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Crowdsourcing for Climate-Smart Agriculture: Insights from the Bolivian Andes

by Rafael Lindemann Taborga

The vast majority of family and smallholder farmers in developing countries do not have access to locally relevant weather forecasts, undermining their capacity to adapt to climate change. Anticipating climate related risks reduces farmers' vulnerability as they can plan ahead and limit the damage caused by storms, extreme temperatures, pests and other weather-related events.

A recent pilot experiment in the Bolivian Andes – run by a consortium of international and national non-profit organisations, research centres and Bolivia's productive development bank – found that encouraging smallholder farmers to crowdsource agro-climatic information enhances the accuracy of local weather forecasts, increasing their adoption of climate-smart practices. As a cost-effective system, crowdsourcing can be harnessed to broaden the coverage of agro-climatic information services, while enhancing their local relevance by responding to actual needs.

The basic principle of crowdsourcing is that of outsourcing a task traditionally performed by a designated agent to individuals, groups of people or a platform that share a common goal. Encouraging smallholder farmers to utilise technology to send reports from their farmlands fosters a sense of ownership and collaboration, thereby favouring forms of collective knowledge production and sharing.

Climate change adaptation and digital information services

The impact of climate change on crop yields and livestock productivity can hardly be overstated. Climate change resulting from human activity has hampered global farming productivity

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by an estimated 21 per cent since 1961.[1]

Between 2005 and 2015, farmers in low- and middle-income countries suffered 96 billion US dollars in crop and livestock production loss due to 332 large- and medium-scale climate related disasters.[2] Such challenges are only going to increase in the future: temperature rise is likely to further reduce critical crop yields by as much as 30 per cent between 2030 and 2050.[3]

Smallholder farmers in developing countries are increasingly gaining access to digital tools that can enhance their resilience to climate change. Digital advisory services that promote climate-smart farming are gaining ground, particularly in Sub-Saharan Africa and South-East Asia – with Latin America lagging behind.

In Latin America and the Caribbean, most climate-smart advisory services have not yet scaled, only involving between 1,000 and 5,000 active users. Very few advisory services have targeted smallholder farmers as they are not yet commercially viable on their own and continue to be supported by national and international NGOs.[4]

By comparison, in Sub-Saharan Africa, 22.6 million smallholder farmers are registered to agricultural advisory and information services. Nine digital advisory services in the region have more than one million subscribers and have developed solid business models.[5] Yet, access to information and services does not necessarily lead to the adoption of new farming practices.

The Consortium of International Agricultural Research Centers (CGIAR) estimates that 42 per cent of farmers in Sub-Saharan Africa actually made use of the information they accessed, and an even lower number (15–30 per cent) are thought to be highly active users of the digital service they registered for.[6] Moreover, it took 12 to 24 months for smallholders participating in FAO's and Telefonica's Smart Agro 4.0 pilots to adopt the recommendations they were receiving.[7]

Innovative services that do not adapt to the needs of customers tend to fail. The success of climate-smart services therefore depends on the match between the value providers think they are delivering and the actual value farmers find in the product or service they are utilising.

[1] Ariel Ortiz-Bobea et al., "Anthropogenic Climate Change Has Slowed Global Agricultural Productivity Growth", in *Nature Climate Change*, Vol. 11, No. 4 (April 2021), p. 306-312, https://doi.org/10.1038/s41558-021-01000-1.

[2] Food and Agriculture Organization (FAO), *The Impact of Disasters and Crises on Agriculture and Food Security: 2021*, Rome, FAO, 2021, p. 26, https://doi.org/10.4060/cb3673en.

[3] Jan Priebe, "Digital Innovation for Climate-Resilient Agriculture", in *GSMA AgriTech Reports*, March 2021, https://www.gsma.com/mobilefordevelopment/?p=69176.

[4] Panos Loukos and Leslie Arathoon, "Landscaping the Agritech Ecosystem for Smallholder Farmers in Latin America and the Caribbean", in *IDB Technical Notes*, No. 2084 (February 2021), http://dx.doi.org/10.18235/0003027.

[5] Michael Tsan et al., *The Digitalisation of African Agriculture Report, 2018-2019*, Wageningen, Technical Centre for Agricultural and Rural Cooperation (CTA)/Dalberg Advisers, 2019, https://hdl.handle.net/10568/101498.

[6] Ibid.

[7] Panos Loukos and Leslie Arathoon, "Landscaping the Agritech Ecosystem...", cit., p. 70.

ISSN 2532-6570

ISSN 2532-6570

Crowdsourcing services and enhanced citizen participation

As official weather data in rural areas of most developing countries is scarce, a growing number of initiatives are encouraging farmers to use their mobile phones to collect data on local agro-climatic conditions.

FAO's Fall Armyworm Monitoring and Early Warning System app encourages farmers and extension workers to report the outbreak of the Armyworm pest.[8] Other global initiatives that provide innovative digital advisory services – such as Precision for Development (5.4 million smallholder farmer users) and Digital Green (2.3 million smallholder farmer users) – are using crowdsourced data from smallholder farmers in Africa, Asia and Latin America. These global initiatives are attracting increased funding from a plethora of private foundations, international development agencies, corporations and multilateral agencies.[9]

Compared to phone surveys and other means of remotely gathering farm-level information, crowdsourcing is a step forward as it promotes continuous interaction, fostering joint problem-solving and the co-development of locally tailored solutions.[10]

Evaluating crowdsourcing systems: Insights from the Bolivian Andes

Supported by the UK-based Nesta Foundation and the Inclusive Markets Project,[11] a recent pilot experiment – implemented by Swisscontact, the Latin American Center for Rural Development (RIMISP), Bolivia's Productive Development Bank and two Bolivian NGOs, PROSUCO and Fundación PROFIN – tested the effects of crowdsourcing in three rural communities of the Bolivian Andes. The experiment ran between 1 February and 15 June 2021.[12]

Crowdsourcing enabled farmers to be at the centre of the service design. By applying digital surveys via KoBotoolbox,[13] each participating household chose options to define how they wanted to receive the advisory service and what content they were most interested in. The design of the advisory service resulted in farmers watching 81 per cent of advisory videos within three days of them being received.[14]

[8] See FAO website: *Global Action for Fall Armyworm Control*, https://www.fao.org/fall-armyworm/monitoring-tools/famews-mobile-app/en.

[9] For more info, see Digital Green website (https://www.digitalgreen.org) and PxD website (https://precisiondev.org).

[10] Timothy Karpouzoglou et al., "Environmental Virtual Observatories (EVOs): Prospects for Knowledge Co-creation and Resilience in the Information Age", in *Current Opinion in Environmental Sustainability*, Vol. 18 (2016), p. 40-48, https://doi.org/10.1016/j.cosust.2015.07.015.

[11] Inclusive Markets is a project of the Swedish and Swiss development agencies in Bolivia implemented by Swisscontact Foundation, PROFIN Foundation, the Latin American Center for Rural Development and other partners.

[12] RIMISP, *Crowdsourcing de información agroclimática local favorece la resiliencia de familias agricultoras en los andes bolivianos*, 3 October 2021, https://www.rimisp.org/?p=2329450959.

[13] KoBotoolbox is a free open-source tool for mobile data collection, available to all. Supported by the Harvard Humanitarian Initiative and a host of other donors such as the World Bank, Cisco and United Nations Agencies. For more info see: https://www.kobotoolbox.org.

[14] Watch examples of the weekly weather

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Encouraging farmers to crowdsource agro-climatic data also enabled providers to generate information that was more relevant at the individual farm-level. Installing seven low-cost weather stations that crowdsourced local weather data has enhanced temperature and humidity forecasts by 25 per cent when compared to official forecasts. Moreover, reports crowdsourced by farmers that detailed the appearance of pests and diseases on their land were essential to validate and adjust early warning systems.

The pilot experiment also found that on average farmers in the crowdsourcing community were 32 per cent more likely to apply preventive actions and monitor their fields when recommended by the pilot early warning system. Crowdsourcing also made farmers more likely to decide whether to irrigate their fields based on the forecasts received. The feedback loop between farmers and service providers made crowdsourcing a dynamic system that is able to adjust to local contexts.

Harnessing crowdsourcing in digital information services

There is no silver bullet to ensure crowdsourcing's successful deployment in digital advisory services that promote climate-smart agriculture. Strategies to integrate crowdsourcing should be designed based on the installed capacities of service providers, smallholder farmers and relevant stakeholders involved in the climate-smart service.

Public services that provide climate information and forecasts are generally underutilised by smallholder farmers as they are not relevant at a local level.[15] National agro-climatic information services would benefit from test-driving open crowdsourcing platforms that provide local weather forecasts.

Cost-free platforms, such as IBM's Weather Underground, allow the public to connect low-cost weather stations to the platform. By doing so, the platform delivers 10-day local forecasts that are publicly available. This crowdsourcing alternative provides reliable hyperlocal forecasts for a fraction of the cost required to develop complex weather prediction models and purchase weather stations that comply with regulations demanded by the World Meteorological Organization.

Similarly, services that provide technical assistance to smallholder farmers in developing countries tend to perform poorly in monitoring and preventing the outbreak of pests and diseases as their presence in rural areas is minimal. Less than 10 per cent of farmers in developing countries have received technical assistance by an extension worker.[16]

Crowdsourcing can improve the ability to remotely monitor the outbreak of

forecast video and the weekly alert of pests and diseases are available in: RIMISP, *Crowdsourcing de información agroclimática local...*, cit.

[15] FAO, *Handbook on Climate Information for Farming Communities. What Farmers Need and What Is Available*, Rome, FAO, 2019, https://www.fao.org/publications/card/en/c/CA4059EN.

[16] Mark Bell, "ICT – Powering Behavior Change in Agricultural Extension", in *MEAS Briefs*, October 2015, https://meas.illinois.edu/wp-content/uploads/2015/04/Bell-2015-ICT-Powering-Behavior-Change-in-Ag-Ext-MEAS-Brief1.pdf.

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IAI COMMENTARIES 21 | 51 - NOVEMBER 2021

such phenomenon. The challenge is that of harnessing real time reports to guide coordinated efforts. Pest and disease control require collective action as efforts to prevent such outbreaks tend to fail if only a part of the farming community adopts them.[17]

Digital advisory services will struggle to coordinate collective action on their own. Leveraging support from local governments, farming organisations, NGOs and other stakeholders that have presence at the local level is necessary to collectively establish rules, protocols and agreements adhered to by all stakeholders involved.

Trade-offs of crowdsourcing and possible ways forward

Crowdsourcing has the potential to change the way in which knowledge is generated and information is accessed. Wikipedia is a clear example of how a distributed and open encyclopaedia can outperform traditional ones. However, according to Wikimedia Foundation's executive director, around 80 per cent of Wikipedia's editors are male, most of which live in developed countries.[18]

Crowdsourcing is a distributed system, yet it does not necessarily result in a socially inclusive system nor a decentralised one. Indeed, crowdsourcing can potentially widen the digital gap: excluding rural women, the elderly, remote communities and other disadvantaged groups that have limited access to mobile phone coverage or smartphones. To promote more inclusive systems, service providers can reward farmers with small amounts of mobile phone credit when helping fellow farmers gather information and alerting the rest of the community to potential weather-related risks by using non-digital tools such as fireworks and flags.

Information crowdsourced by farmers is generally centralised by service providers, then processed and delivered back to individual farmers. This two-way system is effective when farmers can easily evaluate the value of the information received in their own communities.

In the pilot experiment in the Bolivian Andes, farmers empirically evaluated the accuracy of weather forecasts and alerts received, using this information to take better decisions. By contrast, advice regarding the use of new agricultural practices tended to be ignored when these appeared unfamiliar. The percentage of farmers adopting recommended practices drops when farmers have no empirical evidence of their real-world effectiveness.

After working 10 years in the Andean region I have observed that a small minority of family farmers' embrace new practices merely based on theoretical or academic information. Farmers tend to be empirically driven, adopting practices when

[17] Cees Leeuwis and Noelle Aarts, "Rethinking Adoption and Diffusion as a Collective Social Process: Towards an Interactional Perspective", in Hugo Campos (ed.), *The Innovation Revolution in Agriculture. A Roadmap to Value Creation*, Cham, Springer, 2021, p. 95-116, https://doi.org/10.1007/978-3-030-50991-0_4.

[18] "Wikipedia Is 20, and Its Reputation Has Never Been Higher", in *The Economist*, 7 January 2021.

their advantages can be validated in communities similar to their own.

To change entrenched farming practices that yield poor results, centralised service providers should work closely with local organisations, governments community leaders and farmers to establish research farms where new practices can be collectively tested, evaluated and adjusted.

Information and advisory services are irrelevant if farmers do not use or trust them. Experience in the Bolivian Andes has shown that crowdsourcing can help services be more relevant at the farm-level, increasing farmers use of new information sources to take decisions. To better navigate the trade-offs of crowdsourcing, service providers should partner with local leaders and stakeholders to help nudge all farmers towards more effective climate-smart agricultural practices.

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