



Towards a Farmer-Centric Framework for Scaling Productive and Sustainable Cereal Cropping Systems

By Ivan S. Adolwa, Thomas Oberthür and Simon Cook

A case is made for an innovation system framework that integrates farmer-centric and systemic approaches to scaling plant nutrition innovations for positive transformation of cereal cropping systems in Sub-Saharan Africa. A case study from Ethiopia helps to build the case.

Cereal-based cropping systems are vital food production systems across Africa. In these systems, livelihoods are mainly derived from cereals such as maize, millet, sorghum, and wheat; and also legumes, pulses, roots and tubers. In East and Southern Africa, maize-mixed farming systems are the most important food production systems representing 32 million ha (19%) of the cultivated area (Dixon et al. 2001). These systems are encumbered by food insecurity, hunger and poverty, but these problems can be alleviated by successful yield intensification and crop diversification (Garrity et al. 2012).

Ultimately, a vision of success for cereal cropping systems in Africa includes the improvement of smallholder farmer livelihoods through better value creation and return on investment (ROI) (Fig. 1). Precision nutrient management (PNM) combined with the 4R Nutrient Stewardship (i.e., right nutrient source at the

right rate, time, and place) and best crop management practices provides a plausible pathway for sustainably increasing the productivity of African cereal crop yields from the current 2.5 t ha⁻¹ to attainable yields of 5-7 t ha⁻¹ (Phillips, 2014; van Ittersum et al., 2016). Continued stagnation in productivity results from a



Agricultural systems are increasingly being viewed in terms of complex systems thinking, where rapid transformation or scaling is seen to arise from multiple coinciding influences, events, trends or even shocks.

major failure in current research and scaling processes, which embark on agricultural technology transfer with little regard for the unique socio-organizational conditions of target areas (Adolwa et al. 2017; Schut et al. 2020). Agricultural systems are increasingly being viewed in terms of complex systems thinking,

where rapid transformation is seen to arise from multiple coinciding influences, events, trends or even shocks (Schut et al. 2020). In complex adaptive research and development systems, continuous monitoring and learning through feedback loops, system/sub-system interrelationships and context, reflexive thinking, trade-offs and uncertainty, and adaptive management are key (Cook et al. 2018; Klerkx et al. 2012).

Therefore, the target of increased cereal crop productivity calls for an innovative framework that translates scientific knowledge on PNM into innovations that can be adopted by farmers at scale. African farmers will obtain higher ROI by adopting market-oriented models are anchored on structured markets and credit access. Knowledge transfer and agribusiness could potentially propel the move towards cropping

system commercialization and cereal yield gap closure (Green et al., 2016; Sanchez, 2015).

Precision nutrient management is critical in tackling the spatial and temporal variability in African smallholder farming systems given its incorporation of

spatial and temporal information improves farmer decision-making on nutrient use (Phillips, 2014). However, decision-making among farmers in SSA is constrained by a lack of organization and access to evidence-based information/data (Kassie et al. 2013). Also, there is a gap in understanding how to develop and sustain learning relationships between scientists and farmers in Africa.

A key platform on which PNM should be established is on-farm experimentation (OFE). The OFE approach is farmer-centric or farmer-driven, whereby scientists work with farmers to select treatment variables of interest (Cook et al. 2018; Lacoste et al. 2022). In this way farmers are not only passive recipients of technologies but are also experimenters, hence are central to the innovation



Experimental fields established in western Kenya for the OFE process. Farmer's field (left) and Scientifically-optimized field (right).

process. Also, as is demonstrated in the photo of experimental fields in western Kenya, these experiments should be as large as possible to include effects of variation and mimic local conditions (Cook et al. 2018). In addition, OFE is characterized by evidence-driven (standardized data protocols), expert-enabled (added value

through scientific engagement), co-design (of experiments), and scaling by co-learning (sharing of data, insights, or ideas) principles (Lacoste et al. 2022).

Insights from an on-farm experimentation program in Tigray, Ethiopia

In a four-year experimentation program, farmer groups and scientists jointly designed experiments to improve crop yields (Kraaijvanger and Veldkamp, 2015; Kraaijvanger and Veldkamp, 2017). Experiments designed by farmers were based on their views, ideas, experiences, and year-on-year analyses. Farmer-designed experiments, which ran side by side with science-based ones were extremely diverse and involved, for example, combinations of organic and mineral fertilizers. Science-based experiments, which involved the recommended application (use of inorganic fertilizers +

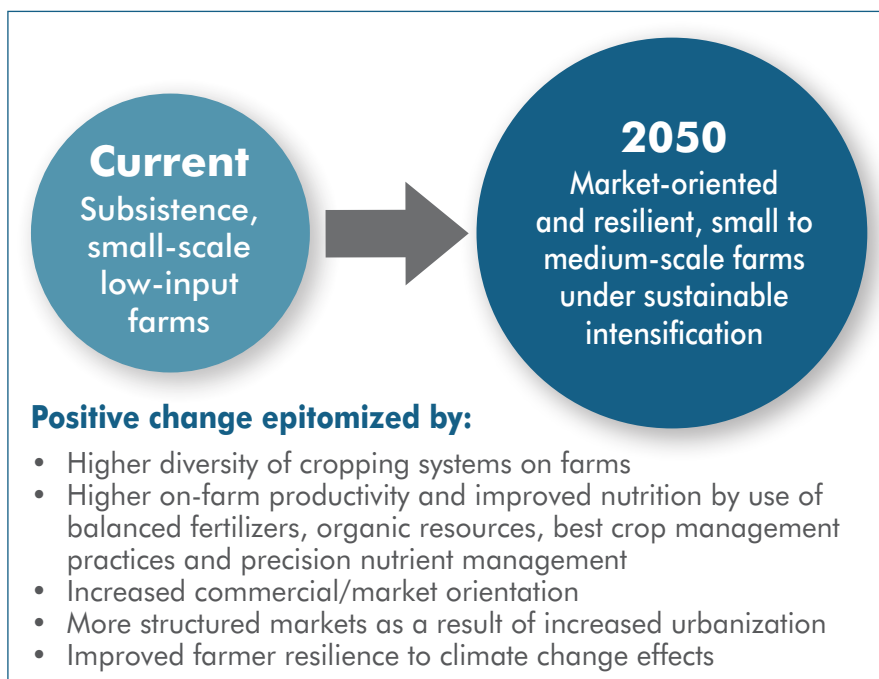
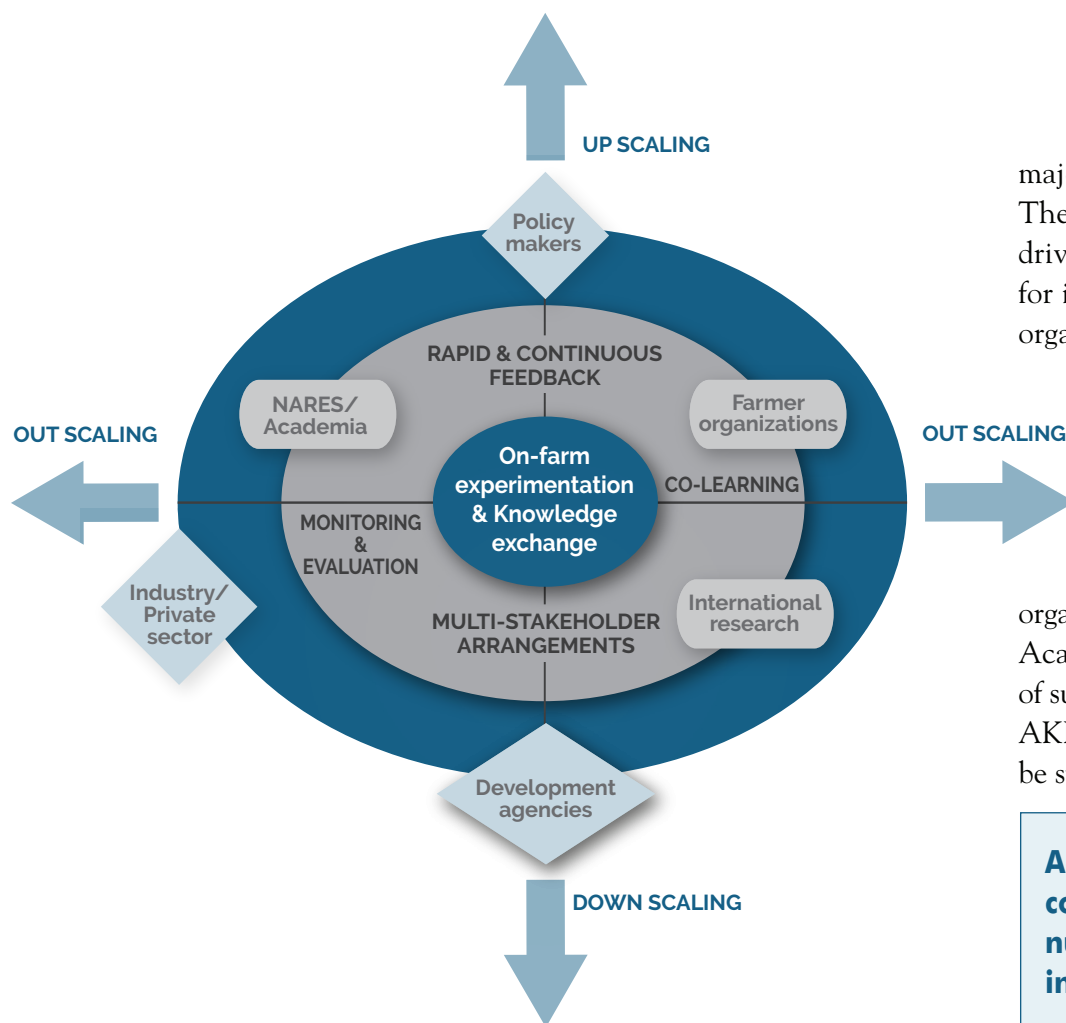


Figure 1. A vision of success for SSA agri-food systems.



major cereal crops (Fig. 2). These processes are farmer-driven and provide a platform for international research organizations and national research and extension systems (NARES) to work effectively with farmers. A tripartite of farmer organizations, international research organizations, and NARES/Academia constitute a sub-system of support within the larger AKIS. For scaling processes to be successful, it is crucial that

Additional issues and considerations for plant nutrition innovation include:

- 1 A socioeconomic characterization of the farming systems to clarify factors that underpin farmer decision-making.
- 2 A review of innovations with high scaling potential for different locations.
- 3 Mapping stakeholder networks using tools such as Social Network Analysis to identify those partners best placed to fulfill scaling functions.
- 4 Identifying key bottlenecks to scaling and developing scaling strategies and approaches (e.g., Scaling Scan; Jacobs et al. 2018, Scaling Readiness; Sartas et al. 2020) to overcome such bottlenecks.
- 5 Monitoring and learning to track impact of scaling approaches (e.g., impact evaluation studies), and documentation frameworks for measuring and reporting of successes, failures, or processes.

Figure 2. Scaling Framework for Cereal Cropping Systems.

sowing in rows) were aimed at being an inspiration for farmer groups to offer them alternatives for crop production. It was observed that farmers matched their experimental design with the requirements of their livelihood system. In this case, farmers focused on enhancing straw productivity (for fodder) at the expense of wheat grain yields. A key outcome with important implications on the trade-off between fertilizer cost and yield increase, was that farmer-led processes did not lead to significantly different average wheat grain yields (2,020 kg ha⁻¹) from the scientific-led process (2,200 kg ha⁻¹). Although this work contributes to our understanding of the choices farmers make in technology adoption and of the processes that

underlie such decision-making, many more studies across several agro-ecological sites and regions need to be conducted to get a clearer picture.

A framework for scaling processes underpinned by the agricultural knowledge innovation systems (AKIS) approach, centered on OFE, is proposed for cereal cropping systems. A key question hinges on whether and how OFE can contribute to scaling processes in African farming systems.

An innovation system framework for cereal cropping systems

This model is centered around farmer-centric processes for experimentation (or OFE) and knowledge exchange on plant nutrition innovation in



this tripartite links with wider value-chain players (i.e., industry/private sector, policy makers, development agents) through mechanisms that propagate co-learning, multi-stakeholder arrangements, monitoring and feedback. Scaling entails three simultaneous and interdependent processes of up-scaling, out-scaling and down-scaling. Out-scaling refers to the horizontal spread of a technology within a homogenous stakeholder category in a certain locality (e.g., a farming community); up-scaling to the creation of conducive conditions and policies for scaling at higher levels (e.g., mainstreaming of new practices in national agricultural policies); and down-scaling the reduction or replacement of existing practices with new ones (Douthwaite et al. 2003; Schut et al. 2020). On-farm experimentation enhances farmer learning and contributes to the efficacy of the three scaling processes. According to Sewell et al. (2014), such co-learning is centered on dialogue and relationships of mutual trust to co-construct shared understanding. By building the individual and collective capacity of actors, particularly farmers, such understanding can be translated into management decisions that put learning into practice. Therefore, an integration of farmer-centric and systemic approaches to scaling is pursued. ■

Dr. Adolwa is APNI's Farming Systems Scientist based in Nairobi, Kenya. e-mail: i.adolwa@apni.net. Dr. Oberthür is APNI's Director of Business & Partnerships. Dr. Cook is Professor, Curtin and Murdoch Universities, Perth Australia.

Cite this article

Adolwa, I.S., Oberthür, T., Cook, S., 2022. Towards a Farmer-Centric Framework for Scaling Productive and Sustainable Cereal Cropping Systems *Growing Africa* 1(1), 24-26. <https://doi.org/10.55693/ga11.gkde6695>

REFERENCES

- Adolwa, I.S., et al. 2017. A comparative analysis of agricultural knowledge and innovation systems in Kenya and Ghana: sustainable agricultural intensification in the rural-urban interface. *Agric. Hum. Values* 34(2), 453-472.
- Cook S., et al. 2018. An on-farm experimental philosophy for farmer-centric digital innovation. In, *Proceedings of the 14th International Conference on Precision Agriculture*. Montreal, CA: International Society of Precision Agriculture.
- Douthwaite B., et al. 2003. Impact pathway evaluation: An approach for achieving and attributing impact in complex systems. *Agric. Syst.* 78(2), 243-265.
- Dixon J., Gulliver, A. 2001. Rome: Food and Agriculture Organization of the United Nations. http://www.fao.org/3/Y1860E/y1860e04.htm#P1_2.
- Garrrity, D., Dixon, J., Boffa, J-M. 2012. Understanding African Farming Systems: Science and Policy Implications. Invited paper, Food Security in Africa: bridging research into practice, 30 Nov., 2012, Sydney, Australia.
- Green H., et al. 2016. Planting seeds for the future of food. *J. Sci. Food Agric.* 96(5), 1409-1414.
- Jacobs F., Ubels, J., Woltering, L. 2018. The Scaling Scan - A Practical Tool to Determine the Strengths and Weaknesses of Your Scaling Ambition. Published by the PPPLab and CIMMYT <https://ppplab.org/2018/11/3223/>
- Kassie, M., et al. 2013. Adoption of interrelated sustainable agricultural practices in smallholder systems: Evidence from rural Tanzania. *Technol. Forecast. Soc. Change* 80, 525-540.
- Klerkx L., van Mierlo, B., Leeuwis, C. 2012. Evolution of systems approaches to agricultural innovation: concepts, analysis and interventions. In: Darnhofer I., Gibbon D., Dedieu B. (eds) *Farming Systems Research into the 21st Century: The New Dynamic*. Springer, Dordrecht.
- Kraaijvanger, R., Veldkamp, T. 2015. The importance of local factors and management in determining wheat yield variability in on-farm experimentation in Tigray, northern Ethiopia. *Agric. Ecosyst. Environ.* 214, 1-9.
- Kraaijvanger, R.G., Veldkamp, T. 2017. Four years of farmer experimentation on soil fertility in Tigray, northern Ethiopia: trends in research strategies. *J. Agric. Educ. Ext.* 23(4), 373-391.
- Lacoste, M., et al. 2022. On-Farm Experimentation to transform global agriculture. *Nat. Food* 3, 11-18.
- Phillips, S. 2014. Precision Agriculture: Supporting Global Food Security. 98(3), 4-6. *Better Crops*
- Sanchez, P. 2015. En route to plentiful food production in Africa. *Nature Plants* 1, 14014
- Sartas, M., et al. 2020. Scaling Readiness: Science and practice of an approach to enhance impact of research for development. *Agric. Syst.* 183.
- Schut, M., Leeuwis, C., Thiele, G. 2020. Science of Scaling: Understanding and guiding the scaling of innovation for societal outcomes. *Agric. Syst.* 184, 102908.
- van Ittersum, M.K., et al. 2016. Can sub-Saharan Africa feed itself? In, *Proceedings of the National Academy of Sciences* 113(52), 14964-14969.