CASE STUDY 1: Herbicide microdosing to control Striga

Striga is a weed that infests up to 40 million hectares of farmland in sub-Saharan Africa. It leads to yield losses between 20% and 100% and affects 100 million livelihoods, causing US$1 billion in annual crop losses. Some of the solutions developed so far include the use of Imazypyr (a non-selective herbicide used for the control of a broad range of weeds), but this can kill or damage the crop.[1]

Striga, a parasitic weed. Credit IITA

The roots of several legumes, such as *Silverleaf desmodium*, are effective in suppressing *Striga* and have been incorporated into push-pull, intercropping system. The desmodium neutralizes the *Striga* and *Napier* grass serves as a lure for pests such as the maize stalk borer. Whilst promising, desmodium can be difficult to establish as small, slow growing desmodium seedlings vulnerable to invasive weeds.

Recently a mutant gene in maize that provides Imazypyr resistance (IR) was developed by tissue culture and bred into local maize varieties such as IR breed KSTP 94 developed by the Kenya Agricultural Research Institute (KARI). The International Wheat and Maize Center (CIMMYT) developed a novel approach of coating these newly resistant maize seeds with the Imazypyr herbicide before distribution. When the non-resistant *Striga* seeds germinate, they attach to the maize roots and take up the herbicide from the seed coating. The *Striga* is killed and the maize grows with little or no impact from the herbicide.

On-farm use of IR maize enables *Striga*-affected farmers in Kenya to increase harvests from an average of 500kg per hectare to 1,500kg per hectare. If 20% of severely infested land in western Kenya is cultivated with IR maize, it is possible to produce an extra 60,000 tonnes of maize or enough to feed at least 100,000 households. Grace Lugongo, a farmer from Butula in western Kenya explains, "Until 2007, I had never known the meaning of harvesting a full sack of maize from my 0.5ha piece of land thanks to the '*Striga*' weed. All my efforts would yield only 2 'gorogoros' (a tin measuring about 2kg) of maize. I decided to try the IR maize and over the years my yields have increased to 10 bags from the same piece of land. From the harvest I am able to cater for my subsistence needs and also afford some surplus to sell to cater for my other needs such as school fees for my children."

Dick Morgan, from Vihiga, a town in western Kenya explained, "Before a new maize variety was introduced to me I used to plant maize without success. This was very frustrating as maize is our main food. In 2005 my fortunes in maize farming started to change after I was introduced to the IR maize which I tried and saw a significant increase in maize yields and also in the reduction of the *Striga* weed on my farm.[2]

CASE STUDY 2: Impact of fertiliser microdosing on crop yields in the Sahel

Fertiliser microdosing. Credit ICRISAT

Less can be more if the appropriate fertiliser is applied at the right time, in the right quantity and in the right place. In sub-Saharan African, fertiliser microdosing developed by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and partners has increased agricultural productivity. In order to improve the productivity of pearl millet and sorghum, at least 100kg of NPK is required per hectare, but Dr Ramadjita Tabo, ICRISAT's Director for West and Central Africa, recognised that the cost of $40 per hectare to meet this requirement was prohibitive to smallholders. Further, the region's sandy soils were phosphorous deficient so ICRISAT recommended that farmers use 6g of NPK (15-15-15) plus 2g of DAP and 1g of Urea, just a 3-finger pinch, resulting in only 2g required per plant and limiting total fertiliser use to just 20g per hectare.

On-farm tests were carried out to assess the effect of microdosing in the semi-arid climate of Mali, Burkina Faso and Niger.[1] In the Sahel, soils are sandy with poor fertility and low levels of rainfall (500mm-800mm annually).[3] In these trials, farmers selected the plant variety and fertiliser type according to what was available in their country. The table below displays the rates of fertiliser application per country. Fertiliser microdosing on average was found to increase yield for millet, sorghum, maize, cowpea and groundnut between 44% and 120%.[4]

Country	Fertiliser microdose
Burkina Faso	4 g of nitrogen, phosphorus, and potassium fertiliser (NPK) (15-25-15)
Mali	4g of NPK (17-17-17)
Niger	6g of NPK (15-15-15), 2g Di Ammonium Phosphate (DAP) (18-46-0), and 2g DAP + 1 g Urea (46-0-0)
Note: *(15-25-15) signals the blend of Nitrogen, Phosphorus, and Potassium. For example, if you purchased a 50-pound bag, 15 pounds (or 15%) would be Nitrogen, 25 pounds would be phosphorus, and 15 pounds would be potassium. The remaining 45% is simply filler, which are there mostly to help disperse the chemicals.*	

CASE STUDY 3: Conservation Agriculture and Microdosing in Zimbabwe

In Zimbabwe, an estimated 75%-90% of crops remain unfertilised each season and when used, farmers on average only apply 3kg of nitrogen fertiliser per hectare, compared to average rates of 9kg per hectare for all of sub-Saharan Africa. The usage rates are low and variable due to limited knowledge of appropriate use, lack of availability and affordability as well as cultural and traditional beliefs that fertilisers 'burn' the crops.

Microdosing in Zimbabwe. Credit, B Das CIMMYT

Since 2004, the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) has been working in partnership with the UK Department for International Development (DFID), the national extension service and NGO's to promote conservation agriculture amongst smallholder farmers. Conservation agriculture consists of 3 principles: minimum soil disturbance, legume-based intercropping and application of organic mulch to improve soil fertility. In 2011, more than 150,000 smallholders practiced conservation agriculture, raising cereal yields 15% to 100% across different regions. When combined with microdosing – the precise application of small amounts of fertiliser that smallholders are likely to be able to afford – farmers in Zimbabwe significantly improved household food security.

To increase the adoption of fertiliser use, ICRISAT provided training on microdosing for more than 650 lead farmers, 241 government extension officers and 119 extension officers from 16 local and international NGOs. From 2003-2007, more than 160,000 households received 25kg bags of nitrogen fertiliser and flyers in local languages explaining how to apply the fertiliser. Despite poorer than average rainfall during the 2006/2007 cropping season, farmers experienced yield increases between 30% and 50%. During the same season, more than 170,000 households increased cereal production by an estimated 40,000 tonnes, saving US$7 million in annual food imports and significantly improving food security. As of February 2013, close to 300,000 farmers are now using both technologies and have achieved productivity gains of up to 100%. Nevertheless, challenges to adoption still remain; the programme is therefore trialling smaller packs of fertiliser between 5g-20g as well as trying to reduce the labour constraints to adopting all 3 tenets of conservation agriculture.[5]

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[1] Woomer, P, Lan'gat, M & Tungani, JO 2004, *Innovative maize-legume intercropping results in above- and below-ground competitive advantages for understorey legumes*. West African Journal of Applied Ecology vol. 6, pp. 85-94.

[2] African Agricultural Technology Foundation, AATF (no date), *Striga Control in Maize Project* [24 June 2015].

[3] Tabo, R, Bationo, A, Hassane, O, Amadou, B, Fosu, M, Sawadogo-Kabore, S, Fatondji, D, Korodjouma, O, Abdou, A & Koala, S 2009. , 'Fertilizer microdosing for the prosperity of resource poor farmers: a success story' in '*Increasing the productivity and sustainability of rainfed cropping systems of poor smallholder farmers: Proceedings of the CGIAR Challenge Program on Water and Food International Workshop on Rainfed Cropping Systems, Tamale, Ghana, 22-25 September 2008,* eds E Humphreys & RS Bayot The CGIAR Challenge Program on Water and Food, Colombo, Sri Lanka pp. 269-279.

[4] The World Bank Data 2015, *Average precipitation in depth (mm per year)* [24 June 2015]

[5] ICRISAT 2006, *Small fertilizer doses yield big impact in sub-Saharan Africa* [24 June 2015]