

## Research briefs

### 3. Adoption of 'micro-dosing' soil fertility restoration technologies through the introduction of the warrantage credit facility in the Sudano-Sahelian zone of West Africa

#### Introduction

The traditional top-down approach to cropping systems and NRM research has been criticized as not being effective because it failed to address farmers' felt needs. ICRISAT and its research partners in Niger, INRAN, the Nigerian NARS, IFDC and Hohenheim started talking more to farmers about 10 years ago to understand better their objectives and constraints. We found out that farmers in the region are aware of the benefits of fertilizers, but they usually cannot afford to follow recommendations that call for large quantities.

In consultation with our farmers about results from ICRISAT sites elsewhere (principally the Southern and Eastern Africa) on applying small quantities of fertilizers we started to experiment to see if they would increase yields and improve incomes. With encouraging results obtained on-station, we then began carrying out participative, on-farm trials to show the technologies to farmers and get their feedback. Based on our participative on-farm trials and demonstrations over the past 10 years, farmers in the region have come to appreciate the value of soil fertility restoration for crop yield improvement, now more than ever before.

The application of small quantities of inorganic fertilizers has come to be called "micro-dosing." Micro-dosing is combined with other NRM technologies to start creating a sustainable system. The NRM technologies include hill placement of small amounts of mixed organic/inorganic fertilizer, mulching with residues to prevent erosion, and the use of the HATA traction weeder. But according to farmers, liquidity constraints still precluded them from buying fertilizers. Like many farmers elsewhere, they have been caught in a vicious cycle of no inputs, low yields and incomes, and thus no cash to buy inputs.

With the help of FAO, the warrantage credit facility was initiated three years ago to remove barriers to the adoption of soil fertility restoration. It provides access to cash credit to enable farmers purchase external inputs such as fertilizers, while using storage of crops to enable farmers to get higher prices during the period, when the market supply begins to decline.

#### Agronomic potential of soil-improving technologies

About 5,000 farmers involved in the warrantage program are reported to have adopted soil fertility improvement technologies over the last three years. Three years data from over 2,800 field plots in two villages, Gaya and Karabedji in Niger, are presented in Table 1. These data substantiate the agronomic potential of fertilizers. Rainfall in Gaya (~800 mm yr<sup>-1</sup>) is more than that of Karabedji (~550 mm yr<sup>-1</sup>). Still the data shows that low rate of fertilizer (4 kg P ha<sup>-1</sup>) more than doubled the millet yield on farmers' fields in the Sahel site at Karabedji. Retaining a portion of harvested crop residues as mulch plus the use of local phosphate rock meanwhile, increased yields three fold at Karabedji. In Gaya, crop residue contributed 14 % to yield as opposed to 43 % at Karabedji, suggesting the need to retain crop residue as surface mulch at the Karabedji.

*Treatment	Karabedji	Gaya
Farmer practice (FP)	210	505
P hill placement (HP)	470	990
HP + Phosphate rock (PR)	470	1150
HP+PR+Crop residue	835	1320

$P < 0.0001$ , for both between sites and among treatments

\*Hill placed (HP): P applied at  $4 \text{ kg ha}^{-1}$  as 15-15-15.

Phosphate rock (PR): P broadcast and incorporated at  $13 \text{ kg ha}^{-1}$  as Tahoua PR

Crop residue (CR): millet stover applied as mulch at  $2 \text{ t ha}^{-1}$

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### Adaptability of the soil-improving technologies

Integrated use of hill placed soluble fertilizer, phosphate rock (PR) and crop residue gave the highest millet yields in the villages where the technologies were tested (Fig.1). This was followed by a combination of hill placed soluble fertilizer and PR. The traditional farmer practice where fertilizer is hardly used was the lowest yielding. Furthermore, the slopes of the regression lines are clearly steeper in the fertilized treatments than the non-fertilized treatment. This implies that there is a higher probability of producing more grain in all environmental conditions if management practices such as fertilization and retention of crop residue are used. Even at the poorest site, presumably due to low rainfall, the fertilized field recorded better yields (Fig.1).

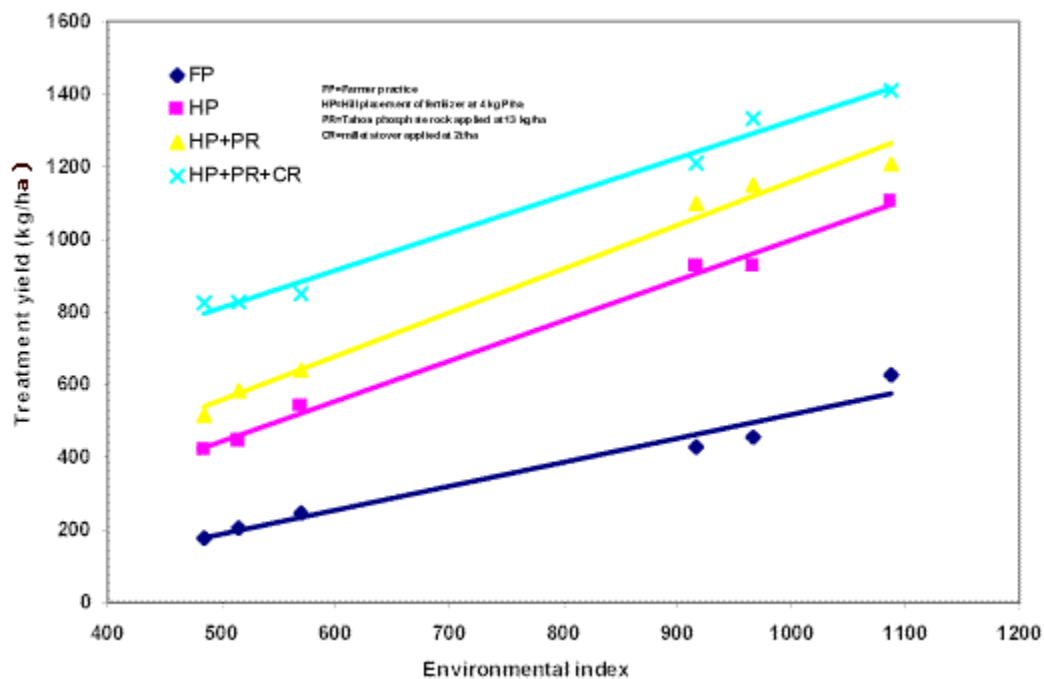


Figure 1: Relationship between environmental index and treatment yield of pearl millet in Niger.

## Returns over variable cost of fertilizer

Returns over variable cost of fertilizer presented in Fig. 2 clearly demonstrate the economic importance of soil fertility restoration made possible through the warrantage system. Under the environmental conditions at Gaya ( $\sim 800 \text{ mm yr}^{-1}$ ) obtaining credit of CFA 10000 to apply  $4 \text{ kg P ha}^{-1}$  enabled farmers to double incomes. Returns over fertilizer cost also increased in the moisture-limited site at Karabedji ( $\sim 550 \text{ mm yr}^{-1}$ ) by about 40 %. Further long term research is needed, but it appears that a mixture of either soluble fertilizer or PR with crop residues would be the most appropriate option under the present circumstances, especially at Karabedji where residue mulch is needed to conserve moisture and protect the soil against wind erosion. Impact assessment of the warrantage system at Karabedji established that fertilizer-use rose from 350 kg in 1998 to 3600 kg in the year 2000. In 2000, which was a drought year at Karabedji, micro-dosing of fertilizer enabled farmers to get reasonably good yields and make a profit, while the crops of neighbors following traditional practices completely failed.

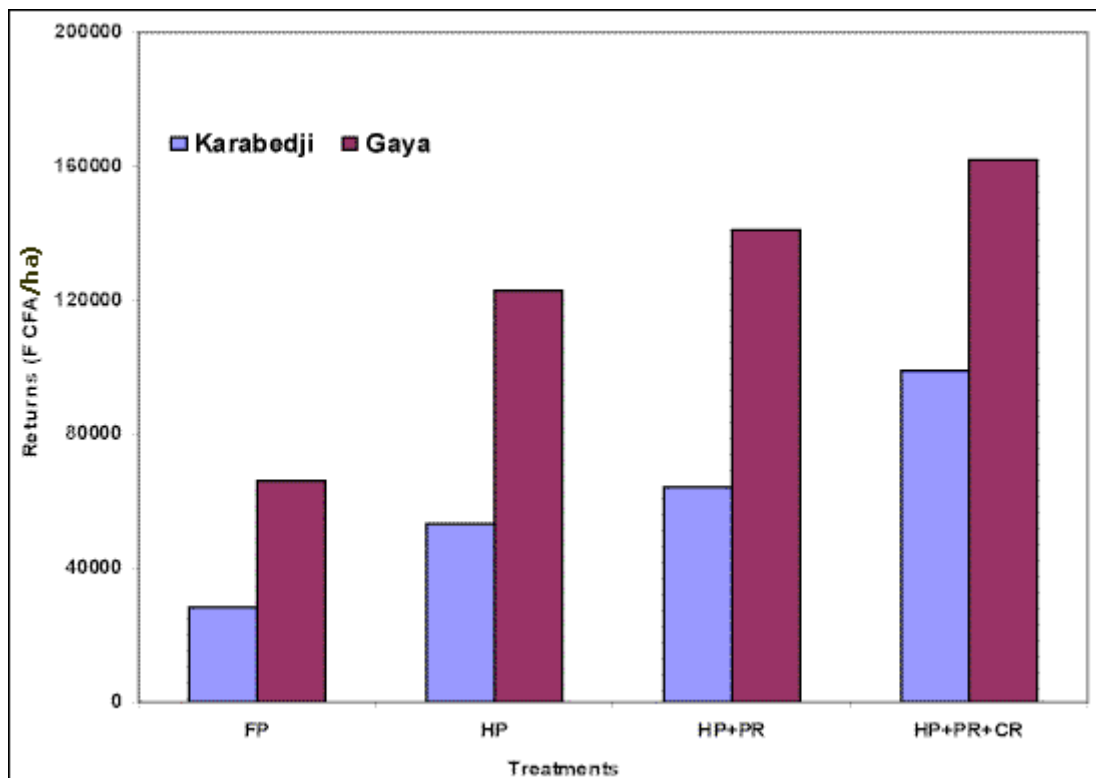


Figure 2: Returns of pearl millet (CFA/ha) over variable cost of fertilizer (treatments are the same as fig.1).

## The warrantage credit facility

'Warrantage' has been practiced in Asia for many years, but was only recently introduced in the Sudano-Sahelian region of West Africa. Recognizing the widespread low crop productivity in the region as a result of slow adoption rate of improved soil management technologies, Food and Agriculture Organization (FAO) in collaboration with ICRISAT and the International Fertilizer Development Center (IFDC) initiated the warrantage to solve farmers' liquidity constraints. This credit system is being popularized with the assistance of over 330 farmers' organizations, some commercial banks, over 20 NGOs and donors.

In the system, farmers stock their produce at harvest with a local entrepreneur and receive cash on credit. Together, they sell the produce about four months later. This creates a higher probability of making about 40 % additional profit. Crop prices are low at harvest time in November. However, by May, just before planting of the next crop, prices go up as evidenced in Fig. 3. In general, as a result of low yields, farmers do not have adequate food reserves to last for whole year, therefore, food prices start rising before May. The system allows farmers to raise cash to buy farm inputs including fertilizers and improved seeds.

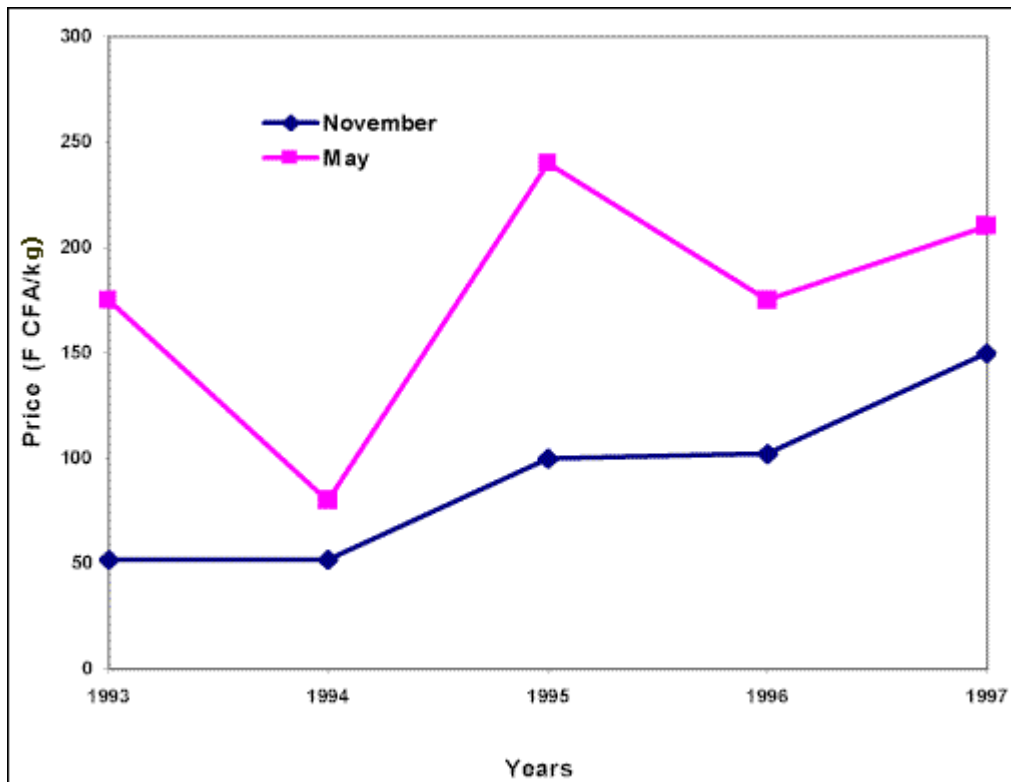


Figure 3: Cowpea grain price variation for November and May, Niger 1993-1997.

## Conclusions

The NRM technologies, including micro-dosing, and extension of the warrantage credit facility in the Sudono-Sehelian zone of Niger removed a major impediment to the adoption and use of soil-related technologies. Through warrantage, farmers were able to secure loans to purchase fertilizers to improve their yields. Given the fact that fertilizer supplement of only 4 kg Pha<sup>-1</sup>, costing less than FCFA 10000 is all it takes to double millet yields, many farmers were attracted to the system. Therefore, it was logical that fertilizer consumption increased 10 fold (from 350 to 3600 kg) within two years in karabedji.

Over 5,000 farmers are now using these NRM technologies in Niger, and other crop management improvements are also occurring in the crop production system. It is reported that over 60 per cent of farmers participating in the warrantage program are now buying insecticide to improve cowpea production, and many are buying product transformation machinery like mills.

There are also other improvements taking place in livelihoods and strategies, including increased attendance in school and more gardening for nutritional improvement. Trading and other income-generating activities are also on the rise. Now that there is increased liquidity in these systems, ICRISAT is working on introducing production and income diversification strategies such as improvements in gardening through low-pressure drip irrigation for high quality date palms and fruit trees (the African Market Garden).

NGOs and IER, the Mali NARS, with the encouragement and technical backstopping of ICRISAT, are now extending these NRM technologies and the warrantage program to Mali.

### **Collaborators**

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