

A fertilizer strategy to reduce poverty of farmers in west and central Africa

About 25,000 smallholder farmers in Mali, Burkina Faso and Niger have used **microdosing** on their nutrient-depleted farms and gained **increases in sorghum and millet yields of 44 to 120%** and **30% increase in their family incomes** between 2009 and 2012. They also adopted the **warrantage** system to leverage gains.



The challenge

Land Degradation & Poverty

- 1** **Losses due to land degradation** are estimated at **US\$42 billion** in income and of 5 million hectares of productive land annually.
- 2** Clearing new lands for farming is blamed for an estimated 70% of Africa's **deforestation**.
- 3** Farmers are so poor that they are not willing or able to invest in fertilizer as the growing season is very risky. Unless nutrients are replaced, soils are depleted and crop yields decline, leading to **widespread hunger and malnutrition**.



The interventions



Microdosing

ICRISAT developed a precision farming technique called 'microdosing' that enhances fertilizer use efficiency and improves productivity. Small doses of fertilizer (ranging from 2 to 6 grams) are placed in the holes at planting. The recommendation for microdosing changes with the crop, plant density, soil fertility and rainfall conditions.

- This technique uses only about one-tenth of the amount typically used on wheat and one-twentieth of the amount used on corn in USA.



Fertilizer in small packets

- Most, farmers cannot afford 50 kg bags of fertilizer commonly sold. ICRISAT negotiated with private fertilizer companies to promote the sale of small packs (1 kg to 10 kg).
- The small-pack approach is also being used to make improved crop seeds more affordable and widely available.
- The small packs of fertilizer are sold in community-managed input stores – linked to agro-dealers – installed in villages for easy access to farmers.



Warrantage

Hundreds of farmer organizations in the region now use the warrantage system, which links them directly to markets but also to finance institutions.

- The warrantage or inventory credit strategy aims to resolve the farmers' capital constraint. Farmers place part of their harvest in a local storehouse in return for inventory credit with which they meet pressing post-harvest expenses and engage in dry-season, income-generating activities.
- The stored grain can be sold later in the year at much higher prices and the farmers are able to make a profit.
- The cooperative approach trains farmers to work together to protect stored grain, which is used as collateral to negotiate loans from finance institutions and allow farmers to obtain better interest rates.

► Impact on farmers

“ Ten years ago I was struggling to make a living. Thanks to microdosing, my millet and sorghum yields increased from 300–500 kg/ha to 1,800–2,000 kg/ha. I can feed my household, and sell surplus. I was able to buy three bulls, two donkeys, 10 cows and 10 goats, and I have invested in two plows, a powered multi-cultivator, a planter and two carts. – **Mamadou Batougouné Sylla** – a microdosing champion in Baraouéli village in Mali, who received government recognition.

Since implementing microdosing and joining the warrantage system, my last seasons have been successful. After starting with rice and corn, I went on to apply the microdosing technique on my potato plot. I got a loan through the inventory credit system that allowed me to pay for labor to increase my production. – **Allassane Anadaga**, Nahouri province, Burkina Faso.

► Impact on policy makers

Mali and Niger

- Subsidized fertilizer has been authorized for use on millet and sorghum farms.
- Village-level input stores were created for distribution of government-supplied fertilizer.

Niger, Mali and Burkina Faso

Many bilateral/multilateral donors (Belgian Cooperation, EU) and international development banks such as IDB are funding large-scale projects.

Future goal

To increase the number of farmers using microdosing and the warrantage system

from **25,000** to **500,000** in the next few years

Future challenges

► Major constraints to the widespread adoption of microdosing

- 1 Access to **fertilizer**
- 2 Access to **credit**
- 3 Insufficient flows of information and **training to farmers**
- 4 Inappropriate **policies**

Experiences from both west and southern Africa have shown that adoption of microdosing technology requires supportive and complementary institutional innovation as well as input and output market linkages.

► Cutting down drudgery

Microdosing is time-consuming, laborious and it is difficult to ensure each plant gets the right dose of fertilizer. To address these issues, researchers are looking at:

- 1 Packaging the correct dose of fertilizer as a tablet
- 2 Use of seed coatings
- 3 Animal-drawn mechanized planter

► Longer-term soil health needs to be addressed

- 1 Return of nutrient to the soil through crop residues
- 2 Water regimes
- 3 Crop rotations for nutrient return

Crop rotation with legumes: Earlier ICRISAT research shows growing cowpea and millet in rotation allows the millet to take advantage of atmospheric nitrogen fixed in the soil by the cowpea, and that subsequent millet crops can have 500 kg of grain more per hectare than from growing millet alone.

Intercropping benefits: Trials also show that a DAP microdose of 50 kg/ha at sowing and 25 kg/ha of urea at ear emergence when maize and sorghum are grown in intercropping greatly improves grain and straw yield worth seven times the input investment for maize and nearly five times for sorghum. Yields for maize and sorghum are, respectively, 900 kg and 600 kg greater than the controls.

Conclusion

Microdosing is not the ultimate solution to poor soil fertility in the Sahel. It is a first step to move farmers to a level where they produce enough grain and improve their resilience in order to play a major role in the marketplace.

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Project title Achieving Pro-Poor Green Revolution in Drylands of Africa: Linking Fertilizer Microdosing with Input-Output Markets to Boost Smallholder Farmers' Livelihoods. Soil Health of the Alliance for a Green Revolution in Africa (AGRA)



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Fertilizer microdosing increases agriculture productivity

Project Policy Brief 2

Smallholder farmers in Niger, Mali and Burkina Faso, who implemented microdosing on their farms saw their **yields double or even triple** at the end of project period.

Variation in yields between provinces is generally due to the difference in soil fertility and rainfall and linked to the specific characteristics of each agroecological zone.

Microdosing adoption rate

A 2012 study shows:

45,000 farmers adopted microdosing

39% area treated

Of the total cropping area, the treated area was nearly 39%

Challenge in the semi-arid regions of West Africa

▶ **Agricultural productivity is low and stagnating** due to:

Prolonged and continuous decline in soil fertility

Low and erratic rainfall

Limited use of inputs such as fertilizer and improved seeds because of their high costs and unavailability

▶ Recent high population growth has put **pressure on arable land** and caused land degradation.

▶ Yields of staple food crops like sorghum, millet and maize are often **below 500 kg per hectare** (about one-fifth of those in developed countries).

▶ Production often falls below household food requirements. Farmers are unable to commercialize their harvest to meet other household needs. The **poverty cycle** worsens as family dependents increase and soil fertility decreases each year.

▶ **Agrodealer networks are poorly developed**, farmers have access difficulties because fertilizer markets are often concentrated in urban areas.

▶ Sometimes poor farmers organize bulk purchases and share fertilizer purchases at a high US\$2 per kg of nutrients (**more than five times the world price**).

▶ Soils in this zone are sandy and of **very low fertility**, particularly in phosphorus (P) and nitrogen (N), with P being more limiting to crop growth and yield than N. Crop response to nitrogen is minimal when phosphorous requirements are not met.

▶ With very little use of fertilizers without any recycling of crop residues, there is a **loss of about 22 kg N, 6 kg phosphorus pentoxide and 18 kg potassium oxide per hectare**.

▶ Most smallholder farmers do not replenish their land not because they do not know what to do but because they do not have the resources (including access to credit).

Introducing microdosing

Around 25,000 smallholder farmers in Mali, Burkina Faso and Niger were introduced to the microdosing technique which helped them gain increases in sorghum and millet yields of 44 to 120%, along with a 30% increase in their family incomes.

The regional AGRA project targeted 360,000 households with microdosing technology between 2009 and 2012.

What is microdosing?

It is a strategic application of **small quantities of fertilizers** in the planting hole or to the base of the plants shortly after planting (10 to 14 days). The standard recommendation of NPK (15:15:15) for millet or sorghum at low plant density in the Sahel is 6 grams (**two three-finger pinches or a full bottle cap**).

Precision placement helps efficient use of fertilizer, the roots grow out more quickly, and this **quick grow-out of roots helps the plants capture more native (non-added) nutrients** before the rains leach them down below the root zone.



► Advantages of microdosing

Affordable

Reduced investment cost makes it accessible to the poor.

Improves grain and biomass yields at both reasonable cost and levels of risk on fields that might otherwise be abandoned.

A quick start to the plant seedling:

The facilitation of fast root growth helps in avoiding early season drought and an earlier maturity, thus avoiding end-of season drought while increasing crop yields.

Benefit/cost ratio

It is about 7, 4 and 6 for sorghum, millet and cowpea, respectively.

Saving on 15kg of fertilizer: With the microdosing technique, between 4 to 9 kg of N, 4 kg of P and 4 to 7 kg of K to give a total of 20 kg of nutrients, depending on the type of fertilizers – DAP (18:46:0) or NPK (15:15:15) – are applied as compared to about 35 kg of nutrients per hectare with the broadcasting method.

Improvement in household nutritional need from 61% to 116%

In one study in Burkina Faso poor households in five provinces had sufficient rainfall for crops to meet their water requirements but some were able to meet only 61% of their nutritional needs, however, with the introduction of microdosing it rose to 116%.

► Problems of microdosing

- 1 Manual microdosing is time-consuming and labor intensive
- 2 Affordability of the fertilizers
- 3 Sustainability of the practice
- 4 Impact on biomass and longer-term soil health needs

► The solutions

Efforts are now required to mechanize the technology to reduce the labor demand, and to obtain financial support to farmers for the purchase of fertilizers.

1 The project together with Institut d'études et de recherches agricoles and the private sector in Burkina Faso is in the process of manufacturing and testing of a prototype mechanized tool using animal traction. The prototype is about **nine times faster** than manual application.

2 The issue of fertilizer packaging is being tackled by convincing agro-dealers that they can sell more fertilizer to small farmers in 1 kg or 10 kg bags rather than the standard 50 kg bags which demand major financial outlay.

3 Further research is proposed to investigate the sustainability of microdosing in relation to soil degradation.

4 The return of nutrient to the soil through crop residues needs to be investigated, along with water regimes and crop rotations including cowpea for nutrient return.

► Capacity building

- **133 showcase fields** established in Burkina Faso; Mali and Niger
- **393 farmer's field days** were held during the three years of the project, **57,338** participants registered. Participants included farmers, political leaders, local authorities and extension technicians whose presence gave credibility to the project activities, thereby contributing to out-scaling of the technology. The original estimate was for 15,000 participants
- **87% of farmers took part in the farmer field schools.** About 440 farmers' field schools were held, training 20,500 people. Most participants were farmers, along with endogenous animators, agricultural ministry technicians and other officials.

► Outcomes Fertilizer use

The project's impact survey shows that fertilizer use rates increased from 7.41 kg/ha in the baseline study to 11.45 kg/ha.

- The proportion of farmers using mineral fertilizer increased from 21% at the beginning of the project to 68% in 2012. This is due to the easy access of inputs due to the proximity of input shops as well as availability of inputs in small bags.
- Average distance to an input shop was reduced from 13 km to 6 km.
- Percentage of farmers who used at least one type of mineral fertilizer is 77% compared to a control village where it is 48%.

Food security

- The percentage of households in the project sites with sufficient cereal stocks to cover 12 months is 45% compared to 37% in the diffusion villages.
- Households have gone from being food sufficient for six months at the start of the project to 10.5 months in 2012.
- This improvement in food security also impacted on the health of rural households.

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Warrantage leverages gains from microdosing

Warrantage, or a warehouse receipt system, provides a few months' **credit secured against a stock product** closable by the finance lender in the case of failure to repay. It was first used by European farmers in the 19th century and is now being shown to work in a number of African countries, including Burkina Faso, Mali and Niger, where ICRISAT has tied it to fertilizer microdosing, in particular.



How warrantage works

- **Provides finances** to farmers to pay for the additional cost of buying and applying expensive fertilizer or improved seeds
- Facilitates **storing of surplus grain** for sale at the right time
- **Cuts out profit-taking intermediary traders** without disrupting the supply of farm products into wholesale and urban markets, and without putting pressure on consumer prices.

Impact

- 1** **Income improvements for farmers is between 19% and 113%** according to the United Nations Food and Agriculture Organization, which trialed warrantage with rice, groundnut and millet growers more than a decade ago.
 - 2** **Increase in yields was between 44% and 120%**, depending on the crop and location. Trial farmers used part of their harvests as collateral for loans and were able to invest in better seeds and fertilizers for their crops.
 - 3** **Millions of smallholder farmers benefit:** The tangible benefits are felt most at the farm level and particularly for those with holdings of less than 5 ha. Niger alone has almost 1.5 million such small holdings that provide livelihood for 84% of the population. A similar pattern can be observed in the neighboring Sahelian regions.
- **Operation of warrantage depends on**
 - ◆ Well-functioning farmers' organizations
 - ◆ Supportive local financial institutions
 - ◆ Safe place for storage
 - ◆ Non-perishable crops that have a track record of rising prices in the months following harvest.
 - ◆ A country's banking regulations must also recognize that agricultural produce is acceptable as a guarantee for lending.
 - **Benefits of warrantage**
 - ◆ Strengthens food security
 - ◆ Freedom from high interest rates
 - ◆ Diversification of income sources during off-season
 - ◆ Agricultural intensification
 - ◆ Supporting local varieties and biodiversity
 - ◆ Economies of scale generated by structured demand for inputs
 - **Limitations of warrantage**
 - ◆ Limited number of suitable crops
 - ◆ Risks inherent to storage of crops susceptible to post-harvest damage by insects and other pests. The burden of such risks is passed from the intermediaries to the farmer organizations.

The example of Burkina Faso

Farmers and warrantage warehousing

- ◆ A total of 3,470 farmers adopted the the warrantage system, of which 1,785 were women (51%).
- ◆ The total amount of credit allocated was 134,884,667 FCFA (US\$271,100 at late 2012 exchange rates).
- ◆ The 206 tons of stored crops in these stores were mainly maize, sorghum, millet, cowpea, rice, soybean, peanuts and sesame.

The process

- 1** At harvest-time the farmers sent their crops to the warehouse and received credits to solve their immediate finance problems such as medical bills and child schooling.
- 2** The loans also permitted farmers, particularly women to diversify off-season activities — from adding value to crop produce (processing groundnuts), through horticulture and livestock to small-scale trading
- 3** At the beginning of the rainy season, they paid back the borrowed money and used their crops as food or sold at the higher late season price.

Importance of input shops

- ▶ Exploiting availability of credit depended on farmers having access to inputs. The presence of input shops in a village had a positive effect on –
 - ◆ **Fertilizer use:** In villages with input shops farmers use 7.90 kg/ha more fertilizer than villages with no input shop. In Mali, by the end of the project, fertilizer use increased by 36% on millet, 34% on sorghum, 53% for maize and 73% for cowpea.
 - ◆ **Crop yields:** Fertilizer use resulted in a higher average of grain yield of millet (541 kg ha⁻¹) where input shops existed, whereas grain yields were lower (486 kg ha⁻¹) in areas where there were none.
- ▶ The presence of input shops where small packs of fertilizers (1, 2, or 5 kg bags) are sold enabled farmers with limited resources to afford these small packs instead of trying to purchase standard 50 kg bags of fertilizers that are out of their financial reach.
- ▶ In Burkina Faso, for example, potential store sites were identified and equipped to sell inputs to farmers in project villages within a target five-kilometer radius. Farmers' organizations were brought together with regional agro-dealers (AGRODIA) through Regional Bank of Solidarity (BRS), and 10 million FCFA was lodged by the project as guarantee money at the bank to support AGRODIA in providing inputs to farmers' organizations.
- ▶ Elsewhere, other sources of affordable credit for warrantage have included credit unions, which are generally closer to the rural population and provide reasonable interest rates. Credit unions are increasingly active in the refinancing of MFIs to carry out warrantage activity. The institution may extend credit to warrantage committees with an interest rate of 7%. Committees, in turn, implement warrantage with the producers paying a 10% interest rate; the 3% differential obtained allows the committee to manage the stores and related expenses, while providing the working capital to perpetuate future warrantage activity.
- ▶ Individual farmers are likely to be paying 100 FCFA (\$US 0.17 in 09/2015) per month and per bag in management fees to their farmers' organization during the six months for which their grain is stored awaiting better market prices.

Future goal

Working with FAO, local agricultural centers, a network of international donors and partners — including the West and Central African Council for Agricultural Research and Development, the USAID and AGRA — ICRISAT is targeting an increase in the number of farmers using both microdosing and the warrantage system from 25,000 to 500,000 in the next few years.

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Impact

Food sufficiency at the Burkinabe project sites went from six months at the start of the project to 10.5 months at project end.

Implementation

It comprised identifying, repairing and equipping stores for common use by farmers' organizations, as well as repairing some government food security storage.

- ◆ 58 warehouses were repaired and made functional between 2010 to 2012.
- ◆ 153 local committee members were trained in warrantage management.
- ◆ 58 contracts were signed at the end of 29 warrantage store visits. The visits built confidence between micro-finance institutions (MFIs) and farmers' organizations.
- ◆ A guaranteed fund was set up by the project in an account created by each farmers' organization to enable them to get loans.