

A climate and pest smart advisory system for Africa

International Centre of Insect Physiology and Ecology (ICIPE)

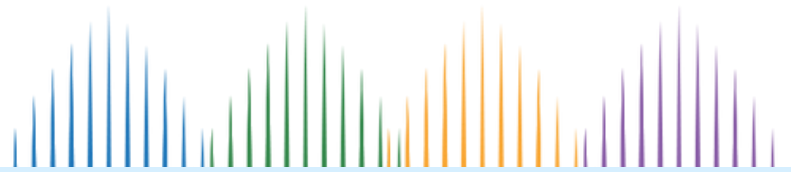


Rwanda
and
Ghana



Funded by
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ABSTRACT

Agricultural performance in Africa is hindered by factors like inaccessible inputs, limited credit, unfavorable weather, pests, diseases, and poor management. The International Centre of Insect Physiology and Ecology (icipe) implemented a project funded by CGIAR to develop digital advisories for Rwanda and Ghana. They created models to forecast fall armyworm invasions and Striga weed risk, which cause significant crop losses. These models, integrated with climate forecasts, run on a Python back-end and are accessible online.

The advisories, sent via SMS, help farmers take timely action. In Rwanda, over 90% of farmers in high-risk areas acted on these advisories. The project used a straightforward data integration matrix to derive various risk levels for each country and month. These risk levels were linked to concrete advisories for different administrative units and formulated with partners in each country.

The advisories were linked with Integrated Pest Management (IPM) practices, including cultural practices and land tillage advice. A bottom-up approach was taken, and the private sector was consulted to find the best subscription or commercialization model. In Rwanda, an ex-ante survey showed that most farmers implemented measures like early weeding or plucking of larvae within five days of receiving the advisory SMS.

TAPedia Tags

Integrated pest management, crop management, agricultural innovation, climate forecasts

Other keywords

Pest and drought predictions, remote sensing, big data, digital advisory systems, food security

Context

In the context of the CGIAR initiative, Transforming Agri-Food Systems in West and Central Africa (TAFS-WCA), a digital advisory tool was developed to inform farmer promoters and farmers in Rwanda and Ghana about Fall Armyworm (FAW) infestations, Striga weed risk, and drought using precipitation anomalies data. The advisory is based on model forecasting, predicting these stressors and their combinations one month ahead, allowing farmers and extension officers to react and safeguard their yields. The risk and forecasting models are produced within an online portal, and text messages are coordinated with stakeholder entities and sent out to farmers during important cropping stages. The warning messages are tailored to the infestation levels and stakeholder needs, considering their technology adaptation potential. The online portal backend uses state-of-the-art ontologies and processing pipelines, continuously updated with remote sensing data such as Land Surface Temperature (LST) from the ESA Sentinel-3 sensor and cropland data from the new ESA World Cereal coverage. These data sets enhance model stability and accuracy, improving advisory outputs. To effectively implement digital data portals in both countries, a bottom-up approach is essential, addressing localized conditions and stakeholders' needs from the start. Agricultural extension services linked to ministries and NGOs were key to the implementation process.

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In Rwanda, the service was co-developed with the One Acre Fund in partnership with the Rwanda Agriculture and Animal Resources Board (RAB). In Ghana, the platform was piloted and co-developed in cooperation with Esoko (NGO), the CSIR, and the Ministry of Food and Agriculture (MoFA). Key stakeholder assessments were performed during the pilot development in

Rwanda in 2022 and in Ghana in early 2023. The initiative considered access to digital tools such as smartphones to maximize adoption potential and addressed language barriers and political advisory reporting frameworks. The digital portal developed is a big data application, showcasing the power of intelligently processing and integrating various big data sets to produce relevant products for enhancing the livelihood situation of thousands of farmers in the two countries. The online portal ingests more than eight data variables to operationally produce FAW, Striga, and climate forecasts, which are then integrated. From the integrated information, the team produced tangible short text messages sent to farmers. In Rwanda, an ex-ante survey assessed the impact of the advisory in terms of early action taken by the farmers, showing that over 90% of farmers in high-risk areas implemented measures like early weeding or plucking of larvae within five days of receiving the advisory SMS.



FAW infestation on maize in Rwanda

Challenges addressed

- *Inclusion of the most vulnerable*
- *Transboundary and emerging agrifood system threats*

Key Problems

Agricultural challenges in Africa, including pests and extreme weather events, significantly impact food security and economic growth. These issues also affect livelihoods, trade, and the broader ecosystem. Small-scale farmers often lack access to credit and knowledge on proper soil and crop management, and many countries have reduced their agricultural extension services. This lack of information and access to adaptive solutions exacerbates the problem.

To address these issues, the International Centre of Insect Physiology and Ecology (icipe) developed a digital advisory tool for Rwanda and Ghana, piloted in 2022 and 2023. This tool uses short message services (SMS) to inform farmers and promoters about risks such as Fall Armyworm infestations, Striga weed, and drought. The advisories are based on model forecasting, predicting these stressors one month ahead, allowing farmers to take proactive measures to protect their crops.

The digital advisory tool integrates various data sources and provides timely information to farmers, helping them adopt integrated pest management practices and other adaptive measures. By linking these advisories to incentives like seeds and fertilizers, the service benefits small-scale farmers and can be commercialized. The proactive dissemination of information through SMS helps mitigate crop losses and improve food security in the region.

INNOVATIVE SOLUTIONS



Advisory committee to review advisory in Rwanda

The overarching aim was to leverage innovative technologies to promote informed decision-making and the implementation of timely interventions. Utilizing state-of-the-art methods in big data analysis and machine learning at fine spatial and temporal resolutions, their project team possessed extensive knowledge in exploring new computational techniques and innovative mathematical, physical, and statistical methods. This expertise was particularly applied for decision support within agricultural systems and in addressing the impacts of climate change and variability, as exemplified by their contributions to platforms like the International Centre of Insect Physiology and Ecology on GitHub.

A key aspect of the project was providing timely information and early warnings through a bottom-up approach, engaging partners and stakeholders from both countries from the start. Farmers received advisories and eco-friendly solutions to address issues like pests, drought stress, and weed infestations, avoiding harmful pesticides and herbicides.

An additional significant innovation was the integration of both abiotic stressors (such as precipitation anomalies or drought) and biotic stressors (including Fall Armyworm forecastings and striga weed risks). This was achieved through an innovative and holistic method, employing a straightforward numerical matrix with unique codes/numbers assigned to each stressor. The codes/numbers were then aggregated to generate a distinct combined code representing one or more of these stressors, effectively identifying risk codes based on single or multi-stressors. The integration of both abiotic and biotic factors is a rarity in early warning digital advisories for small-scale farmers in Africa, as highlighted by Jarvis et al. in 2016

Furthermore, their intervention successfully addressed the challenge of the geographic dispersion of extension agents and services, as well as limited resources for advisories over larger distances. The digital services developed demonstrated the ability to provide seamless and effective advice, attributed to its intelligent design using a bottom-up approach.

KEY OUTCOMES AND MEASURABLE IMPACTS



The project, in spite of it being a small grant and operational for only 17 months, has sent out SMS a-based advisories to 4,662 farmer promoters for May 2023 (Rwanda) and >1,200 SMS advisory messages to farmers in Ghana through the ESOKO network for October 2023. For 2022, the advisories were only sent for Rwanda; for both cropping seasons > 1,300 SMS were sent to farmers during 2022 with advisory texts in the local language. These outputs were verifiable by the SMS dispatch reports received from the service providers.

To assess the impact of the advisories and ascertain and measure the impact, they interviewed 1,004 farmers and farmer promoters in Rwanda in May 2023. About one third of the interviewed farmers/farmer promoters were found to be female. The survey showed that most advisories were taken up within 5-14 days (56% of the interviewed farmers) after the message was received. 43% of all recipients acted right away, within 3-5 days.

90% of all farmers who received the advisory had taken up the recommended measures (acted upon receiving the message).

In most cases (>71%), a combination of two sets of advises for FAW and striga weed (climate stress was nonexistent in 2023) were taken up by farmers, this in alignment with the predicted risk levels, i.e., risk combination from the integrative model. The most common advice followed in Rwanda (for May 2023) was “manual plucking of larvae/early weeding of Striga” in combination with “seek further advice from field station” or “buy pesticides/implement IPM”.

The overall outcome was that yields were safeguarded, and food security was enhanced, laterally the advisory led to better planning regarding pesticide and farm management needs, including planting alternative crops.

Factors for Success



The icipe team in Rwanda interviewing farmers

Factors for success were the involvement of political entities and consideration of institutional frameworks in each country. In Rwanda, it was critical to involve RAB (for accreditation) and One Acre Fund and use their existing SMS services infrastructure, while in Ghana the involvement of CSIR in formulating the advisory text and ESOKO and using their dissemination platform proved to be critical. In Ghana, also, the Agricultural industry (MoFA) was involved and consulted in the beginning of the project, while in both countries the team reached out to the Meteorological Agencies for data sharing and to improve their services portfolio (that will include pests and diseases forecasting in due time). For sustainability it was critical to implement an advisory committee for Rwanda that oversees the results and advisories sent. For both countries, a business plan was devised that uses an optimal subscription model for entities such as African Foods in Rwanda and development partners (such as GIZ). The feedback from the private sector and development partners helped to redefine the business model and its viability.

CRITICAL CAPACITIES

This work is part of the CGIAR Research Initiative on Transforming Agri-Food Systems in West and Central Africa (TAFS-WCA), through its Work Package 2 (Informed Digital Agriculture for Climate Resilience - Managing Climate Risks and Accessing Services) led by the Alliance Bioversity International and CIAT. This network enabled the effective selection of partners in the digital advisory sphere in both countries.

It was, furthermore, decided to work in Rwanda and Ghana since these two countries had better and more mature digital infrastructures over other countries in Africa, leading to better and more effective uptake of results and implementation. Furthermore, as stated, it helped the contractor to consider institutional and political frameworks from the beginning of the project and hold meetings with private sector entities to establish a business plan.

Moreover, the existing SMS infrastructure provided by One Acre Fund in Rwanda and ESOKO and Minari in Ghana helped to fast track the digital dissemination of the advisory. Capacity in self-generation of the FAW and Striga weed infestation risk and forecasting models still must be created in both countries by training through ICipe, the project contractor.



The project team meeting with farmers

The main lesson learnt was that availability of FAW density data from traps and striga weeds data must be firstly probed before scaling this tool and advisory to other countries in Africa. Moreover, the consideration of institutional and political frameworks was vital for project success and sustainability (including uptake). The issues of adoption in rural settings must be individually determined, e.g., for a country like Ghana, various language and data accessibility options would have to be developed. Generally, the advisory uptake was better than anticipated (a positive aspect), based on the Rwandan survey.

Challenges encountered/Efficiencies gained

In this project the main challenge has been access to quality data. The scarcity of data, especially FAW data, host plants (maize and sorghum) coverage data had been a challenge. To overcome this, they used already available data for all Africa, trained models using this data, and validated the results with an independent subset of the Africa-wide data. The models were then applied to other regions where data was a problem (i.e., Ghana).

Their model produced relatively high accuracies that have been validated by stakeholders on the ground, using stakeholder and advisory committee workshops.

Another trade off was the various languages spoken in Ghana and literacy rates, and access to smartphones in those countries. To manage this, the partner in Ghana (ESOKO) also used phone-based voice messaging and a variety of language widely spoken in each province.

However, the downfall is that if voice messaging is used, it does not allow for feedback.



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Links to additional materials

[icipe](#)

[WORLDAGROFORESTRY](#)

[IGARSS](#)

[DIGITELLINC](#)

Acknowledgements

In Rwanda, the following stakeholders were involved in a consultation workshop and an advisory committee that was set up to review and accredit the advisory outputs;

- Rwanda Agriculture and Animal Resources Development
- Twigire Muhinzi Extension program
- ABC CIAT (donor) and the One CG initiative
- One Acre Fund
- Rwanda Meteorological Agency

In Ghana, where the pilot project started in 2023, the following actors and stakeholders were/are involved;

- CSIR INSTI - The Institute for Scientific and Technological Information (INSTI) of the Council for Scientific and Industrial Research (CSIR)
- ESOKO
- Alliance Bioersivity international BC and CIAT (donor and technical partner) and the One CG initiative
- KNUST – Knust University of Science and Technology

In both countries an extensive multi-stakeholder and participatory approach was taken by jointly identifying needs and gaps for such a digital advisory through a workshop that facilitated match making between what can be offered and what the end users demands are. Both users demand workshops were facilitated at the early stages of each project and in each country, respectively.

In Rwanda, as stated, an advisory committee was established by the contractor that met twice in 2023 to discuss the advisory content, validate the icipe models and assess the needs going forward. Moreover, in Rwanda, a survey was conducted with farmer promoters and farmers to gain insights into the adoption potential and impact of the advisory. This involvement of end users led to the further visibility and participation of end users in the improvement of the advisory. Within the SMS service, an end users feedback possibility was created, meaning farmers can ask for call backs to get further advice on how to apply IPM and implement other measures.

THE TROPICAL AGRICULTURE PLATFORM

The Tropical Agriculture Platform (TAP) is a G-20 initiative launched in 2012 to promote agricultural innovation in the tropics. TAP has formed a coalition of more than 50 partners, led by the Food and Agriculture Organization of the United Nations (FAO) and generously supported by the European Union (EU). The main goal of TAP is to strengthen agricultural innovation systems (AIS) in developing countries through coordinated multi-stakeholder interventions.



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MORE INFORMATION

- www.fao.org/in-action/tropical-agriculture-platform
- www.fao.org/in-action/tap-ais
- [TropicalAgriculturePlatform](https://www.youtube.com/TropicalAgriculturePlatform)
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Global Call for Agrifood System Innovations and Stories of Capacity Development for Innovation

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