



Agriculture Challenges

Winter 2016

Teach Microdosing Techniques

Increasing effective use of fertilizer has potential to unlock significant crop yield for smallholder farmers in sub-Saharan Africa. The high costs of fertilizer often make this intervention inaccessible, yet microdosing can significantly reduce that cost. In three months, pilot an evidence-based model that teaches farmers about microdosing, growing to 3,000 farmers in two years. A successful plan will include continuous monitoring and testing, and a commitment to change if evidence suggests your approach is not working.

The problem: Much of the developing world's population works in agriculture, including more than 60% of laborers in sub-Saharan Africa.¹ However, crop yields there are low: about 1.2 tons/ha for cereal crops in sub-Saharan Africa, while the developing world average is about 3 tons/ha.² Low crop yields affect several poverty-related issues. Farmers who do not produce high yields suffer from low profitability. Low food production and profitability can also magnify calorie deficiencies, leading to health issues and lost productivity.^{3,4}

Fertilizer, when used effectively, has increased crop yields throughout most of the world. However, high fertilizer costs are one factor deterring greater use in sub-Saharan Africa.⁵ (More discussion on costs and on what constitutes effective fertilizer use is covered in the *Increase Effective Use of Fertilizer* challenge: www.d-prize.org/D-Prize_Agriculture_Fertilizer.pdf).

The solution: Microdosing is one proven method for applying fertilizer cost-effectively. When using microdosing techniques, a farmer will apply a small pinch of fertilizer directly to the seed (either when planting the seed or a short time afterward). The microdosing method uses 60-75% less fertilizer than the traditional "broadcasting" method^{6,7}, while simultaneously increasing yields by 30-50%, across a variety of soil and climatic conditions and farmer practices.⁸ However, many farmers are unaware about microdosing techniques.⁹ Increasing education on microdosing has potential to improve the yields for millions of farmers.

1 http://hdr.undp.org/sites/default/files/2015_human_development_report.pdf

2 http://www.fao.org/fileadmin/templates/wsfs/docs/Issues_papers/HLEF2050_Africa.pdf

3 <http://data.unicef.org/wp-content/uploads/2016/06/130565-1.pdf>

4 <http://www.undp.org/content/dam/rba/docs/Working%20Papers/Food%20Production%20and%20Consumption.pdf>

5 <https://openknowledge.worldbank.org/bitstream/handle/10986/6650/390370AFR0Fert101OFFICIAL0USE0ONLY1.pdf>

6 http://ageconsearch.umn.edu/bitstream/205879/1/Profitability%20_sustainable%20intensification_AAEA2015_2.pdf

7 <http://www.mdpi.com/2073-4395/4/3/436/pdf>

8 <http://bob-mccown.com/wp-content/uploads/2011/10/Twomlow2008Microdosing.pdf>

9 <http://purl.umn.edu/235021>

Variables that impact effectiveness

Evidence demonstrates that microdosing techniques *can sometimes* increase profitability. To determine whether microdosing is appropriate in your operating area, your proposal will need to address a number of unanswered questions:

- What are the factors contributing to low fertilizer use in your operating region, and how strong is each factor? Microdosing is appropriate when fertilizer is physically available, but is unaccessible because of costs. Answering this question will help you determine if this intervention fits with your local area.
- How optimal are existing levels of fertilizer use in your operating region (accounting for the rational risk aversion that farmers have)?
- Given high variation in yields and soil nutrient availability, will microdosing allow farmers to choose profitable amounts of fertilizer?
- How dependent is the profitability of fertilizer on other inputs, such as irrigation on better seed varieties? If dependency is high, a fertilizer-only approach will do little.

You will also need to show that the local conditions in your operating area are a good fit with a microdosing intervention. These are the local conditions we've encountered in our research that can impact effectiveness of fertilizer:

- Local variables, like crop type, region and season, and other factors, like lack of water. While microdosing increases yields without additional water, chronic, unalleviated drought will prevent farmers from realizing significant gains.
- Consistent and reliable supply of fertilizer.
- Farmers are exposed to high risk. Bad weather can completely wipe out crop yields, and as can volatility in crop prices. Because investing in fertilizer inputs might not pay off, farmers can face a disincentive to use it.

Key metrics to measure success

There are several categories of metric which you might use to evaluate program success:

- Yield indicators, such as % improvement in yield. This has a couple of weaknesses: a farmer may increase yields whilst decreasing earnings if the cost of fertilizer required for increasing the yield are too high. Yields are also variable year-to-year, which means that unless you compare with a control, a yield increase may not be due to your intervention
- Income indicators, such as % improvement in earnings. This is better than measuring yield because it avoids the weaknesses listed above. However the improvement in earnings could still be temporary, perhaps because of normal year-to-year variation.
- Long-run standard of living indicators, such as asset accumulation or Grameen Bank's 10 indicators. These show lasting improvement to farmers lives.
- Metrics should be weighted so that gains to the poorest score more highly than the same gain to a richer person.

Your challenge: We will award up to \$20,000 to a Distribution Entrepreneur who will teach 100 smallholder farmers (cultivating land of 2 hectares or less) about microdosing techniques, with a vision to reach 3,000

farmers within two years. You must prove that your education intervention reliably increases the standard of living for farmers. This must also occur without causing increased risk of losses to any of the farmers.

Because other variables can impact the effectiveness of microdosing and of fertilizer use, you must have a localized plan that can manage uncertainty, including:

- An evidence-based model which identifies the strongest factors that cause low earnings for farmers, specific to the region in which you will operate
- An evidenced-based model of how and why your intervention will boost earnings in the long run
- A plan for continuous testing and evaluation of the program
- A commitment to change the plan if the evidence suggests that the approach isn't working

A winning proposal may also bundle microdosing classes with other proven agricultural interventions. For instance, your proposal could include a credit scheme that helps farmers better afford fertilizer, bundling with high-quality seeds, etc.

A successful team for this challenge will likely require previous experience in research and impact evaluation in international development, especially relating to agriculture, and previous field experience with agriculture in the region where you will operate.

Additional Useful Resources

- Education interventions that teach microdosing techniques have been tried across a variety of countries in sub-Saharan Africa. For example, ICRISAT's training program led to a 30% adoption rate with 80% increase in yields in Zimbabwe.¹⁰ Using an existing education intervention already proven to work is highly encouraged.
- Fertilizer is widely available in Africa for those who can afford it, but access can be inconsistent due to supply chain problems. Fertilizer use rates vary widely from zero/negligible in Niger to 100% of South African wheat. Your proposal should not be blindsided by a lack of access to fertilizer. Statistics are widely available.
- Local crops grown, soil types, and weather vary substantially across the developing world. While fertilizer is beneficial, yield responses are not uniform. For example, microdosing increases pearl millet yields more in silty clay soil in Mali than in sandy soil in west Africa.¹¹ The various components that make soils fertile--nitrogen, phosphorus, potassium, etc.--are found in different ratios in different areas.
- Access to water is another constraint, as rainfall is erratic and irrigation is not the norm in Africa. However, lack of nitrogen appears to be the more important constraint.¹² Your proposal should account for inconsistent water supply.
- Microdosing works best when combined with other productivity-enhancing methods like spacing seeds optimally; One Acre Fund includes this in its training program <https://www.oneacrefund.org/blogs/information/post/http-www.oneacrefund.org-blog-p170/385>.
- Where the technique is known, one of the reasons for low adoption rate is that it is more laborious and time-consuming than the broadcast method. Solutions may be technical (e.g. bundling seeds with

¹⁰ <http://www.icrisat.org/impacts/Impact-Assessment/Brief-Microdosing-Research-Development.pdf>

¹¹ <http://www.academicjournals.org/journal/AJAR/article-abstract/5E8DB6336493>

¹² <http://bob-mccown.com/wp-content/uploads/2011/10/Twomlow2008Microdosing.pdf>

fertilizer prior to planting, creating a device that fertilizes while seeding) or informational (convincing farmers that it is worth the effort).

Ready To Start?

Download a First Round Application Packet at www.d-prize.org/application.pdf

Questions? Email the D-Prize team at help@d-prize.org