of the fourth backcrossing was found by ICA to be 89 percent of that of the normal hybrid H-253. Hence, the yield differences obtained from the field trials with respect to the fifth backcross Opaque-2 hybrid and the best

Table 2. Yields obtained from field trials on Opaque-2 maize 1/

Level of Technology	Seed	Yields Kg/ha.	Yields Index 2/	Yields Index 3
Current	Current variety or hybrid	1,962	100	50
Current	Opaque-2	2,198	112	56
Optimal	Current variety or hybrid	2,952	150	75
Optimal	Opaque-2	3,557	181	90
Optimal	Best hybrid	3,951	201	100

1/ Results from 22 farms in five regions of Colombia, one growing season 1969-70. A more detailed analysis of the field trials will be published by the Plant Science Divisions of CIAT and ICA at a later date.

2/ Setting the yields obtained from the variety or hybrid currently used by the farmer using the technology he currently applies equal to 100.

3/ Setting the yields obtained from the best hybrid using a high level of technology equal to 100.

normal hybrid were essentially the same as the yield differences obtained at the ICA experiment station between the fourth generation backcross and the normal hybrid H-253.

The field trials indicate that an introduction of white Opaque-2 seed, either alone or as a part of an input package, is likely to increase maize yields among the farmers who do not presently grow the best hybrid. Likewise, if Opaque-2 maize is introduced as an ingredient of a complete input package, the farmer presently growing the best hybrid at low levels of technology may improve his yield. In both cases, however, the yield increase is likely to be higher if the best normal hybrid is introduced instead of the white Opaque-2 hybrid. Alternatively, if the farmer grows the best hybrid at high levels of technology, an introduction of Opaque-2 maize is likely to reduce yields. Thus, the commercial farmer who is prepared to

apply new technology to increase maize yields would find it more profitable to choose the best normal hybrid if the market price of Opaque-2 maize is equal to or less than the price of normal maize. If the maize is produced primarily for home consumption, awareness of the high nutritional value of the Opaque-2 may lead him to plant it.

Commercial yields

Average yields of Opaque-2 maize produced on contract for two processing companies in Cali were reported as 3.1 and 3.2 tons per hectare on 23 and 130 hectares, respectively. The maize was grown in Valle on good soils at high levels of technology. The seed was a fifth backcross. These yields appear to be below the yields obtained in Valle from normal hybrids using this level of technology.

The farmers producing Opaque-2 maize on contract for the two previously mentioned processing firms are guaranteed a price of 15 to 20 percent above the current maize price to compensate for expected low yields. Likewise, the price received by the farmers producing seeds for Caja Agraria is 15 percent above the price received when producing seed of ordinary maize.

Relative cost of production and on-farm storage

Because of higher seed costs, the cost of production of Opaque-2 maize per unit of land may be slightly above the cost of producing ordinary maize. The price of seed of Opaque-2 maize at the time of the study ranged from seven to nine pesos per kilo. According to the producer survey, the average selling price of maize was Col. $ 1.28 per kilo, while the price of non-hybrid seed was Col.$ 1.80 to Col.$ 2.20 per kilo and the price of hybrid seed was Col. $ 4.50. The farmers interviewed planted an average of 18.5 kilos per hectare.

For a farmer presently using home produced seed, the additional cost associated with a change to Opaque-2 maize would be Col. $ 106 to Col. $ 143 per hectare. This sum may be considerable for a subsistence farmer, whereas it would be of little importance to the commercial producer. Although the costs of production per unit of the land may be essentially equal, yield differences may cause considerable differences in the cost per unit of output.

Results of a survey carried out among 20 farmers, 3-4 months after they had harvested their experimental plots of Opaque-2 maize, point out that Opaque-2 maize is less resistant to insect attacks than ordinary flint type maize during storage.

Eighty-four percent of the farmers said that the insect damage in Opaque-2 maize was larger than what they usually found in ordinary flint type maize. Some of the farmers expressed the opinion that it was extremely difficult to store Opaque-2 maize under traditional storage conditions even for a short period of time.

Fifteen of the 20 farmers interviewed (75 percent) did not have any Opaque-2 maize left at the time of the interview.

It may be concluded that the risk associated with on-farm storage of Opaque-2 maize without improved storage practices is high. The expected loss during storage is larger than that for ordinary maize.

The farmers' attitudes towards and ability to change

This study attempted to predict the obstacles to an introduction and expansion of the production of Opaque-2 maize that might occur because of adverse attitudes and lack of resources, and to suggest ways by which these obstacles may be avoided or overcome.

The analysis is in three parts: (1) The level of use of improved seeds, the ability to raise this level, and the attitudes toward improved seeds. (2) An analysis of the same factors with respect to other improved technology such as fertilizer, insecticide, weedkiller and irrigation. (3) Present attitudes towards Opaque-2 maize.

Improved seeds

Slightly less than half of the farmers interviewed used improved seeds. The most common hybrids used were ICA H-104, H-207 and H-253, each used by about 10 percent.

On the average, the farmers using improved seeds had done so for two years. Seventy-eight percent of these farmers had changed from a local variety, while the rest did not grow maize previously.

Almost one-third of the farmers who had changed to improved seed said they made the change after getting information from friends and neighbors. Twenty percent of the farmers changed on the basis of information from ICA, while 19 percent mentioned the Caja Agraria. A rapid introduction of improved seeds among small and medium size farmers should therefore be based on means of facilitating extensive inter-farmer communication.

The farmers who changed from local to improved seed were asked why they changed. The most common response was "because they told me that the yields were higher" (58 percent). Eighteen percent said that they changed after having seen the results of farm trials on their own or neighboring farms.

It was found that almost half of the farmers who changed from the local to improved seed did not obtain the expected yield increases.

Forty-one percent of the farmers interviewed, i.e., 78 percent of those not using improved seeds, saved seed from the maize grown on the farms for the next planting. The majority of those using hybrids knew that they could not plant second generation hybrids and maintain high yields. Another major reason for buying seeds was that the maize produced on the farm was consumed or sold before planting time. Finally, storage of the corn from harvest to planting time was said to be difficult because of insect attacks.

Other improved technology

Of the 154 farmers interviewed, 19 percent irrigated maize. About one-fourth of those who did not irrigate said that there was no need for it. The majority of those who thought they needed irrigation said that no water was available.

One-third of the farmers used fertilizer for their maize, one-half used insecticides, and 6 percent used herbicides. Urea was the fertilizer used most frequently. Almost all the weedkiller used was Gesaprim, and the insecticides used by most farmers were Aldrin and Cebicid.

Farmers who did not use one or more of the three inputs were asked why. In the case of fertilizer, almost half of the farmers gave lack of money and credit as the reason. Seventeen percent did not think it was profitable and 15 percent did not know the type of fertilizer needed.

The most frequent reason given for not using herbicides was that sufficient labor was available to control weeds mechanically. One-fourth of the farmers said that they did not use herbicides because they did not know how or when to apply them. Sixteen percent of the farmers believed herbicides would sterilize the soil.

The most common reason given for not using insecticides was that no insect damage was observed. However, lack of money and credit was another important reason. Sixteen percent

would not use insecticides because they thought it was dangerous for children and farm animals, while 11 percent said they did not know what they needed nor how and when to apply it.

An indication of the farmers' awareness of the yield potentials of the maize they presently grew, as related to the yields they actually got, was obtained from two questions, one asking them what they thought was a normal yield of the maize and another asking them what yields they had obtained. Farmers reported an average yield of 1,480 kilos per hectare; the normal yield of the maize grown was thought to be around 2,300 kilos per hectare.

Seventy-eight percent of the farmers thought they could increase the yield of the maize presently grown. When asked how to do this, one-half said they would use fertilizer, 22 percent would use improved production techniques such as better land preparation, and 10 percent would use insecticides. When asked how much they thought that yields could be increased by the actions they suggested, the answers ranged from 72 to 3,400 kilos per hectare, with the largest frequency between 500 and 1,500 kilos.

As these farmers knew how they could increase maize yields, why did they not do so? One-half said that they did not have the money nor the credit necessary. Fourteen percent did not know how to put into effect the action they had suggested.

When asked if in the past they had made a considerable effort to increase maize yields, more than half answered affirmatively. Initiating the use of fertilizers, improved seeds and insecticides as well as improving land preparation, were the efforts most commonly mentioned. Eighty-six percent of these farmers said that the yields had increased considerably as a result of these efforts.

Attitudes toward Opaque-2 maize

Few of the farmers interviewed had seen Opaque-2 maize prior to the interview, but about half of them had heard about it. Forty percent of these heard about it over the radio, 28

percent knew about it from talking with ICA personnel, while 7 percent had heard about it from neighbors. At this early stage, inter-farmer communication apparently had not yet taken effect to any large degree.

To evaluate the degree of promotion necessary to convince them to produce Opaque-2 maize, the farmers were shown three pictures. First they were shown a picture of three pigs, one fed with ordinary maize only, one with Opaque-2 maize only, and one with ordinary maize and soybean oil meal. The interviewer explained the reason for the differences in appearance among the pigs. Then the farmer was asked whether he was interested in producing this type of maize (Opaque-2 maize) if the yields were equal to those he presently obtained. Seventy-eight percent said yes, 4 percent said no, and 18 percent said they did not know. Those who said "no" or "I do not know" were then shown a picture of a child suffering from protein deficiency and another picture of the same child after a three-month diet of Opaque-2 maize.

When asked again whether they would like to grow Opaque-2 maize, none of the farmers said no and only 11 percent said they did not know. There is some question as to the validity of the above-mentioned procedure to obtain reliable answers. The farmers were faced with two alternatives, one of which was obviously better than the other. It was apparent to the farmer what the most "intelligent" choice would be. It is extremely questionable whether all those who said they would like to plant Opaque-2 maize after having seen the pictures actually would.

Even if the money were available to buy the seeds and expected yields of Opaque-2 maize were equal to those presently obtained, a number of those farmers who apparently were so easily convinced might settle for traditional seeds. One reason might be the appearance of Opaque-2 maize. Each farmer was shown four ears of maize representing white and yellow Opaque-2 maize, and white and yellow ordinary maize, respectively. 9/ He was then asked to rank the ears of maize in order of personal preference. Measured on a frequency basis,

9/ H-255, H-208, H-253 and H-207, respectively.

farmers ranked the four ears of maize as follows, with number one being the most preferred:

1. Ordinary white maize.

2. Ordinary yellow maize.

3. White Opaque-2 maize.

4. Yellow Opaque-2 maize.

Only 4 percent of the farmers ranked yellow Opaque-2 maize as most preferable, while 55 percent ranked it least preferred. White Opaque-2 maize had a somewhat better acceptance, with 27 percent of the farmers placing it first and 14 percent placing it last.

The two factors most frequently used by the farmers to explain their preference for ordinary maize over Opaque-2 maize were the heavier ears of the ordinary maize and its resemblance to the maize traditionally planted.

Hence, a rapid introduction of Opaque-2 maize among producers may be handicapped by the adverse attitudes of the farmers with respect to the lighter weight of the ears and their lack of resemblance to the flint type maize which is the only kind known in certain regions.

Considerable regional differences were found with respect to the preference of Opaque-2 maize relative to ordinary maize on the basis of appearance. One of the most important factors associated with these differences is undoubtedly the presence in certain regions of local floury varieties similar in appearance to Opaque-2 maize. The highest rate of acceptance of Opaque-2 maize on the basis of appearance was found in the departments of Nariño and Risaralda. The appearance of Opaque-2 maize was least appreciated in Cauca, Tolima and Valle. The validity of regional comparisons is somewhat restricted because of the small number of farmers interviewed.

The 42 farmers who participated in the agronomic study were asked what yields they would require from Opaque-2 maize relative to the yields they obtained from presently-grown maize before changing to Opaque-2. One-half of these

farmers said that they would shift to Opaque-2 maize if the yields could be expected to equal yields obtained from the maize presently grown. Seventeen percent said it would depend on the relative prices, and the others said that they would require yield gains between 40 and 1,000 kilograms per hectare before shifting.

Marketing aspects

Before an attempt is made to promote and accelerate commercial production of Opaque-2 maize, it is important to identify reasons why its marketing process may differ from that for ordinary maize.

Only the factors entering into marketing and processing before the product is offered to the final consumer are considered here. Consumer acceptance is treated elsewhere.

The analysis is presented in two parts. Differences in the marketing costs related to Opaque-2 maize versus ordinary maize are treated first, followed by an analysis of the marketing agencies' attitudes toward Opaque-2 maize.

Differentials in marketing costs

Results of the producer surveys show that Opaque-2 maize is less resistant to insect attacks during storage. The cost of insecticides and application therefore may be higher. A more serious implication of the lower insect resistance is the high risk associated with storage of maize without use of insecticides.

Only minor cost differentials were identified in the marketing of nonprocessed Opaque-2 maize.

Two companies, Maizena and Quaker, are the principal commercial producers of Opaque-2 maize in Colombia.

Processing of Opaque-2 maize is still at the experimental level, and little information is available on relative processing costs. Processing of the soft Opaque-2 maize appears to be somewhat more difficult than the processing of the flint type.

One company reports that the flour yield of Opaque-2 maize is slightly lower, while the other said that it was the same as the yield of flint type maize. The yields of grit used for arepa mix appear to be considerably lower for Opaque-2 maize. It appears that the major problem in processing Opaque-2 maize is that the machinery used for flint type maize is not readily adaptable to soft Opaque-2 maize. Until more information is available, it is difficult to estimate actual processing cost differentials.

Opaque-2 maize may be used in complex products to replace, at least partly, other high protein commodities such as soybeans and powdered milk. One of the problems of using soybeans and certain other high protein commodities in complex products for human consumption is that the taste of these commodities may reduce the consumer acceptance of the final product. If these products can be replaced by Opaque-2 maize, either completely or in part, the consumer acceptance may be improved while maintaining the quality of the protein present in the product.

Furthermore, it may be profitable to use Opaque-2 maize to replace the relatively expensive powdered milk.

If Opaque-2 maize is to be sold to the final consumer in direct competition with ordinary maize, for example as flour or arepa mix, higher costs of obtaining or processing Opaque-2 maize must be accompanied by price differentials in the final products. As will be discussed in a later section, such a price differential will probably not occur.

Attitudes of the marketing agencies

The attitudes of the marketing agencies may be an important consideration before encouraging commercial production. There are good reasons for rejection of a new product by the marketing agencies. The risk and uncertainty may be high. Communication between the final consumer and the marketing agency with respect to consumer acceptance is often deficient or completely lacking. New agricultural products often are not test marketed before the general farm sector is urged to produce them. The marketing agencies thus have no way of knowing the demand structure before becoming involved in handling the product.

As discussed earlier, it was attempted to determine the present attitudes of the maize wholesalers in Valle toward Opaque-2 maize 10/ First, it was attempted to determine their present stage of knowledge with respect to Opaque-2 maize. Only one of the 25 wholesalers interviewed had not heard of Opaque-2 maize. Forty percent of them had heard about Opaque-2 maize from farmers, while the remaining 60 percent knew about it from the radio or newspapers. The radio and newspaper promotion was carried out primarily by one of the processors of Opaque-2 maize as a part of the test marketing of the above mentioned baby food.

Less than one-half of the wholesalers had actually seen Opaque-2 maize. Nine (36 percent) said they had been offered Opaque-2 maize, but only four of them had bought it. The other five did not buy it because they did not think they could sell it. Of the four wholesalers who bought Opaque-2 maize, one sold it to a commercial processor, while the others sold to corn retailers.

The wholesalers were shown a sample of white Opaque-2 maize. They were then asked whether they would buy this type of corn if it were offered to them and if so at what price relative to the price of the white maize they usually bought. Fifty-six percent of the wholesalers said they would not buy it, even at a price below the current price of white corn. Twelve percent said they might buy it, but only at a price below that of other white maize. Two wholesalers (8 percent) said they would buy Opaque-2 maize at a price equal to the price of other white maize. One-fourth did not know.

The wholesalers who would not buy Opaque-2 maize said they did not think there was a market for it. The majority of the others thought that its present market was small and uncertain but that a market might develop in the future.

The wholesalers interviewed were reluctant to buy Opaque-2 maize for a number of reasons. Past experience with certain other new agricultural products which were not accepted by the

10/ The two earlier-mentioned processing firms were not included in the sample.

consumers was one reason. Some argued that they thought that the two large processors of Opaque-2 maize had a monopoly on it. Lack of information on the consumer preference with respect to Opaque-2 maize was, however, the major reason for wholesalers' unwillingness to buy Opaque-2 maize at the present time.

Inquiry among the farmers participating in the field trials supported the conclusion that the wholesalers were not interested in buying Opaque-2 maize.

Twenty farmers who had Opaque-2 maize field trials were interviewed 3-4 months after the harvest. Nine of these (45 percent) had wanted to sell Opaque-2 maize but four were turned down by wholesalers. Three of the five who sold Opaque-2 maize did so at a price below the prevailing price of ordinary maize, while two sold Opaque-2 at the same price as ordinary maize.

In conclusion, the marketing survey indicates that a farmer producing Opaque-2 maize may have serious difficulties finding a buyer unless he produces on contract for a processor.

Relative consumer preference

Unprocessed maize

An overwhelming majority of all the maize used for human consumption in Colombia is bought by the consumer as grain. This is particularly true among families with low incomes. These same families tend to lack high quality protein in their diets, which results in malnutrition primarily among children. It was felt that main emphasis should therefore be placed on an analysis of the possibilities of introducing Opaque-2 maize as an unprocessed staple commodity.

The average weekly consumption of maize per family in the two sub-samples was reported as 3.9 kilograms for Bellavista and 8.1 kilograms for Coronado. The total amount was purchased as grain. Weekly per capita maize consumption was then estimated as 0.6 kilograms in Bellavista and 1.0 kilograms in Coronado. If the daily adult requirements of amino acids can be fulfilled by 250-350 grams of Opaque-2 maize, the

families in Coronado could receive almost one-half of their essential amino acid needs from maize by shifting to Opaque-2 and maintaining their present level of consumption. Consumption of Opaque-2 maize in Bellavista would supply the families with about one-third of their amino acid needs.

Consumption patterns and knowledge of human nutrition

Information on consumption patterns was obtained to evaluate the need for additional high quality protein. Information to determine the homemakers' knowledge of human nutrition was sought to obtain guidelines for use in future efforts to introduce Opaque-2 maize to consumers.

The homemaker was asked to name the four foods that the family consumed most frequently. Maize, rice and beans were those most frequently mentioned. Foods of animal origin were rarely mentioned. The homemaker was then asked which of the foods mentioned she thought was most healthy. About one-fourth selected beans and another one-fourth selected soups as the most healthy food. About one-fifth selected maize, and products of animal origin accounted for another fifth. Only a few could explain why they thought a particular food was better than another.

It appears that the homemakers either did not have a basic knowledge of human nutrition or were so short on purchasing power that only the cheapest food could be purchased. To obtain more information on their knowledge, each homemaker was asked to place ten cards, each representing a food commodity, in order of assumed nutritional value.

The results are shown in Table 3. Eighty-three percent of the homemakers thought that one of the products of animal origin had the highest nutritional value. The ranking made by each homemaker was tested against the "correct" ranking to estimate her knowledge of relative nutritional values. 11/

11/ Information concerning the "correct" ranking was obtained from the Instituto Colombiano de Bienestar Familiar.

Table 3. The opinions of the non-farm homemakers concerning the relative nutritional value of ten foods.

Food Commodity ("correct" ranking)	Ranking made by the homemakers . 1/ 1st	2nd	3rd	8th	9th	10th	Rank by Frequencies 2/
	Percent of homemakers						
1. Meat	41	11	11	4	2	4	1
2. Fish	6	26	22	4	2	2	3
3. Milk	36	30	9	0	9	2	2
4. Beans	6	0	13	4	7	2	4
5. Maize	9	7	16	7	4	2	5
6. Rice	2	2	7	15	26	11	9
7. Potatoes	0	7	7	9	11	2	7
8. Plantain	0	15	4	26	11	7	8
9. Cassava	0	0	0	11	15	59	10
10. Unrefined sugar	0	2	11	20	13	9	6

1/ Only six of the ten ranks are shown.

2/ The food commodity with the highest frequency in each individual rank was chosen to represent that rank.

Fifty-two percent based their ranking on some knowledge of the relative nutritional values of the ten foods, while 48 percent used some other basis for ranking. 12/ The overall ranking as shown in Table 3 was made on the basis of some knowledge of nutritional values.

A considerable difference was found between the two subsamples as to knowledge of relative nutritional values. While about two-thirds of the homemakers in Bellavista were determined to have based their choices on some knowledge of relative nutritional values, only one-third of those in Coronado were determined to have done so.

12/ A rank correlation test was used. The data was tested at a ninety-five percent probability level. The test is explained in R. Clay Sprowls, "Elementary Statistics," MacGraw-Hill Book Company, New York. pp. 253-255, 1955.

It may be concluded that the homemakers included in the survey had a considerable knowledge of the relative nutritional values of the food commodities with which they are familiar. In order to determine their perception with respect to the nutritional value of a new product, it is necessary to know the characteristics used to evaluate the nutritional value of a food commodity. If, by tradition, it is believed that milk is good and cassava is poor, what influences their beliefs about new products? The more knowledge available on this point, the easier it will be to select the most efficient message in a possible educational campaign to introduce Opaque-2 maize.

About half of the homemakers could not explain why the food they selected as the best was actually better than the others. The factors most frequently associated with high nutritional value were vitamins, calcium and phosphorus; protein content was not mentioned.

The conclusions of this part of the consumer study are that the families included in the sample did not obtain sufficient high quality protein. The primary reason was lack of purchasing power. The majority of the housewives knew that foods of animal origin have a higher nutritional value than most plant products. Most of them did not know why. Promotion of Opaque-2 maize using the higher quality protein as the argument will therefore probably not be successful unless preceded by an educational campaign to teach the consumer the importance of protein in the diet. Opaque-2 maize might be successfully promoted with a campaign which equates its nutritional value to that of meat and milk.

Purchasing patterns

The majority of the families interviewed (57 percent) buy only white maize. Thirteen percent buy only yellow maize and 30 percent buy both. The 70 percent of the homemakers who purchased only one color gave customs and traditions as primary reasons for not buying the other color. Other important reasons were the difference in cooking quality and taste believed to exist between the two.

A little less than half of the families bought the maize in the

central market place, while the remaining half purchased it in grocery stores or from grain dealers.

The majority of the families (66 percent) buy maize only once a week, while 14 percent buy twice a week and another 14 percent only every other week.

Shopping for maize is done by the homemakers in 60 percent of the families interviewed, while the husband does the shopping in 36 percent. The husband and wife shop together in 4 percent of the families.

For the region under survey it appears that the white Opaque-2 maize has the best chance of being accepted. A nationwide survey is needed, however, to determine regional differences in color which might affect consumer acceptance.

To reach the low income groups, the Opaque-2 maize should be available in the central market place, in certain grocery stores and at grain dealers.

A promotional campaign to introduce Opaque-2 maize should be aimed at both the homemakers and the head of the household. This is so partly because of the large proportion of families where the husband buys the maize and partly because of his strong position as decision maker, particularly in low income families.

Price awareness

If no preference differential exists between Opaque-2 maize and other types, the price awareness among the buyers may be an important factor in determining the relative price at which Opaque-2 maize can be sold.

Seventy-two percent of the homemakers knew what they paid for maize the two previous weeks before the interview. The remaining 28 percent did not know the price, primarily because their husbands bought the maize. Knowledge of price variations among sellers likewise showed a considerable price awareness among the homemakers interviewed.

It may be concluded that unless a considerable preference differential exists it is not feasible to introduce Opaque-2

maize at a price higher than the price of the maize presently available. Even if a considerable preference differential exists, lack of purchasing power may prohibit a rapid replacement of the present maize by Opaque-2 maize. On the other hand, if no preference differential exists, a considerable price awareness may imply that a slightly lower price of Opaque-2 maize would cause homemakers to rapidly replace ordinary maize by Opaque-2 maize. If relative prices are believed to be associated with relative quality, such a replacement may not result.

The acceptability of Opaque-2 maize

At the second interview, homemakers were asked their opinions about the two maizes. 13/

The opinions were obtained partly by structured and partly by open-ended questions relating to differences in cooking characteristics, other differences and personal preferences. The homemakers were at no time informed of the nutritional differences between the two types.

Cooking Characteristics

The utilization of the maize is reported in Table 4. The majority of the housewives used the ordinary maize for mazamorra, and Opaque-2 maize for coladas. It is obvious that they had pre-determined opinions about what each of the two types of maize was best suited for. Eighty-eight percent of the homemakers found Opaque-2 maize to be more soft than ordinary maize, hence many of them did not think that Opaque-2 maize was suited for mazamorra. This was primarily a pre-determined opinion. When asked if they had actually tried to make mazamorra with it, the majority said no.

A few of the women tried to make mazamorra with Opaque-2 maize. Some succeeded and some failed. Further inquiry re-

13/ Interviewing procedures are explained in the Appendix.

Table 4. The utilization of the two one-pound bags of maize by the homemakers.

End Product	Percent of homemakers	
	Using ordinary maize	Using Opaque-2 maize
Arepa	9	11
Buñuelo	0	2
Colada	6	51
Masa	0	2
Mazamorra	60	21
Natilla	0	2
Soup	25	11

vealed that in order to make mazamorra from Opaque-2 maize the cooking procedure had to be somewhat different than when using flint type maize. With the correct cooking procedure, Opaque-2 maize was just as suitable as ordinary flint type maize.

Seventy-four percent of the homemakers found differences between the two types of maize related to the preparation and cooking. Of these, 85 percent said that Opaque-2 maize was easier to prepare. Almost all of them said that this was because Opaque-2 maize was softer, hence easier to prepare.

It may be concluded that the major difference between Opaque-2 maize and ordinary flint type maize, as seen by the women interviewed, is the degree of softness. The majority were convinced, just by looking at Opaque-2 maize, that it could not be used for making certain products.

This belief is well founded. If the traditional cooking methods are used with Opaque-2 maize, a failure may result. If the cooking methods were changed slightly, Opaque-2 maize could be used with satisfactory results. Hence, efforts to improve the consumer acceptance of Opaque-2 maize should include information to explain how to change cooking methods.

Personal Preferences

The homemakers were asked which of the two types of maize they preferred. Forty percent said they preferred Opaque-2 maize, 26 percent preferred the ordinary maize, while 34 percent were indifferent.

Those preferring Opaque-2 maize did so primarily because it was soft, hence easier to cook. The primary reason for preferring ordinary maize was that it was believed to be better suited for a wider range of products. Subjective differences in taste do not appear to be an important issue. Twenty-one percent of the housewives who preferred Opaque-2 maize and 17 percent of those preferring ordinary maize gave better taste as the reason for this preference.

Fifty-two percent of the homemakers said that their husband were indifferent as to the two maizes. Twenty-four percent preferred Opaque-2 maize and 12 percent of the husbands preferred ordinary maize.

When asked about the children's reaction, 57 percent of the homemakers said that their children were indifferent as to the two types of maize; 17 percent preferred Opaque-2 maize and 11 percent preferred ordinary maize. The homemakers were asked at the first visit to obtain the opinions of their husband and children, but the influence of the women's prejudices in reporting these opinions cannot be determined. Hence, it may not be safe to interpret the opinions of the wife, husband and children as independent.

Given their acquired knowledge of the differences between the two types of maize, the homemakers were asked which kind they would buy if both were available at the same price at the same store. Fifty-one percent said ordinary maize while 47 percent said Opaque-2 maize. No significant difference was found between the two sub-samples with respect to personal preference. 14/

14/ A chi^2 analysis showed no significant difference at the 95 percent level.

While the majority preferred Opaque-2 maize, only about half of them said they would actually buy it if the price were the same as the price of ordinary flint type maize. This tendency was found in both sub-samples. The reason for this apparent paradox was found to be that although the Opaque-2 maize was preferred, primarily because of its softness hence easier cooking, this same softness caused them to think that Opaque-2 maize could be used only for making certain products.

An attempt was made to check the validity of the answers obtained as to which maize the housewives would actually buy. About three weeks after the second visit, the women were visited again. The interviewer carried two baskets of maize, one with Opaque-2 maize and one with ordinary flint type maize. The homemakers were told that some maize was left over from the survey, and that it was to be distributed among those who had participated. Each homemaker could get one pound of whichever of the two maizes she preferred.

To simulate actual selling practices, the maize was presented in open baskets rather than in bags. Furthermore, by waiting three weeks it was expected that the homemaker might have forgotten which maize she said she would buy unless she strongly preferred one or the other. Finally, possible errors caused by excess sensitivity during the previous interview might be eliminated because the women did not consider this final visit as part of a survey.

The information obtained on relative preference of Opaque-2 and ordinary flint type maize at the two visits is summarized in Table 5.

A considerable difference was found between what the homemakers included in the Bellavista sub-sample said they would buy and what they actually selected at this final visit. While 44 percent said they would buy Opaque-2 maize, only 33 percent actually selected it at the final visit. No such differences were found among the homemakers included in the Coronado subsample.

There was some indication that the women tended to select the type of maize which they thought was best suited for making

Table 5. The homemakers' relative preference of Opaque-2 and ordinary flint type maize.

	Bellavista	Coronado	Total
	(percent of homemakers)		
Preference expressed after having tried both maizes:			
Opaque-2	44.4	52.7	47.9
Ordinary	55.6	47.3	52.1
	100.0	100.0	100.0
Selection at a later visit:			
Opaque-2	33.3	52.7	41.4
Ordinary	66.7	47.3	58.6
	100.0	100.0	100.0
Homemakers who preferred:			
Opaque-2 at both occasions	22.2	37.0	28.4
Ordinary at both occasions	44.5	31.6	39.1
Opaque-2 at first, ordinary later	22.2	15.7	19.5
Ordinary at first, Opaque-2 later	11.1	15.7	13.0
	100.0	100.0	100.0

the product they wanted on that particular day. This may explain at least some of the differences encountered. Another explanation is that they, not considering the final visit as part of the survey, selected the type of maize they traditionally buy. In any case, it may be expected that the choices indicated at the final visit would be reflected in the market place, if Opaque-2 maize were available at the same price as ordinary maize.

An attempt was made to determine characteristics of the homemakers and their families which might influence the choice of type of maize. The choice was found to depend somewhat on where in the country the homemaker was born. A large sample is needed, however, to yield reliable information

on this subject. There is some indication that the families with monthly incomes of less than 500 pesos favored Opaque-2 maize more than those with higher incomes. Finally, those families which customarily buy white maize favored Opaque-2 maize, those buying only yellow maize preferred ordinary white maize, while those who buy both white and yellow maize were equally divided in the preference of Opaque-2 versus ordinary white maize.

Processed maize

Two products containing Opaque-2 maize have been test marketed. One, a baby food (Duryea), was well received by the consumers and has now been introduced commercially on the Colombian market. The other product that was test marketed was an arepa-mix (Ricarepa). The consumer acceptance with respect to this product was not as high, and attempts are presently being made to improve the product.

Attempts to use Opaque-2 maize in other products, such as bread, are still in the laboratory.

Reports by Maizena on the consumer acceptance of Duryea are optimistic. After eight months of test marketing in Cali, a Maizena survey among 300 families with small children showed that 19 percent of the families interviewed used Duryea at the time of the interview. There is no information on the quantity used per child or per family. Maizena reported a monthly sale of seventeen tons of Duryea in Cali after six months of test marketing.

The feasibility of using processed foods containing Opaque-2 maize to reduce malnutrition depends on the extent to which such processed foods are consumed by low income families.

In the Maizena survey it was found that 16 percent of the families belonging to the lowest income group possessed Duryea at the time of the interview. It is not clear how much Duryea was consumed per child nor what products were replaced. More research is needed in this area.

The acceptance of Opaque - 2 maize for consumption by the producers

The objective of the research reported in this section was to analyze some of the major obstacles to the introduction and expansion of the consumption of Opaque-2 maize among farmers growing maize and to identify methods by which these obstacles might be overcome. Major emphasis was placed on low-income farmers.

Only consumption aspects are analyzed here. It should be kept in mind that the obstacles to production also influence the extent to which the maize producers will change their consumption patterns from ordinary to Opaque-2 maize.

Consumption patterns

No attempts were made to estimate the extent to which protein deficiencies existed among farm families interviewed.

To determine the importance of maize in the diet, the farmers were asked to mention the five food commodities they consumed most frequently. Maize was most frequently mentioned (69 percent), followed by meat (65 percent), rice (63 percent), plantain (60 percent) and cassava (48 percent).

One-third of the families consumed all the maize produced on the farm. In addition, the majority of these families bought maize because their own production was not sufficient.

About one-third of the farmers interviewed said that they sold all or part of the maize they produced and bought the maize they used in the household. Asked why they did not keep a sufficient supply of the maize they produced to meet household needs, more than one-third said that they could not store maize because of insect attacks. Twenty percent sold maize immediately after harvest to obtain cash and another 20 percent did not have milling facilities; hence they sold the maize they produced and bought flour.

Opaque-2 maize was found to be vulnerable to insect attacks during storage. Farmers participating in the field trials clearly pointed out the seriousness of the storage problems. Unless storage practices are improved considerably, it is doubtful that the small farmers can keep Opaque-2 maize from one harvest to the next unless they learn improved storage practices. Attempts to persuade the small farmer to produce Opaque-2 maize for home consumption are not likely to succeed unless accompanied by an effective educational program which includes methods to improve storage.

Knowledge of human nutrition

Each of the farmers interviewed was given ten cards, each representing a food commodity, and asked to place the cards in order of nutritional value. The results are shown in Table 6. Three-fourths of the farmers thought that one of the products of animal origin had the highest nutritional value.

The overall ranking as well as the ranking made by each farmer was tested against the "correct" ranking to estimate the extent of knowledge possessed by the farmers with respect to relative nutritional values. Fifty-seven percent of the farmers based their ranking on some knowledge of the relative nutritional values of the ten foods. The ranking based on frequencies was made on the basis of some knowledge of nutritional values.

If the wife of the farmer was available, she was also asked to rank the ten foods. The results were somewhat similar. Thirty-nine percent of the 72 wives interviewed thought that milk had the highest nutritional value, and 35 percent said that cassava had the lowest nutritional value. Sixty-three percent of the wives had some knowledge of the relative nutritional values of the commodities.

It appears that the farmers and their wives were more aware of relative nutritional values than the non-farm housewives.

The farmers were asked why they thought that the commodity they selected as the most nutritional was actually more nutritional than the other nine foods. One fourth of the farmers thought that the food had more vitamins than the others, and 11 percent said that that particular food had more energy. A large

Table 6. The opinions of the farmers concerning the relative nutritional value of ten foods.

Food Commodity ("correct" ranking)	Ranking by farmers 1/						
	1st	2nd	3rd	8th	9th	10th	Rank by frequency 2/
	Percent of farmers						
1. Meat	26	26	13	5	3	1	2
2. Fish	20	14	14	5	3	4	5
3. Milk	30	23	19	2	3	1	1
4. Beans	5	14	15	4	5	6	3
5. Maize	11	7	15	4	3	1	4
6. Rice	0	0	2	15	28	17	9
7. Potatoes	1	0	3	25	17	23	8
8. Plantain	2	11	7	11	10	7	7
9. Cassava	2	0	7	13	20	35	10
10. Unrefined sugar	2	5	5	16	8	5	6

1/ Only six of the ten ranks are shown.

2/ The food commodity with the highest frequency in each individual rank was chosen to represent that rank.

number of other answers was obtained. On the basis of this study it appears that the characteristics that Colombian farmers most frequently associate with high nutritional values of food commodities are as follows in order of importance:

1. They contain vitamins.

2. They give energy.

3. They have a good taste.

4. They are complete foods (have all the necessary elements).

5. They are traditional or customary foods.

6. They contain protein.

7. They contain phosphorus.

8. They contain calcium.

Farmers are likely to respond more to a new product if it is promoted on the basis of high vitamin content rather than on the basis of high quality or quantity of protein. In the case of Opaque-2 maize, the most efficient message in a promotional campaign among farmers would probably be that its nutritional value is equal to that of milk and meat. Most of the farmers know that milk and meat have a high nutritional value but do not know why.

The acceptance of Opaque-2 maize for consumption

The relative preference of Opaque-2 maize and ordinary flint type maize on the basis of appearance is likely to influence the rate by which Opaque-2 maize is adopted for consumption as well as for production. The findings related to this factor and reported in the section on the farmer's attitudes apply equally to the analysis reported here.

After they had had sufficient time to prepare and consume Opaque-2 maize several times, the farmers who participated in the field trials were asked for their opinions and experience with respect to the cooking characteristics and personal preference of Opaque-2 maize.

Maize-based meals most frequently made by the farm families interviewed were, in order of frequency, colada, mazamorra, arepa and soup. Two-thirds of the women said that Opaque-2 maize was easier to prepare than ordinary maize, while almost one-third said that the preparation of Opaque-2 maize was more difficult.

Almost all the farmers' wives who reported differences between ordinary and Opaque-2 maize with respect to preparation referred to the softness of Opaque-2 maize as the reason for the difference. Homemakers generally agreed that the most serious difficulties with the Opaque-2 were encountered in the preparation of mazamorra and arepa. On the other hand, because Opaque-2 maize was easier to grind, it was easier to prepare certain other products with it.

Neither the farmers nor their wives reported any differences in the taste of the two maizes. Eighty-four percent of the women said they would prefer Opaque-2 over ordinary maize if the price was the same. It should be noted that each of these families had an Opaque-2 maize trial on the farm and had been informed of the high nutritional value of Opaque-2 maize several times during the growing season. Their awareness is supported by the fact that when asked why they preferred Opaque-2 maize, almost all of the women said "because of its high nutritional value". It is difficult to determine how many of them were actually convinced of the nutritional advantage of Opaque-2 maize and how many were trying to please the interviewer.

It may be concluded, however, that the majority would not use Opaque-2 maize for making two of the most common maize products, mazamorra and arepa, if they could get ordinary maize. But they would most likely prefer Opaque-2 maize for other products such as colada. If the information on the high nutritional value of Opaque-2 maize had been accompanied by information on how to adapt cooking methods, it is likely that these women might have wanted to replace all or nearly all ordinary maize by Opaque-2 maize.

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Appendix

Sampling procedures and sample characteristics

Primary data were obtained from five surveys carried out among maize producers, marketing agencies and consumers.

The producer surveys

The producer surveys were carried out in cooperation with a CIAT - ICA agronomic study to analyze the perfomance of Opaque-2 maize in six regions of Colombia; 154 farmers were interviewed, 42 of whom participated in the agronomic study. The geographical distribution of the sample is shown in Figure 1.

The farmers were selected by the CIAT agronomists responsible for the agronomic study in each region. Only farmers who grew maize and appeared to be representative of the farmers in the region were included in the sample, although major emphasis was placed on interviewing small farmers. Using his knowledge of the region and supplemented in some cases by information from ICA, INCORA, and CAJA AGRARIA, each of the six agronomists then visited and interviewed about 25 farmers, including those who participated in the agronomic study.

While the average size of the farms included in the survey was 71 hectares, one-third of the farms had less than 5 hectares, 78 percent had less than 50 hectares and only 4 percent had more than 500 hectares. The average maize area on the farms included in the sample was 8.2 hectares. Thirteen percent of the farms had less than 0.5 hectares of maize, while only 21 percent had more than 5 hectares, and 3 percent had more than 50 hectares of maize. Even though a number of the farms were relatively large, few of the farmers had a large acreage of maize. One-third of the farmers consumed at home all the maize they produced.

The average age of the farmers interviewed was 44 years. Farmers 60 years of age or older accounted for 13 percent. On the average, the farmers had 4.5 years of schooling. Two and three years of schooling were most common (15 percent in each case). Ten percent had never gone to school, while 28 percent had more that five years of schooling.

The average size of the family living on the farm was 6.7 persons, with 2.7 children of less than 14 years of age, and an average of 4 adult family members per houseold.

A considerable inter-departmental mobility was found among the farmers interviewed. Fifty nine percent reported that they were borne in the departments where they now live.

The Marketing survey

A survey was carried out during the month of May, 1970, among 25 wholesalers of maize in 5 towns in the Department of Valle. 15/

About half of the firms surveyed were private companies while the others were corporations. Forty-five percent of the firms bought less than 100 tons of maize per year, while 10 percent bought more than 1,000 tons.

Considering not only the activities in maize but also their total trade, 25 percent of the firms were considered small relative to similar type firms in Colombia, 32 percent were of medium size and the remaining 43 percent large.

The owner was interviewed in 56 percent of the firms, while the manager was interviewed in the rest.

The consumer survey

Basic information concerning consumer acceptance of Opaque-2 maize was obtained from a two-part survey con-

15/ Five wholesalers were interviewed in each of the following towns: Cali, Palmira, Buga, Tuluá and Cartago.

ducted during March and April, 1970. One survey was carried out in Bellavista, a low income section of the city of Cali, the capital of Valle. A sample of 30 families was selected at random among the 240 families living in this section.

Bellavista was selected partly because of its low levels of family income and the existence of extensive protein deficiencies among the children living in the section, and partly because of the large number of rural migrants living in the area. By using a section with a large proportion of migrants, it might be possible to identify differences in the factors of concern caused by geographically-determined consumption patterns and traditions.

A second survey was carried out in Coronado, a small low income village near Palmira, 30 kilometers from Cali. A sample of 20 families was selected at random among the 95 families living in the village. The questionnaire and the procedure used to carry out the interviews were the same for the two locations.

By carrying out the survey both in a section of a big city and in a small village it was felt that more confidence could be given to the information obtained, while at the same time significant differences among the factors determining the acceptability of Opaque-2 maize might be identified between the two types of population. It should be pointed out, however, that both surveys were carried out within a distance of 30 kilometers. The results, therefore, do not necessarily hold wide geographical validity.

Each of the 50 homemakers was asked a number of questions aimed at determining the consumption and purchasing patterns related to maize and her knowledge of certain aspects of human nutrition. She was then given two one-pound bags of maize, one with white Opaque-2 maize and another with ordinary white flint type maize, and was asked to cook the two types of maize on two different days. The decision concerning the method of cooking and the end products to be obtained was left up to the individual homemaker. Three days following the interview, a follow-up interview was made to obtain the reaction on the two types of maize. Three of the 50 homemakers refused to give information on the second visit. The actual samples were thus reduced to 28 and 19, respectively.

The average household size was 6.6 persons in Bellavista and 7.8 in Coronado, while the average number of children below the age of 14 per household was 2.9 and 3.8 for the two samples, respectively. The level of education among the homemakers was about the same for the two samples, 2.5 and 2.4 years of schooling, respectively. Considerable difference, however, was found among the men. While those included in the Bellavista sample averaged 4.0 years of schooling, the same figure for Coronado was only 2.5 years.

The family incomes were slightly higher among the families interviewed in Bellavista. No families reported monthly incomes of less than 100 pesos, 39 percent of the families said that the income was between 100 and 500 pesos per month, and 54 percent reported a monthly income in excess of 500 pesos. Seven percent of the homemakers did not know. In Coronado, 5 percent of the families reported a monthly income of less than 100 pesos, 32 percent said between 100 and 500 pesos, and 47 percent reported a monthly income in excess of 500 pesos. Sixteen percent said they did not know.

The majority of the men whose wives were interviewed were industrial workers (83 and 67 percent, respectively); while 13 and 11 percent, respectively, were classfied as having private business, zero and 16 percent as agricultural workers, and 4 and 5 percent, respectively, reported that they were unemployed. One-third of the homemakers interviewed in Bellavista worked outside the home as opposed to only 10 percent of those interviewed in Coronado.

Two of the housewives interviewed in Bellavista and one of those in Coronado were born in the respective locations. The rest were born in any one of nine departments, with the majority born in Valle. Sixty-eight percent of the housewives interviewed in Bellavista and 95 percent of those interviewed in Coronado said that they had lived for some time in Valle before moving to their present location.

Glossary

MASA:	Dough. Usually made with maize, cheese, eggs and butter.
COLADA:	A thick corn soup.
AREPA:	Unleavened corn bread prepared by boiling the threshed corn and making a corn meal which is then formed into rolls and baked or cooked over an open fire. Sometimes eggs, cheese and butter are added before cooking.
MAZAMORRA:	A soup of boiled corn, milk and unrefined sugar (panela).
BUÑUELO:	Fried corn meal muffin made of corn flour, cheese, egg, baking soda and salt. Dough is made into balls, which are fried and served hot.
NATILLA:	A gelatin-like dessert, made of corn, water and unrefined sugar, usually served with a coating of cinnamon.