General Information

**30,221,532 km²**
Africa (Area)

**1.1 billion**
Africa (Population, 2011)

**30.51/km²**
Africa (Population density, 2011)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Kenya</td>
<td>42 749</td>
<td>952</td>
<td>121.73</td>
<td>29.5</td>
<td>0.535</td>
</tr>
<tr>
<td>Zimbabwe</td>
<td>13 014</td>
<td>659</td>
<td>105.04</td>
<td>34.0</td>
<td>0.492</td>
</tr>
<tr>
<td>Malawi</td>
<td>15 883</td>
<td>291</td>
<td>162.03</td>
<td>90.5</td>
<td>0.414</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>86 539</td>
<td>461</td>
<td>135.96</td>
<td>50.9</td>
<td>0.435</td>
</tr>
<tr>
<td>Mali</td>
<td>16 319</td>
<td>659</td>
<td>142.59</td>
<td>54.5</td>
<td>0.407</td>
</tr>
<tr>
<td>Nigeria</td>
<td>166 629</td>
<td>1 727</td>
<td>101.85</td>
<td>36.2</td>
<td>0.504</td>
</tr>
<tr>
<td>Niger</td>
<td>16 644</td>
<td>400</td>
<td>137.56</td>
<td>55.8</td>
<td>0.337</td>
</tr>
</tbody>
</table>

**Source:** Ten Facts about Africa - African Development Indicators 2011
African Statistical Yearbook 2013
In the dry, and often barren, semi-arid tropics of sub-Saharan Africa (SSA), the long-term overuse of soil leads to land degradation, decline in soil fertility, and decline in crop yields. Studies show that land degradation in West and Central Africa (WCA) leads to a loss of about $42 billion in incomes, and 5 million hectares of productive land each year. In Zimbabwe, 75-90% of crop land is unfertilized as the average fertilizer application by smallholder farmers, when they can afford it, is a mere 3 kg/ha. Resource-poor smallholder farmers remain poor due to three interlocking factors:

Contribution by

Mahamadou Gandah, Project Coordinator - AGRA
Microdose Project and Country Representative-Niger (Resilient Dryland Systems) ICRISAT, Niger

Jupiter Ndjeunga, Principal Scientist (Markets, Institutions and Policies), ICRISAT, Niger

Microdosing, warrantage and small seed packs for better incomes in Africa

Women's group in Mali at a microdosing training.

Photo: ICRISAT
i. Low yields due to poor soil fertility and land degradation, leaving no surplus to be sold in the market. This keeps them trapped in subsistence farming;

ii. Farmers have almost no resources to prepare for the next planting season. At the onset of the cropping season, these subsistence farmers have barely enough food to eat and to engage in cropping activities, and almost no money for seed and fertilizer to plant new crops.

iii. Smallholder farmers do not have direct access to markets and are dependent on intermediaries for both farming inputs as well as for sale of produce.

Farmers are caught in this vicious circle year after year, and desperately need to find a way out of this situation if they are to survive as farmers and produce enough to feed themselves, with surplus to sell and earn a livelihood.

The Solution

Fertilizer microdosing seemed to be the logical solution to replenishing the soil. This involves the placement of small doses of fertilizer at the base of the young plant (or in the planting pit), thus giving the plant an early boost that allows it to develop a vigorous root system, which captures more water and helps it cope with initial stress, thus ensuring a healthy growth and yield capacity. Another benefit of microdosing is the savings in fertilizer use; about 6 grams of fertilizer in a bottle cap (for 2-4 plants), or a three-finger pinch per plant, is applied directly to the plant, so large amounts of fertilizer, used in the broadcast method, are avoided.

Fertilizer microdosing has been used widely in the West African Sahel and also in southern Africa (Zimbabwe) with promising results. The success of the technology, though, was not due to microdosing alone, but to a combination of three solutions to address the three concerns mentioned initially.

To alleviate these concerns, three key activities needed to be implemented

- Building of input stores at the community level for the sale of small (and affordable) packs of fertilizer and seed;
- Building of warehouses to store grain from the farmers. Farmers could then avail credit to buy farming inputs based on the credit allocation proportional to the amount of grain stored (called warrantage); and
- Linkage of farmer groups to finance institutions (banks, microfinance, etc) and markets. Finance institutions are able to offer lower interest rates and market suppliers are able to purchase large quantities of grain at once.

The Success

The success of this technology comes from the changes obtained at the farmer household level.

The use of improved seed and small amounts of fertilizer has increased grain yields by 30 to 100% in both WCA and Zimbabwe. Yield increase is
due to incorporating the fertilizer in the soil and reducing most of the loss to the atmosphere or through runoff. More grain yield allows households to have extra grain for sale in order to improve their livelihoods (better health, education, house and house equipment, etc). Also, by increasing household food security, microdosing has supported the empowerment of women within male or joint-headed households.

The innovation designed for the poor farmers helps them move from subsistence to progressive farming. More than 300,000 farmers in Mali, Burkina Faso and Niger have learned the microdosing technique. Increases in their sorghum and millet yields have led to income increases of 50 to 130%. In Zimbabwe, by the year 2006, over 170,000 households increased cereal production levels by an estimated 40,000 tons, and by 2012, close to 300,000 farmers practiced microdosing. In the Zimbabwe National Region IV alone, maize yields due to microdosing increased by 80%. The success of microdosing saved US$ 7 million in annual food imports.

An ICRISAT commissioned extensive impact assessment study conducted by the University of Illinois in Zimbabwe showed that promotion of the microdosing technique raised adoption levels by 30% in 2013, and that this technique generated a net present value (NPV) of US$ 26 million with an internal rate of return (IRR) of 36%.

ICRISAT’s key roles in the success was the scientific expertise used in the technology, advice on which fertilizer to use, the optimum quantities to use, and the where and when to apply the fertilizer. ICRISAT was also responsible for managing several regional projects to upscale the technology.

How this was Market Driven

Subsistence farmers and smallholders with marketable surplus are the sectors benefiting most from microdosing. Rich merchants and intermediaries usually take advantage of these two sectors by giving loans to farmers at the onset of the cropping season when they are most vulnerable, and extracting payment at harvest time when prices are low. This type of deal maintains farmers in a vicious cycle of poverty. The warrantage system allows farmers to store their grain at harvest time (rather than hastily selling it at a low price), and wait for more favorable prices a few months later. In the interim they pursue other income generating activities such as sheep fattening, vegetable growing, and extraction of groundnut oil. Farmers are able to obtain a credit at relatively lower interest rates in order to satisfy their urgent needs (health, education, social activities). Finally, when selling the grain from the

Farmer training and capacity building with stakeholders in Mali.
warehouse, farmers have a stronger bargaining power and can take advantage of the commodities price increase. The main beneficiaries are the individual farmers who can now bypass the middle-agents. They gain 30% more income through this system. Market linkages are created by farmers through the inventory credit scheme (called warrantage in WCA).

**Incorporating Inclusiveness**

Microdosing is essentially based on inclusiveness of various stakeholders. All the various components of the technology are based on farmers taking the lead in making choices according to their interests and at the same time managing the system on their own. Managers of input and warrantage stores are elected by their peers. Farmers contribute in the actual building of stores, and as a group, decide on marketing issues for their products.

All farmers (men and women) are encouraged to participate, provided they store grain in the warehouse, no matter how small the quantity is. In WCA, those who do not have enough grain are allowed to store other food products instead (moringa leaves, onions, dry bell pepper, etc).

Resilience and risk management are addressed in microdosing. After the rainfed cropping season, leftover fertilizer is used for vegetable production with seed purchased from input stores. Farmers can therefore take advantage of 2 cropping seasons rather than relying solely on the rainfed crops.

Gender issues, such as participation of women is imbedded in microdosing. Women are quite often in charge of fund management. Their role in many field activities allows them to play an influential part at all times. Even women without a field in which to grow crops, have found ways to be involved. When paid in kind for their labor, they put their “earnings” in the warrantage scheme and at the end are paid in cash.

Several other benefits of microdosing include a reduction of land degradation as a result of low fertilizer use, the reduction of conflicts in highly populated regions where small acreages are able to produce enough food for household use, allowing communities to share their land with others.

During 2003-2006 in Zimbabwe, more than 160,000 resource poor households received at least 25 kg of nitrogen fertilizer and a simple flyer in the
vernacular explaining how to apply microdosing. ICRISAT also linked with the Zimbabwe Fertilizer Company (ZFC), from which 12 trade stores received small packs of fertilizer for sale to local farmers.

ICRISAT continued to conduct training for stakeholders (even those outside the consortium). In Zimbabwe, more than 650 lead farmers, 241 government extension officers, and 119 extension officers from 16 local and international NGOs were trained.

Lessons Learned

• The IMOD approach fits well with fertilizer microdosing. Poor Sahelian farmers are able to improve crop productivity and their livelihoods. Farmer capacities are built and they are empowered to manage a more progressive system of farming, and their futures.

• Some key factors leading to the success of microdosing as an IMOD exemplar are:
  - Simple technology for use by all farmers;
  - Responsibility is given to farmers for management and cost sharing;
  - Attractive to private sector and finance institutions who can now do business with clients who can pledge collateral in the form of stored grains and generate more returns from selling grains when the prices are higher;
  - Markets can deal with large quantities and reduce their charges (a store can supply 40 tons or more as compared to hundreds of sellers with a few kilograms each)
  - Finally, farmers are able to benefit directly from their product while bypassing middle-agents.

The Way Forward

The technology has been scaled up in WCA in several countries. It has been supported by many donors (EU, African development Bank, Islamic Development Bank, USAID, DGIS, and others).

Sheep fattening by women in Mali with small loans from warrantage.

Photo: ICRISAT
ICRISAT and partners need to ensure that agro-dealers in the vicinity are able to stock small packs of fertilizer and seed in a timely manner.

Although the results are good, farmers have reported that microdosing is time consuming, laborious and difficult to ensure each plant gets the right dose of fertilizer. In an attempt to address these issues, researchers are looking at packaging the correct dose of fertilizer as a tablet that aids in application. ICRISAT is also exploring the use of seed coating as another option of further reducing the quantity of fertilizer to be used as well as the labor constraint.

Seeing that in Zimbabwe women-headed households were slower to adopt microdosing, it would be worth it to understand the constraints of women farmers and adapt methods or training to their circumstances, which could help extend the adoption of this technique.

ICRISAT has played a major role in developing the technology with NARS partners, in building the capacities of stakeholders, and in encouraging partnerships for win-win relationships. They now need to extend the training to underserved areas, and hope to increase the number of farmers using microdosing to 500,000 in the next few years.

**Key Information**

Since the development of the microdosing technology by the University of Hohenheim, ICRISAT, IFDC, and other development partners, a number of projects have been initiated to promote the technology through farmer field schools, demonstrations, on-farm trials and a series of media support materials such as leaflets and rural radios. In addition, some of these projects have facilitated access to credit through warrantage schemes and/or access to inputs through the establishment or enhancement of input shops in the intervention zones. These include the FAO projet INTRANTS, the CORAF-ADB project, USAID Target project and lately the AGRA project. The cumulative outreach could be estimated to more than 300,000 households as of 2012/2013.
**Name of project:** 1) CORAF Microdosing: June 2005-May 2008; 2) Target Microdosing: June 2002-December 2004; 3) AGRA Microdosing: June 2009-June 2013

**Key scientists:** Ramadjita Tabo, Mahamadou Gandah, Moses Siambi, Fatondji Dougbedji, Jupiter Ndjeunga, Saidou Koala, Steve Twomlow, NARS scientists (Burkina, Mali, Niger)

**Key partners:** Farmers and farmers organizations NGOs, National Extension Service, financial institutions, fertilizer companies

This work was undertaken as part of the...