November 2000 **flash ...** No. 21E

http://www.aec.msu.edu/agecon/fs2/mozambique/flash21e.pdf

MARD-Directorate of Economics*

Comparing Yields and Profitability in MARD's High- and Low-Input Maize Programs: 1997/98 Survey Results and Analysis

by Julie Howard, José Jaime Jeje, Valerie Kelly and Duncan Boughton**

INTRODUCTION AND OBJECTIVES: Mozambique, one of the poorest countries in the world, must increase agricultural productivity to feed its growing population and spur economic recovery following years of civil war. Agricultural intensification is one way to increase productivity, but the use of technologies such as improved seed and fertilizer is extremely limited.

The Department of Rural Extension (DNER) in the Ministry of Agriculture and Rural Development (MARD) operates several programs to stimulate maize production through the use of improved technologies in Mozambique's high-potential regions. Until recently no formal analysis had been carried out to assess the yield performance and profitability of the improved technology packages. In 1996/97 the Department of Policy Analysis (DAP) in MARD's Directorate of Economics began a three-year study of yields and profitability in alternative maize intensification programs in collaboration with DNER. This paper summarizes the results from data collected during the study's second year, 1997/98.[1] The analysis is based on a sample of 210 smallholder farmers in Nampula Province using three different sets of production practices: (1) the DNER/Sasakawa-Global 2000 Program (DNER/SG) high-input package (improved open-pollinated maize, 100 kg/ha each 12-24-12 and urea fertilizer on credit); (2) improved planting and weeding practices only (using local seed, without fertilizer); and (3) a control group of farmers using traditional practices (no improved seed or fertilizer).

The objectives of the research were to: (1) describe the characteristics, input use patterns and yield response by group; (2) analyze the relative contribution to yield of the different technologies, environmental factors, and management practices; and (3) assess the profitability of the three different technology types at the farm level. We estimated econometric yield models to quantify the effects of key inputs and field practices on productivity. Financial budgets were constructed to assess the farm-level profitability of improved maize technology use.

YIELD RESULTS AND DETERMINANTS: Average yields in the 1997/98 season **ranged from 1.4 tons/ha for control group members (traditional practices, no purchased inputs) to 1.7 tons/ha for improved management only farmers (no purchased inputs) and 2.0 tons/ha for high-input farmers.** Yields for all groups exceeded average yields for Nampula Province in previous years by a wide margin. Provincial averages were 0.8 ton/ha in 1994/95, 0.9 ton/ha in 1995/96 and 1.0 ton/ha in 1996/97. Our analysis of socioeconomic characteristics indicated that sample farmers are not significantly better off in terms of resources than average farmers in Nampula Province. The relatively high sample yields for farmers using no improved inputs (compared to provincial averages) suggest that the sites included may have relatively better cropping conditions than other areas in the province. Therefore it will be important to use caution in generalizing from these findings to areas where agroecological conditions are less favorable.

---

* 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.

**Howard, Kelly and Boughton are faculty members in the Dept. of Agricultural Economics, MSU. Jeje is an analyst with the Economics Directorate, MARD.

[1]The full report is also available: Howard, Julie, José Jaime Jeje, Valerie Kelly and Duncan Boughton. 2000. *Comparing Yields and Profitability in MARD's High- and Low-Input Maize Programs: 1997/98 Survey Results and Analysis*. Research Report No. 39. Maputo: Ministry of Agriculture and Rural Development.

Although average high-input yields exceeded improved management only and control group yields across the sample, when the results are disaggregated by region they reveal that high-input yields are significantly higher than improved management yields only in Monapo/Meconta Districts (Region 8). Average high-input yields in Region 8 were 2.7 tons/ha, compared to 2.0 tons/ha for improved management only farmers, and 1.8 tons/ha for control group members. Differences between groups in Regions 7 and 10 were not statistically significant.

Despite this apparent evidence of poor average performance from high-input technology, **our econometric analysis of yield determinants revealed a very strong and positive relationship between higher yields and the use of improved seed and fertilizer together with increased plant density. The results suggest that high-input maize technology holds considerable potential for increasing yields, but the performance of the improved input package in 1997/98 may have been compromised by poor program implementation.** In two of three regions, improved seed and fertilizer were delivered late and planting was subsequently delayed by 2-5 weeks. The results also show that **use of high-input technology is riskier (i.e., yields are less stable) than low-input or traditional methods.** This is an especially important consideration if high-input technology is extended to farmers in more marginal agroecological areas or with fewer household resources for whom a yield loss in one season could be catastrophic.

The analysis indicates that **increasing plant density is critical to improving yields of high-input maize.** While high-input program participants in our sample had significantly higher plant densities than plots of improved management only or control groups, high-input densities were still well below recommended levels: 30,808 plants/ha compared to the recommended level of 50,000 plants/ha. Further investigation is required to determine the factors underlying these discrepancies and for the large variation in density across plots.

Seed and fertilizer recommendations in the high-input package were standard across the three agroecological regions we examined, but the analysis suggests that differences between the three agroecological regions are significant. **Fine-tuning seed, fertilizer, and crop management recommendations could improve yields, given the differences in soil types, rainfall, altitude and other agroecological characteristics between the three regions**. Farmers also noted yield losses due to locally severe problems with termites and rats, wind damage in higher-elevation areas and drought. More region-specific adaptive research is needed to identify specific solutions, e.g., recommendations on pesticide use and ways to increase its availability at the local level, and on specific varieties that could better withstand wind and drought conditions.

The lack of clarity regarding whether input credit would have to be repaid, combined with the late delivery of inputs in two of the three regions, may have compromised the technical performance of the improved seed and fertilizer and reduced farmer incentives to manage their plots – especially weeding – as well as they might have.

FINANCIAL ANALYSIS: The yield results indicate that farmers can significantly increase maize yields through the application of the recommended improved seed and fertilizer package, if inputs are delivered on time and crop management recommendations are followed. The results of the financial analysis are more sobering. A summary of the results is presented in Table 1. Under the conditions faced by smallholder farmers in 1997/98 (including uncertainty about weather conditions, the timing of input delivery and commodity prices), the analysis indicates that in most scenarios (sales in September, shortly after harvest, or in November, or January) **the yield gains did not compensate for the high cost of the inputs**, if net income/ha is used as the measure of profitability. Farmers achieved higher returns (net income/ha) when they used only improved management techniques without purchased seed or fertilizer. Only in Region 8 (Monapo/Meconta), where inputs were delivered on time and weather conditions were good, did the profitability of the high-input package exceed that of improved management alone, and then only if farmers waited until January to sell maize (benefitting from a price rise of 100% between September 1997 and January 1998).

The results of the financial analysis also suggest that farmers – regardless of the technology package used – can potentially benefit from gains to storage and later sale of maize, especially when insecticide is used to reduce grain losses to storage pests. Gains from storage are not assured, however. In 1997/98 seasonal price rises were impressive, but in 1998/99

Table 1: Summary of Results from Farm-Level Maize Enterprise Budgets

	Region 7 -- Ribaue District			Region 8 -- Monapo/Meconta Districts			Region 10 -- Malema District		
	Hi Input	Improved Management Only	Control Group	Hi Input	Improved Management Only	Control Group	Hi Input	Improved Management Only	Control Group
Maize grain yield[a]	1.3	1.3	1.1	2.7	2.0	1.7	1.9	2.0	1.2
1. September 1998									
September price (mt/kg)	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050
Net income (mt/ha)	(68,134)	1,272,828	1.030,941	1,204,39	1,660,743	1,434,016	214,509	1,399,380	1,210,142
Net income/labor day	(1,117)	13,686	9,458	16,059	10,315	7,628	4,564	12,957	10,432
2a. November 1998									
November price (mt/kg)	1,714	1,714	1,714	1,520	1,520	1,520	1,714	1,714	1,714
Net income (mt/ha)	667,211	2,010,923	1,637,274	2,204,76	2,400,548	2,090,409	1,245,76	2,488,099	1,906,364
Net income/labor day	10,938	21,623	15,021	29,397	14,910	11,119	26,506	23,038	16,434
2b. November 1998 storage insecticide used									
Net income (mt/ha)	704,017	2,047,153	1,667,036	2,263,53	2,443,390	2,128,422			
Net income/labor day	11,541	22,012	15,294	30,180	15,176	11,321			
3a. January 1999 prices									
January price (est.)	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100	2,100
Net income (mt/ha)	985,418	2,352,652	1,917,998	3,367,18	3,269,044	2,860,985	1,700,97	2,992,906	2,228,308
Net income/labor day	16,154	25,297	17,596	44,896	20,305	15,218	36,191	27,712	19,210
3b. January 1999 storage insecticide used									
Net income (mt/ha)	1,087,2	2,452,805	2,001,104	3,573,49	3,417,817	2,993,118	1,843,05	3,139,634	2,323,833
Net income/labor day	17,824	26,374	18,359	47,647	21,229	15,921	39,214	29,071	20,033
4. If credit is not repaid									
Net income (mt/ha)	1,263,5			2,536,09			1,546,20		
Net income/labor day	20,714			33,815			32,898		

Source: Survey data, CLUSA and SIMA reports (for price data)

because of increased production in Malawi and the southern Africa region generally prices have been much flatter.

The main finding from the financial analysis is that while the use of improved technology on maize can result in increased yields and profitability, but the level of risk and uncertainty surrounding use of improved maize technology, and the cost of supplying improved seed and fertilizer, are very high. In 1997/98 the yield increases generated through the use of the technology package generally did not compensate for the high cost of the inputs given prevailing output prices.

CONCLUSIONS: The results of this analysis suggest the need for policy and program actions, and further research, to reduce (1) the risks and uncertainty of input use at the farm level, and (2) the cost of input supply, to allow Mozambican smallholders to benefit from technological improvements that can potentially increase yields, food security and incomes. Possible actions and research include:

Reducing production risk by fine-tuning agronomic recommendations. There were significant differences in yield response between the three agroecological regions studied. Because a large part of the differences may be attributable to variations in altitude, rainfall, and soils, this suggests the need for fine-tuning the current blanket agronomic recommendations. Institutional incentives are required to motivate researchers and extensionists to modify technology recommendations for specific areas by synthesizing the results from on-station and on-farm trials, including INIA's national geographically-referenced database on soil quality and response to fertilizer.

Focusing more adaptive research and extension effort on solving problems that seriously affect maize yield. Our analysis indicates that plant density -- in conjunction with improved seed and fertilizer
use-- is the most important determinant of maize yield. There were very high levels of variation in plant density among high-input farmers, 26,000-33,000 plants per hectare, compared to the recommended level of 50,000 plants per hectare. Closer extension supervision at planting time may be required, but adaptive research is also needed to address other problems identified by farmers (e.g., termites, rats, early season mini-droughts).

Adjusting agronomic recommendations according to farmers' ability to bear risk. Recommendations, particularly for expensive inputs such as commercial fertilizer, may also need to be adjusted on the basis of farmers' capacity to bear risk. For example, farmers who have more than one commercial crop (e.g., cotton, maize, oilseeds, beans) may have a higher risk threshold than farmers with a single marketable commodity. In the event of a poor return on one crop, input loans can be paid off with returns from another. More research needs to be carried out to understand how farmers perceive risks and the attractiveness of alternative investments within the farming system. Preliminary results suggest the need for recommendations geared not only to agroecological differences but to variations in farmers' ability to spread risk among different crops in the farming system, or among different on- and off-farm enterprises.

Improving research and extension on the costs, returns and risks of alternative technologies in a cropping systems context. Through the efforts of the Cooperative League of the USA (CLUSA) and other NGOs, farmers in Nampula Province are becoming more aware of the need to analyze potential costs and returns from alternative commercial crops, e.g., cotton, maize, sunflower, sesame, pigeon pea. Researchers and extensionists can contribute to this discussion by (1) collecting data on labor inputs and carrying out financial analysis of trials (especially on-farm trials) of new technology and crop management techniques; (2) making information on yield and profitability available to farmers in an easy-to-understand extension bulletin format; (3) DNER, DAP and SIMA (Market Information System) collaboration to assess and extend information about the price risk associated with alternative commodities and input use; and (4) improving research and extension on alternative crops and technologies in a cropping systems context.

Reducing the cost of input supply. Our analysis showed that the cost of improved seed and fertilizer represented 68-80% of production costs (exclusive of family labor) for sample farmers. Reducing costs at strategic points in the input sector will clearly improve the farm-level profitability of improved

technology. The research activity described in this paper did not focus on the impact of government and donor policies and programs on input supply, but these are discussed at length in a recent DAP study on constraints and strategies for the development of the Mozambican inputs sector. Key recommendations of that paper include: (1) investments to reduce transport costs, including road, rail and shipping infrastructure, and incentives to the private sector to expand and maintain rural transport fleets; (2) government withdrawal from management of the KRII program for supply of fertilizer, pesticides and machinery; (3) reduction of policy barriers to regional trade in inputs by the private sector, and research to explore the possibility of reducing shipping and transport costs through bulk ordering of fertilizer with partners in neighboring countries; (4) expansion of programs to train input dealers in rural areas; and (5) programs to supply improved seed varieties to remote, less commercially developed areas of Mozambique.

Farmer associations are increasingly active in Nampula Province and present one of the most promising avenues for lowering input and output marketing costs. Farmer associations can potentially lower the private sector costs of input supply and credit recovery, and increase extension effectiveness, by (1) aggregating input demand from scattered rural villages; (2) organizing local delivery to member villages after inputs are delivered to a central location; (3) organizing extension assistance on a group basis; and (4) providing group guarantees for input loans.

[2]MARD/DE/DAP.2000.*Avaliação dos Impedimentos para o Desenvolvimento do Sector dos Insumos Agrícolas e Veterinários*. Rascunho. Maputo:MARD.