Impact Assessment

Brief No. 3

Impact of **Fertilizer Microdosing Research and Development** in Semi-Arid Zimbabwe

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International Crops Research Institute for the Semi-Arid Tropics

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The main report is available here

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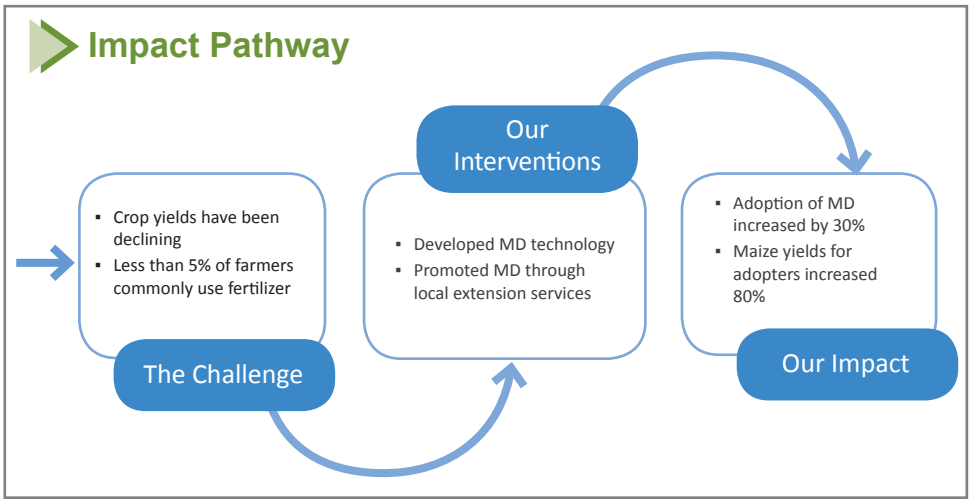
Key Fact

ICRISAT's promotion of microdosing in Zimbabwe has led to a 30% adoption rate and 80% productivity gain in maize yields for adopting households.

Summary

Crop yields in the fragile semi-arid areas of Zimbabwe have been declining over time due to decline in soil fertility resulting from mono-cropping, lack of fertilizer, and other factors. ICRISAT worked with the Agricultural Production Systems Research Unit to develop microdosing (MD), which involves application of small quantities of fertilizer per unit area in dry agro-ecological regions. Subsequent research, development and promotion of MD has generated fertilizer practices that allow smallholder farmers in low-rainfall areas to increase their productivity by using small amounts of fertilizer in a carefully targeted manner.

Impact Pathway



Who Helped Us (Funding)

The Department for International Development (DFID), and subsequently a consortium of donors under the management agency GRM International.

Return on Investment

For a wide range of projected prices and possible cost allocations, the internal rate of return is over 30%. Assuming the most likely estimates of all, the internal rate of return is 45% with an estimated NPV of benefits of over US$33 million over 20 years. These results understate the full impact of MD research, development and extension because they consider only maize production, excluding small grains, and do not account for diminishing yield potential in the absence of fertilizer use.

Impact Summary

Introduction

Crop yields in the fragile semi-arid areas of Zimbabwe have been declining over time due to decline in soil fertility resulting from mono-cropping, lack of fertilizer, and other factors. Surveys during the mid to late 1990s and early 2000s in semi-arid areas in Zimbabwe indicated that less than 5% of farmers commonly used fertilizer. Farmers in these marginal areas believed that in low rainfall conditions fertilizer use would 'burn' crops and reduce yields. In response, ICRISAT worked with the Agricultural Production Systems Research Unit to initiate a crop systems modeling exercise to assess a range of options for the use of small quantities of nitrogen fertilizer. This led to the development of microdosing (MD), which involves application of small quantities of fertilizer per unit area in dry agro-ecological regions. Subsequent research, development and promotion of MD has generated fertilizer practices that allow smallholder farmers in low-rainfall areas to increase their productivity by using small amounts of fertilizer in a carefully targeted manner.

In 2013 a study was conducted to measure the aggregate economic impact of microdosing in Zimbabwe and its effect on ICRISAT priorities: food security, intensification, diversification, resilience, health and nutrition, and women's empowerment. The study also analyzed the implications of the MD technology on different stakeholders. Because very few households in low-rainfall areas apply fertilizer by any means other than MD, the analysis was unable to distinguish the effects of fertilizer top dressing from the effects of MD. The impact of MD is therefore measured in comparison to the observed alternative technology: the negligible use of organic or chemical fertilizer.

Data

This report is based on a structured household survey with additional information about fertilizer availability and demand from key informant interviews with local extension service providers, non-governmental organizations (NGOs) and agrodealers. Focus group discussions provided further information about farmers' perceptions of MD technology, extension, and local input and output markets.

Field work was implemented between December 2012 and January 2013. The MD household survey collected information on household characterization, livelihood assets, cropping patterns, agricultural production, training in MD extension techniques, and fertilizer use and adoption. Particular attention was focused on management practices and output on cereal plots during the last two cropping seasons (2011-12 and 2010-11). The research approach sought to sample households exposed to MD training and to compare that group with similar households that had not received the training. The existing ICRISAT panel dataset on conservation agriculture (CA) provided a representative random sample of households that had been exposed to MD in the context of CA training. The study sample covered eight districts in semi-arid areas in Zimbabwe. Within each selected district from the CA panel, three wards were selected: two from the CA panel (capturing households known to have been trained in MD) and one that had not been exposed to MD training.

Impact

Survey data showed strong impact of MD promotion on fertilizer use. Use of chemical fertilizer or manure was not common in households not exposed to MD or CA training and common among households that did receive such training. Moreover, attitudes towards fertilizer differed markedly between these two groups. Those exposed to MD training generally disagreed with the notions that fertilizer is not worth its price or that it burns crops. Those not exposed to MD training expressed no opinion, uncertainty or agreed with these sentiments.

Survey data revealed that about 75% of households receiving MD training used fertilizer in 2011. This compares to less than 25% of households who used fertilizer despite not having received such training. Econometric analysis suggests that training in MD raised the probability of adoption by 30 to 35 percentage points. Female-headed households were significantly less likely to adopt MD than others, possibly reflecting labor shortages or difficulties accessing fertilizer. Results suggest that even without subsidies, at least 30% of households use both fertilizer and MD.

Further econometric results indicated a maize yield differential of 60% for households that used MD and 80% for those that did not. These high-yield effects

were within the range observed in other examinations of MD and CA methods in Zimbabwe. Analysis of the costs of research, development and promotion of MD in Zimbabwe to the gains achieved through a 30% adoption rate and an 80% productivity effect suggests an internal rate of return on the investment in MD of over 40%.

Table 1: Fertilizer use in recent seasons.

	Share of households (%)	
Fertilizer adoption	MD-trained households	Non-exposed households
Used fertilizer in 2011-12	70.1	25.2
Used fertilizer in 2010-11	74.7	18.7
Used fertilizer in 2009-10	69.5	25.6
Used fertilizer before 2009	24.7	38.3
Never used fertilizer	0.6	35.5

Table 2: Cereal output (2011-12 season).

	Output per household (kg)			
Crop	MD-trained households (SD)		Non-exposed households (SD)	
All cereals	963.0	(1,200)	424.4	(517)
Maize	782.9	(1,143)	283.1	(467)
White sorghum	91.8	(215)	31.7	(87)
Red sorghum	3.0	(21)	2.5	(13)
Pearl millet	85.4	(288)	107.1	(298)

Table 3: Livelihood situation compared to 3 years ago.

Perceived household situation compared to 3 years ago	Share of households (%)	
	MD-trained households	Non-exposed households
Much better	13.1	5.6
Better	35.6	16.8
About the same	27.8	45.8
Worse	20.9	30.8
Much worse	2.6	0.9
Total	100.0	100.0

At the household level, survey results showed that MD contributed to intensification by facilitating use of fertilizer, while enhancing food sufficiency by generating higher yields in maize and small grains. Self-reporting on food security and the impacts of negative shocks indicates that MD has enhanced resilience and nutritional health. Nearly half of MD-trained households described their current livelihood situations as better or much better than 3 years ago while nearly 32% of non-MD-exposed households described their current livelihood situations as worse or much worse.

Implications for Stakeholders

Investment in MD seems to have unlocked the power of chemical fertilizers in low-rainfall areas of Zimbabwe. But, practice of MD is contingent on the availability of fertilizer. Sustaining and expanding the benefits of MD will require efforts to address several issues that were raised in key informant interviews and focus group discussions. These constraints include:

- Lack of training and extension material,
- Limited availability of fertilizer at local, private agrodealers,
- Lack of financial resources for households to purchase fertilizer.

Expansion of MD will only occur through coordinated efforts to promote MD training and fertilizer availability. The need to continue MD training suggests an important role for Agritex, while the equally critical need to secure the reliable supply of fertilizer implies a need for coordination with the private sector. Sustaining the benefits of MD will require efforts to ensure that private agrodealers are able to stock the product in a timely manner and to package it in a manner that smallholder farmers find useful. Achieving this goal is complicated by the financial capacities of agrodealers and the difficulty in projecting fertilizer demand, which varies with rainfall.

The survey data reveal that farmers are price-sensitive in their demand for fertilizer. By increasing both availability and affordability, the presence of a fertilizer subsidy or other fertilizer schemes significantly increases the probability of using MD. But because such programs cannot be sustained indefinitely, it is important that the programs contribute to development of a local fertilizer marketing system. As of now it is not clear that fertilizer availability will persist in the absence of special distribution programs. If the benefits from MD investment are to be continued, it will be necessary to develop mechanisms to better articulate private distribution of fertilizer schemes. Donors, private sector agents and policy makers will need to coordinate activities and clarify roles to ensure that fertilizer is available for purchase locally, in a timely manner, and in appropriate volumes and packages. Efforts to enhance access by female-headed households could further expand the benefits of MD.

Microdosing technology has been a success story in terms of economic impacts and household effects. To sustain and expand this success story, MD training and fertilizer access will need to be expanded and reinforced, especially among women and in wards that have remained unexposed to either MD extension or input programs. Moreover, additional investments and institutional interventions may be needed to ensure that fertilizer is available and affordable in the low-rainfall areas of Zimbabwe.

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ICRISAT-India (Headquarters)
Patancheru, Telangana, India
icrisat@cgiar.org

ICRISAT-Liaison Office
New Delhi, India

ICRISAT-Mali (Regional hub WCA)
Bamako, Mali
icrisat-w-mali@cgiar.org

ICRISAT-Niger
Niamey, Niger
icrisatsc@cgiar.org

ICRISAT-Nigeria
Kano, Nigeria
icrisat-kano@cgiar.org

ICRISAT-Kenya (Regional hub ESA)
Nairobi, Kenya
icrisat-nairobi@cgiar.org

ICRISAT-Ethiopia
Addis Ababa, Ethiopia
icrisat-addis@cgiar.org

ICRISAT-Malawi
Lilongwe, Malawi
icrisat-malawi@cgiar.org

ICRISAT-Mozambique
Maputo, Mozambique
icrisatmoz@panintra.com

ICRISAT-Zimbabwe
Bulawayo, Zimbabwe
icrisatzw@cgiar.org

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ICRISAT's scientific information: **EXPLORE*it*.icrisat.org**

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