TECHNOLOGY DEVELOPMENT AND TRANSFER: THE CASE OF LA MAQUINA AND UREA ADOPTION IN LES CAYES PLAIN *

Dr Ousmane GUINDO **

---

* Paper presented at the XXXVII annual meeting of PCCMCA in Panama City, Panama, March 17-23, 1991

** CIMMYT Economist - Haiti

SUMMARY

Population increases at a natural rate of 1.7 percent per year in Haiti while maize and sorghum production decreased by 7 percent per annum during the past 15 years, leading to cereal deficits estimated in 1987 at 35 000 MT of maize equivalent. Any reduction of this deficit must involve yield increments given the lack of available cultivable land. Attainment of yield increases will require that farmers change production technology (Winkelmann, 1976).

Developing new technology usually involves research. In this regard CIMMYT and the Haitian Ministry of Agriculture (MARNDR) initiated in 1981 a collaborative research program on maize improvement and crop management in Les Cayes Plain in Southern Haiti.

The program has led to the selection of an improved maize variety (Maquina 7827) which yields better than the local variety regardless of fertilizer application. An additional recommendation is urea which proved to be the most economical source of nitrogen.

In order to assess the aggregate adoption of these two technological components, a survey was carried out five years after their recommendations. The main objectives of the survey were to mesure the degree of awareness and adoption of La Maquina and urea recommendations and to diagnose possible acceptance problems and constraints involved in the adoption process.

Survey results indicate that twenty four percent of farmers planted La Maquina at least once and approximately half to these farmers did so in 1986. Around one third of former Maquina growers mention the poor seed quality of the 1986 emergency program as the reason which deterred them from continuing Maquina production. Around twenty six percent of farmers who use urea on their maize crop started their application after the MARNDR-CIMMYT team recommendation in 1985. Approximately, ninety one percent of maize producers who applied urea at least once on their maize crop continue their application.

INTRODUCTION

The Ministry of Agriculture, Natural Resources and Rural Development (MARNDR) and the International Maize and Wheat Improvement Center (CIMMYT) carried out in Southern Haiti a research project on maize improvement and crop management since 1981. The project was initially funded by the Swiss Development Corporation (SDC) and the Rockefeller Foundation. The program has been financed by the Canadian International Development Agency (CIDA) since 1983.

The objectives of the Program are twofold:

- To develop appropriate technologies to increase productivity and income for representative farmers. The development of these technologies is based on On-Farm Research (OFR).
- To institutionalize OFR as a cost-efficient method of generating productivity-enhancing technologies. The achievement of this objective involves training of haitian agronomists and economists in OFR procedures.

An informal survey was carried out in Les Cayes Plain by a joint MARNDR/CIMMYT team in 1981. A semi-formal survey was done in October and November 1981 by a joint team of haitian agronomists and agricultural technician and a CIMMYT Economics program staff. The aims of these surveys were to obtain detailed information on farmer circumstances, to understand farmer practices and how the later reflect the former. Results of the surveys were used to diagnose key maize production problems, to identify suitable technological alternatives and to design the initial experiments in farmers' fields.

To date, the project has led to the selection of two improved maize varieties (Maquina 7928 and 7827). Research carried out in Les Cayes Plain shows that with or without fertilizer application, yields of these two maize varieties exceed that of the local variety. The project has also identified urea as a profitable source of nitrogen. Research results indicated that an application of 40 kilograms of nitrogen per hectare increased yields by 0.4 tonne per hectare (Table 1). Other technological components developed by the project include

zero-tillage for flat lands and mulching for eroded hillsides.

Given the fact that some technological components such as zero-tillage and mulching are at the recommendation stage, only La Maquina and urea recommendations are deemed suitable for an adoption survey. These two technological components have been recommended in 1985. The objective of this paper is to assess farmers' response to the recommended technological alternatives. Such assessment could contribute to identify possible acceptance problems and assist researchers to tailor research activities in such a way that farmers' needs are met by the new technologies.

The paper is organized as follows. The next section describes the objectives and methodology of the survey. This is followed by the results which present the adoption of La Maquina and urea and the reasons put forth by farmers for no longer or not using these technological components. The third section summarizes the conclusions and the policy implications of the results.

OBJECTIVES AND METHODOLOGY

I.- Objectives

The objectives of the survey are threefold:

1) To mesure the degree of awareness and adoption of La Maquina and urea recommendations.
2) To diagnose possible acceptance problems and constraints to the adoption of the recommended technologies. Such identification will help researchers to better tailor technologies to the needs of farmers and make representations to policy-makers in order to ease bottlenecks affecting availability of recommendations.
3) To identify additional research problems and opportunities.

II.- Methodology

1/ Questionnaire

The questionnaire was divided into four parts:

i) Field data

First an inventory was made of all maize fields owned, rented or sharecropped by the farmer. Next, each field was characterized in terms of tenancy, irrigation, agricultural practices and yields.

ii) Varietal adoption

A historical use of La Maquina was provided along with a description of problems encountered, reasons for not or no longer growing the variety. Also, a comparison is made of La Maquina and the local maize variety in terms of taste, milling, shelling, marketing, storage and yields under various weather conditions and fertilizer use.

iii) Fertilizer use

This section gives a historical use of fertilizers and especially urea and the reasons for not or no longer employing this input. Also, a portrayal is provided of crops other than maize on which farmers apply urea.

iv) General questions

Farmers are characterized in terms of age, schooling, gender, years of farm management, contacts with agricultural technicians and membership in farm associations. Additional questions involve fields rented or sharecropped out, access to sprayer and ownership of animals.

The present paper reports basically on varietal adoption and fertilizer use. The other elements of the questionnaire are extensensively presented in a research report dealing with the same issues.

2/ Sampling technique and questionnaire administration

The recommendation domains identified during the OFR process were 12 000 farmers for La Maquina and 6000 farmers for urea. The difference in size between these two recommendation domains is due to the tenancy system whereby sharecroppers pay all input costs and obtain only half of the harvest. Hence urea was recommended only to producers who own their farm(s). The urea recommendation domain is a sub-set of the La Maquina one.

A sample of 105 farmers was randomly selected from the afore-mentioned list. The number of farmers interviewed from each of the 44 communal sections (the smallest administrative division) comprising the recommendation domain was chosen in proportion of the locality's maize growers in the overall maize producer population. The sample included maize growers who have planted La Maquina at least once, regardless of how they got the seed and maize growers

who have never planted La Maquina. The sample also involved farmers who have used urea or any other type of fertilizer on their maize crop and farmers who have never utilized urea or any fertilizer at all in growing maize.

A pre-test of the questionnaire was done through some 20 maize growers selected randomly outside the sample of 105 but within the recommendation domains. The questions were later modified following suggestions made by farmers during the pre-test.

The survey was carried out during a full week in August 1989 by three agronomists and eight 3rd to 5th year students from the Agricultural College in Port-au-Prince. The enumerators were fluent in creole, which is the common local language throughout Haiti and they were familiar with the agro-socio-economic conditions of Les Cayes Plain. All sample farmers were interviewed.

Out of the one hundred and five respondents' questionnaires, one hundred and one made the final selection and four were discarded because of missing information an incomplete questionnaire. The results of the interview are presented in the following section.

RESULTS

I.- Adoption of La Maquina

1) Planting of La Maquina

Twenty four percent of interviewed farmers planted La Maquina at least once compared to seventy six percent who never tried this variety. Among farmers who grew La Maquina, about forty six percent planted the variety in 1986 (Table 2). In that year, MARNDR set up an assistance program for Les Cayes Agricultural District following floods which destroyed over two third of the maize crop in the area. The program involved distribution of fertilizers and maize seed. The Maquina seed distributed to farmers was purchased from "Comme Il Faut" tobacco company. The seed was of a very poor quality with germination rates of less than 30%. A substantial proportion of farmers who planted La Maquina through the emergency program were reluctant to try this variety again. Hence, this well-intentioned program contributed to create a lasting negative image for La Maquina throughout Les Cayes Plain.

Thirty nine percent of farmers who grew La Maquina learned about the variety through the 1986 emergency relief program. Thirty five percent of informants got acquainted with La Maquina through Levy Farm. However, this experimental farm was one of the emergency program's distribution centers. Hence, it's possible that a higher proportion of farmers who cultivated La Maquina learned about it in 1986.

The role played by the 1986 emergency program and Levy Farm as the major sources of information about La Maquina illustrates the lack of extension about La Maquina since its recommendation in 1985. Extensionists who were supposed to join the MARNDR-CIMMYT program were never assigned by the Ministry of Agriculture. This is part of MARNDR's commitments in the project which were never honoured. To make up for the lack of extensionists, the research team made radio broadcasts at the beginning of each maize growing season and carried out a limited number of field days.

2) source of seed the first year

Fourty one percent of maize producers who cultivated La Maquina for the first time obtained the seed through the 1986 emergency program (Table 3). Levy Farm is the second source of seed for maize growers who tried La Maquina for the first time. Again, Levy Farm was one of the emergency program's distribution centers and it's possible that a higher proportion of farmers who cultivated La Maquina for the first time got the seed through the emergency program.

The inavailability of La Maquina seed from 1987 on has hampered the adoption of this variety. Some US 20 000 dollars were supposed to be earmaked for seed production in the MARNDR-CIMMYT project. However, this other commitment of the Ministry of Agriculture was never honoured. Only minimum quantities of La Maquina seed are produced each year through the variety maintenance program at Levy Farm. Even this seed is sent to the Ministry of Agriculture where it is treated and sold to areas other than Les Cayes Plain.

3) Reasons for no longer growing La Maquina

Table 4 presents the reasons put forth by farmers who once grew La Maquina but do no longer plant the variety. Twenty nine percent

of respondents mention the poor seed quality of the 1986 emergency program. The failure of this program represents the leading cause for farmers who do no longer cultivate La Maquina. The second major reasons mentioned by farmers for restraining from La Maquina are the variety's higher fertilizer requirements and non-resistance to drought. Twenty four percent of informants present each of these characteristics of the variety as causes for no longer planting it.

As stated by Feder et all (1985) HYV seeds will not be adopted by most farmers unless both seeds and some fertilizers are available. The high-yield potential of the seed can be realized only if at least some fertilizers are applied. Given fertilizer supply irregularities and high prices in Les Cayes since 1987, it is not surprising that about one fourth of respondents have abstained from La Maquina.

4) Farmers' awareness of La Maquina

Eighty percent of farmers who never grew La Maquina know about its existence compared to twenty percent of informants who have not heard about the variety. However, there is a difference between knowing about the existence of a variety and being aware of the agronomic characteristics of that variety. Some farmers classify as Maquina any maize variety that is not Chicken Corn. In addition, considering that approximately forty percent of farmers who planted La Maquina for the first time learned about the variety through the 1986 emergency program, it is possible that a substantial proportion of farmers who never grew La Maquina heard about it through the same program. Given the failure of the program, it can be argued that many farmers who didn't cultivate La Maquina but report knowing about it, are not fully aware of the real agronomic characteristics of the variety.

Farmers who have heard about La Maquina but never planted it, singled out the inavailability of seed as the major reason which prevented them from growing the variety. Twenty two percent of respondents point out the lack of seed as illustrated in Table 5. Other important reasons are the bigger cob of La Maquina, tradition and the lack of information. Farmers feel that the grain to cob ratio is lower for La Maquina because of its bigger cob. These farmers

do not take into account the bigger grains of La Maquina and its higher number of grain rows. Thirteen percent of informants prefer to stick to the local variety while twelve percent identify the lack of information as the reason which refrained them from growing La Maquina.

5) Comparative characteristics of La Maquina and Chicken Corn

Table 6 presents the comparison made between La Maquina and Chicken Corn by farmers who grew both varieties. The majority of interviewees acknowledge that La Maquina has better taste, conserves better under local storage conditions and yields better with fertilizers than Chicken Corn. La Maquina is sweeter than the local maize variety and this explains farmers' overwhelming preference for Maquina's taste. The harder endosperm of Maquina allows a better conservation of the product especially in the absence of insect treatment.

Forty eight percent and more of respondents prefer Chicken Corn for its easy shelling and marketing, shorter production cycle, better yield of maïs moulu when ground and better production yield without fertilizer and under dry and normal weather conditions. Because of the lack of extension, farmers are not aware that La Maquina yields approximately the same percentage of maïs moulu than Chicken Corn. A milling test on both varieties carried out in 1989 by DCCH (a local NGO) found the same percentage of maïs moulu and flour for the two varieties. The easier marketing of Chicken Corn is also based on interviewees' impression that the local variety yields more maïs moulu than Maquina. In addition, informants' perception that Chicken Corn yields better than Maquina when no fertilizer is applied to both varieties comes from their unawareness of variety testing results obtained in Les Cayes Plain. The MARNDR-CIMMYT program carried out research during three years on 12 varieties including Chicken Corn and Maquina and found the later yielding slightly better than the former when no fertilizer is applied to both varieties.

II.- Adoption of urea

1) First year to use urea on maize

Table 7 shows that twelve percent of informants never applied urea on their maize crop compared to eighty eight percent who fertilized their maize with urea at least once. Urea use on maize started basically

during the 1960-69 decade. This concides with the establishment of the Agriculture Credit Bureau (BCA). This Bureau provides farmers with input and cash credit for financing agricultural production activities. The addition of the Agricultural Development Bank (BNDAI) contributed to expand credit granted to farmers for production purposes. The existence of US-funded integrated agricultural development projects such as PDAI and the corn improvement project were conducive in fostering the use of off-farm purchased inputs and particularly fertilizers. These factors together explain the forty two percent of respondents who applied urea on their maize crop at least once during the 1960-69 and 1970-79 decades.

The opening of three private input dealerships since 1982 played an important role in farmers' access to fertilizers during the 1980-89 period. Prior to 1982, the Agricultural District was the only fertilizer dealer in Les Cayes Plain. Fertilizers sold at this outlet were 86% N-P-K blends. Urea represented only 4% of the overall amount of fertilizers sold. The establishment of the staple crops promotion project (PPV), the provision of fertilizers through Japanese Aid Assistance program and the implantation of a fertilizer mixing plant in Port-au-Prince are additional factors which contributed to increase fertilizer use in Les Cayes Plain during the last decade.

Since the recommendation of urea in 1985 by the MARNDR-CIMMYT program, some twenty six percent of interviewees report using urea on their maize. This percentage is higher than that mentioned for any other time period. This comes from various factors. The Agricultural District and the PPV project decided to make more urea available to farmers following the urea recommendation. The MARNDR-CIMMYT team worked closely with input dealers and US-funded projects such as ADS I and II to expand the extension of the urea recommendation. The decrease in urea use in 1988 and 1989 comes from the increase of urea prices in local currency following the closure in 1987 of the fertilizer mixing plant in Port-au-Prince, the rise of urea prices on the world market, the depreciation of the local currency with respect to the US dollar, the closure of BNDAI and the reduction in BCA operations. All fertilizers are now imported or received as grants from foreign assistance programs. These programs have been cut down since 1987.

2) Source of information on urea

Approximately thirty percent of informants report getting their information on urea from neighbours. This illustrates the important role that colleagues can play in the adoption of technologies such as the urea recommendation. BNDAI and agronomists are mentioned by twenty five and twenty four percent of interviewees respectively as sources of information on urea. BNDAI's importance comes from its provision of supervised credit to farmers. Agronomists referred to include those working for all agricultural institutions and NGOs. The same observation holds for agricultural technicians. Levy Farm is mentioned especially by respondents who participated in field days organized at the state farm. Although, the PPV project is aimed at providing subsidized inputs to farmers, it does not rank as a major provider of information on urea. This comes from the limited number of staff assigned to this project, its newness and limited reach in Les Cayes Plain.

3) Source of urea during first year of application

Thirty two percent of interviewed farmers who applied urea at least once on their maize crop mention the Agricultural District as their source of urea. Approximately thirty percent of interviewees indicate BNDAI while thriteen percent point to private dealers as their initial source of urea. The PPV project is mentioned by only eight percent of respondents. The ranking of the various sources reflect their importance as subsidy or credit providers to farmers.

4) Reasons for no longer applying urea

Ninety one percent of interviewed farmers who applied urea at least once on their maize crop continue their application. Only nine percent of informants who used urea once on maize refrained from the practice. Among those who do no longer apply urea on their maize, fifty and twenty five percent mention lack of money and high prices of urea respectively as the factors which prevent them from continuing to use urea (Table 8). Sharecropping and inavailability of urea are each pointed to by twelve percent of respondents. Urea prices have doubled at the private dealerships since December 1987 and supplies have been irregular.

5) Reasons for not using urea

One fourth of the twelve percent of interviewees who never

used urea on their maize crop indicates lack of money as the reason (Table 9). Production risks, tradition, fertility of land, share-cropping, inavailability of urea and lack of information are each mentioned by twelve percent of respondents as the factors which prevent them from applying urea on their maize.

CONCLUSIONS AND POLICY IMPLICATIONS

On-Farm Research contributes to generate technologies that meet farmers' needs.

- Twenty four percent of farmers in Les Cayes Plain have planted La Maquina with virtually no extension. About half of these farmers have learned and planted La Maquina through the 1986 emergency relief program. The failure of this program has led a substantial number of La Maquina growers to restrain from planting the variety. Additional reasons put forth by maize producers for no longer growing La Maquina are the variety's non-resistance to drought and high input requirements for realizing its high-yield potential. Farmers who have never planted La Maquina point to the lack of seed as the main impediment which prevented them from growing the variety. Rapid increases in the adoption rate of La Maquina would require that future research be aimed at improving the variety through the incorporation of some desirable features of the local variety i.e resistance to drought, easy shelling and thiner cob.
- Twenty six percent of farmers in Les Cayes Plain have used urea on their maize crop at least once since its recommendation by the MARNDR-CIMMYT team in 1985. About 90% of these farmers continue to apply the fertilizer. Farmers who do no longer or have never applied urea point to the lack of money and high urea prices as the main reasons preventing them from using this fertilizer. Given the doubling of urea prices since December 1987, sensibility analysis should be performed regularly as fertilizer and product prices change in order to monitor the profitability of urea as source of nitrogen. Future

research should aim at identifying alternative economical sources of nitrogen for maize production.

Agricultural policy has an important bearing upon the adoption of recommended technologies.

- Lack of extension hampers adoption of technologies. An important feature of promotion is information. If farmers are not informed about a technology, they wouldn't be aware of it, let alone learning and trying it. Hence, it is not assured that La Maquina, urea or any other technological component would promote itself just by its existence. Therefore, a well-structured extension system must be set up in order to complement research activities and guarantee the delivery of technological components that meet farmers' needs.

- Conflicting policies are detrimental to adoption. The Ministry of Agriculture intended to promote La Maquina while providing farmers with poor seed of this maize variety. Further, prices of domestically-produced staples are maintained at a low level because of cheaper imported foodstuff. This conflict between long term agricultural development policy and short term food policy deters resource-poor farmers from investing in improved technologies such as HYV. In order to stimulate agricultural production, food imports should be controlled and taxed in the short term. Additionnally, price targets for basic cereal crops should be set each year at the beginning of the growing season. This policy should also involve purchasing and storage of staples by some governmental agency. Needs of the poor ought to be considered through a welfare program.

- The inavailability of recommended technological components represents a serious impediment to their adoption. MARNDR recommends the use of La Maquina while not making any seed of La Maquina available to farmers. A well-structured seed program appending to research activities appears to be critical for the adoption of improved maize varieties. Further, prices of inputs such as urea have

doubled since 1988 and these price increases can't be passed on to consumers because of competing cheaper imported maize. The domestic price of urea is 50% higher than the world price. Reducing this price gap to about 10% through price control and subsidy to farmers is an attainable short term objective for policy-makers. In addition, the implementation of the National Seed Program will help to alluviate seed shortages for basic cereals.

Socio-economic factors play an important role in the adoption of recommended technologies.

- Interest rates ranging from 15 to 20% per month on the informal capital market inhibit resource-poor farmers from investing in agricultural innovations. Technologies such as HYV that require expenditures on seed and fertilizers are not affordable to the majority of small farmers. A revamping of the agricultural lending institutions along with an increase in their financial resources would contribute to reduce the cost of capital on the informal market.

- Shelling is done in Haiti through beating maize ears with poles. La Maquina is more difficult to shell under these conditions than the local maize variety. Shelling of La Maquina involves additional expenses for farmers.

- La Maquina appears to be less tolerant to drought than the local maize variety in an area where many farmers have no meaningful access to irrigation. This feature has led a substantial number of small farmers to prefer their local variety because of the perceived lower objective risk attached to it. The average farm size in Les Cayes Plain is 0.56 ha and risk-averse farmers are less inclined to stake the food security of their households by adopting technologies they can't afford or don't master the use. Researchers should be sensitive to the particular characteristics of the technologies they recommend and be ready to imporve them in order to meet farmers' needs.

. The existence of public or private institutions promoting a technological change plays an important role in the adoption of improved technologies. In this regard, BCA, BNDAI and the Agricultural District have been instrumental in the widespread use of urea on maize in Les Cayes Plain. Unfortunately, the same institutions were not in a position to make La Maquina available to farmers and the adoption of this maize variety has not been as extensive as that of urea.

REFERENCES

Byerlee, D : "Food for Throught: Technological Challenges in Asian Agriculture in 1990's. USAID, Washington, 1989.

Byerlee, D et all: "Diagnosing Research and Extension Priorities for Small Farmers: Maize in the SWAT Valley". PARC-CIMMYT No 87-19. Islamabad, Pakistan.

CRDA - IICA : "Programme National de Développement et de Transfert de Technologie pour la Production du Maïs en Haiti - PRONATMA (Un Cadre de Référence)". IICA Port-au-Prince, Haiti, Mars 1990.

Feder, G et all : "Adoption of Agricultural Innovations in Developing Countries: A Survey". Economic Development and Cultural Change 33 (256-297) 1985.

Guindo, O : "The Role of Adaptive Research in Increasing Agricultural Productivity: The Experience from Haiti". Canadian Journal of Agricultural Economics 37 (887-897) 1989.

McLain, R.J and Stienbarger, D.M : "Land Tenure and Land Use in Southern Haiti: Case studies of the Les Anglais and Grande Ravine du Sud watersheds". Land Tenure Center. Research paper 95. University of Wisconsin. Madison, Wisconsin. April 1988.

Picard, L : "L'enseignement primaire et secondaire en Haiti". Collège Canado-Haitien. Port-au-Prince, Haiti, 1989.

Polson, R.A and Spencer, D : "The Technology Adoption Process in Subsistence Agriculture: The Case of Cassava in Southwestern Nigeria". Paper presented at the annual meeting of the American Agricultural Economics Association, Vancouver, Canada, 1990.

Reusche G et all : "Haiti Corn Improvement Project". DARNDR-USAID Virginia Polytechnic Institute and State University. Contract AID/la - c - 1113/Haiti. Blacksburg, Virginia, USA, July 1979.

Tweeten, L : "Systems Planning For Rural Development", in: The Development of Rural America. Brinkman, G. L (ed). The University Press of Kansas, Manhattan, 1974.

Winkelmann, D : "Promoting the Adoption of New Plant Technology". Paper presented at the World Food Conference, Iowa State University, June 1976.

Yates, M and Martinez, J.C: "On-Farm Research Methodologies at Work". Progress Report From Les Cayes, Haiti, Les Cayes, August 1985.

Yates, M : "Progress Report on the Area Specific On-Farm Research Program in Les Cayes". Research Report. Haiti, Les Cayes,April 1984

Yates, M : "Results of a SERA/CIMMYT farmer survey in the Cayes Plain Research Report. Les Cayes, Haiti, June 1982.

Table 1: Levels of Nitrogen x Variety Across Locations

Marginal Rates of Return

	Treatment	Yield (tonnes/ha)	Variable costs ($/ha)	Net benefit ($/ha)	Marginal net benefits ($/ha)	Marginal costs ($/ha)	Marginal rate of return
Chicken Corn	N_0	1.70	0	272.0			96 %
	N_1	2.10	32.6	303.4	31.4	32.6	
La Maquina 7827	N_0	1.82	0	291.2			175 %
	N_1	2.38	32.6	348.2	57.0	32.6	
La Maquina 7928	N_0	1.90	0	304.0			87 %
	N_1	2.28	32.6	332.2	28.2	32.6	

FPN = $ 0.74 /kg

FPM = $ 0.16 /kg

N_0 = 0 kg of nitrogen/ha

N_1 = 40 kg of nitrogen/ha

FPN : Field price of nitrogen

FPM : Field price of maize

Table 2: First year of planting La Maquina

Year	Frequency	Percent	Cumulative Percent
1983	3	12.5	12.5
1984	3	12.5	25.0
1985	1	4.2	29.2
1986	11	45.7	74.9
1987	4	16.7	91.6
1988	1	4.2	95.8
1989	1	4.2	100.0
Total	24	100.0	

Table 3: Source of La Maquina seed the first year

Source	Frequency	Percent	Cumulative Percent
Levy Farm	6	27.3	27.3
Neighbour	2	9.1	36.4
PPV	1	4.5	40.9
1986 program	9	41.0	81.9
PDAI	1	4.5	86.4
BNDAI	1	4.5	90.9
Friends	2	9.1	100.0
Total	22 a/	100.0	

a/ Missing value: 2

Table 4: Reasons for no longer growing La Maquina

Reasons	Frequency	Percent	Cumulative Percent
Longer production cycle	1	4.9	4.9
Marketing problems	1	4.9	9.8
Seed inavailability	2	8.8	18.6
Non-resistant to insects	1	4.9	23.5
High input requirements	5	23.9	47.4
Non-resistant to drought	5	23.9	71.3
Failure in 1986	6	28.7	100.0
Total	21 a/	100.0	

a/ Missing value: 3

Table 5: Reasons for not growing La Maquina

Reasons	Frequency	Percent	Cumulative Percent
Lower yield	5	8.2	8.2
Difficult to shell	4	6.7	14.9
Longer production cycle	2	3.3	18.2
Bigger cob	9	15.0	33.2
Lack of information	7	11.7	44.9
Seed inavailability	13	21.7	66.6
Absence of irrigation	1	1.7	68.3
Higher input requirements	6	10.0	78.3
Tradition	8	13.3	91.6
Non-resistant to drought	1	1.7	93.3
Failure in 1986	3	5.0	98.3
Difficult to store	1	1.7	100.0
Total	60	100.0	

Table 6: Comparative characteristics of La Maquina and Chicken Corn

Characteristics	Maquina is better	Chicken Corn is better	The two varieties are equal
Yield with fertilizer	68.4 %	26.3 %	5.3 %
Yield without fertilizer	-	80.0 %	20.0 %
Yield under dry weather	-	81.2 %	8.8 %
Yield under normal conditions	37.7 %	64.3 %	-
Production cycle	16.7 %	83.3 %	-
Taste	100.0 %	-	-
Milling	38.9 %	50.0 %	11.1 %
Marketing	33.3 %	47.6 %	19.1 %
Shelling	-	95.8 %	4.2 %
Storage	46.7 %	26.7 %	26.6 %

Table 7: First year to use urea on maize

Year	Frequency	Percent	Cumulative Percent
Never	10	11.9	11.9
1950-59	3	3.6	15.5
1960-69	18	21.4	36.9
1970-79	17	20.2	57.1
1980-83	14	16.7	73.8
1984	4	4.8	78.6
1985	6	7.1	85.7
1986	3	3.6	89.3
1987	5	5.9	95.2
1988	1	1.2	96.4
1989	3	3.6	100.0
Total	83 a/	100.0	

a/ Missing value: 17

Table 8: Reasons for no longer applying urea

Reasons	Frequency	Percent	Cumulative Percent
High price of urea	2	25.0	25.0
Lack of money	4	50.0	75.0
Sharecropping	1	12.5	87.5
Inavailability of urea	1	12.5	100.0
Total	8 a/	100.0	

a/ Missing value: 3

Table 9: Reasons for not using urea

Reasons	Frequency	Percent	Cumulative Percent
Lack money	2	25.0	25.0
Lack of information	1	12.5	37.5
Inavailability of urea	1	12.5	50.0
Sharecropping	1	12.5	62.5
Land is fertile	1	12.5	75.0
Tradition	1	12.5	87.5
Production risks	1	12.5	100.0
Total	8 a/	100.0	

a/ Missing value: 2