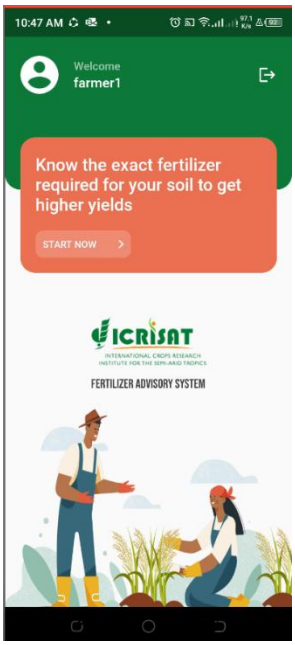
A decision support tool for landscape targeted fertilizer management in Ethiopia



Mobile app advisory to help extension agents and farmers know the amount of targeted fertilizer applied for wheat, teff and sorghum following topo-sequence at the hillslope, mid slope, and foot slope landscape positions.

Background

In Ethiopia, smallholder agriculture is characterized by spatial and temporal variability of production factors such as climate, soil type, topographic, and crop management. This variability also affects the potential crop yield, fertilizer use efficiency, and return to fertilizer investment. Fertilizer recommendations are often based on soil test and crop response at specific locations which disregard the variability of production factors over space and time. Optimum fertilizer application should be differentiated according to landscape strata, soil type and fertility status, cropping system, and climate. The government has supplied only 1.7 million metric tons of fertilizer in 2020 that shows prioritization of fertilizer investment and site-specific recommendation is a major concern.

In poorly managed landscapes, the landscape position could be a proxy indicator of soil fertility status and soil moisture variability. Farmers use landscape positions as a decision factor to determine the amount and type of fertilizer to be applied. The key policy challenge is thus knowing whether the actual fertilizer demand in these types of variable landscapes is hindered by low fertilizer use efficiency, market failures, or the fact that the profitability of fertilizer use is just too low to justify its use. There is very limited incentive for farmers to

invest in inputs in sloping and undulating fields given the very low crop response and associated low profitability.

Decision support tool targeting landscape specific fertilizer use

Thus, the development of a decision support tool (DST) that supports site-specific fertilizer application is crucial for optimized fertilizer use efficiency, increased crop yield, and profitability. ICRISAT developed DST with data generated from crop response to fertilizer on-farm trials implemented between 2014 and 2021. The DST was co-developed with demand partners (government agricultural extension service providers). It provides landscape-specific fertilizer requirements based on optimum yield response to fertilizer that will be further integrated into the fertilizer recommendation cluster map at the district level.

Farmers, agriculture experts and researchers perform evaluation of DST validation trials.
Left picture, farmers at Basonawerana district asked to score (using green, yellow, red cards to represent very good, good, and poor performance). Right picture, group of participants conducted performance evaluation of sorghum and teff validation trials at West Belesa district.

To enable user-friendly DST, ICRISAT developed an app that provides the required landscape specific data regarding the specific area and to get textual results about the specific fertilizer requirement of the targeted landscape. The final output of the DST is a site-specific fertilizer rate that end-users could easily apply in the field with an expected yield performance. DST integrated with the fertilizer cluster map could be used as an advisory for decision-makers to prioritize the demand and investment in fertilizer. Overall, DST is a simple tool and offers an alternative for crop response to fertilizer and soil test-based methods.

The outcome is that yield potential is lower in hillslope soils even with the application of higher fertilizer rates, while the foot slopes will keep producing relatively higher yields with the application of optimum fertilizer rates. Validation of the decision support tool in comparison with the local extension fertilizer recommendation

rate revealed that 20% and 13% yield gain and -17% yield loss for wheat at foot slope, mid slope, and hillslope with corresponding profit of 8720, 8855, and -1980 Eth Birr/ha over the extension recommendation rate, respectively, were achieved. For teff, on average 56% and 6.5% yield gain and 10% yield loss, with the respective profits of 1634, 1970 and -4161 ETH Birr/ha were obtained at foot slope, mid slope, and hillslope. For sorghum, on average 29%, 28% and 17% yield gain with the respective profits of 11927, 19171, and 8469 ETH Birr/ha were obtained at foot slope, mid slope, and hillslope. The yield loss and negative profit at hillslopes revealed the need to reconsider applied fertilizer amount and suggest application of organic inputs. Alternative incentive strategies and investment options such as the application of manure, crop residues, green manures, and other alternative sources could help to improve soil quality and allow crops to grow better and respond more to applied nutrients, particularly in degraded landscapes. Pilot demonstrations of the landscape targeted fertilizer decision advisory tools for wheat, teff and sorghum have been implemented in low and high rainfall districts and scaling strategies have been co-designed with demand partners.

Optimized and targeted fertilizer management along landscape positions at farmer relevant scales results in an increased return to fertilizer investment via reducing the cost of inputs and increasing profitability of farmers; and improving production efficiency and thereby increasing system productivity through judicious use of fertilizers and other agronomic practices.

Learnings

- The co-design and validation of DSTs enhanced localized understanding of agronomy and its relevance and impact by the decision makers, extension agents and farmers.
- Creating feedback loop with end users and contextualizing the tool with local knowledge increase the relevance of the content and maturity of the tool to scale. for instance, customize the app to farmers' farming context – parcels, cropping system, planting dates and characterize farmer relevance landscape scale (bundling of agronomy and spatial features).
- Setting a participatory and partnership processes that enable collaborative platforms at local and national level is essential, specifically collaboration between field agronomy and research (for developing content), and extension communication (for extension delivery).
- Establishing social media platforms on DST for landscape targeted fertilizer applications supported to facilitate communities of practice and exchange of knowledge and experiences among researchers, extension agents, experts, and decision makers.

- Considering the current fertilizer management practice of farmers at landscape scale, setting target on the crop yield increase/response and nutrient use efficiency to fertilizer application is an important aspect of developing a strategy of site-specific soil nutrient management and optimized fertilizer recommendation. Target optimal nutrient use efficiency that does not lead to environmental and economic cost is essential.

- Investing on inorganic fertilizer alone does not lead to efficient and economic production levels. Despite there is high yield response by applying high amount of inorganic fertilizer, there is however leaching and mining of soil nutrients if it is applied beyond the optimum amount. Thus, an integrated soil health approach is essential to increase sustainable nutrient use and will require actions across scales, sectors, and disciplines.

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