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*Measuring the Impact of Public and Private Assets on
 Household Crop Income in Rural Mozambique, 2002-2005 **

by David Mather, Cynthia Donovan, and Duncan Boughton

This brief summarizes detailed analysis of the determinants of household crop income in rural Mozambique from 2002 to 2005. Increased crop income is associated with increases in **household land area**, use of **animal traction**, **crop diversification** into tobacco or cotton, access to **market price information**, and access to **extension** agents (for tobacco/cotton growers). Decreases in crop income are associated with **drought**. Results demonstrate that there are both public and private investments that can enhance farmers' ability to increase crop income and avoid losses. Priority investments include: development and dissemination of drought-resistant varieties for maize and cassava, conservation farming, animal traction, market information, access to high-value crops and small-scale irrigation.

INTRODUCTION: Crop income is the predominant source of income for most rural Mozambican households, accounting for 73% of rural household income on average in 2002, and greater than 80% for the poorest 40% of rural households. While the Government of Mozambique recognizes the importance of increased agricultural productivity, there is little empirical evidence to date based on farmer survey data from Mozambique to identify what public and private investments would best achieve this goal. To better understand the determinants of household crop income in rural Mozambique, we use the nationally representative Trabalho do Inquérito Agrícola (TIA) panel household survey of 2002-2005 to measure the effect on total household net crop income of factors that are assumed to have a positive effect on crop productivity and profitability, including: private assets such as landholding; household diversification into tobacco or cotton and use of improved inputs (fertilizer, animal traction); and access to public goods such as extension advice, market price information, and farm association membership.

DATA AND METHODS: This study uses panel households from the TIA (Trabalho do Inquérito Agrícola) rural household-level surveys from 2002 and 2005. A total of 4,058 households first surveyed in 2002 were re-visited in 2005 to understand their crop and livestock production systems, sources of non-farm income, family membership, land use, and community characteristics. Staff from the Directorate of Economics (DE) of MINAG developed and implemented the surveys with technical assistance from Michigan State University (MSU), based upon sampling standards from the National Statistical Institute (INE). Our analysis focused on household net crop income, which includes the retained and sold value of food crops (grains, beans, oilseeds, roots/tubers), retained and sold value of cashew and

coconut, sales of field cash crops (such as tobacco and cotton), and sales of horticultural and fruit crops, less the costs of seed, chemical fertilizers and herbicides. We used the following variables to explain changes in household net crop income: district drought days, road infrastructure, and dummies; private household assets such as those for farm production (land, labor, livestock), marketing (bicycle, radio), and human capital; household choice variables such as diversification into tobacco or cotton, use of improved inputs (fertilizer, animal traction), and access to non-farm livelihoods; and household access to public goods, such as agricultural extension, market price information, and farmer association membership.¹ (For more details on the variables, regression methods and other technical aspects, please see Mather et al, 2009.)

Data are analyzed at the regional level given well-known regional differences in agro-climatic potential, market access, and other factors. Because the TIA survey is nationally representative, the results and policy recommendations are therefore applicable to the population at large in these regions, not just the households surveyed.

FINDINGS & POLICY IMPLICATIONS:

In the following section, we discuss findings and recommendations in relation to the main factors found to be driving changes in crop income, both positive and negative.

¹ With the panel data, we can build upon previous analysis of TIA02 crop income with greater precision, since we follow the same households over time and can thus control for factors such as household management skills, soil quality, and social connections which are unobserved but are not likely to not change from period to period in these three years.

Climate: We find that an additional **day of drought** during the principal growing season results in an average 5.5% loss in crop income in the south, and a 1.9% loss in the north. These results highlight the extreme sensitivity of crop income to weather shocks, and thus the potential value of: a) **widespread promotion of smallholder access to low-cost methods of irrigation and/or conservation agriculture techniques** to reduce the impact of drought – investments in formal perimeter irrigation schemes benefit only a very small proportion of the smallholder population, at very high cost, and are insufficient to address the widespread nature of the problem; and b) **investment in development and dissemination of drought-tolerant maize varieties, as well as varietal improvement in traditionally drought-resistant crops such as cassava and sweet potato.**

Landholding: A 5% increase in total landholding significantly increases crop income by 2.1% in the north, 2.8% in the center and 1.5% in the south. When we look carefully at the determinants of total household landholding, we find that adoption of animal traction use increases total landholding by 13.8% in the center and 18.5% in the south. Thus, an **important constraint to increased landholding appears to be low use of animal traction in the Center, and virtual non-existence of it in the North** (attributed to trypanosomiasis spread by the tsetse fly, and lack of experience in draft animal care).

Animal traction: Use of animal traction significantly increases crop income by 33% in the Center, a very large effect. Since this effect is in addition to the landholding effect described above, this suggests that increases in crop income from animal traction use are likely due to improved soil productivity.² Evidence of significant, large positive effects of animal traction use on both productivity (in the Center) and total landholding (in the Center and South) suggest that successful promotion of animal traction use could lead to major increases in crop income. Public investments could potentially increase adoption of animal traction in the North by **alleviating disease constraints to animal traction via medicinal subsidies and/or eradication of the tsetse fly.** Because oxen ownership represents a high investment cost, **support for rural financial services might help to address household financial constraints to financing traction purchases.** Given the lack of tradition of maintaining oxen in these areas, **livestock extension could also play a valuable role in promoting oxen ownership or rental.** While cost-benefit studies may be required to

² Related to productivity, analytical results of impact of fertilizer use were inconclusive and will be studied in greater detail, so there is no discussion here on that investment.

evaluate the expected ex ante rate of return to some of these investments, the high farm-level benefits that we find from animal traction use suggest that such investments could have large aggregate returns, and could help foster the emergence of more commercial farmers.

Crop Diversification: Diversification into cotton or tobacco resulted in very large and significant increases in total net household crop income. Central region households that grew tobacco had 55% higher crop income than that of non-growers and those with cotton experienced 194% higher incomes than non-growers. In the North, cotton growers had 33% higher crop income relative to non-growers, yet growing tobacco did not have a significant effect on crop income. While these crops have historically offered high returns, the option of growing such crops is only available for households that live within a reasonable distance from concession areas, and previous research has suggested that there appear to be landholding thresholds below which household participation is unlikely. Thus, tobacco and cotton are unfortunately not a universal remedy for widespread poverty reduction among smallholders due to these existing barriers to participation.

It should also be noted that this evidence of relatively high returns to production of these crops is based on data from the 2002-2005 period, during which tobacco and cotton producers enjoyed relatively high prices due to high prices on world markets. Given that world prices have since fallen for these commodities, Mozambique's tobacco and cotton subsectors must look to improve their performance to remain profitable at farm and industry levels. Such opportunities for cotton include **improving farm level profitability of cotton production via adoption of Bt cotton varieties**, combined with efforts to **improve farm gate cotton prices through entry of new cotton firms, investments in ginning efficiency, and improved road infrastructure** (Pitoro et al, 2009). Since the recent departure of a major tobacco company, tobacco growers have reported abuse of quality grading by the buying agents of the remaining tobacco company. Opportunities for tobacco may therefore involve efforts to **promote the entry of other tobacco exporting companies**, which may help ensure consistency in quality grading (by providing some measure of competition), and should expand the number of household with potential access to growing this highly remunerative crop.

Market Price Information: We find that household receipt of market price information significantly increased crop income by 23% in the center and 31% in the south. There are several potential policy implications from these results. First, considering the

size of these farm-level benefits of market information, and the widespread receipt of market price information by rural households (40% of rural households in 2005), it is likely that the rate of return to investments to date in the Agricultural Market Information System of Mozambique (SIMA) is very high. Second, these results suggest that there would also be large returns to investments that increase the access of rural households to market price information by first restoring and then increasing funding to SIMA.

Radio is the predominant source of market price information, as 74% of households that reported receipt of market price information (MPI) said that they received it via radio. Radio is also the lowest-cost (per household) method of disseminating price information in rural Mozambique. Increasing household access to SIMA radio broadcasts can be achieved by increasing radio coverage of SIMA broadcasts and/or increasing the frequency of these broadcasts on existing radio stations. Nineteen percent of rural households live in areas that did not receive SIMA broadcasts in 2005, while a greater number of households (32%) reported no receipt of SIMA broadcasts, although they live in areas that receive them. Limited access to market price information in areas that already receive broadcasts cannot simply be explained by lack of radio ownership, because 45% of households that owned a radio (and also lived in a village that receives SIMA broadcasts) in 2005 said that they did not receive MPI. This suggests that low frequency of SIMA broadcasts on existing radio stations is a key constraint to household access to MPI, thus we recommend that increasing the frequency of SIMA broadcasts within areas that already have radio stations could significantly increase the number of households receiving MPI.

A second way to increase household use of market price information, and thus its impact, would be to improve the appropriateness of the content of the SIMA price information, relative to local needs. For example, SIMA could possibly **deliver price information in local languages, and report on all the major crops on a provincial basis, with more district-level information.** Additional information could also include price forecasts and trends, or potential markets and transport costs. Addressing these types of constraints would require additional investments to set up more provincial SIMA units (SIMAPS) that collect, analyze and disseminate province-specific market information on a broader range of products and markets than those covered by the national SIMA. For example, reporting goat meat prices in markets in Tete, or sesame and soybean prices in Nampula and Manica markets, would specifically target the needs of the radio audience in those provinces. Dissemination of price information by mobile phone messaging may also be an appropriate

strategy in some areas, particularly for farmer associations.

Extension: Because some extension advice may only result in improved productivity over time, we created extension variables to measure the possibility that an extension visit has an immediate impact on crop income (number of cumulative extension visits, including 2002 and 2005) or an impact which is realized over time (receipt of extension visit in 2002). We also constructed separate extension variables for tobacco/cotton growers because of the advantage those growers have in terms of net returns as well as access to credit, fertilizer, etc. For households that do not grow tobacco/cotton, there are no significant effects of the **number of cumulative extension visits** on the crop income in any region, although **households in the south that received an extension visit in 2002** had 81% higher crop income in 2005 than other households. The results from these two extension variables suggest that **extension messages do not improve a household's crop income in the year in which the visit is made, but that, in the south, this advice led to an increase crop income over time.** One policy implication of these results is that caution may be warranted prior to substantial increases in extension funding without a better understanding of what kinds of extension are working well and which are not, and why impacts are only found over time (and only in the south).

For tobacco/cotton growers, an increase in the **number of cumulative extension visits** improves crop income of tobacco/cotton growers by 41% in the north, while the effect of an extension visit in 2002 over time is significant and leads to an 82% increase in crop income over time in the center. Policy makers should note that it is possible for extension advice to result in higher crop income in both the year when farmers met with extension agents and over time, although further research is necessary to know if extension is successful for tobacco/cotton growers due to high returns from these crops, or because tobacco/cotton growers have better input access and are thus better able to implement extension recommendations across all crops.

Farmer Associations: Farmer association membership is associated with a nearly-significant 22% increase in crop income in the North, yet had no significant effects in the South or Center. As with extension, positive impacts are found for farmer associations only in a specific region, suggesting that it would be valuable to continue to invest in farmer associations in the North. Further research is recommended to understand why farmer associations have successfully improved crop income in the North yet not in the Center or South.

SUMMARY OF POLICY RECOMMENDATIONS

1) Reduce sensitivity of crop income to low rainfall and drought

- Widespread promotion of smallholder access to low-cost methods of irrigation and/or conservation farming techniques
- Investment in development and dissemination of drought-tolerant maize varieties, as well as in varietal improvement in traditionally drought-resistant crops such as cassava and sweet potato

2) Increase landholding and productivity by promoting animal traction

Animal traction use has a large effect on total landholding, as well as productivity effects in the Center. Address low use of animal traction in the Center, and non-existence of it in the North through these actions:

- Alleviate disease constraints to animal traction via medicinal subsidies and/or eradication of the tsetse fly
- Support rural financial services to address household constraints to financing traction rental
- Increase livestock extension efforts to promote oxen ownership or rental in areas with little experience in oxen husbandry

3) Increase household access to market price information

- Increase the frequency of SIMA broadcasts in a given region, using existing radio stations
- Increase coverage of public radio stations to areas currently not receiving radio signals
- Deliver price information in local languages
- Report on all the major crops on a provincial basis

4) Improve access to and profitability of high value crops such as cotton and tobacco

- Improve cotton profitability via state approval and farmer adoption of Bt cotton
- Improve farmgate cotton prices through entry of new cotton firms, investments in ginning efficiency, and improved road infrastructure
- Improve tobacco prices via promotion of entry of other tobacco exporting companies

5) Invest in **understanding** role and impact of **different extension and farmer organization** methods and implementation

- Determine why farmer association membership only had significant impacts in the North, why

extension advice for tobacco/cotton growers was successful, and why extension advice for non-cotton/tobacco farmers was only significant in the South.

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