Document:	EB 2020/130/R.2
Agenda:	3
Date:	28 August 2020
Distribution:	Public
Original:	English

E

Investing in rural people

Precision Agriculture to Support Inclusive Food System Transformation

Note to Executive Board representatives

Focal points:

Technical questions:

Thouraya Triki
Director
Sustainable Production, Markets and Institutions Division
Tel.: +39 06 5459 2178
e-mail: t.triki@ifad.org

Dispatch of documentation:

Deirdre Mc Grenra
Chief
Institutional Governance and Member Relations
Tel.: +39 06 5459 2374
e-mail: gb@ifad.org

Executive Board — 130th Session
Rome, 8-11 September 2020

For: **Review**

Precision Agriculture to Support Inclusive Food System Transformation

I. Rationale

1. IFAD believes that precision agriculture solutions offer a key opportunity to radically innovate the way the organization supports small-scale producers and the rural poor. Precision agriculture approaches can help expand the number of beneficiaries reached by IFAD. They also create opportunities for institutional learning; accelerate the delivery of ad hoc support based on behavioural economics; allow for the testing of new solutions for blended learning among farmers and their peers, and increase access to services. For this reason, IFAD proposes a strategic discussion to explore the Executive Board's views on whether precision agriculture should be integrated as a priority area in the implementation of IFAD's recently adopted Information and Communication Technologies for Development (ICT4D) Strategy (2020-2030) and as a key enabling element of the business model for the Twelfth Replenishment of IFAD's Resources (IFAD12).

II. Precision agriculture: background and definitions

2. The concept of precision agriculture emerged in the 1980s as a combination of techniques and technologies aimed at making the practice of farming more accurate and controlled.[1] Precision agriculture initially referred to an approach to adapt fertilizer distribution to varying soil conditions, enabling farmers to apply optimal treatments in the right place at the right time.[2] In the early 1990s, the use of global positioning system guidance for tractors was further included to automatically steer the machines based on the coordinates of a field, thus minimizing the waste of seeds, fertilizers, fuel and time.

3. Since then, precision agriculture has evolved to encompass an increasing number of information and communication technologies (ICTs) and other digital technologies seeking to optimize agricultural production by better accounting for variability and uncertainties within agricultural systems.[3] These include geographic information systems, local and remote sensors, robotics, drones, enhanced machinery, variable rate technology, information systems and computer-based applications. These technologies enabled the development of innovative agricultural practices such as autonomous machinery and processes, on-farm research, product traceability, and the comprehensive management of agricultural production systems.

4. Today, precision agriculture allows the optimal management of agricultural inputs based on the site-specific requirements of farm fields and animals, enabling more effective and efficient use of natural, human and financial resources to maintain the quality of the environment while increasing agricultural supply. Precision agriculture also provides a way to monitor agricultural supply chains and manage both the quantity and the quality of agricultural produce.[4] The global market size for precision agriculture reached an unprecedented US$4.7 billion in 2019.[5]

5. A key enabling factor in this impressive growth is the reduced cost of technologies and their increasing popularity, notably mobile phones. The Groupe Spéciale Mobile

[1] Zarco-Tejada, P. J., Hubbard, N., & Loudjani, P. (2014). Precision agriculture: An opportunity for EU farmers – potential support with the CAP 2014-2020. Joint Research Centre (JRC) of the European Commission.
[2] Gebbers, R., & Adamchuk, V. I. (2010). Precision agriculture and food security. Science, 327(5967), 828-831.
[3] Stafford, J. V. (2000). Implementing precision agriculture in the 21st century. Journal of Agricultural Engineering Research, 76(3), 267-275.
[4] Bucci, G., Bentivoglio, D., & Finco, A. (2018). Precision agriculture as a driver for sustainable farming systems: State of art in literature and research. Calitatea, 19(S1), 114-121.
[5] Grand View Research. (2020). Precision Farming Market Size, Share & Trends Analysis Report By Offering, By Application, By Region, And Segment Forecasts, 2020-2027. Available at: https://www.grandviewresearch.com/industry-analysis/precision-farming-market.

Association (GSMA)[6] reported that in 2020, 67 per cent of the world's population were unique mobile subscribers and this percentage is expected to reach 70 per cent by 2025. Access to the Internet via mobile phone is also on the rise: 49 per cent of the global population have used Internet services on a mobile device and only 9 per cent live in areas not covered by mobile broadband. Thanks to mobile phones, access to timely and accurate information for farmers has become easier and cheaper over time, and has made precision agriculture solutions much more widely available. Combined with mobile phones, other technological trends are enabling the implementation of precision agriculture practices worldwide. For instance, the decreasing cost of hardware is allowing the collection of essential farm data, sourced both locally (e.g. drones, soil sensors) and remotely (e.g. via satellite). The increasing availability of computational power across cloud computing systems at lower prices also enables the generation of hyper-local recommendations, regardless of the availability of local infrastructure.

6. Precision agriculture is no longer solely focused on large-scale farmers in high-income countries; it is increasingly being used in poor and resource-scarce areas.[7,8] Some precision agriculture practices – such as mobile-based advice, soil mapping, precise irrigation systems and the use of modern sensors – can be adopted at low cost and with ease by small-scale farmers in low-income countries.[9] Adoption rates are already rising in Argentina, Brazil, South Africa and Turkey,[10] and the feasibility of a low-cost package for precision farming to increase land and labour productivity has been proven in some low-income countries, such as in semi-arid West Africa.[11] Furthermore, the emergence of hotspots for the development of digital technologies supporting local agriculture – such as Côte d'Ivoire, Ghana, Kenya, Nigeria, Senegal, South Africa, Uganda and Zimbabwe in Sub-Saharan Africa[12] – should accelerate the development of appropriate precision agriculture solutions for small-scale producers.

III. Potential and challenges

7. Precision agriculture holds huge potential to increase the quantity and quality of agricultural output while using inputs in a smarter and more sustainable way. This facilitates sustainable land use and is particularly valuable in a context where resources are scarce. Indeed, by giving small-scale producers in poor rural areas precise and timely practical information, precision agriculture helps sustainably increase their productivity and incomes and strengthen their livelihoods by reducing the negative environmental externalities. The adoption of precision agriculture practices seems particularly promising, because for farmers, economic considerations are among the most important determinants when opting for innovative practices. Farmers practising precision agriculture often state that the most beneficial outcome is the cost-savings achieved through variable fertilizer application, as confirmed by the literature.[13]

8. An interesting illustration of the benefits of precision agriculture is the use of sensors among small-scale producers in Mozambique, United Republic of Tanzania

[6] See: https://www.gsma.com/mobileeconomy/.
[7] Mondal, P., & Basu, M. (2009). Adoption of precision agriculture technologies in India and in some developing countries: Scope, present status and strategies. Progress in Natural Science, 19(6), 659-666.
[8] Ncube, B., Mupangwa, W., & French, A. (2018). Precision agriculture and food security in Africa. In Systems Analysis Approach for Complex Global Challenges (pp. 159-178). Springer, Cham.
[9] Robert Paarlberg. (2016). Precision Agriculture: Can Smallholders Participate? The Chicago Council on Global Affairs. Guest Commentary.
[10] Say, S. M., Keskin, M., Sehri, M., & Sekerli, Y. E. (2018). Adoption of precision agriculture technologies in developed and developing countries. Online J. Sci. Technol, 8(1), 7-15.
[11] Aune, J. B., Coulibaly, A., & Giller, K. E. (2017). Precision farming for increased land and labour productivity in semi-arid West Africa. A review. Agronomy for sustainable development, 37(3), 16.
[12] Krishnan, A., Banga, K., & Mendez-Parra, M. (2020). Disruptive technologies in agricultural value chains. ODI.
[13] Jacobs, A. J., Van Tol, J. J., & Du Preez, C. C. (2018). Farmers perceptions of precision agriculture and the role of agricultural extension: a case study of crop farming in the Schweizer-Reneke region, South Africa. South African Journal of Agricultural Extension, 46(2), 107-118.

and Zimbabwe to improve water management. By learning how to interpret data and information, farmers changed their irrigation management practices. Not only did they decrease irrigation frequency by 50 times while doubling productivity,[14] but their behaviour also spread to farmers outside the direct project group.[15]

9. However, precision agriculture is not a panacea. Poor small-scale producers, especially women, face challenges in accessing these solutions. Development of the last mile – by leveraging proven solutions like SMS, interactive voice systems and radio – is key to allowing those without access to ICTs and communication technologies to benefit from precision agriculture. As technological solutions improve over time, it is important to consider such infrastructure as dynamic sources of services. Even with these developments, women run the risk of unequal access. Women are 20 per cent less likely to use mobile Internet than men, down from 27 per cent in 2017. Over 300 million fewer women than men access the Internet through a mobile phone.[16] Hence, accelerated efforts are needed to close the digital gender divide and ensure equitable access to ICTs. It will be particularly challenging to develop appropriate services for farmers living in remote areas of the poorest countries, with limited access to technology and lower levels of literacy. IFAD's comparative advantage in working with these groups will prove essential for this mission.

10. Scale is also a significant challenge. Most precision agriculture solutions target the performance improvement of a specific subset of agricultural production – i.e. an increase in yields and/or income for a certain crop. Such an increase for small-scale producers, who often depend on diversified on- and off-farm activities for their livelihood, would not translate into dramatic gains at the household level. To achieve strong impact precision agriculture solutions need to be scaled up for use by a large number of small-scale farmers.

11. A third challenge is that of operational learning at scale. The site-specificity of agricultural production means that the success of technological applications depends on their capacity to determine and interpret the local context. Applications require location-specific data, and the use of local languages is essential for optimal communication. In the case of precision agriculture, this factor is further increased by the information intensity and use of ICT solutions, which add further complexity to the scaling up of solutions across geographies. Operational settings must therefore be set up to allow for the processing of the data generated by local-level experimentation, leading to the generation of the social learning that is key for success.

IV. IFAD and precision agriculture

12. IFAD is committed to promoting ICT-based solutions in agriculture to accelerate the inclusive and sustainable transformation of food systems. In 2019, IFAD developed a 10-year (2020-2030) ICT4D strategy, aimed at leveraging digital technologies to increase the organization's development impact and improve the economic and social conditions of rural people. By 2030, IFAD envisions rural societies in which ICT-enabled services and solutions significantly contribute to achieving food security and prosperity and leaving no one behind.

13. Some of the initiatives implemented by IFAD that informed the development of the ICT4D strategy leveraged precision agriculture solutions. The partnership with Intel Corporation allowed IFAD to deliver an innovative solution to local entrepreneurs

---

[14] Pittock, J., & Ramshaw, P. (2016). Annual report: Increasing irrigation water productivity in Mozambique, Tanzania and Zimbabwe through on-farm monitoring, adaptive management and agricultural innovation platforms. Project number, FSC-2013-006.

[15] Stirzaker, R., Mbakwe, I., & Mziray, N. R. (2017). A soil water and solute learning system for small-scale irrigators in Africa. International Journal of Water Resources Development, 33(5), 788-803.

[16] GSMA, 2020. *Connected Women: The mobile gender gap report 2020*. GSMA, London. Retrieved 19 August 2020 Available at: https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2020/05/GSMA-The-Mobile-Gender-Gap-Report-2020.pdf.

across 210 locations in Cambodia to help farmers test soil, buy seeds and connect to markets. Specifically, small-scale producers used a step-by-step software programme to analyse soil, determine fertilizer requirements, receive advice on the best seeds to use and how to manage pests and diseases. In this initiative, the complementarity of capacity and expertise between IFAD and Intel expanded access to IFAD's knowledge expertise at a fraction of the cost. Another key success factor was the explicit inclusion of sustainability and scalability in the design of the initiative, which allowed rapid scaling up of the ICT solution offered to farmers.[17]

14. Based on its comparative advantage, cross cutting-priorities and previous work in this area, IFAD plans to promote the use of digital technologies to improve rural people's access to information and services and promote their financial inclusion, with the aim of increasing their agricultural productivity, expanding their benefits from market participation, and strengthening their household resilience. In these efforts, an emphasis will be placed on ensuring access and usage by women, youth, indigenous peoples, persons with disabilities and other vulnerable populations.

15. Expanding access to information at the farm and rural level is a prerequisite for small-scale producers and rural people to benefit from precision agriculture. IFAD plans to support countries in identifying the barriers that prevent small-scale producers from using precision agriculture solutions, and help design appropriate strategies to overcome them – thus accelerating the adoption of precision agriculture solutions in developing and emerging regions. Moreover, IFAD will seek partnerships with development partners that are actively addressing ICT infrastructure gaps – a necessary condition for any ICT4D intervention's success. Such partnerships could be based, for instance, on the concept of smart villages,[18] which aims to mutualize investments to build shared infrastructure for improving service provision in rural areas, reducing operational costs and broadening the impact of various development initiatives.

16. Precision agriculture is also part of IFAD's overall strategy to respond to the COVID-19 crisis through the Rural Poverty Stimulus Facility (RPSF). One of the four main activities of the RPSF is the promotion of digital services, which includes precision agriculture solutions to respond to the needs of partners and beneficiaries during the crisis, such as access to key information on agricultural production, weather, finance and markets to strengthen farmers' productive capacity; ensure the efficient and effective supply of agricultural inputs; and allow access to targeted conditional transfers.

17. As part of this effort, IFAD just launched a new project in partnership with Precision Agriculture for Development (PAD). A global non-profit organization, PAD pioneered a new model for agricultural extension that delivers personalized agricultural advice to farmers through their mobile phones. PAD uses social learning theory to identify what type of information and delivery mechanisms work best for farmers. Thanks to the collaboration with PAD, IFAD will provide actionable and timely information to 1.7 million small-scale producers – including women and youth – in Kenya, Nigeria and Pakistan to help them improve their productivity, increase their profitability, and advance environmental sustainability in the context of COVID-19. After this initial phase, IFAD's ambition is to replicate and scale up digital extension solutions with PAD and additional partners at a larger scale globally.

18. The use of digital technology and precision agriculture is also a key element of the IFAD12 business model. For a country programme to be transformative and deliver impact, it needs to foster innovation. As noted in the IFAD12 Business Model and

[17] For further information on this initiative, please see: https://www.ifad.org/en/web/latest/news-detail/asset/39070734; and https://www.ifad.org/en/web/latest/video/asset/39617881. For a description of the lessons learned through the partnership, please see IFAD's ICT4D strategy (p. 12): https://webapps.ifad.org/members/eb/128/docs/EB-2019-128-R-5.pdf.

[18] Visvizi, A., Lytras, M. D., & Mudri, G. (Eds.). (2019). Smart Villages in the EU and Beyond. Emerald Publishing Limited.

Financial Framework paper, digital technologies are widely recognized as necessary for accelerating progress towards the Sustainable Development Goals. Digitalization through precision agriculture not only helps increase small-scale producers' productivity, improve access to markets and strengthen resilience to climate change, but also empowers the most vulnerable groups, such as women, youth, indigenous peoples and persons with disabilities. Innovations such as precision agriculture are central to the transformational approach envisioned in IFAD12.

19. Incorporating precision agriculture into the organizational 2020-2023 ICT4D action plan under development will expand the availability of precision agriculture solutions across IFAD's project portfolio. The development of the ICT4D Partnerships Plan with the Global Engagement, Partnership and Resource Mobilization Division and the Private Sector, Advisory and Implementation Unit, as well as the design of a joint initiative with the South-South and Triangular Cooperation Facility, will further integrate precision agriculture into operations IFAD12. Moreover, IFAD12 highlights the Fund's focus on being a results-driven organization. Precision agriculture, agri-information and the development of digital agri-markets, among other technologies, contribute to data generation and collection, which support better data analysis. The Fund's ability to enhance data-driven decisions contributes to better, more systematic decision-making and to de-risking the innovation portfolio.

V. Way forward

20. The digital technologies used in precision agriculture can revolutionize rural livelihoods by enabling communities to access and share customized and actionable agricultural information in real time. Two elements are fundamental: investments and partnerships.

21. As recently highlighted by the President of IFAD and the Nobel Laureate, Professor Michael Kremer, making the right investments and establishing the right partnerships can kick-start digital adoption and reduce the income gap that has long held rural areas back.[19]

22. As per the ICT4D strategy, IFAD will play a key role to ensure that investments in rural areas will leverage the technological advancements needed to accelerate poverty reduction and expand development impact. IFAD will ensure that precision agriculture solutions are people-centric and development-driven. In these efforts, an emphasis will be placed on improved and affordable access for women, youth, indigenous peoples, persons with disabilities and other vulnerable groups.

23. IFAD will seek to mobilize resources for precision agriculture through its project portfolio, and will forge strategic partnerships for the successful implementation of this agenda. Finding complementarities in capacity and expertise among development partners has been critical for multiplying the impact of IFAD's work in a cost-effective manner. A priority area for IFAD will be to increase both the availability and the quality of data in the agriculture sector, which will be key to improving the targeting of investments in rural areas, promoting evidence-based decisions and policymaking, and developing new services for the rural poor. Among such services, IFAD will particularly focus on the promotion of digital extension services.

24. The successful uptake of precision agriculture solutions needs careful planning at the organizational level to generate institutional shared learning, and to efficiently and effectively scale up operations. For IFAD and many of its development partners, this implies developing a clear learning and knowledge agenda to develop the capacities needed to move the agenda forward and establish a knowledge platform

[19] M. Kremer, G. Houngbo. 2020. "Grow back better? Here's how digital agriculture could revolutionise rural communities affected by COVID-19". Available at: https://www.weforum.org/agenda/2020/07/digital-agriculture-technology/.

for large-scale data collection, validation and processing to manage its resources dynamically. It also entails close collaboration to create conducive ecosystems, encompassing clear and conducive policy frameworks, adequate and reliable infrastructure, good capacity and investment in hard and soft infrastructure.

25. IFAD will need to engage with the private sector to invest in rural and remote areas and develop solutions for small-scale producers and rural people, and will also need to partner with them to explore alternative commercial models along with national institutions.