Fertilizer Micro-Dosing to Enhance Yield and Use Efficiency

Solution Holder is **Dougbedji Fatondji** and can be contacted through **d.fatondji@cgiar.org**

Summary

Most small-scale millet and sorghum farmers do not use recommended rates of mineral fertilizers. Those who so usually apply too little fertilizer by surface broadcasting, an inefficient approach. Risk of crop failure due to drought further discourages investment in fertilizer. As a result, insufficient nutrient replenishment and gradual soil fertility decline takes place. Micro-dosing is a form of precision agriculture based on the application of small amounts of fertilizer in a shallow hole at the base of each plant. The method offers a low-risk strategy for farmers as it uses small and affordable quantities of inputs. Because fertilizer is placed close to active plant roots, the crop establishes more quickly and can better absorb nutrients and water, circumventing problems of soil degradation. In this way, micro-dosing decreases investment costs of farmers and increases yield responses to lower rates of fertilizer application. Proportionally less nutrients from mineral inputs are lost to the environment and more are assimilated by sorghum and millet, especially if the practice is combined with input of organic matter, water harvesting in zaï pits and contour bunding techniques. Mechanized equipment is available for this operation.

Technical Description

Large areas of land across millet and sorghum growing areas in semi-arid areas of Africa are severely depleted in nutrients like nitrogen, phosphorus, and potassium, reducing yield and nutritional quality. Conventional fertilizer application methods rely upon top-dressing on the soil surface, posing a financial risk due to lower returns per unit input and land. Alternatively, concentrated placement of mineral fertilizer inside the planting hole or near the base of the plant by micro-dosing make more nutrients available to the crop and thereby enhances the growth of roots, grain and stover. This results in healthier crops that are better able to counteract mid- and late-season drought, increasing the climate resilience of food production. Promoting fertilizer micro-dosing among small-scale farmers requires that input supply companies provide appropriately formulated blends or compounds in 2-5 kg package sizes that match the nutrient requirements of crops and soils, making fertilizers affordable to more farmers. On the other hand, fertilizer micro-dosing should not be implemented over extended periods of time if it results in negative nutrient balances.

Uses

Micro-dose fertilizer application can be practiced in all millet and sorghum growing areas of Sub-Saharan Africa, including drylands in the Sahel, Eastern Africa, and Southern Africa. The technology of micro-dosing is particularly suitable for resource limited farmers working on degraded lands, who cannot afford “recommended” amounts of mineral fertilizers.

Composition

Mineral fertilizers formulations used for micro-dosing are based on availability of single, blended or compound types from local suppliers and nutrient deficiencies of croplands. It offers an effective strategy to replenish nutrient stocks in small-scale farming systems by allowing for gradually increased investment and improved organic matter recycling through greater availability of stover.

Means of application

Micro-dosing is as simple as applying a couple pinches or a bottle cap full of fertilizer to each planting hole at the time of sowing or drilling it next to the base of the plants two weeks after emergence. Fertilizers must be covered with soil to prevent surface runoff and rapid volatilization. The total amount of fertilizer used in micro-dosing varies depending on the crop type and planting density. For instance, millet grown at 16,666 plants per ha requires about 50 kg of fertilizer whereas sorghum cultivated at a density of 26,666 plants per ha requires about 100 kg of fertilizer per ha. Applying compound fertilizer NPK (15-15-15) at a rate of 60 kg ha-1 is equivalent to 6 g per plant/hill, and DAP (18-46-0) at a rate of 20 kg ha-1 corresponds to 2 g per plant/hill. It is advised that nitrogen fertilizer be applied in 2 or 3 splits over the growing season by micro-dosing urea at times when rainfall is received. This strategy allows for high yields and reduces financial losses in drought-stricken years by avoiding wastage of fertilizers.

Agroecologies	Dryland area, Moist savanna.
Regions	Africa South of Sahara.
Developed in Countries	Burkina Faso, Chad, Ethiopia, Kenya, Mali, Niger, Nigeria, Senegal, Sudan, Tanzania, Zimbabwe.
Available in	Burkina Faso, Chad, Ethiopia, Kenya, Mali, Niger, Nigeria, Senegal, Sudan, Tanzania, Zimbabwe.
Solution Forms	Management.
Solution Applications	Soil fertility management.

Agricultural Commodities	Sorghum/Millet.
Target Beneficiaries	All farmers, Women, Youth.

Commercialization

Commercialization Category

Commercially available

Startup Requirements

Initiatives to scale the technology must consider the following steps: 1) Raise awareness about the advantages on crop yield, soil nutrient management and climate adaptation, 2) Make sure the right formulation and package size is provided at local markets close to farmers, and 3) Conducting training of trainers among extension agents about the methods and schedules for micro-dosing fertilizer.

Production Costs

The cost of the fertilizers for micro-dose application is lower compared to conventional surface broadcasting since less inputs are used. A survey in Burkina Faso showed that fertilizer micro-dosing without mechanized equipment has a labor opportunity cost of about US $43 per hectare, while that of conventional broadcasting by hand is only US $26 per hectare. Campaigns for dissemination and capacity building to scale the technology require substantial investment that must be covered by agricultural development programs from national and non-governmental agencies.

Customer Segmentation

Fertilizer micro-dosing appeals to small-scale and commercial producers of sorghum or millet from an operational and financial perspective as well, but the methods and pathway of implementation may vary. Input suppliers can realize major growth of sales by including specialty packages for fertilizer micro-dosing among their product lines.

Potential Profitability

Farmer field experiments with sorghum in Ethiopia showed that micro-dosing fertilizer 5 cm away from the plant instead of spreading it along the entire row saved 25% to 50% on the recommended nitrogen and phosphorus dose while increasing yields by 15% to 28%. Research of ICRISAT at other pilot sites found that micro-dosed application enhanced the efficiency of fertilizer use by 13% to 27% compared to the conventional practice of broadcasting. Fertilizer micro-dosing was disseminated to 170,000 Zimbabwean households, increasing grain production by 40,000 tons despite lower-than-average rainfall. The intervention significantly improved household food security and

saved US $7 million in food imports, generating a net present value of US $26 million and an internal rate of return of 36%.

Licensing Requirements

The manufacturing of fertilizer blends or compounds intended for micro-dosing to different crops and soils may be subject to intellectual property licenses and trade secrets.

Innovation as Public Good

Knowhow about this technology is a Public Good and is freely available from ICRISAT and others.

Solution Images



Use of a bottle cap for fertilizer micro-dosing



Fertilizer micro-dosing by hand



Fertilizer micro-dosing by hand

Institutions

ICRISAT
INTERNATIONAL CROPS RESEARCH INSTITUTE FOR THE SEMI-ARID TROPICS

Accompanying Solutions

Varieties for Better Nutrition and Stress Resistance

Dual-purpose Varieties for Crop and Livestock Integration

Proactive Management of Striga Infestation