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Research Results from the Department of Policy Analysis
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Observations and Emerging Lessons from the 1998/99 High-Input Maize Program in Nampula Province, Mozambique

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BACKGROUND: Since 1997, Ministry of Agriculture and Rural Development (MARD) and Michigan State University (MSU) researchers have been collaborating to assess (1) the current financial and economic profitability of improved technology use, and (2) the costs and benefits of interventions to increase profitability by reducing input marketing costs and improving extension assistance.

A farm-level survey[1] of Rural Extension Directorate and Sasakawa-Global 2000 (DNER/SG) high-input maize program (improved seed and fertilizer) participants was undertaken in 1997 in Nampula Province (northern Mozambique), focusing on the 1996/97 production season. In the following production season (1997/98), the survey was broadened to include participants in DNER's low-input maize program (improved management only) and farmers who did not participate in either program. Yield results for these two seasons are summarized in Table 1, and profitability results are presented in Table 2.

The 1996/97 and 1997/98 results showed that significant yield increases are possible with the application of improved seed and fertilizer technology. However, given the high cost of inputs and the relatively low farmgate price of maize at harvest, the yield increases achieved by the average participant were generally insufficient to render production of improved maize more profitable (on a net income per hectare basis) than production of maize using traditional low-input methods. If farmers were able to store maize and gain from steep price rises that took place during both 1996/97 and 1997/98 marketing seasons (Table 2), then profitability increased. The steep price rises were spurred by a surge in maize exports to neighboring Malawi in 1996/97 and 1997/98. 1999 prices were flat and farmers have been unable to improve profitability through storage to the same extent. Maize exports declined substantially in the 1998/99 and 1999/2000 seasons due to increased domestic maize production in Malawi.

During the first two years of the study, maize yields were affected by the late delivery of inputs, inadequate extension assistance, and mixed signals regarding farmers' obligation to repay input credit extended by the DNER/SG program. In the 1998/99 season, in an effort to improve implementation and enhance program sustainability, DNER/SG began collaborating with the Cooperative League of the

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* The views expressed here are those of the authors and do not necessarily reflect the official position of the Ministry of Agriculture and Rural Development.

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[1] Methods used in the MARD/MSU study included physical crop cuts for yield estimation and interviews with sample farmers to collect information on labor and other inputs used in the production process. Since the objective of the study was to assess the performance and profitability of the improved maize program **under typical on-farm conditions**, our approach was inclusive – gathering yield and input data from almost all participants. This approach contrasts with the more traditional agronomic focus on assessing the **potential** performance of the technology. Agronomists may prefer to exclude poorer results from the analysis on the grounds that if crop management is flawed (e.g., because of late input delivery, delayed planting or weeding) the trials do not represent true tests of the technology. From the socioeconomist's perspective, delays in input delivery, flawed technology application and uncertain weather are typical constraints of the real farm environment in which improved technology must perform. Failing to consider these constraints and the impacts they may have on yields and profitability can result in a misleading assessment of the risks of technology adoption from the farmer's perspective, and underestimate the importance of designing policies and programs that help reduce marketing costs and ameliorate weather, management and price risks.

Table 1. Maize Yield Results from DNER/SG Maize Programs

Year	Region 7 -- Ribaue District			Region 8 -- Monapo and Meconta Districts			Region 10 -- Malema District		
	Hi-Input Maize	Lo-Input Maize	Non-participant	Hi-Input Maize	Lo-Input Maize	Non-participant	Hi-Input Maize	Lo-Input Maize	Non-participant
96/97[a] (tons/ha)	0.8			2.4			2.9		
n	(16)			(24)			(21)		
97/98[b] (tons/ha)	1.3	1.3	1.1	2.7	2.0	1.7	1.9	2.0	1.2
n	(34)	(27)	(21)	(32)	(34)	(30)	(13)	(10)	(7)
98/99[c] (tons/ha)	2.4		1.1				3.0		1.6
n	(24)		(13)				(20)		(23)

Source: Calculated from MARD/MSU survey data

Notes:

[a] 1996/97 data were collected from individual farmers participating in the DNER/SG hi-input program. Inputs used were 100 kg 12-24-12, 100 kg urea and 30 kg improved maize seed per hectare.

[b] 1997/98 data were collected from plots of individual farmers: (a) participating in the DNER/SG hi-input program using the same inputs as above (sole-cropped); (b) participating in the DNER lo-input extension group program who received advice about cultural practices but did not use fertilizer or improved seeds (sole or intercropped); and (c) plots of individual farmers who did not participate in either program (sole or intercropped).

[c] 1998/99 data were collected from 80 plots belonging to members of 5 farmer associations assisted by CLUSA. Data were collected from (a) plots where DNER/SG improved seed and fertilizer (same amounts as above) were used (primarily sole-cropped maize); and (b) plots where no improved inputs were used (primarily intercropped).

USA (CLUSA), which has been working to develop farmer associations in Nampula Province since 1996. Twenty-one CLUSA-assisted associations (involving some 300 farmers) participated in the DNER/SG improved maize program during the 1998/99 production year. With CLUSA assistance, contracts for delivery of improved seed and fertilizer were developed with private sector companies[2] and signed by individual associations. Performance contracts were also signed with the extension service. At the end of the season, CLUSA helped associations (through meta-association groups called "fora") to negotiate contracts with commodity buyers for the sale of maize produced in the program.

During 1998/99, MARD/MSU researchers followed the progress of the improved maize program in five CLUSA-assisted associations located in two different agroecological zones of Nampula Province. The objective of this study was to assess how greater involvement of farmer associations in maize intensification affects marketing costs and extension effectiveness. This preliminary report summarizes our observations on the 1998/99 production season and part of the 1999/00 marketing season, based on analysis of maize yield data and informal group interviews with participating farmer associations carried out in March and November 1999. In the final section we discuss some of the preliminary conclusions that are emerging from the broader three-year maize intensification study.

OBSERVATIONS:

Preliminary results indicate that 1998/99 high-input maize yields were substantially higher than high-input yields from previous seasons. In Region 7 (Ribaue)1998/99 maize yields were 1.1-1.6 tons/ha higher than high-input yields from 1996/97 and 1997/98. In Region 10 (Malema, a more favorable agroecological zone for maize) 1998/99 yields exceeded 1997/98 yields by 1.1 ton/ha and were similar to yields achieved in 1996/97 (2.9 tons/ha) (Table 1). Participating farmers and other observers raised the following points about factors affecting maize performance in 1998/99 and plans for the 1999/2000 season.

[2] The private sector companies involved were Agroquimicos for the supply of fertilizer and SEMOC for the supply of improved maize seed.

Table 2. Summary of Results from 1996/97 and 1997/98 Farm-Level Maize Enterprise Budgets

	Region 7 (Ribaue)			Reg. 8 (Monapo/Meconta)			Region 10 (Malema)		
MAIZE PROGRAMS 1996/97 1 USD = 11,500 mt	**Hi-Input Maize**	Lo-Input Maize	Non-Prog. Part.	**Hi-Input Maize**	Lo-Input Maize	Non-Prog. Part.	**Hi-Input Maize**	Lo-Input Maize	Non-Prog. Part.
Maize grain yield (tons/ha)	**0.8**			**2.4**			**2.9**		
3. Returns at June 1997 prices									
June farmgate price ($/kg)	0.06			**0.06**			**0.06**		
Net income ($/ha)	**-61.97**			**32.32**			**53.27**		
Net returns to family labor ($/ae day)	**-0.73**			**0.48**			**0.6**		
4. Returns at average July-December 1997 prices									
Avg. July-December price ($/kg)	**0.073**			**0.068**			**0.073**		
Net income ($/ha)	**-62.15**			**29.53**			**72.2**		
Net returns to family labor ($/ae day)	**-0.73**			**0.44**			**0.81**		
5. Returns at December 1997 prices									
December price ($/kg)	**0.12**			**0.098**			**0.12**		
Net income ($/ha)	**-32.41**			**80.74**			**188.95**		
Net returns to family labor ($/ae day)	**-0.38**			**1.21**			**2.12**		

	Region 7 (Ribaue)			Reg. 8 (Monapo/Meconta)			Region 10 (Malema)		
MAIZE PROGRAMS 1997/98 1 USD = 12,000 mt	**Hi-Input Maize**	Lo-Input Maize	Non-Prog. Part.	**Hi-Input Maize**	Lo-Input Maize	Non-Prog. Part.	**Hi-Input Maize**	Lo-Input Maize	Non-Prog. Part.
Maize grain yield (tons/ha)	**1.3**	1.3	1.1	**2.7**	2	1.7	**1.9**	2	1.2
6. Returns at September 1998 Prices									
September price ($/kg)	**0.09**	0.09	0.09	**0.09**	0.09	0.09	**0.09**	0.09	0.09
Net income ($/ha)	**-5.68**	106.07	85.91	**100.37**	138.4	119.5	**17.88**	116.62	100.85
Net returns to family labor ($/ae day)	**-0.09**	1.14	0.79	**1.34**	0.86	0.64	**0.38**	1.08	0.87
7. Returns at November 1998 Prices									
November price($/kg)	**0.14**	0.14	0.14	**0.13**	0.13	0.13	**0.14**	0.14	0.14
Net income ($/ha)	**55.6**	167.58	136.44	**188.63**	203.62	177.37	**103.81**	207.34	158.86
Net returns to family labor ($/ae day)	**0.91**	1.8	1.25	**2.52**	1.26	0.94	**2.21**	1.92	1.37

Weather conditions were somewhat better than 1997/98, but it is unlikely that the 1998/99 yield increase can be attributed entirely to improved weather. Maize production in 1997/98 was affected by spotty droughts in some areas and flooding in others. There were two problems during the 1998/99 season, but in general, conditions were better than in 1997/98. First, a 2-week drought shortly after planting necessitated re-seeding of many plots – often at lower than the recommended density because of a shortage of improved maize seed. Following the initial drought, rains were fairly regular throughout the 1998/99 season. Second, termite attacks throughout the season affected both plant density and yield.

Farmers were able to plant high-input maize on time. Fertilizer and improved maize seed arrived in most association villages well before the planting season because of advance planning facilitated by CLUSA, DNER, SG2000 and increased cooperation between Agroquimicos, SEMOC and the associations. In previous seasons planting was delayed by 2-5 weeks because of the late arrival of inputs. Mozambique's private sector input distribution system is very weak, with only a handful of input dealers in the country.

Extension agent performance improved in 1998/99. At the beginning of the 1998/99 season, CLUSA associations signed an agreement specifying technical assistance to be provided by DNER. Technical assistance included the selection of appropriate fields for improved maize and demonstrations of planting and fertilization techniques. Most extension agents felt they were able to work more efficiently through the associations, and associations thought that extension agents were more responsive to their needs. Some associations that were unhappy with their extension agent's performance complained to DNER, which replaced the agents. While overall performance was better, problems remain, i.e., assigned extension areas are very large, lack of transportation is a significant constraint, and extension agents require additional training and backstopping.

Most association members have already repaid their input credit. Although in previous years high-input program participants have signed input credit contracts with DNER/SG, most Nampula participants were never required to repay the credit. CLUSA personnel have worked intensively to help association members understand the contracting mechanism, the obligation of SEMOC and Agroquimicos to deliver inputs on time, and the corresponding obligation of the farmers to repay the input credit regardless of the season's outcome. As of November 1999, three-quarters of associations had repaid their maize input loans in cash. The remaining associations renegotiated with SEMOC and Agroquimicos to extend the repayment date in the expectation that maize prices would rise during this period. Under the terms of the agreement, each farmer granted an extension had to store 600 kgs of maize for later sale. A delegation of input company and DNER representatives visited each association to verify the quantity of maize in storage.

Farmers in several associations wanted to repay the maize input loan with proceeds from cotton sales. These plans were frustrated because of major delays in the start of cotton marketing during the 1998/99 season. Ordinarily cotton marketing begins in July, but cotton had not yet been collected in two of three cotton-producing associations by mid-November.

The high repayment rate is especially significant given farmers' disappointment over the low profitability of improved maize production in 1998/99. Nampula farmers expanded maize area in 1998/99 in response to strong demand from Malawi in the previous two seasons. Nampula farmers can transport maize cheaply to Malawi using the railway line linking the Mozambican port of Nacala with southern Malawi. Malawi's demand for imported maize plummeted in 1998/99. Malawi's own maize harvest was good, in part because of the distribution of free maize inputs and favorable weather conditions. While in the previous two seasons the price of maize has doubled between the June-September post-harvest period and December-January, in 1998/99 maize prices price remained flat. The major commodity buyer in Nampula, V&M/ICM, paid farmers 1000 mt/kg in August-September and accumulated large stocks. With much weaker demand from Malawi, the price had declined to 800 mt/kg by November.

Although high-input maize program yields rose in 1998/99, given the low maize prices, repaying the input credit will require 56-70% of the average farmer's gross maize revenue in Ribaue and 44-55% of gross revenue in Malema. Our 1997/98 analysis revealed that even when we consider only high-input maize produced under "optimal conditions" – the highest tercile of yields from the zone where inputs were delivered on time (Monapo/Meconta) – net income per hectare from high-input maize exceeded net income from traditional maize only if farmers stored their maize until January, taking advantage of the substantial maize price rise that year. Even with the substantial yield increase realized by association farmers in 1998/99, a preliminary analysis suggests that net earnings per hectare will again be higher for traditional maize than high-input maize until maize prices rise to 1100-1200 mt/kg.

Although farmers expressed disappointment with its overall profitability, interest in the improved maize program continues to grow, especially in Malema (Region 10). Farmers in several associations, when asked why they wanted to continue growing improved maize, stated that maize was important not just as a commercial crop but also for home consumption – and that they would be willing to pay for the maize inputs with the earnings from other commercial crops. Indeed, many association farmers have paid or plan to pay for maize inputs with cotton earnings. This strategy permits them to repay the maize input loan on time while allowing them the flexibility to store maize for later sale or consumption. The latter point may be very important in some cases: past MSU research in Mozambique and elsewhere suggests that many farmers become net buyers later in the season when prices are usually high.

One possible explanation for the apparent paradox (low profitability/increasing interest in intensification) is that although improved maize may not always be a highly profitable commercial crop, use of improved maize seeds with fertilizer permits farmers to produce a targeted amount of maize using less land and labor, for both family consumption and the market. With this strategy more land and labor are available for the production of other marketed commodities. This may become increasingly important in Malema, where smallholder cash cropping systems are diversifying. Farmers have experience with cotton and tobacco and are beginning to experiment with pigeon pea and oilseed crops. The expansion in demand for maize inputs comes from new participants. Current participants in Malema will continue to grow improved maize, but do not appear to be significantly expanding maize area.

This result underscores the importance of analyzing the profitability of individual crops within the context of the farming system. It is essential to analyze the contribution crops (whose individual profitability may be limited if viewed on a purely commercial basis) make to food security and income both directly and indirectly. Farmers in Malema evidently are already viewing the contribution of intensive maize in this larger context. The use of improved inputs on maize directly contributes to family food security and may directly contribute to income through its commercialization. Even if it is not sold, however, improved maize may make an important indirect contribution to total family income by freeing up land and labor (ordinarily needed for the production of food staples) for additional production of non-maize commercial crops.

EMERGING LESSONS: Our discussions with farmers, extension and CLUSA personnel revealed the emerging role of farmer associations and fora in Nampula Province as facilitators/brokers for a range of agricultural services, including agricultural input and output marketing, credit and agricultural extension services. Farmer associations and fora are facilitating private sector expansion by reducing marketing and other transactions costs. For example, farmer groups reduce input supplier marketing costs and risks by aggregating demand for inputs, facilitating local delivery of products and guaranteeing credit repayment. During 1998/99 254 CLUSA-assisted associations received credit worth nearly USD 180,000 in agricultural inputs for cotton, tobacco, maize and sunflower provided by agribusiness, agricultural chemical and seed companies.

Private sector input companies are responding to the increased demand for agricultural technology. Demand is increasing for improved seeds of existing and new commercial

commodities such as cotton, pigeon pea, oilseeds, groundnut and beans. During 1998/99 Agroquimicos and Agrivet (another private sector pesticide dealer working in the region) sponsored on-farm trials of technologies (including termiticides, cotton insecticides and herbicides) with farmer associations. Following these trials, a number of associations are planning to sign individual contracts with input companies for the supply of agricultural chemicals. There are similar cost advantages for commodity brokers working through associations and fora.

During the past three seasons associations have served as marketing agents for their communities, buying maize from individuals on behalf of private wholesalers and storing it for bulk collection. New marketing and production opportunities are continuing to emerge (e.g., in sunflower, sesame, groundnut, bean and pigeon pea production) as mutual trust develops between farmer associations and private sector companies. CLUSA's head office in Nampula provides an easy point of contact for interested private sector businesses. The head office in turn can in turn disseminate information through the region quickly through the network of fora and association leaders.

Farmer associations and fora are also serving as a focal point and facilitator for NGO activities. In Nampula Province, CARE and World Vision are using the CLUSA methodology to develop associations in villages where they work. These NGOs are increasingly focusing on helping the private sector link with rural farmers instead of providing services themselves. For example, World Vision and CARE are building private sector capacity to market small packs of oilseeds, village oil presses and spare parts for presses instead of providing these directly. Technoserve is currently working with Mozambican investors interested in establishing large-scale oil press facilities in the region to (a) estimate the potential supply and sources of oilseeds, (b) identify equipment suppliers, and (c) facilitate forward production contracts between the companies and farmer associations.

The increase in agricultural opportunities is creating a demand for more effective extension services. As a result of the performance contract drawn up between associations and DNER, farmers participating in the maize program have new, clearer expectations of extension agents serving their villages. In most cases both associations and extension agents reported that the contract helped to focus and improve extension assistance for maize. In cases where associations were dissatisfied with the extension agent, the contracting process empowered farmers to complain to the DNER supervisors and get a new agent. Farmers recognize that DNER operates under severe resource constraints in many areas. As a response, a new program has begun to provide basic agricultural technical training to farmer fora representatives through a series of courses to be offered in conjunction with DNER and donor organizations. These fora representatives will in turn train association representatives, who will assist DNER extension agents assigned to their villages and share technical information with other association members.

Further development of export markets for maize and other crops is crucial to keep this process going. Recent research has shown that the surge in formal maize exports to Malawi during the 1997/98 and 1998/99 marketing seasons increased producer prices by 15-21% in Nampula and Zambezia Provinces. Of equal importance, this trade opportunity brought large traders with greater operating capital into the maize market, most of them for the first time. The entrance of such traders improves liquidity, provides competition for smaller informal traders, and allows farmers and farm associations to bulk maize and produce with greater confidence for the market. On the other hand, the failure of some of these traders to find sufficient export markets during the 1999/2000 marketing year, and their decision to stop or slow their maize purchases, severely affected farmers planning to sell maize. Without a dependable export market, the growth in demand for improved technologies and services will be limited by the self-sufficiency needs of most smallholder farmers. The increasing cross-border trade in maize and other commodities also means that it is very important for donors and governments to consider the possible regional as well as national impacts of programs such as Malawi's distribution of free seed and fertilizers

to smallholders in the 1998/99 production season.

ROLE OF SG2000 AND OTHER PROGRAMS IN RAISING AGRICULTURAL PRODUCTIVITY:

Sasakawa Global 2000 (SG) in Mozambique has played a pivotal role in introducing improved maize technology to Mozambican smallholders through initial financing of the technology package and in the design and implementation of the DNER extension program for improved maize. SG was also one of the first NGOs in Mozambique to recognize the importance of motivating private sector involvement in agricultural input distribution.

As Nampula Province and other areas of Mozambique move out of the initial phase of the improved technology "campaign," however, it is important that SG and similar pilot programs also make adjustments if they are to effectively promote agricultural development.

First, it is crucial that intensification efforts be pursued in the context of expanding domestic and regional markets. Regional exports of maize have been shown to significantly increase producer prices and thus improve the profitability of the DNER/SG package. Beyond the direct effect on prices, only regional export markets will provide the level of demand needed to absorb the production increases that would come from sustained intensification efforts over a long period of time.

Longer-term programs aimed at reducing transportation costs can have a critical impact on both intensification and the regionalization of commodity trade by lowering the farmgate cost of inputs and raising the price farmers receive for their products. Transportation costs represent at least one-third of the farmgate cost of fertilizers in Mozambique. Examples of key interventions include improvements to the farm-to-market road and rail network, port infrastructure and logistic improvements to reduce regional sea freight costs, and increasing the capacity and efficiency of truck fleets.

Second, it is important to ensure that the technology packages being promoted are financially profitable from the smallholder perspective and do not expose farmers to high levels of risk. MARD/MSU study results from the last three seasons suggest that the improved maize technology package currently being promoted in Nampula Province (improved open-pollinated seed, 100 kg 12-24-12, 100 kg urea/ha) is inappropriate as a primary anchor for commercialization. Improved maize as a primary commercial crop is excessively risky because potential smallholder yields are relatively low compared to competing maize-growing areas at higher altitudes in neighboring provinces and countries in the region, and maize prices are extremely volatile worldwide. Although improved maize produced solely for commercial purposes is excessively risky for most smallholders, it can be an important component of a diversified cash cropping system in which the earnings from other cash crops (such as cotton, sunflower, pigeon pea) ensure that credit can be repaid.

Several alternative strategies are possible. **It will be important to move away from blanket fertilizer recommendations and toward recommendations geared more specifically to soil needs and economic capacities of farmers as quickly as possible.** Economic analysis of INIA/DNER fertilizer trial results in Nampula indicates that profitability would improve considerably with reduced fertilizer rates (particularly P and K). **A second strategy would be to target technology packages consisting of maize hybrids (with higher yield potential) and fertilizer to higher altitude areas of Nampula and other regions of Mozambique.** Third, NGOs such as World Vision and CARE are actively working with INIA and DNER to **identify technology packages and markets for alternative crops that have a higher payoff than the intensive maize package.**

Pilot programs such as DNER/SG and others have as a long-term objective increased agricultural production through adoption of commercially viable technology packages. **It is important to ensure that short-term program implementation strategies do not compromise the achievement of the longer-term goal.** During the first two years of the MARD/MSU study repayment of credit by farmers and stockists was not enforced by DNER/SG in Nampula Province. The consequences of creating a culture where credit repayment is not

expected are readily apparent in neighboring Zambia, where years of subsidized input schemes have made it extremely difficult to establish a viable private sector marketing and credit system.

It will also be important for future pilot programs to include a cost and returns analysis as part of the training accompanying the technical package. Farmers need to have a realistic understanding of the potential gains and risks of adopting any new technology. Nampula participants in the DNER/SG high-input maize program were told they could expect yields of 5 tons per hectare and prices of 1500 mt/kg by December 1999. Our analysis suggests that even good farmers will get 2.5-3 tons with improved technology under normal circumstances, and maize prices are extremely volatile. Creating unrealistic expectations among farmers about yields and prices may discourage them from trying new technologies in the future.