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Assessing Farm-Level Maize Storage as an Opportunity for On-Farm Research: Some Economic and Technological Considerations

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Introduction

In cooperation with colleagues in national research institutions, CIMMYT has sought to develop methods that help focus agricultural research on the needs of representative farmers. That methodology, widely known as on-farm research (OFR), has three operational phases:

1) assessing farmers' circumstances to identify potential research opportunities;

2) ranking those research opportunities in terms of their probable payoffs; and

3) undertaking on-farm experimentation that focuses on the high-priority opportunities (Byerlee et al. 1982).

A careful assessment of farmers' circumstances (that is, the biological and socioeconomic environment in which farmers make their production decisions) is particularly important. This step is essential for the correct identification of priority research opportunities, which in turn conditions the efficiency of the process of generating and transferring technology.

This paper describes an OFR program's evaluation of a potentially promising research opportunity in Les Cayes, southwestern Haiti. The program is being implemented by the Ministry of Agriculture with technical cooperation from CIMMYT and financial support from the Canadian International Development Agency (CIDA).

Maize in the Les Cayes area is an important "leverage point" for increasing the productivity and income of representative farmers. The crop occupies approximately 37% of all cultivated land, and virtually all maize used locally is for human consumption. Furthermore, the area is a net exporter of maize to other parts of Haiti.[1]

An assessment of farmers' circumstances at the diagnostic stage of research showed important seasonal fluctuations in maize prices, a tendency not to store maize on the farm, and a lack of appropriate farm storage facilities. In view of those circumstances, farm-level maize storage appeared to be a promising near-term research/extension opportunity. Subsequent technical

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1 A full report of the maize research (surveys and experiments) can be found in Yates and Martinez (1985) and is therefore not covered in detail here.

reviews continued to indicate that this topic merited the attention of the Les Cayes OFR team.[2]

This paper evaluates the potential of that proposed research opportunity, taking into consideration farmers' circumstances in Les Cayes. Both the technological and economic dimensions of the storage problem are described and a simple, appropriate framework is presented for analyzing similar cases confronted by national on-farm research workers elsewhere.

We first examine whether farmers' tendency not to store maize is related to the sharp seasonal fluctuations in maize prices. Various hypotheses explaining why farmers do not store maize are briefly discussed. Next, we present a simplified conceptual framework for analyzing the economic and technical dimensions of on-farm maize storage. That approach is then applied to the case of Les Cayes, using the limited information available from a diagnostic study of the area. Additional information about patterns of maize storage on farms in the area is followed by an explanation of why on-farm maize storage in Les Cayes is not presently a promising research opportunity.

The Problem

Maize prices in the Cayes plain show important seasonal fluctuations. Peak spring prices (about eight months after harvest) are often 50% above those prevailing one or two months after harvest (Figure 1).

Most maize is produced during the spring cycle on rainfed plots. Although two-thirds of the farmers plant a second maize crop, those fields tend to be much smaller and less important (Yates and Martinez 1985). Farmers using irrigation have much more flexibility in planting dates, but irrigated land makes up only a small percentage of the total area planted to maize (estimated at 14,000 ha) in the Cayes region. Thus, although no precise quantitative estimates are available, to some extent the seasonality of production appears to explain the fluctuations observed in maize prices.

Under the circumstances described above, one might assume that farmers would tend to develop some kind of "time arbitrage" by storing maize for delayed sale (perhaps eight months after harvest; see Figure 1). Nevertheless, during the diagnostic stage of the OFR program, we observed

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2 Donor interest in this issue was such that funding for a maize storage research component was added to the ongoing national program in Les Cayes.

that farmers generally did not store maize for delayed sale. Many farm families owned simple storage facilities (usually wooden boxes) used primarily for short-term storage (one to three months) of only limited quantities of maize. As Desrouilleres (1981) notes, however, such storage is *not* "a means of speculating on maize selling prices" but rather appears to be designed to meet three other objectives:

- to insure a degree of short-term food security;[3]
- to provide a highly liquid (albeit meager) asset to meet emergency cash needs; and
- to provide farmers with a small supply of seed for the next planting season[4] (Desrouilleres 1981).

Those key points emerged from a diagnostic study that called the attention of a CIDA technical review team to the issue of maize storage. The team hypothesized that appropriate storage facilities might improve the income of farmers in the region by enabling them to benefit from higher maize prices with delayed sales (Draper and Saint-Arnaud 1984). The following analysis reveals, however, that the hypothesis is too simplistic and does not take into account all of farmers' circumstances pertaining to maize storage.

Hypotheses

Three explanations, not mutually exclusive, were advanced for the prevailing tendency not to store maize at the farm level:

1. The cost of alternative farm storage facilities, such as silos, is beyond the means of most farmers.
2. High storage losses (occurring because farmers have little technical knowledge about how to manage stored grain) make storage a costly alternative.

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3 In Les Cayes this form of security appears to be important until the sorghum harvest begins in December (sorghum is typically rotated with spring-cycle maize in the nonirrigated areas). One might hypothesize that spring maize price increases would be even greater if consumers did not substitute sorghum for maize, which is more scarce (for more on this issue, see Borsdorf, Foster, and Haque 1985).

4 Approximately half of all farmers in the Cayes Plain store their own maize seed, purchasing additional amounts if necessary (Yates and Martinez 1985).

3. The high opportunity cost of capital makes storage economically infeasible.

In studies of cases like Les Cayes, it is not uncommon to find that hypotheses 1 and 2 are emphasized. The result is that storage programs concentrate on appropriate farm-level infrastructure and management practices. Where hypotheses 1 and 2 prove to be correct, on-farm storage research addressing those issues can produce appropriate alternatives for storing grain that can increase farmers' income in the near term.

However, when the opportunity cost of capital is high (that is, capital is generally scarce and/or farmers face pressing needs for cash), such programs may prove to be difficult, if not impracticable, depending on the magnitude of seasonal price fluctuations. In that case the availability of improved on-farm storage methods would not by itself lead to an increase in on-farm storage and farm income. The constraint in the farmers' economic environment would not permit them to make use of the new methods. Under what conditions, then, would farm storage be possible? The following section tries to address that question with the limited amount of information available from Les Cayes.

Farmers' Behavior and Storage Patterns

Farmers in the Cayes area, like rational farmers anywhere, will store maize if the expected benefits of storage (i.e., being able to sell at a higher price in the future) are greater than the expected storage costs.

This can be expressed as:

$$P_t - P_0 (1 + R_t) > S_t + (1 - A_t) P_t \qquad (1)$$

where:

P_t is the expected price of one kilogram of maize t months after harvest;

P_0 is the price of one kilogram of maize in the postharvest season (lowest point in the price cycle);

R_t is the farmer's opportunity cost of capital for the entire period t;

S_t are the direct costs of storing one kilogram of maize for a t-month period; and

$(1 - A_t)$ is a coefficient reflecting expected storage losses during the storage period. A_t is the proportion of the amount stored that is expected to be suitable for sale at month t.

The left side of equation (1) represents expected per-unit benefits of storage after considering the cost of capital, and the right side represents the expected physical cost of storing one unit of maize. Note also that whereas the left side isolates purely economic conditions (market prices) the right side deals with physical or technological parameters that can be modified by storage technology.

Consider the following simplified example. Let:

P_0 = \$2/kg

P_8 = \$4/kg

$(1 - A_8)$ = .07; that is, expected storage losses are 7% for the eight-month period;

S_8 = \$.60/kg; that is, the storage cost of one kilogram for eight months is 60 cents; and

R_8 = 10% for the eight-month period.

Assuming that all expectations are realized, the benefits of storage in this situation would be:

$$P_8 - P_0 (1 + R_8); \text{ or } \$4/kg - \$2/kg (1.10) = \$1.80/kg$$

That is, the farmer will get \$1.80 for each kilogram stored, an amount which should be sufficient to compensate for storage costs:

$$S_8 + (1 - A_8) P_8; \text{ or } \$.60/kg + (.07) \$4/kg = \$.88/kg$$

In this hypothetical example, farmers have a real incentive to store maize, since they can expect to make a profit of \$0.92 for each kilogram stored. The development and transfer of appropriate improved methods of maize storage

might expand that margin of benefit, making on-farm storage even more attractive.

In Les Cayes, researchers found that spring maize prices generally peak around eight months after harvest at approximately 50% above postharvest prices (see Appendix). Assuming that farmers' price expectations are based on historical seasonal patterns, one alternative might be to store maize in the middle of the harvest period (July) for sale later in the middle of the scarcity period at planting in March. That option implies a ratio of approximately 1.5 between the expected and actual price, or $P_8/P_0 = 1.5$. To consider this ratio, we can divide each term in equation (1) by P_0:

$$\frac{P_8 - (1 + R_8)}{P_0} > \frac{[S_8 + (1 - A_8) P_8]}{P_0} \quad \frac{1}{} \qquad (2)$$

The cost of capital for representative farmers can best be estimated by determining the real cost of borrowing capital in the informal credit market, since the vast majority of farmers do not have access to official (subsidized) credit sources.[5] The OFR team's experience in Les Cayes indicates that interest rates range from 10 to 20% per month,[6] reflecting the scarcity of capital. If we assume an average of 15% per month and an average storage period of eight months, R_8 can be estimated to be 120% for the entire storage period.

With these data, the benefits side of equation (2) can be calculated as

$$1.5 - (1 + 1.2) = -0.70$$

This outcome indicates that if price expectations are realized farmers can expect to *lose* 70% of the postharvest price (P_0) per kilogram stored, without ever considering the additional physical storage costs (represented by the right-hand side of equation 2).

Farmers in Les Cayes point to pressing cash needs as the principal constraint to maize storage (see the following section, "Some Partial Evidence"). Other authors (Borsdorf, Foster and Haque 1985; FONDEV 1984; and Smucker

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5 Smucker (1983) estimates "not more than 6% of Haiti's . . . farm families have access to credit from formal institutions." This is consistent with observations made in Les Cayes.

6 Smucker (1983) reports an average of 10-25% per month; interest rates are not compounded in the Haitian countryside.

1983) agree that alternative funds (replacing those normally received through postharvest maizes sales) would have to be obtained to enable farmers to store their maize inventories. As mentioned previously, funds are available almost exclusively through the informal credit market, where interest rates average approximately 15% per month. Under those circumstances the opportunity costs of storage become actual financial costs associated with the delayed sale. Those costs clearly appear to be greater than the gains from seasonal price fluctuations.

So far, only the left side of equation (1) has been considered. Given the results, however, it is entirely unnecessary to consider the right-hand side (physical costs) to understand why virtually no maize is stored in bulk for later sale in the region. Even in the unrealistic case of *no* storage losses (A_t = 1) and free storage facilities and management (S_t = 0), farmers clearly would have no economic incentive to store their maize. Indeed, under the unrealistic assumption of no losses and free storage, seasonal price fluctuations would have to exceed 120% in the period considered for maize storers to break even. The average seasonal price increases in Les Cayes[7] have not exceeded 120%[8] for at least 15 years (the period for which data, albeit incomplete, are available; see Borsdorf and Foster 1985).[9] As more reasonable (positive) values for (1 - A_t) and S_t are considered, it becomes even more apparent that farmers should prefer to sell most of their maize shortly after harvest, which is precisely what almost all of them do in Les Cayes.

Even though these are preliminary calculations, the results are still of interest because they point to the high opportunity cost of capital as the main factor explaining the tendency not to store maize in the area. Furthermore, programs trying to lower the cost side of the equation would apparently prove unfruitful, given prevailing economic conditions. In other words, under

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7 The average for the postharvest months (June-September) versus the average for the months of scarcity (January-April).

8 One source (La Gra, Charleston, and Fanfan, cited in Borsdorf and Foster 1985) reports an increase of 128% for 1972-73, a time of unusually sharp price increases for all cereals (Borsdorf, Foster, and Haque 1985), though the other available source (Institut Haitien de Statistique et d'Informatique, also cited in Borsdorf and Foster 1985) reports an increase of only 86%.

9 The Les Cayes data are apparently typical, with price fluctuations averaging only 25-30% for both the capital, Port-au-Prince, and the semirural markets, with peaks of 45-75% in years following production shortfalls (see Borsdorf and Foster 1985). Note, too, that even if the absolute optimum periods are considered (Figure 1)--i.e., from the price low in October to the high in May--the 62% price increase is not nearly enough to offset the cost of capital after seven months of storage (105%).

farmers' present circumstances, studying on-farm maize storage does not appear to be a promising research opportunity. The following section gives some additional partial evidence from Les Cayes supporting this conclusion.

Some Partial Evidence

After carefully identifying some improved maize varieties (La Maquina 7827 and La Maquina 7928) in farmers' fields, the Les Cayes OFR team had eight drum silos constructed (each with a capacity of approximately 300 kg) to permit timely distribution of quality seed throughout much of the Cayes plain (cf. Magloire and Yates 1983). Cooperating farmers were loaned silos filled with seed and told they could use the silos as they wished after the seed had been distributed for the spring planting. The OFR team kept in contact with the seed distributors throughout the year, and a surprising and interesting pattern soon emerged. Farmers were *leaving the silos empty* after the maize harvest rather than storing their own maize for later sale at higher prices. Certainly, the costs of the silos (hypothesis 1) could not explain that behavior. Moreover, the seed distributors had free access to technical advice on proper maize storage (hypothesis 2). Why then were they ignoring the opportunity for free storage? Their answers to the team's questions suggested that the high costs of capital were a key factor explaining the reluctance of Les Cayes farmers to store maize.[10]

Final Remarks

We have discussed how simple economic analysis and an understanding of farmers' circumstances can shed some light on the rationality of the maize storage practices in Les Cayes. We have also tried to show how the analysis can be used to correctly identify research opportunities and thus improve the efficiency of research.

What first appeared to be a promising research opportunity in the near term turned out to be less so as various dimensions of the problem (economic as well as technical) were considered more fully. On the basis of that analysis, improvement of storage methods for use by small-scale farmers was not

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10 Desrouillere's research (1981) with traditional maize storage techniques in rural Haiti is also interesting in this context. In his experiments he observed that insect infestation of untreated grain stored in traditional wooden boxes (like those used in Les Cayes) occurred only after five or six months of storage. Farmers do not store maize even that long for delayed sale, which also suggests that the key constraint is not technical but economic.

included in the Les Cayes OFR program. Instead, the national OFR team's resources were devoted to other more promising research opportunities, two of which have already led to recommendations for farmers (a new maize variety and nitrogen fertilization with urea).

If further research or other action is considered on farm-level maize storage in the region, a number of questions have to be addressed. Why, for example, is the cost of capital so high, and what would be the social benefit/cost of the alternative market interventions required to make on-farm storage of maize profitable? Attempting to answer those questions would lead one a long way from the initial issue of on-farm maize storage. Yet it appears that one would have to study those broader and more complex issues before considering the investment of scarce government funds or donor assistance in developing and transferring improved methods of maize storage in Les Cayes.

References

Byerlee, D., L.W. Harrington, and D.L. Winkelmann. 1982. Farming systems research: Issues in research strategy and technology design. *American Journal of Agricultural Economics* 64(5): 897-904.

Borsdorf, R., and K. Foster. 1985. *A Compilation of Market Price Data for Cereals and Beans, Haiti.* USAID Technical Assistance Report No. 103A. Manhattan, KS: Food and Feed Grain Institute, Kansas State University.

Borsdorf, R., K. Foster, and E. Haque. 1985. *Feasibility of a Grain Price Stabilization Program in Haiti.* USAID Technical Assistance Report No. 103. Manhattan, KS: Food and Feed Grain Institute, Kansas State University.

Draper, M., and R. Saint-Arnaud. 1984. Recherche appliqué sur le maïs (DARNDR/CIMMYT) République d'Haiti. Evaluation de Fin de Projet. Agence Canadienne de Développement Int. Dossier No. 444/08201.

Desrouilleres, J. 1981. *La conservation traditionelle du maïs en milieu rural: Pertes et agents responsables.* Mémoire. Port-au-Prince: Université d'Etat d'Haiti, Faculté d'Agronomie et de Medecine Veterinaire.

FONDEV. 1984. *ESP-Haiti: Etude d'Execution du Programme de Securité Alimentaire.* Port-au-Prince: FONDEV.

Magloire, E., and M. Yates. 1984. Recherche chez les paysans. In *Seminaire Sur les Systèmes de Production Agricole en Haiti.* Projet d'Appui au Developpement Agricole II, MARNDR/USAID, University of Arkansas/Winrock. 5/1-18.

Smucker, G. 1983. Supplies of credit among Haitian peasants. Washington, D.C.: Development Alternatives.

Yates, M., and J.C. Martinez. 1985. On-farm research methodologies at work: Progress report from Les Cayes, Haiti. Draft paper. Mexico: CIMMYT.

Appendix

Maize Prices, Les Cayes

Average monthly prices (US$/kg)[a] for whole maize, Les Cayes, Haiti, 1980-83

Month	1980	1981	1982	1983	Average
January	0.38[b]	0.44	0.28	0.28	0.34
February	0.37[b]	0.40	0.28	0.30	0.34
March	0.40[b]	0.46	0.26	0.34	0.37
April	0.40	0.48	0.24	0.34	0.37
May	0.42	0.38	0.24	0.46	0.38
June	0.35	0.36	0.20	0.38	0.32
July	0.22	0.28	0.18	0.31	0.25
August	0.22	0.28	0.16	0.30	0.24
September	0.26	0.26	0.18	0.34	0.26
October	0.24[b]	0.20	0.19	0.30[b]	0.23
November	0.26[b]	0.22	0.23	0.34[b]	0.26
December	0.27[b]	0.20	0.25	0.34[b]	0.27

Source: Borsdorf and Forster (1985). Period 1980-83 selected as it offers the most complete data set.

a Original data in gourdes per marmit.

b Proxy prices estimated by applying increases/decreases to adjacent months proportional to those calculated from complete annual data set.

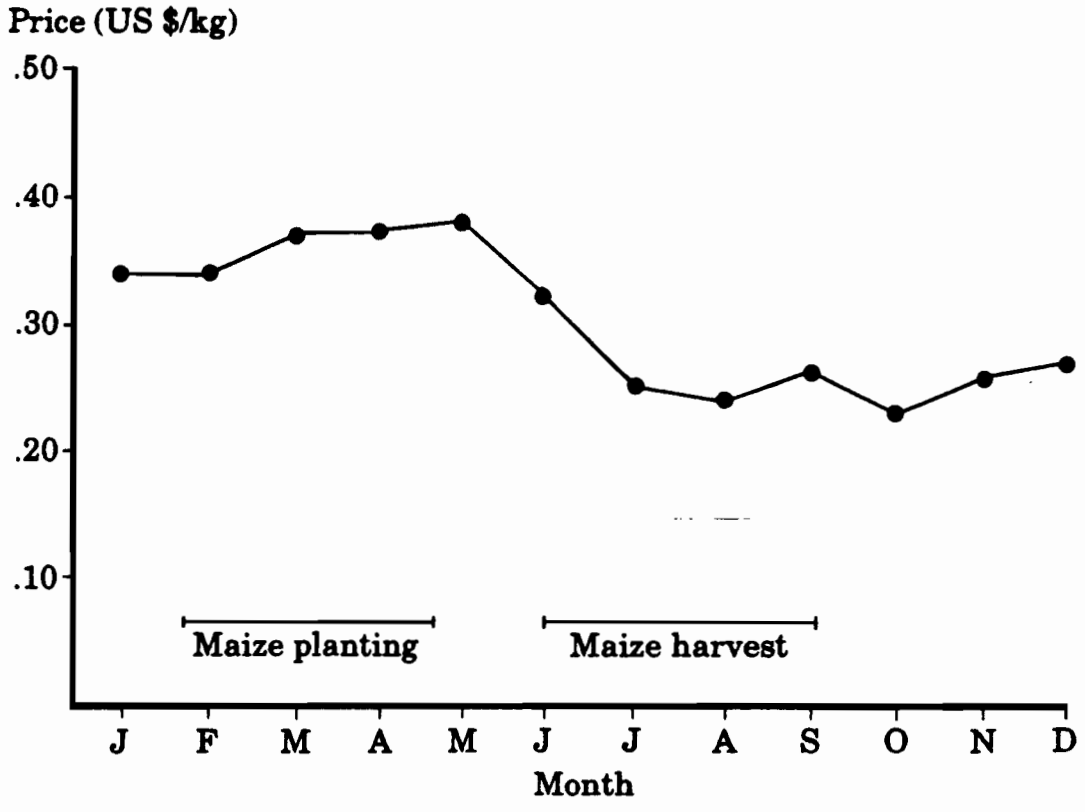

Figure 1. Average monthly maize prices, Les Cayes, 1980-83
Source: Appendix