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Essay

Prospects for Enhancing Climate Services in Agriculture

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ABSTRACT: Agricultural stakeholders can effectively manage the risks and opportunities arising from climate change and variability by enhancing climate services in agriculture. Key to understanding and addressing the climate challenge is the provision and the use of climate information to aid decision-makers and policy-makers. Climate services are now integral to the United Nations Framework Convention on Climate Change, the Intergovernmental Panel on Climate Change's Assessment Reports, governments' national adaptation plans, funding bodies, and a growing number of sectors and industries worldwide. The article provides our personal perspective, experience, and views on the important and timely issue of managing better the risks and opportunities to the agriculture sector and community that are arising from changes in climate. We describe a framework to help drive action to tackle the climate challenge comprising enhanced knowledge and information products, efficient information delivery and use, and assured policy and institutional support, in an iterative loop.

KEYWORDS: Climate services; Climate change; Climate variability; Agriculture

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The COVID-19 pandemic created new challenges for food security, such as increased price volatility and destabilized supply chains due to labor shortages, restricted mobility, and general uncertainty, worsening the severity of preexisting food crises due to climate change (FAO 2021; Phillips et al. 2020). In addition, the feasibility of conducting face-to-face services and providing farmers with weather-informed agricultural advisories has been reduced in many countries (FAO 2020). While the COVID-19 crisis will undoubtedly challenge livelihoods and agricultural systems worldwide, calls to address the concurrent climate crisis have identified the need for transformational shifts away from business as usual. The disruptions and changes resulting from the pandemic can also provide an opportunity for catalyzing drastic shifts in agricultural systems to be more resilient, sustainable, and stronger in the future.

Climate affects the agriculture sector in multiple ways, from farm-level production, processing, and transportation and marketing (WMO 2019). Climate services for the agriculture sector provide relevant climate information for agriculture, impact-based forecasts on crops, livestock, forestry, and fisheries to manage climate risks, and weather-informed agricultural advisories that are essential to modulate weather extremes (Bernardi 2011), leading to significant socioeconomic and environmental benefits (Brasseur and Gallardo 2016). Climate services are also recognized as a key enabling instrument for scaling climate-smart agriculture, integrating necessary adaptation, and capturing potential mitigation of climate change and variability (Lipper et al. 2014). In addition, the service aspect requires proactive and systematic outreach, including institutional agreements and arrangements, technical support, communication, and feedback mechanisms through timely monitoring and evaluation (Hewitt et al. 2017).

Following the establishment of the United Nation's Global Framework for Climate Services (GFCS) in 2009 (Heffernan 2009; Hewitt et al. 2020), agricultural communities worldwide have managed the risks and opportunities arising from climate change, climate variability, and related extreme weather events through climate services at national and local scales. In fact, recent assessments of the global state on climate services indicate that 85% of the countries identified climate services as a critical element for planning and decision-making for agriculture and food security (WMO 2019). Development and provision of effective climate services entails multiple stages (Fig. 1), beginning with data collection and monitoring of climate and agronomic variables that are then used by experts to codesign, codevelop, and coproduce tailored products with the decision-makers, enabling participation in climate-informed decision-making and action. The decision-makers and users of information, in turn, provide feedback for continuous enhancement of the products and services.

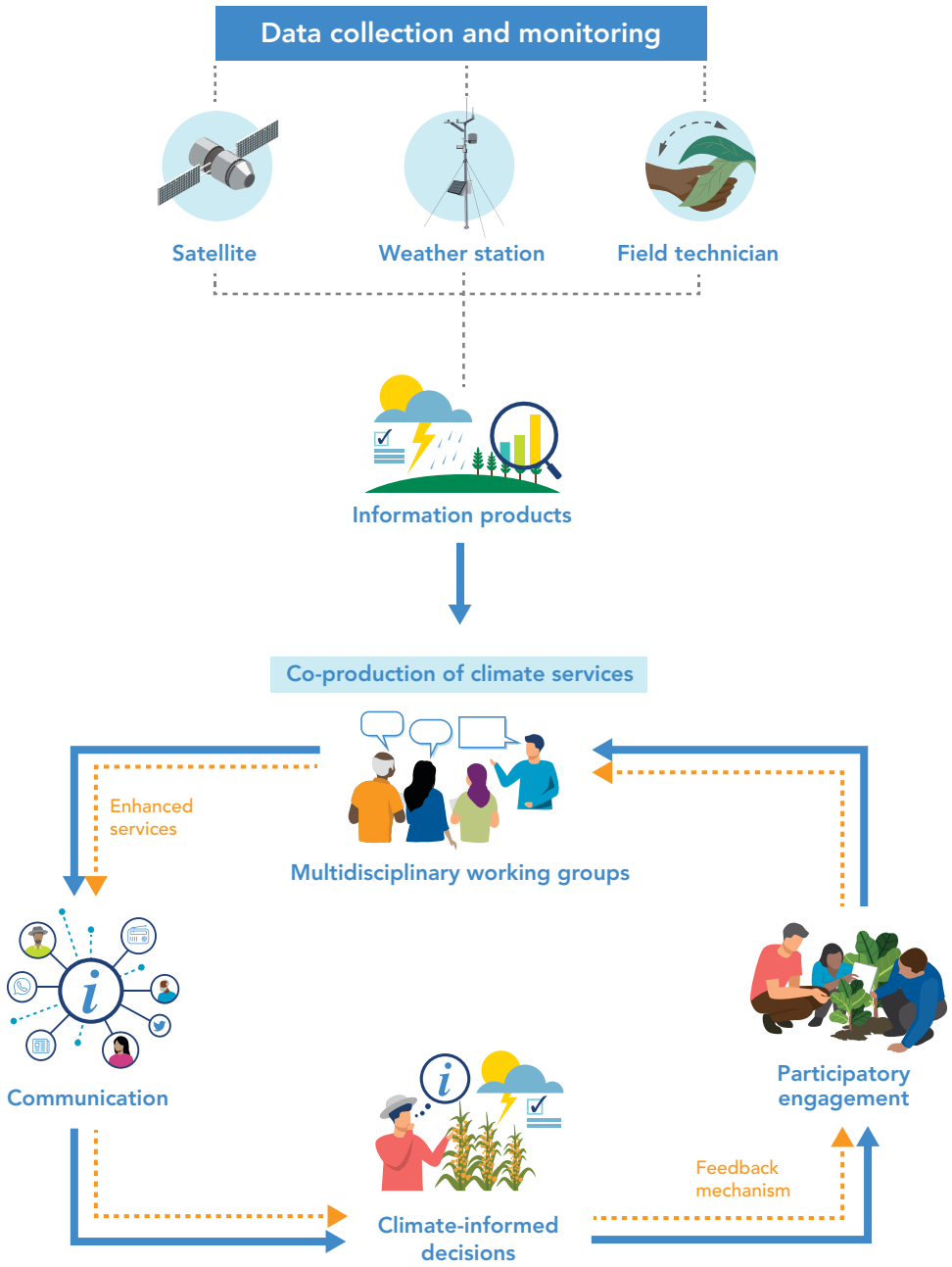

Fig. 1. Stages for effective development and provision of climate services for the agriculture sector. Adapted with the permission from the Food and Agriculture Organization of the United Nations (FAO).

During the Asia-Pacific Agriculture Climate Services Weeks in July 2019 and December 2021 (Han et al. 2022) and related workshops and consultations held for that period, diverse stakeholder groups with large representations from public sectors of developing countries and research communities, both in agriculture and climate, identified barriers and challenges that significantly hinder effective climate services in the agriculture sector (summarized in Table 1). Some of them echoed the findings from the past large body of literature on climate services (Ferdinand et al. 2021; Findlater et al. 2021; Hansen et al. 2019; Hewitt and Stone 2021), while others better reflected the demand side of the climate services, e.g., agricultural stakeholders from national ministries to farmers, complementing the previous findings. For instance, the lack of national capacity for last-mile communication, lack of user-driven and participatory tailoring of services, insufficient translation of relevant services into actionable products, and the strong digital divide across and within countries were among those identified as main barriers to the effective and equitable uptake of climate services.

Table 1. Barriers and challenges that can potentially be addressed through the implementation of key components of the climate services framework for agriculture.

Barriers and challenges	Stages of the climate services in agriculture	Key components required to address
Insufficient weather and/or climate information, such as long-term, high-quality data, climate forecasts with reasonable credibility	Data collection and monitoring	Information products
Lack of quality agriculture data regularly collected from agricultural fields and capacity for database management	Data collection and monitoring	Information products; information delivery and use
Insufficient weather and agrometeorological stations essential for monitoring weather and agronomic variables, and weak financial support and technical capacities for their long-term maintenance	Data collection and monitoring	Information products; institutional and policy support
Inadequate investment in research and development, agro-innovation, and agricultural entrepreneurship, which are essential drivers for agricultural transformation through climate services	Data collection and monitoring	Information products; institutional and policy support
Weak technical capacity for data storage and analysis to translate the data collected from agriculture and meteorology sectors into climate services	Coproduction and codesign of tailored products	Knowledge and capacity building; information products
Lack of data sharing and standard operating procedures for the coordination and coproduction of climate services by multiple stakeholders	Coproduction and codesign of tailored products	Knowledge and capacity building; institutional and policy support
Insufficient resources and budget for the sustainable operation and upscaling of climate services	Coproduction and codesign of tailored products	Institutional and policy development
Weak coordination between the government agriculture and meteorology entities and stakeholders across scales	Coproduction and codesign of tailored products	Knowledge and capacity building; institutional and policy support
Lack of impact data of weather and/or climate risks on a cropping system or on various crops	Coproduction and codesign of tailored products	Knowledge and capacity building
Insufficient operational mechanisms (production and dissemination) for localized and last-mile climate services	Communication of services to the last mile	Knowledge and capacity building; information delivery and use
Insufficient tailoring of the climate services to the needs and preferences of farmers, resulting in reduced uptake and use	Climate-informed decisions	Knowledge and capacity building; information delivery and use
Poor digital literacy among information users, making it slow for farmers to understand the potential applications of advisory services in agriculture	Climate-informed decisions	Knowledge and capacity building; information delivery and use
Lack of effective two-way communication between producers and users of climate information	User feedback mechanisms to improve climate services	Information delivery and use; institutional and policy support
Unbalanced gender participation and knowledge gap with low finance to further engage farmers and improve the outreach of advisories	User feedback mechanisms to improve climate services	Information delivery and use; institutional and policy support

Experiences over the past decade developing and successfully using climate services in the agriculture sector have highlighted the need for four key components to overcome the identified barriers and challenges across the entire climate services value chain, from production to delivery of the services (Fig. 2, Table 1):

- Enhancing knowledge and capacity building
- Improving information products
- Creating effective and efficient information delivery and use
- Ensuring institutional and policy support

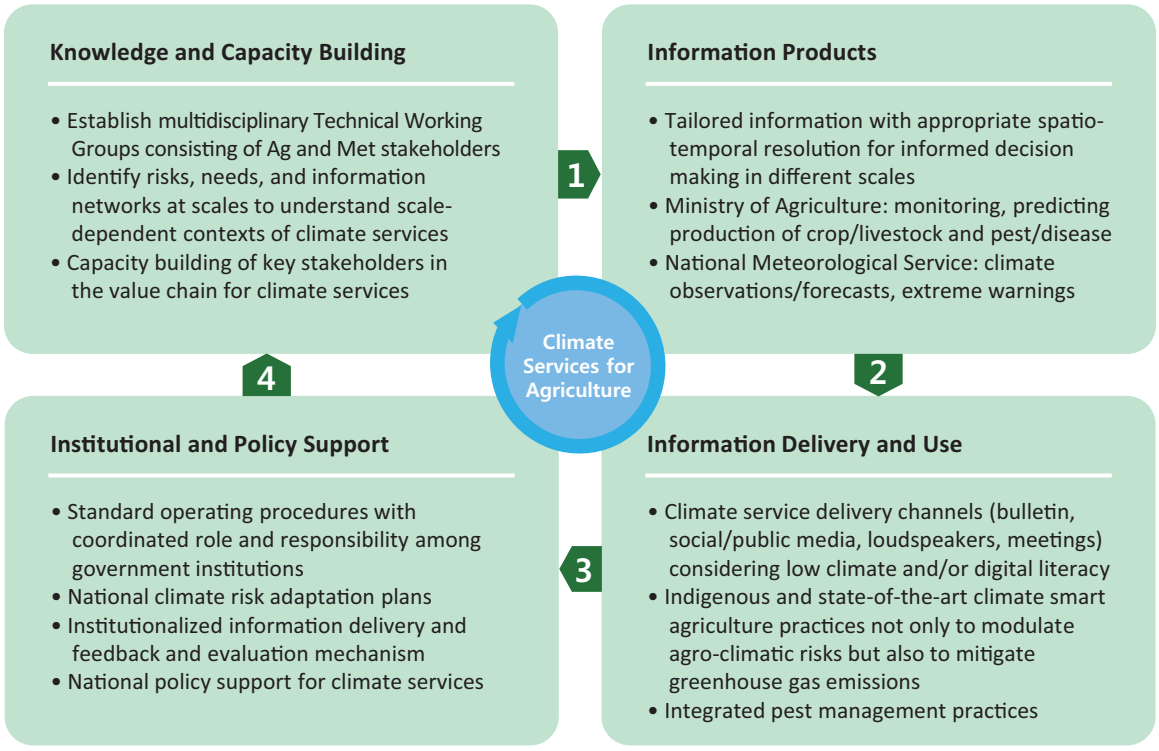

Fig. 2. Key components of climate services framework for agriculture.

To address the challenges and establish sustainable climate services, we propose that all climate services for the agriculture sector implement these four components, which, in principle, should run sequentially and iteratively engaging decision-makers at every stage. First, the baseline knowledge must be identified to understand the informational and institutional needs at the target scale (1 in Fig. 2). Tailored products can be provided to meet the requirements and user needs (2 in Fig. 2). These products can then be delivered and utilized alongside local agricultural technologies and practices (3 in Fig. 2). Further, institutional and policy support are required for effective and sustainable climate services (4 in Fig. 2). Learning gained during each stage, supported by monitoring and evaluation, provides further information to be incorporated as the loop is restarted and iterated through as necessary and when relevant. The learning may identify additional information products, improve the climate service delivery and use, and strengthen institutional and policy support. Such an approach will help address the identified challenges and barriers by strengthening each relevant component (Table 1). Similarly, climate services for improved adaptation outcomes can be represented by a simple value chain encompassing the production and delivery of climate services, stakeholder actions and outcomes, and routine evaluation of socioeconomic costs and benefits (WMO 2015).

Enhancing knowledge and capacity building

A multidisciplinary technical working group, representing the institutional coordination between the information provider, mediator, and decision-makers, needs to be established based on an initial scoping of knowledge and institutions. Coordination needs to be established among the information providers, such as the Ministry of Agriculture, National Meteorological Service, and other institutions. Baseline analyses, including local climate risks, service needs, information products, and institutional networks, should be conducted to identify climate services in the local context. Technical working groups should meet regularly and focus on building additional capacity to benefit all stakeholders.

Information products

Based on the findings from the technical working group, new or reworked tailored products can be identified, developed, and validated, requiring high-quality climate and agronomic data being available, accessible, and usable. Some climate services, such as those providing pest and disease and crop production forecasts, require a standardized framework for data collection and distribution to minimize errors and ensure readily available and timely warnings. Scientific research and development can then produce tailored products by adopting state-of-the-art tools, such as modeling and data analytics.

Information delivery and use

Agricultural practices and technologies, along with information products, provide realistic and actionable advisories to the decision-makers. Timely information delivery, through effective data collection and distribution, increases information uptake. Scientific evidence regarding the credibility and socioeconomic benefits of products, when combined with local agricultural practices and traditional knowledge, facilitates their practical utilization. Weather-informed agricultural advisories are communicated with the stakeholders through various delivery channels, such as bulletins, apps, and social and traditional media, with feedback mechanisms assessing how users are receiving and prefer to receive the service.

Institutional and policy support

The technical working group identifies the policy and institutional arrangements (such as collaborative agreements for data sharing and cocreation, standard operating procedures, and guidelines) to support the sustainable implementation of the information products, agricultural practices, and technologies, and to build the necessary capacity on how to use and interpret these technologies and advisories, respectively. A complete cycle of the key components of climate services identifies remaining barriers and challenges that are subjected to institutional and policy support. All stakeholders across the value chain should be involved in implementing the established policy and institutional arrangements.

The way forward

Shared insights, learned experiences, and recommendations from the Agriculture Climate Services Weeks and the intensive review on climate services literature have highlighted the following areas for improvement, especially in developing countries:

1) Sustainable operations and upscaling involve iterative loops along the key components, which, at the national level, use the lessons learned from previous iterations of the framework. Priorities should be identified through the following questions: Who produces, translates, communicates, and uses climate services? What are the users' information needs? What specific information should be integrated, and who can provide it? Which mechanisms and capacities should be developed or strengthened? How can these be implemented, from institutional and policy perspectives?
2) Regional collaborative efforts should be considered for sharing knowledge and increasing capacity through a peer-to-peer approach and/or establishing regional training centers that are linked with projects and programs in regional agricultural universities and research institutes. A strategic collaboration between United Nations specialized agencies, the World Meteorological Organization (WMO) and the Food and Agriculture Organization of the United Nations (FAO), would enable such regional learning initiatives and could develop a regional standardized framework to guide and document data collection, sharing, analysis, climate service creation, and last-mile communication.

3) A national road map to strengthen and operationalize climate services for the agriculture sector, which considers the four key components described above, could be incorporated into the operational budgets, resourcing, and standard operating procedures. Early buy-in from policy makers is important, through a proactive program to raise awareness during the developmental stages of the climate services.
4) To strengthen climate services at the local scale, local authorities should be recognized, establishing mandatory communication systems between national and subnational authorities prior to releasing climate services. Participatory approaches, such as the Farmer Field Schools, could facilitate information uptake and subsequent action by updating products with local technical resources (Waddington et al. 2014), which would help sustain climate services and crowdsource key data for improving advisories. As localized climate services require high-resolution climate and agriculture data, significant funding, either internal or external, should be invested in rehabilitating existing weather stations and improving the technical capacity of government organizations for data collection and management, forecasting and crop monitoring, including the use of remote sensing technologies. Ensure meaningful feedback mechanisms among actors and users to systematically integrate user needs and preferences along the climate services value chain.

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