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CIS impacts on farmer wellbeing in Senegal: evidence and opportunities

James Hansen | Anthony Whitbread

Climate information services (CIS) involve the "production, translation, transfer, and use of climate knowledge and information in climate-informed decision making and climate-smart policy and planning." When they are implemented well, CIS enable farmers and pastoralists to better understand, anticipate and manage climate risks.

At a national level, Senegal's foundation for CIS is among the strongest in West Africa, including a strong national meteorological service (ANACIM) with advanced online products, a National Framework for Climate Services (NFCS), a formal mechanism (*Groupes de Travail Pluridisciplinaire* (GTP)) to coordinate action among institutions, and expanding radio and digital delivery of information to farmers.

Key messages

- Use of weather and climate information increases farm productivity.
- Farmers' access to, use and benefit from CIS vary with location, wealth and gender.
- Local multidisciplinary working groups enhance CIS effectiveness, use and impact.
- Participatory communication processes build farmers' capacity to understand and act on probabilistic climate information.
- Economic and gender-based inequities, weak integration into agricultural advisories, and capacity gaps limit benefits.
- AICCRA works to enhance impact through improved information; integrating CIS, Ag Data Hub and decision support tools; and building capacity of extension providers.

Yet the potential contribution of CIS to the wellbeing of the country's farmers and agropastoralists remains underexploited and inequitably distributed. Impediments to realizing this full potential include economic and gender-based disparities, inadequate integration of climate information into agricultural advisories, weak capacity to communicate and interpret probabilistic information at a climate time scale, and lack of climate knowledge among agricultural professionals who support farmers and agropastoralists with information and advisories.

Building on an earlier summary, this brief summarizes available evidence of the use and impact of CIS for Senegal's farmers, and discusses what AICCRA is doing to alleviate impediments and enhance the benefits of CIS to Senegal's farming population.

Productivity and profitability impacts

Reviews of the expanding set of CIS outcome and impact evaluations reveal significant improvements in productivity, agricultural incomes, food security and subjective wellbeing associated with use of CIS, and that most farmers who access weather and climate information do use it (Vaughan et al., 2019; Hansen et al., 2021). In Senegal, three studies associated with the CCAFS program sought to quantify impacts of CIS use.

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An early preliminary study that employed farmer-managed field trials showed that agronomic management based on weather and seasonal climate forecasts increased millet yields 15% and groundnut yields 15% relative to control plots using farmers' traditional management strategy (Lo & Dieng 2015).

Diouf et al. (2020) assessed the impact of seasonal forecast use on crop (rice, maize, sorghum, millet and groundnut) yields and farm income, based on a survey of 1481 farmers (44% women) conducted in 2019 in five Departments (Kaolack, Kaffrine, Kolda, Sedhiou and Ziguinchor). Seasonal forecast use significantly increased farmers' income by US $41/ha, or 16%. The income gains from using seasonal forecasts were associated with increased millet (158 kg/ha), sorghum (878 kg/ha) and rice (140 kg/ha) yields; but decreased maize (-55 kg/ha) and groundnut (-37 kg/ha) yields.

Using a survey of 795 farmers in Kaffrine and Kaolack Districts, and difference-in-difference and instrumental variable methods to control for selection bias, Chiputwa et al. (2022) estimated that the use of seasonal and daily forecasts increased the value of crop income from groundnuts, maize and millet by between 10 and 25%, depending on the crop, estimation method, and presence of a local GTP.

Benefits are distributed unevenly

Quantitative studies in Senegal confirm evidence from elsewhere that gender, wealth and other farmer characteristics influence who uses and benefits from CIS.

In their study of the impact of seasonal forecast use on crop yields and income, Diouf et al. (2020) found that the income benefit was lower for women farmers (US $11) than for men (US $56). The productivity impact of the use of seasonal forecasts was greater for men than for women in the case of millet (203 kg/ha vs. 17 kg/ha) and rice (321 kg/ha vs. -25 kg/ha), but greater for women in the case of maize (210 kg/ha vs. -105 kg/ha).

A survey-based study of farmers in five of Senegal's 11 Regions found that age (favoring youth), education level, location, producer organization membership, and radio ownership significantly influence the likelihood that farmers act on weather and climate information (Ouedraogo et al., 2021). Despite the inequities, most (85%) farmers reported changing decisions based on weather or climate information.

GTP strengthens uptake and impact

The local GTPs aim to engage stakeholders with a diverse set of mandates, perspectives and expertise to co-produce climate-related information and advisories, and to bridge the communication gap between national information providers and local decision makers including farmers.

A two-part study, which employed rigorous econometric methods to compare farmers sampled in districts where a GTP was active (Kaffrine) and inactive (Kaolack) demonstrates their positive influence on CIS use and benefit at the

farm level. Improved climate services supported by local GTP were associated with increased adoption of improved seed (22% for seasonal forecasts, 23%, for seasonal plus weather forecasts), manure (11%, 16%) and chemical fertilizers (9%, 24%), in response to seasonal climate forecasts, or seasonal and weather forecasts respectively. The presence of local GTP increases farmer's awareness of WCIS by 18%, access by 12%, and uptake by 10% (Chiputwa et al., 2020). For farmers exposed to the GTP, the use of seasonal and daily forecasts significantly increased the value of crop income from groundnuts, maize and millet by between 10 and 25% compared to farmers with no access to the MWG, depending on the estimation method (Chiputwa et al., 2022).

Participatory communication empowers farmers

While broadcast media and mobile phone channels work well for daily weather forecasts and the routine agricultural decisions they inform, face-to-face participatory communication processes are more effective at building farmers' capacity to understand and use probabilistic information about climate variability (e.g., historical analyses, or forecast for the upcoming season) for strategic planning. Pilot experiences with the 2011 seasonal forecast training and planning workshop in Kaffrine that launched CCAFS work in Senegal, and with the Participatory Integrated Climate Services for Agriculture (PICSA) method in Kaffrine in 2016 (Dayamba et al., 2018) showed that such processes are effective and well received among Senegal's farmers, and that informal sharing among farmers multiplies their influence. A quantitative assessment (Ouedraogo et al., 2021) confirmed that participation in farmer training increased the likelihood of acting on climate services.

Key challenges limit benefits

Despite the strength of Senegal's climate service foundation at a national level, its potential contribution to the wellbeing of the country's farmers and agropastoralists remains underexploited and inequitably distributed. Challenges to achieving this potential include:

- inadequate integration of climate information into agricultural advisories;
- limited capacity to communicate and interpret probabilistic information at a climate time scale;
- economic and gender-based disparities; and
- limited climate knowledge of agricultural professionals who support farmers with information and advisories.

ANACIM provides advanced climate information products for the agriculture sector, but they are not routinely translated into actionable information about farm-level agricultural impacts or management options, or adequately integrated into agricultural extension advisories.

The distinction between *weather* and *climate* suggest has important implications for the communication strategies and support that agricultural decision makers need (Table 1). *Weather* refers to the state of the atmosphere at a particular time, and include daily observations, and forecasts up to about ten days into the future. *Climate* refers to statistical information about

Table 1. Differences between weather and climate information with implications for communication needs.

Characteristics	Weather Information	Climate Information
Examples	• Observations at daily and shorter intervals • Short- (≤ 3 days) and medium-range (≤ 10 days) forecasts • Extreme weather alerts	• Historical seasonality, variability, trends, risks • Probabilistic seasonal forecasts (≥3 months) • Probabilistic sub-seasonal forecasts (< 3 months)
Frequency	Used frequently for tactical decisions, needed quickly	Used infrequently for strategic decisions at particular strategic times
Complexity	Relatively simple	Complex due to probabilistic nature
Training needed	Users learn through repeated experience	Users need training and support
Suitable channels	Simple messages, frequency of information fit mobile phone, broadcast media channels	Timing, training and support needed fit group participatory processes

weather over longer time intervals, and include seasonal and sub-seasonal forecasts, and summaries of historical seasonal cycles, variability and trends. Because climate information is inherently probabilistic, and is more abstract and consulted less frequently than weather information, it is more challenging to interpret and use appropriately. Senegal's progress in digital agricultural service delivery via mobile phones is effective for short-term weather information and advisories, but currently leaves a gap in support for farmer decisions at a climate time scale (i.e., seasonal forecasts for strategic planning).

Intentional effort is required if CIS are to reduce rather than reinforce the economic and gender-based disparities that exist within Senegal's rural population. Rural women in Africa are often less likely than men to access and use weather and climate information via digital channels, and are less willing to pay for it. Challenges that rural women face – limited control over household financial resources, lower education and literacy rates, and gender norms that limit control over climate-sensitive decisions – are relevant in Senegal, and interact with other facets of identity such as age and ethnicity. While available willingness-to-pay studies show that many farmers

Table 2. Published studies of farmers willing to pay for weather and climate information in West Africa.

Study	Country	Product	Unwilling to pay (%)	Mean WTP*	Sample size
Amegnaglo et al., 2017	Benin	Seasonal forecasts	19	$23.42	354
Antwi-Agyei et al., 2021	Ghana	various	57	n/a	193
		Seasonal forecast	79		
		Daily forecast	76		
Donkoh, 2019	Ghana	Weather forecast	54	$28.37	n/a
Ouédraogo et al., 2018	Burkina Faso	Seasonal forecast	47	$7.51	169
		Daily forecast	47	$4.27	
		Agro-advisories	67	$3.50	
Zongo et al., 2015	Burkina Faso	Seasonal forecasts	36	$1.19	629

*Annual amount per farmer, averaged among entire sample, adjusted to 2022 USD.

in West Africa would be willing to pay for CIS, they also show that fee-based WCIS would exclude a large proportion of farmers (Table 2), who tend to be disproportionally subsistence-oriented farmers and women with limited control over household finances. On the other hand, evidence from Rwanda shows that participatory CIS communication and capacity development interventions can reduce or eliminate gender inequities in CIS access and use.

Gaps in climate knowledge among agricultural professionals, – particularly the amalgam of actors who comprise the country's pluralistic agricultural extension system – limit their capacity to integrate climate information into agricultural advisories, to build farmers' capacity to use probabilistic information at a climate time scale, and to ensure that the benefits of CIS are more widely and equitably distributed across Senegal's farming and agropastoralism population.

AICCRA works to address challenges and enhance impact

Building on a long history of collaboration, AICCRA is supporting ANACIM to strengthen its use of Next Generation seasonal and sub-seasonal forecasting tools; expand its high-resolution gridded climate (currently precipitation and temperature) data to include humidity, wind, solar radiation and potential evapotranspiration; and develop soil water balance tools for agricultural drought management and crop water demand applications.

ANACIM's advanced climate information and other sources of data are being integrated in a national agricultural data hub (AgDataHub). The AgDataHub enhances the accessibility of a range of existing data, and links these data to dashboards and decision support tools such as iSAT that support location- and crop-specific weather-based agro-advisories. AgDataHub will streamline the integration of information and advisories into dissemination channels such as radio, SMS and the FAO SAIDA app. Integrating the AgDataHub into the existing GTP portal hosted by ANACIM ensures buy-in across relevant institutions.

Finally, AICCRA is working with research, extension, meteorological, academic and private sector agritech organizations to co-developing competency-based curriculum to strengthen capacity of agricultural advisory providers to incorporate climate information into their support to farmers. Strengthening capacity of agricultural professionals to bring CIS into their ongoing support to farmers and agropastoralists is expected to overcome the main obstacles to building the resilience of Senegal's agriculture sector and rural population to a variable and changing climate.

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About the authors

James Hansen (jhansen@iri.columbia.edu) is a Senior Research Scientist at International Research Institute for Climate and Society (IRI). *Anthony Whitbread* (a.whitbread@cgiar.org) is Principal Scientist and AICCRA-Senegal Project Leader at International Livestock Research Institute (ILRI).

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