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## Scaling deep and out: inclusive ai-driven and voice-based digital extension systems for smallholder farmers in east Africa

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### Abstract

Smallholder farmers in low- and middle-income countries often face a “knowledge gap” due to underfunded and overstretched traditional extension services. While digital tools are frequently proposed as a solution, their impact is often limited by a lack of local grounding, gender-blind designs, and technical barriers such as low digital literacy or poor connectivity. In the context of the SNF-funded CIRNA project (CIRcularity of Nutrients in Agroecosystems), this study demonstrates how localised digital innovations can be designed to inclusively address the knowledge gap. We conducted a baseline assessment of ICT access among livestock-rearing smallholders in Kenya and Uganda, revealing a comprehensive basic phone ownership (99%) but a stark digital divide in smartphone adoption (82% in Kenya vs. 28% in Uganda). We thus developed two distinct technological pathways in collaboration with a Kenyan social enterprise: (1) An AI-driven WhatsApp chatbot for the Kenyan context, utilising natural language processing to provide interactive advice. (2) An Interactive Voice Response (IVR) hotline for Uganda, specifically designed for feature-phone users and those with limited literacy. The chatbot also includes an SMS dial-in option to ensure maximum reach and are built on a social business model where revenue is reinvested into platform maintenance. Early demand testing in Uganda has already engaged over 29,000 farmers, highlighting a strong appetite for localised digital advisory services. We aim to reach (i.e. “scale out” to) over 120,000 farmers in the first two years of operation, including gathering feedback on our service utility and complementary demands. By specifically targeting women and youth, these tools aim to “scale deep”—transforming social norms and enhancing the participatory exchange of knowledge between research and practice. In our presentation we share the results of a literature review, market study as well as practical lessons learnt on digital extension. Our approach provides a scalable model for how digital knowledge systems can foster sustainable land-use and equitable rural development in the Global South.

**Keywords:** Digital extension, Kenya, scaling deep, scaling out, smallholder, Uganda, women, youth