17. Enabling Fertilizer Use Optimization in Sub-Saharan Africa

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17.1 Introduction

Low soil fertility in sub-Saharan Africa (SSA) is associated with low crop productivity. Most small-scale farmers in SSA apply little or no fertilizers to their crops due to financial constraints and other socio-economic factors. Many use manure, compost and crop residue as nutrient sources but the supply is generally small relative to need and these materials often have alternative uses such as for fodder, thatch and fuel. The farmer's major dilemma on fertilizer use has always been poverty and low ability for fertilizer purchase. After taking care of their basic survival needs, they need high benefit to cost ratios at little risk for investments to be competitive.

The Optimising Fertilizer Recommendations in Africa (OFRA) project developed a fertilizer use optimization approach that enables farmers to maximize net returns from their investment in fertilizer use while reducing risks compared with conventional fertilizer recommendations (Chapter 1). The approach considers crop nutrient response functions determined from field research together with the economic and agronomic context of the farmer. It guides the farmer to the choice of the crop-nutrient-rate combinations with the greatest profit potential for the farmer's situation. It reduces risk for the financially constrained farmer by applying fertilizer at lower rates and often to more crops than with typical fertilizer recommendations. This combined with the 4R Nutrient Stewardship (http://soilhealthconsortia.org/files/Newsletter%203rd%20edition.pdf) contributes to nutrient use efficiency and low nutrient loss. Fertilizer use optimization has been developed for 67 agro-ecological zones (AEZ) or recommendation domains of 13 countries including Burkina Faso, Ethiopia, Ghana, Kenya, Malawi, Mali, Mozambique, Niger, Nigeria, Rwanda, Tanzania, Uganda and Zambia. For each of these AEZs, Excel and paper fertilizer optimization tools (FOT) were developed (http://agronomy.unl.edu/OFRA).

This chapter discusses the methodology used by OFRA to transfer the fertilizer use optimization approach to technology uptake pathways and the lessons drawn from this process. We discuss how farmer demand for fertilizer use optimization was generated, how stakeholders were engaged, how farmer advisors were trained and how the advisors worked to enable optimization of fertilizer use by farmers.

17.2 Enabling fertilizer use optimization by farmers

Fertilizer use optimization is an innovative approach for enabling financially constrained farmers to optimize profit from limited investment in fertilizer and thus enable them to increase fertilizer use and improve their income. The greatly improved profit opportunity is expected to result in increased fertilizer use by smallholders and thereby increase productivity, income and food security, and for many, break out of the cycle of poverty. Fertilizer use optimization is also relevant to farmers with adequate finance for fertilizer use who wish to maximize profit from fertilizer use.

Enabling fertilizer use optimization requires application of much research-derived information through OFRA decision tools enabling choice of fertilizer use options with the greatest profit potential for the farmer's situation.

Country-specific stakeholder engagement plans were developed so as to effectively take fertilizer use optimization to technology uptake pathways and finally to farmers. A country OFRA team guides this enablement (Figure 17.1). Some of the immediate enabling activities were: creating farmers' awareness and demand so

Fertilizer Use Optimization in Sub-Saharan Africa (2017) Charles S. Wortmann and Keith Sones (eds). Published by CABI.

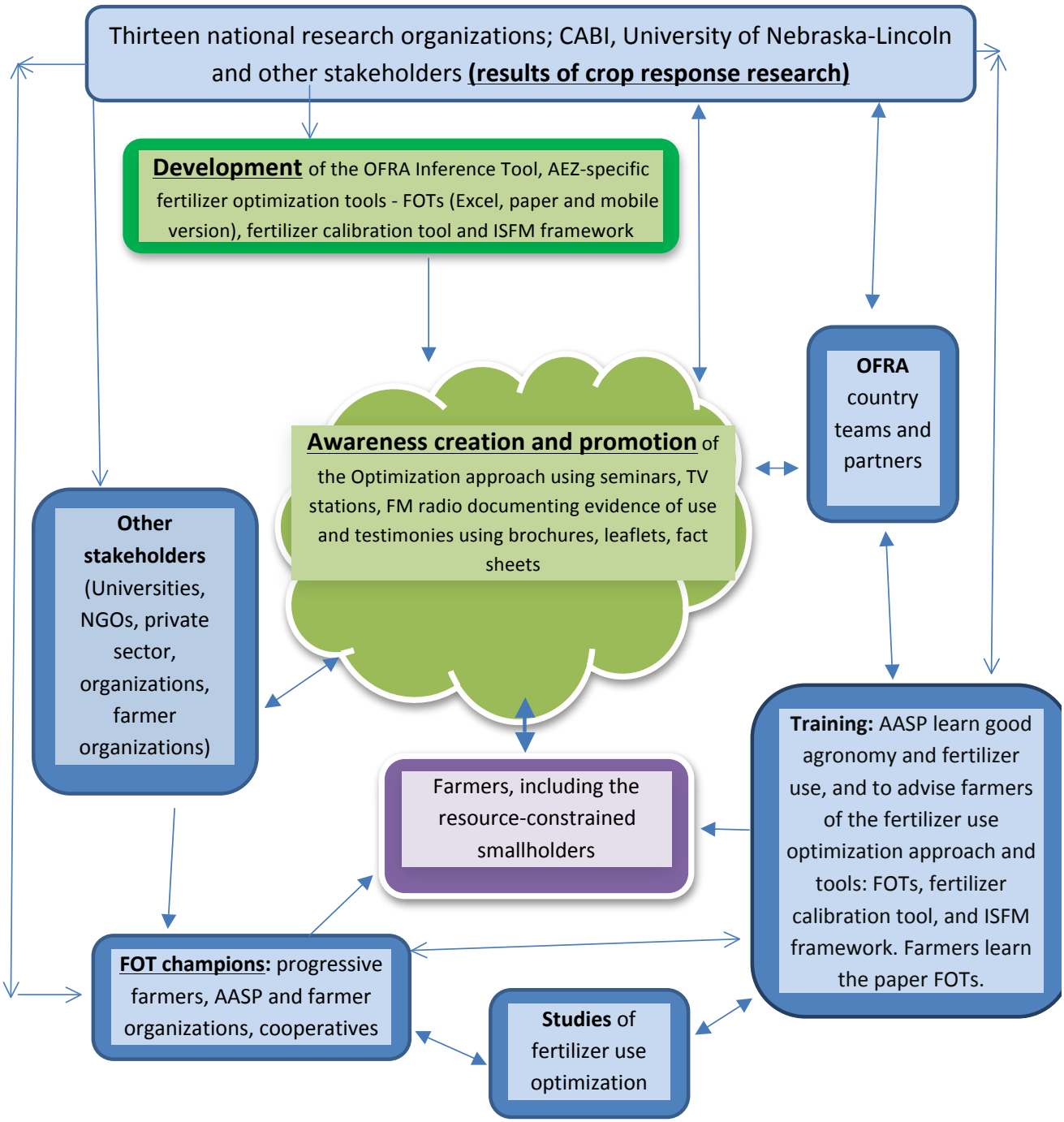

Figure 17.1: A framework for promotion and enabling of fertilizer use optimization.

that farmers request their advisors' help or seek to learn to optimize on their own and thereby drive rapid adoption; creating broad stakeholder support and securing adequate human and financial resources; and training farmer advisors, including government and non-government extension workers and fertilizer retail staff.

Effective delivery of a practice or approach to farmers requires that they become aware, interested and convinced of the benefit opportunity so that the adoption process becomes demand driven. Awareness of fertilizer use optimization aimed at farmers and other stakeholders is through diverse means including mass media. Once interest and farmer demand is created, farmers are likely to look to their advisors for assistance to apply fertilizer use optimization.

Other stakeholders important to successful adoption of fertilizer use optimization include researchers, extension workers, agro-dealers, farmer cooperatives, CGIAR centres,

Table 17.1: Stakeholders for fertilizer use optimization

Stakeholder	Geographical coverage	Major Roles/Mandate
CABI	International	Communications, research†, data management, extension, coordination
University of Nebraska-Lincoln	International	Training, research, geospatial analysis, science development, scientific reporting
Universities	National/regional	Training, research, education
IFDC, CGIAR, IPNI, AGRA	International	Funding, research, further development of the approach, improvement of the FOTs
NARS	National	Research, training, extension
African research associations	Regional	Research, further development of the approach, improvement of the FOTs
AFSIS	Regional	Research and geospatial analysis
Government	National	Policy, extension, resource mobilization
Private sector	National/regional	Extension, enterprise development, credit facilities
Farmer organizations	National/regional	Extension, credit facilities, resource mobilization, training farmers
NGOs	National and international	Adaptive research, extension and training

† Research throughout refers to research for further improvement of fertilizer use optimization for strengthening response functions, adding more important crops, and adding more nutrients including micro- and secondary nutrients.

universities, NGOs and policy makers (Table 17.1). Equally important to facilitation of adoption is that stakeholders do not stymie dissemination of fertilizer use optimization. Extension workers and other farmer advisors are especially important and necessary to achieve adoption of fertilizer use optimization and therefore need to fully understand and own the approach and tools (http://agronomy.unl.edu/OFRA).

Training to prepare extension and other farmer advisors to apply the fertilizer use optimization approach and use the OFRA tools is a major task requiring many human and financial resources. The stakeholders who control such resources need to be convinced of the priority of fertilizer use optimization (Figure 17.1). Many farmers are capable of learning to use the paper version of the Fertilizer Optimizer Tool but need some initial training. Technical support, such as by subject matter specialist at district levels, is needed to assist and monitor farmer advisors. On-going study of farmer adoption is expected to review additional lessons for more efficient on-going and future roll-out.

17.3 Creating demand for fertilizer use optimization

Farmer and other stakeholder demand for fertilizer use optimization has been achieved through communication of success stories and lessons from Uganda where promotion of the optimization approach began in 2012. OFRA partnered with the BMGF-funded African Soil Health Consortium (ASHC) to prepare for communicating the benefits of fertilizer use optimization (http://africasoilhealth.cabi.org/tools/fertilizer-tools/fertilizer-optimisation-tools/). Country-specific flyers were developed for use by the countries in creating awareness of fertilizer use optimization with researchers, extension workers, agro-dealers and farmers' organizations. Furthermore, different forums and media were used to create awareness including radio (Radio Africa in Tanzania), print media (Seeds of Gold in Kenya and Uganda newspapers), TV, video documentaries, national and international seminars, country soil health consortia (CSHC) forums, and regional and international conferences. Four articles were developed from studies conducted in Uganda to understand the challenges and opportunities for farmer adoption

and distributed to 500 stakeholders in other countries to guide their planning for enablement of fertilizer use optimization.

Farmers who have seen the benefit of fertilizer use optimization in Uganda work with their advisors in fertilizer use decisions. Fertilizer use optimization has been presented to research stakeholders through numerous international conferences and journal publications (e.g. Jansen et al., 2013; Kaizzi et al., 2013), this 17-chapter book and other journal articles are in preparation. The promotion of fertilizer use optimization through the media and other channels is expected to generate demand from scientists and other stakeholders to learn more about the approach and adapt it to suit farmer interests.

17.4 Training farmer advisors on fertilizer use optimization

Government and non-government extension staff and fertilizer-supplying agro-dealers are typically important sources of information for farmers concerning fertilizer use. In Uganda, the fertilizer optimization approach was deployed by training researchers of the National Agricultural Research Organization (NARO), extension staff of the National Agricultural Advisory Services (NAADS) and other farmer advisors on the principles of fertilizer use optimization and in the use of FOTs (FOT; http://agronomy.unl.edu/OFRA). During the 2-day training events, conceptual/informational sessions covered soil and crop management and use of organic materials and fertilizers. Trainees had hands-on experience with the FOTs and associated tools. Nine agro-ecological zones were targeted.

Over 1000 farmer advisors were trained in Uganda, Kenya and Tanzania. Using lessons from Uganda, the approach was popularized in Kenya and Tanzania through mass media and seminars. In Kenya, a training event was held at KALRO headquarters for farmer advisors, agro-dealers, farmers and researchers. In Tanzania, events have been held at Sokoine University of Agriculture and Selian Agriculture Research Institute.

Extension training materials include English and French versions of three Microsoft PowerPoint presentations, a manual for fertilizer use optimization and practical exercises (http://agronomy.unl.edu/OFRA).

The trainees learn a 3-step process to aiding farmers in deciding on fertilizer use. First, they practically learned to use the Excel and/or paper versions of the FOT for generating fertilizer recommendations specific to the farmer's context. They then learned to use a fertilizer calibration tool and to advise farmers on how to achieve the correct rates of fertilizer application. The third step was to adjust the recommended fertilizer rates in consideration of soil test information and other soil fertility management practices, e.g. use of crop rotation, use of organic materials such as farmyard manure and intercropping. These fertilizer rate adjustments were made using a fertilizer substitution table that accompanies the FOT (see Chapters 4-16).

17.5 Lessons learned

At the time of writing (May 2016), FOTs have been developed for 67 recommendation domains across the 13 OFRA countries. Most countries are in the early stages of enabling fertilizer use optimization with farmers and their advisors. Therefore, the following lessons were drawn mostly from reflection on experiences from Uganda where enablement of fertilizer use optimization by farmers began in 2012.

- Given the diversity of the stakeholders involved in enabling fertilizer use optimization, communication support was critical to ensure that harmonized messages were passed to the diverse stakeholders. Information materials needed to be packaged for different audiences such as researchers, farmer advisors including fertilizer retail dealers, fertilizer manufacturers, policy makers and farmers. Experience in Uganda showed that farmer advisors needed training on integrated soil fertility management, including fertilizer use, to support the delivery and use of fertilizer use optimization. Policy makers also required information to support adoption and scale-up of fertilizer use optimization within their national frameworks.
- Having paper FOT versions was essential for advisors and farmers to optimize fertilizer use when a computer was not available.
- Essential to fertilizer use optimization was good agronomy and fertilizer use practices including the 4Rs of fertilizer use (right source at the right rate, right time and right method of application). Other yield limiting factors typically

reduce crop response to fertilizer application and fertilizer use can be ineffective in situations where another constraint such as soil water deficit is too severe. These points needed to be addressed in training advisors and in their advising farmers on integrated soil fertility management.

- Follow-up with trainees to determine how they were delivering the FOT and the effectiveness of the methodology used was essential. There was a need to establish the extent of use of the FOT by the different stakeholders.
- Technical advisory support and backup was needed for farmer advisors assisting with fertilizer use optimization.
- Migrating the FOT to a Mobile App was also important for FOT access on their mobile phone. This worked briefly in Uganda but should be exploited further in future.
- Assisting more capable farmers to learn to use paper FOTs on their own is very important.
- In enabling farmers to use fertilizer use optimization, extension workers and other advisors might use complementary activities such as farme-led demonstrations, farmer field schools and farmer-to-farmer extension to inform farmers.
- The FOTs can be used to demonstrate the profit potential of good choices in fertilizer use to micro-finance and other agricultural lending institutions to convince them to improve credit access and terms for fertilizer use by smallholders. Also, actors in the fertilizer supply chain can use the FOTs to assess profit potential for fertilizer use with different crops in an AEZ and ensure supply of fertilizers with the most profit potential. It is expected that as farmers learn which fertilizers have greater profit potential, demand for these fertilizers will increase and suppliers need to be ready to respond. These actors may include farmer associations where effective, as the associations can influence fertilizer supply decisions.
- Sustainability of fertilizer use optimization can be enhanced through on-going support of private and public sectors and of regional and international organizations (Table 17.1; Fig. 17.1).
- Linking with the existing opportunities, such as the CABI-supported Plantwise plant clinics implemented in all OFRA countries, are potential platforms for awareness creation and sustainability. This was confirmed by the results of a follow-up study on the challenges and lessons in enabling fertilizer use optimization in Uganda, which revealed the value of working through plant clinics if well-coordinated. One extension worker suggested that the curriculum that is used to train the plant doctors could be expanded to include fertilizer use optimization and use of OFRA tools.

17.6 Conclusion

Fertilizer use optimization is the maximization of the profit potential of fertilizer use according to the farmer's context while keeping risk low. It was based on field research from which crop-nutrient response functions were developed and applied in the development of FOTs for 67 AEZs of 13 countries.

Enabling fertilizer use optimization at the farm level is in early stages for most countries but considerable experience has been gained from Uganda, as well as Kenya and Tanzania. As with any extension effort, early creation of farmer awareness of the potential benefits of fertilizer use optimization is very important in order to make adoption demand driven.

Engagement with diverse stakeholders is needed to gain the necessary resources and avoid obstacles in enabling fertilizer use optimization. Much training of farmer advisors is needed. More capable farmers need to learn to use the paper FOTs on their own. Diverse partnerships are needed for sustained support of fertilizer use optimization.

17.7 Acknowledgements

OFRA is funded by the Alliance for a Green Revolution in Africa (AGRA) and jointly led by the Centre for Agriculture and Bioscience International (CABI) and the University of Nebraska-Lincoln.

17.8 References

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