

POLICY BRIEF

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Exemplary features of digital tools for agroecology: A global review

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KEY MESSAGES

- Few digital tools support agroecology comprehensively, but many have agroecological components.
- Features that improved two-way farmer communication, targeting of farmer subgroups, farmer-driven content and use of human intermediaries were exemplary features for social inclusion.
- Exemplary features for technical advisory tools included context-specific technical options, use of videos, integration with coaching and hotlines for questions, and two-way communication.
- Exemplary features for performance assessment included collaborative definition of indicators with farmers, easy to use spreadsheets (for researchers) and easily digestible quick view reporting such as pie charts.

Many digital tools are available to provide farmers agricultural advice and assessment of their farm performance. Increasing interest in agroecology has created a demand for digital tools that can include agroecological principles such as farmer codesign, diversity, and whole farming system transitions. Digital tools can also be a means of rapidly scaling up agroecological practices. This brief sets out to answer two questions:

- How well do available digital tool features in agriculture support agroecology practices?
- To what extent do these digital tools' features also support farmer co-creation and smallholder farmer inclusion?

To answer these questions, we identified existing digital tools that provided agro-advisory services or performance assessment and reviewed their features against indicators for socially inclusive, agroecological transitions relevant to smallholder farmers in low- and middle-income countries (LMIC).

We used web searches, expert interviews and platforms such as the CGIAR Evidence Clearing House and Digital Agri Hub to identify tools and used information available online to characterize tools' content and features. Tools were classified as technical advisory resources if their primary function was to

deliver recommendations regarding farming practices, and as performance assessment if their primary function was to report on farm outcomes, status or operations. See Dittmer et al. (2022) for an in-depth description of the methodology.

We found 61 tools that provided agro-advisories or performance assessment. Of these, 43 included agroecological components, including 37 that provided agro-advisory services and 14 that provided performance assessment. Although productivity is an agroecology principle, we did not consider tools that only addressed productivity as having an agroecological component.

This analysis covered tools for a wide range of geographical areas, target users, and intervention strategies. Analysis across tools was complicated by differences in what was exemplary for different target users and contexts— a smallholder farmer often has different literacy requirements, incentives, and training needs compared to a researcher. The transition of industrial agriculture to agroecological practices requires different approaches than a smallholder farmer seeking to improve their livelihood. Reaching smallholders may include more than just one tool, and appropriate implementation of tools may depend on the broader digital ecosystem of enabling conditions and combined use of other tools such as [FarmStack](#) for secure data transfer, [Amplio talking book](#) for e-

extension, and [FarmOS](#) for farm management. Tools that are geospatially enabled, provide local environmental data, or connect to local weather information services are key features for supporting contextually relevant solutions.

Exemplary features for agroecology

We explored three exemplary features of digital tools for agroecology in our review: (1) the extent to which tools comprehensively addressed agroecological principles, (2) features for technical agro-advisories and performance assessment, and (3) how well tools supported farmer communication and access to tool content. A summary of the tools and their features may be found in Table 1.

1) Agroecological completeness

We considered tools more exemplary to the extent they reflected a more complete set of agroecological principles. We defined agroecological completeness as the degree to which tools addressed 12 agroecological principles, based on [Barrios et al. 2020](#) and [HLPE 2019](#) (Figure 1). Tools were classified as agroecological if they included four or more agroecological principles and complete if they included all twelve. A tool was counted as addressing a principle if it included content or features related to agro-advisories or performance assessment related to this principle. Examples include sending short message service (SMS) messages on how to apply fertilizer appropriately (agro-advisory for efficiency/input reduction) or collecting information in an app about gender representation in farm roles (performance assessment for gender and youth).

Agroecological completeness was weak among the tools reviewed. Most tools (65%) addressed four or fewer agroecological principles. Only three tools in our sample were complete: F-ACT: Farm-Level Agroecology Criteria Tool, Tool for Agroecology Performance Evaluation (TAPE), and Access Agriculture. Most tools addressed sustainability issues at levels of granularity that did not capture the nuances or multiple scales of agroecology. Use of agroecological principles at social scales, such as culture and food traditions or governance were rare for the types of tools we reviewed. Productivity was the primary principle covered by most tools.

The most frequently represented agroecological principles among the 43 tools reviewed were productivity, income, and their stability over time (81%), co-creation and sharing of knowledge (58%), and efficiency/input reduction (56%). Agro-advisory tools reflected a similar pattern, while performance assessment tools included productivity, income, and their stability over time (93%), followed by efficiency/input reduction (64%), with co-creation and sharing of knowledge in under half of the tools (43%). All four tools with only one principle included co-creation and sharing of knowledge, farmer-relevant content (67%).

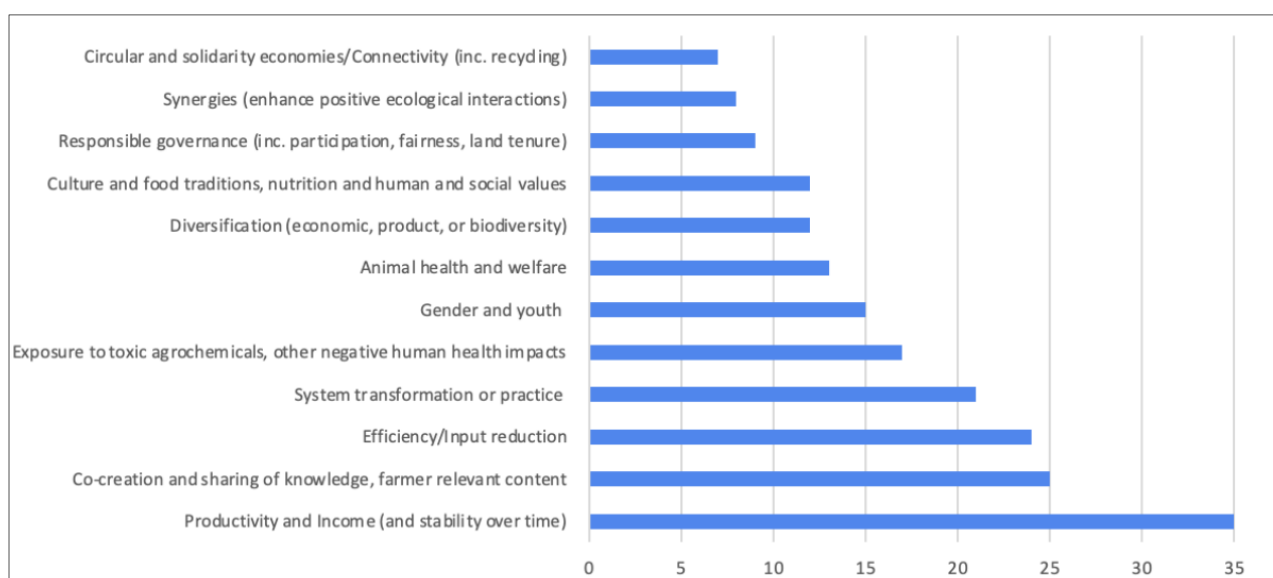


Figure 1 Number of tools per agroecological principle

Tools that were agroecological (four or more principles) did not include communication features that can enhance access or usability for smallholder farmers in LMICs. Such features include interactive voice response (IVR), audio or video text messages and iconography as an alternative to text-based communication. Tools that did have these features only addressed up to three agroecological principles, indicating a gap.

Given the low number of tools available for agroecology, one approach for tool implementers is to identify the priority agroecological principles for application in each community or region to guide selection of tools, or use combinations of tools, rather than seek a single tool. For example, overuse of toxic agrochemical inputs may be an issue requiring urgent attention in some places and tools could be selected that address this content.

Tool developers that want to improve the agroecological completeness of an existing tool should look to see which principles are included in the tool as it exists and which agroecological principles are most appropriate for improving the tool. They can then work to pilot and test modifications that include those principles. We suggest that, in this process, agroecological completeness should be flexibly defined according to the tool's objectives and local contexts for its application. Advocates for agroecological principles should be considered another "stakeholder" and their interests weighed carefully against those of targeted tool users and farmers.

2) Exemplary features for agro-advisories and performance assessment

Exemplary features of the 37 agroecological agro-advisory tools included context-specific technical options, use of videos, integration with people-based support systems that included coaching and hotlines for questions, and two-way communication. Agro-advisories require accessibility and actionability of information at the farmer-level. The goal of co-creation requires farmer input into the development of these advisories.

Exemplary features of the 14 performance assessment tools included collaborative definition of indicators with farmers and other stakeholders, distinguishing between characterizing agroecological transitions and farm performance according to the United Nations Sustainable Development Goals (SDGs), options for use of multiple languages, options to modify tools to fit users' needs; easy to use spreadsheets (for researchers) and easily digestible, quick view reporting such as pie charts. Spreadsheet tools can provide meaningful evidence for policymakers and other decision makers, collecting data across the agroecological principles. An exemplary feature such as a spreadsheet, while suitable for researchers or farmers in wealthy countries, would be a prohibitive feature for the smallholder, marginalized farmer who usually would not have access to a computer.

Data privacy issues of farmers should be considered with digital tool design and implementation. This information was not readily available for each tool reviewed, but experts interviewed noted this concern.

3) Smallholder farmer inclusion and co-creation

Features that improved farmer communication such as targeting farmer subgroups, farmer-driven content, and use of human intermediaries were exemplary features for socially just inclusion of farmers and farmer co-creation of farming solutions. Both social inclusion and farmer co-creation are core tenants of agroecology. Social inclusion is defined here as "the process of improving the terms on which individuals and groups take part in society—improving the ability, opportunity, and dignity of those disadvantaged on the basis of their identity" (World Bank 2013). We use co-creation to mean the collaborative process of developing and implementing knowledge about farm practices among farmers, advisors and researchers.

Communication features of the 43 tools reviewed that supported inclusion and co-design enabled farmers to provide input, feedback, direct the type of information they received or enable two-way communication. Features included IVR, SMS, and sometimes video (Table 2). SMS and video or non IVR-audio were most common. Tools with these features also included the most agroecological content. Only 21% of tools offered more than one way of communicating. Other exemplary features for communication were use of local language, tailored recommendations and group SMS messages.

Few tools were designed to target specific sub-groups such as women or youth (19%) or include citizen science (16%). Farmer-driven content was possible in 26% of the tools.

Many smallholder farmers, women and other marginalized groups in LMICs have limited literacy and access to technology, which often requires the role an intermediary to facilitate their access to digitally available information. The enabling environment and how a tool is used to support inclusion and co-design is as important as digital tool features. For example, the lack of wireless internet access, digital literacy, and access to devices are major barriers to social inclusiveness. Some experts told us they were better able to reach smallholder farmers when tools were designed for intermediaries rather than smallholders.

Many tools in this review were primarily used by farmers' support organizations such as farmer unions, extension agents, or community NGOs. As a trusted intermediary, these organizational agents around the farmer provide opportunities for use of technologies that farmers may not have access to or the capacity to use. For example,

Digital Green partnered with the Andhra Pradesh Department of Agriculture and Cooperation to provide farmer videos. The community video framework is an important innovation, but the collaboration with the state government, and the focus on the Andhra Pradesh Community Natural Farming (APCNF) practices, allowed them to reach 300,000 smallholder farmer households with climate-resilient agronomic practices.

As with any user, tools that have farmers as the target user should add value for the farmer to use them and reflect a strong understanding of the context in which the farmer is working. Value-for-farmer examples include improved income, digital inputs layaway, e-extension services through video recordings, and e-extension via web and smartphone applications.

Recommendations

There is an opportunity to improve the agroecological completeness of digital tools and the inclusion and co-design features of digital tools for smallholder farmers in LMICs. Increasing farmers' use of tools will also require finding ways to make tool compelling to use and financially or culturally meaningful. Our recommendations include:

- Identify how a digital tool is intended to support agroecology before evaluating which tool to use or feature to improve. Is it a priority of the project to address all agroecology principles? Recognize that more than one tool may be needed.
- Work with a trusted intermediary to connect to preexisting groups of farmers, such as farmers unions, trade groups, or established governmental and nongovernmental organizations.
- Review existing tools and their use to identify exemplary features that might be relevant to the project's objectives and local context.
- Improve the number of performance assessment tools by improving existing tools or adding agroecology components to performance assessment tools.
- In existing tools, incrementally build up agroecological completeness. If currently 3 or 4 principles are covered, see how to make it to 5 or 6 as opposed to unreasonably stretching to cover all 12.
- Create digital tool features related to social-scale agroecological principles such as governance or culture and traditions. Agro-advisories and performance assessment tools currently focus on on-farm aspects of agroecology such as productivity and input reduction.
- Include multiple and innovative ways of engaging the farmer or end user such as SMS, IVR, mobile app, or other.
- Consider the appropriateness of replacing existing in-person interactions such as extension work with digital options, which may not always be appropriate or best for the farmer.

Table 1: Exemplary features of 43 digital tools for agroecology

GHG = greenhouse gas. SDGs = Sustainable Development Goals. AFOLU = agriculture, forestry and other land use. IVR = interactive voice response. IVR = interactive voice response. SMS = short messaging service. AI = artificial intelligence.

Digital Tool	Functions & exemplary features
3S Management Information System	Farm crop management, full chain traceability, analytics and business intelligence. Measure the impact and progress made on the sustainability goals in the cashew supply chain.
Access Agriculture	Farmer-to-farmer training videos with agroecological principles applied. Enables global and local access to open-access training videos in local languages. Combines scientific and indigenous knowledge. Multiple ways to access content: website, app and audio podcasts.
AgriApp	Crop advisory, soil testing, drone services, crop practice advice, market access and information. Farmer-to-farmer videos on smart farming practices, organic farming, managing against diseases, weeds and pests, etc. Hotline or SMS to chat with experts.
AgriExt App	Information and advice on crop or livestock management, good agricultural practices, sanitary and phytosanitary measures. Exchanges between farmers or with extension workers can be done with messages, photos and videos
AgriNapsis	Virtual training courses and technical assistance. Collective knowledge sharing platform and app. Farmer videos and community forum.

Agrisuite NEO	Decision support information system for crop and livestock production, market information. Adapts seamlessly to the smaller displays of multiple devices.
Agroecology Criteria Tool (ACT)	Assesses a project's alignment with agroecological principles. Provides a structured and graphically intuitive way to identify the focus and agroecological character of an initiative.
Agroecomakers	Traceability system applied to agroecological systems. Developed via participatory research and citizen science. Strengthens a circular economy by committing to products at fair prices that provide quality of life to all those involved.
AtSource	Traceability, carbon and water footprint calculator. Monitors nine core sustainability topics related to 12 SDGs. Strong focus on women and youth.
BharatAgri	Personalized crop calendar, weather based advisory, crop advisory. Soil health reports printed and sent to farmers. Timely notifications on the preventive steps to be taken at the farm based on the weather conditions. Video and chat/call support.
Clima y cafe - Cafenica Prognostico	Early warning system, decision support, farm data collection. Focus on family inclusion and protagonism of young people and women.
Climate FarmRise	Agronomic information and advice for smallholder farmers. Farmer-to-farmer chat. Agricultural news and event information to educate farmers on industry developments and opportunities. Information available in multiple languages.
CubicA	Agricultural advisory via free hotline or IVR. Field-level human-centered design. Advisory in local languages and on any mobile device. Internet connection not required.
DigiFarm	Access to quality farm inputs, input loans, learning content (crop and livestock), market access. Insurance yield cover and extension services through remote agronomists (call center or on ground advisors). Learning content available via app or SMS.
Digital Green (Community Videos)	Community videos made by the community to share knowledge with one another. Illiteracy sensitive. Option to provide feedback about videos.
EcoFarmer SMS Advisory Tips	Subscription based SMS advisory service offering tips on maize, groundnuts, tobacco, cattle, goats, bees and sorghum.
Esoko	Weather information, early warning systems, climate-smart agronomic advice and crop protocols, market price information, market linkages and insurance coverage. Customizable announcements and reminders. Content delivered via SMS, voice SMS, IVR or call center.
EX-Ante Carbon-balance Tool for value chains (EX-ACT VC)	Environmental and socio-economic performance assessment of value chains. Additional analysis opportunities on gender and youth employment engagement. Makes direct links to six SDGs indicators.
Extension Solution	Field activity monitoring and management, individual farmer workplan, certification and verification. Integrated with WhatsApp for direct communication.
Farm-Level Agroecology Criteria Tool (F-ACT)	Holistic farm assessment to identify agroecological development and areas for further development relative to a farm's unique context and objectives. Generates automatic bar charts that provide qualitative indicators of a farm's strengths and areas for further agroecological development.
Farm(x)	Crop management system for tree crops. IVR and mobile app interface. Machine learning platform suggests irrigation schedule, optimizes water and fertilizer use and helps predict crop yield.
FarmBetter	Tailored land management recommendations to farmers based on their location, practices and goals. Linked to the Carbon Benefits project and connected to WOCAT Sustainable Land Management Database.
Farming Solution	Decision support and technical assistance on diverse crops and livestock. Illiteracy sensitive (information delivered via iconography, video and audio for agricultural management practices).
Farmshine	Market access, traceability, technical advice. Technical field agents provide farmers with advice and support throughout the growing season and help them aggregate crops for sale to large buyers.
Haller Farmers App	Open access to farming techniques and agricultural information. Supported by Swahili audio to allow for wide access. Visually based.
iCow	Information disseminating aimed at improving extension services. iCow library consists of over 30,000 SMS categories across all practices of smallholder production systems.
iShamba	Call center for farming tips on crop and livestock, market prices and weather updates. SMS alerts for farmer trainings in the user's area.
Mergdata	Farm data collection integrated with IVR agro-advisory (weather, farming tips and market prices. Offline mode. Voice surveys. Inbuilt features that ensure data accuracy and reduce human error. GPS enabled.
mFarmer	Farm management recommendations, farm data collection, certification. Available on Facebook's Free Basics or as a browser based mobile website. Multiple languages.

miCampoApp	Participatory research for decision support combined with a certification for market differentiation. The farmer collects information using simple icons and produces traceability pages for research or certification purposes.
Mobile Kilimo (M-Kilimo)	Market access and consulting service. SMS-based, where farmers can text in specific inquiries to be answered by extension agents.
mooOn	Herd management app that provides recommendations to optimize herd performance. Aims to improve animal health and welfare and animal productivity.
MyAgro	Input access, agricultural training, harvest-improving agricultural techniques tailored to specific regions and crops, mobile layaway.
Plantvillage Nuru	Mobile AI assistant, with human agents available, capable of diagnosing cassava diseases.
Premium Hortus	Market access, e-commerce of organic and agroecological products. Connects consumers to smallholder produce markets.
RiceAdvice	Farm-specific advice on rice management practices, crop calendar, fertilizer plan. Offline mode. Face-to-face training.
Shade Tree Advice	Decision-support for selecting tree species in agroforestry systems. Developed via participatory approach.
SmartFarm	Farm data management, crop advisory via SMS, certification. Customizable business intelligence dashboard and reporting.
Sowing App	Insights around soil health, fertilizer recommendations and seven-day weather forecasts using AI and crop modelling tools.
Stepwise	Helps farmers adopt best farming practices in small increments and decreases investment burden.
Tool for Agroecology Performance Evaluation (TAPE)	Participatory tool to assess the multidimensional performance of agroecology. Informs various dimensions of sustainability: land tenure, productivity, income, added value, exposure to pesticides, dietary diversity, women's empowerment, youth employment, biodiversity, and soil health.
WADI Virtual Assistant	WhatsApp. Enables the farmer and extensionist to interact and access information from multiple sources (satellites, weather services, soil testing and logistics).
xarvio FIELD MANAGER	Farm management recommendations, farm data collection, independent field-zone specific agronomic advice. Map generation for multiple assessments (soil conditions, seeding, fertilization, crop protection, growth regulator and yield).

Table 2. Digital tool innovations for farmer communication

All tools (total of 43 tools)	Feature	Innovations	Tool Example	Drawbacks	High agroecology content (total of 15 tools)
4	IVR	Delivers tailored recommendations in an accessible way with option for farmer to engage. Allows a call center to triage calls.	DigiFarm ¹	Limited to the logic of the menu	0
9	Iconography	Provides opportunity for interaction and conveying information about a practice or idea where farmer literacy is limited.	miCampoApp ²	Smartphones usually require a level of literacy	2
11	Video/ non-IVR audio	Brings video capabilities to exchange among farmer peers. Delivers recommendations to farmers in a local language. WhatsApp application allows farmers to use video clips, instead of requiring text literacy.	Access Agriculture ³	One-way or slow two-way communication	4
13	SMS	Cheap and widely accessible text communication that farmers can read any time. Farmers can subscribe to tool's advice via SMS. Advice can be distributed to many farmers at once.	myAgro ⁴	Dependent on literacy	4

* High content reflects tools with content or features reflecting 5-12 agroecology principles

Further reading

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