Info Note

Launch of the Ethiopian Digital AgroClimate Advisory Platform (EDACaP)

Progress Report on EDACaP Development and Hosting

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Key messages

- EDACaP aims to build farmers resilience through digital agro-climate advisories
- EDACaP combines advanced seasonal climate forecasting, crop modeling and digital dissemination platforms
- Scaling is underway to reach 10 million smallholders in the coming years.

This brief outlines progress achieved with the establishment of the Ethiopian Digital AgroClimate Advisory Platform (EDACaP) under the CCAFS project # P263 (Regional and national engagement, synthesis and strategic research) with support from P1605 (Capacitating African Stakeholders with Climate Advisories and Insurance Development). EDACaP aims to build farmers resilience through agro-climate advisories that digitally integrate climate, soil, crop and agronomic data and are delivered through SMS, IVRS and radio to development agents and farmers in local languages. It builds on a partnership between the Ethiopian Institute of Agricultural Research (EIAR), the Ministry of Agriculture (MoA), the National Meteorological Agency, CIAT, ILRI, CIMMYT with additional support from ICRISAT, IRI and University of Florida.

Introduction

Ethiopia is heavily dependent on rain-fed agriculture coupled with low adaptive capacity, and thus high vulnerability to climate change. Agriculture contributes about 47% of the country's Gross Domestic Product (GDP). About 85% of the population in Ethiopia (more than 70 million people) depend on agriculture directly or indirectly for their livelihoods. Therefore, climate variability and change effects on agriculture will significantly affect the Ethiopian economy. The International Maize and Wheat Improvement Center (CIMMYT) and Ethiopian Institution of Agricultural Research (EIAR) have been working for the past ten years with the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) and the International Center for Tropical Agriculture (CIAT) to strengthen agro-meteorological services in Ethiopia. These collaborative efforts believe in demand-driven approaches for a climate service to be successful. The developed system, named "Ethiopian Digital AgroClimate Advisory Platform (EDACaP)," formalizes the understanding of demand, then builds information chains and corresponding systems for processing of climate and crop information that include modules for quality control, forecasting, and tailoring to crop-specific decision-making processes. The platform aims to improve seasonal climate prediction and advisory by integrating crop-climate modeling with the national AgData infrastructure to deliver agro-advisories to individual farmers, extension officers, researchers, and policymakers through mobile phones and a web platform (*Figure 1*):

- EDACaP is expected to reach 86 targeted woredas under the Agricultural Growth Program (AGP), covering 8 regional states, and 25 agricultural research centers (17 federal and 8 regional);
- EDACaP has the potential to reach the entire MoA extension service, with about 60,000 agricultural agents serving almost 16 million farmers;
- Direct dissemination will be done by SMS, IVRS and will support extension agents' direct interactions with farmers assisting with up-to-date information for enhanced decision making.

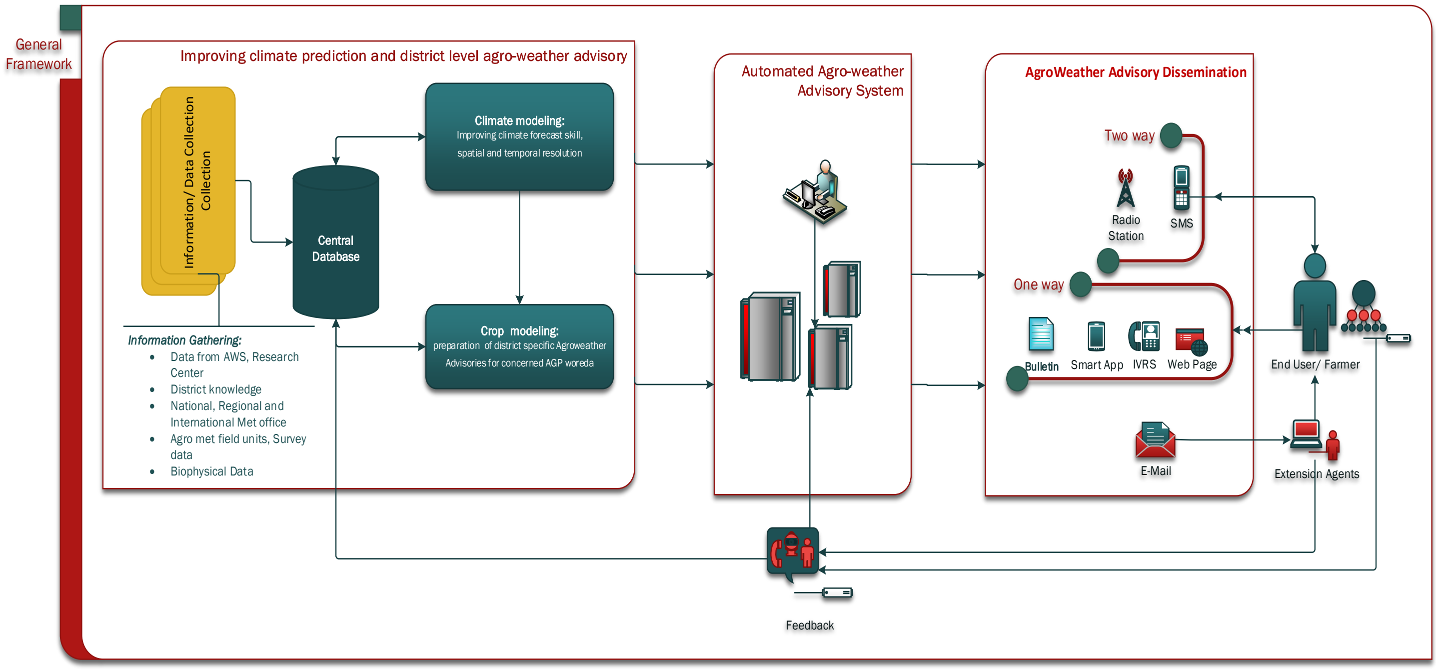


Figure 1. Operational Framework of EDACaP

Geographical scope

Emphasizing the demand perspective necessitated that the development of the EDACaP system was developed in constant consultation and collaboration with various next-users (farmers, extension agents, farmer organizations) and information producers (e.g., NMA, EIAR, CGIAR centers). The system was initially developed and implemented for four regions of Ethiopia where maize, wheat, and sorghum are crops of primary importance. The system initially developed for three district/kebeles (Ada'a, Assela and Kobo) across the two regions and then scaled out to cover 14 kebeles/ localities across four regions (*Figure 2*).

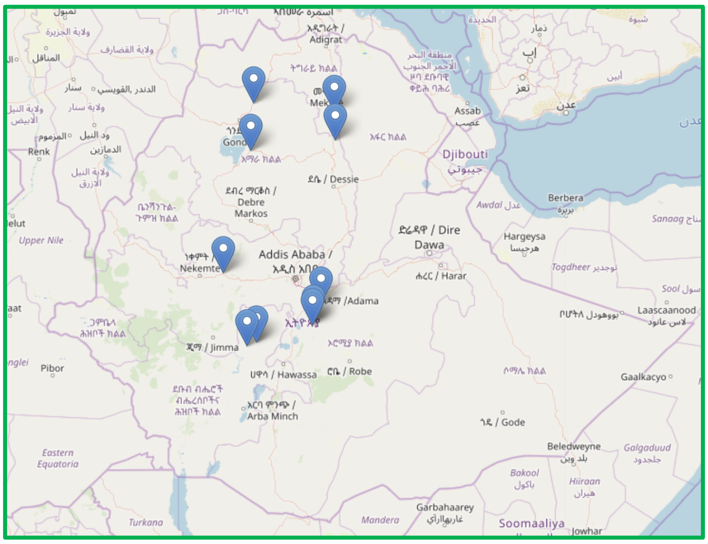


Figure 2. EDACaP Pilot Sites

Meteorological and crop model data

EDACaP connects historical meteorological data, seasonal climate forecasts, and crop model simulations with a co-designed user interface. Meteorological data comes from 304 NMA ground stations in the Amhara, Oromia, Tigray, and SNNP regions (Fig. 2). Quality control for the observed meteorological data was done following Esquivel et al. (2018) using the RClimTool (Llanos-Herrera, 2014). The procedure involved three filters aimed at flagging and removing wrongly reported values based on a range check, outlier detection, and constant values. Data gap filling (Esquivel et al., 2018) was performed using linear regression and a quintile mapping model that combines the Climate Hazards Infrared Precipitation with Stations (CHIRPS) (Funk et al., 2015) with the observed weather data from NMA.

Crop modeling is an essential tool in the translation of a seasonal forecast to a producer-relevant seasonal agro-climatic forecast. Crop model data included experimental data for crop model calibration and evaluation, as well as crop management data and soil profile information for seasonal crop forecasting for the study sites. The crop model input data was collected from EIAR, CIMMYT (Tesfaye et al., 2015) and CIAT for a representative set of cultivars grown in Ethiopia. Data recorded included daily meteorological data (maximum and minimum temperatures, precipitation and solar radiation), chemical and physical soil data (texture, hydrological parameters, organic matter), and periodic crop growth and development (total and organ biomass, yield, leaf area index and phenology). Agronomic management, including sowing dates, planting density, irrigation, fertilization, and crop protection, followed optimal site-specific recommendations to reduce biotic and abiotic stress.

Seasonal climate predictions

The seasonal climate forecasts produced within the EDACaP forecast system generated through Canonical Correlation Analysis (CCA) (Glahn, 1968; Goddard et al., 179 2001; Hotelling, 1936), implemented via the Climate Predictability Tool (CPT) software package (Mason and Tippett, 2017). The CCA relates Surface Sea Temperatures (SSTs) with local climate patterns to develop probabilistic forecasts, expressed in three categories (terciles): below-normal, normal and above-normal. All climate predictions performed using the IRI NexGEN of an ensemble of the Multi-Model Ensemble (MME) SST and precipitation forecast (Saha et al., 2014) as the predictor variable, and seasonal precipitation as the predictand. Conventionally, CCA-based forecast models in CPT require the definition of a rectangular domain for the predictor (in this case, the SST). However, the canonical patterns obtained by the CCA generally do not exhibit an explicit rectangular behavior. For this reason, in our implementation of CCA models, we optimize the initial predictor domain by selecting the areas (i.e., pixels) of the ocean within a prescribed domain that maximizes both physical plausibility and forecast skill.

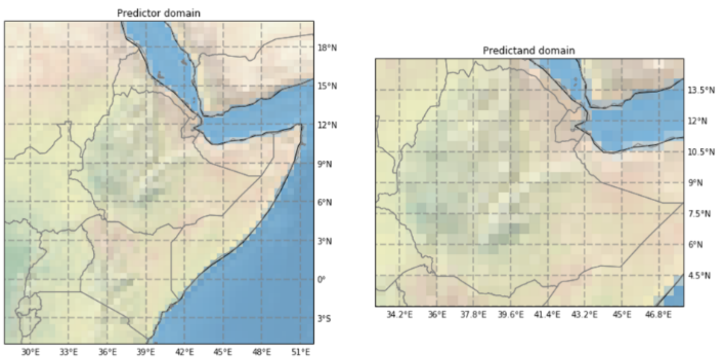
EDACaP incorporates crop simulation models, which require daily meteorological data as inputs. Hence, in order to connect the CCA-based probabilistic seasonal climate forecast with the crop models, we developed a forecast probability re-sampler (Capa-Morocho et al., 2016). We obtain daily weather data for all variables (i.e., precipitation, maximum and minimum temperatures, and solar radiation) by resampling the observed record for the season of interest (e.g., June-July-August) with replacement following the probabilities specified by the precipitation forecast for each tercile category.

To ensure having sufficient weather data for the crop model simulations, we concatenate the immediately following season (e.g., September-October-November, if the forecast is for June-July-August). The resampling repeated 100 times so as to capture uncertainty in the resampling process explicitly. As a result of the resampling process, a total of 99 weather realizations with 180 days (i.e., for the next six months) produced for use in the crop models.

Crop modeling

Crop models are useful tools to evaluate possible scenarios, including expected climate conditions and associated tactical agronomic management in response to seasonal forecasts (Hammer et al., 1996; Soler et al., 2007). In the EDACaP, we implemented ORAYZA & DSSAT crop simulation models for rice and cereal crops to translate seasonal climate forecasts into actionable information in support of two agronomic decisions, namely, the choice of planting dates and cultivars for each site of interest for any given seasonal forecast.

As stated above, the calibrated and evaluated crop models were used in the system to perform crop simulations. Toward this aim, within the EDACaP forecast system, for each weather realization of a given seasonal prediction, the crop models are run for 45 planting dates starting on the first day of the forecasted season for all calibrated cultivars and using standard management for each site (Table 2). Outputs of the simulations then used to provide information to aid decisions on optimal planting dates and cultivars for each site and forecast situation, thus translating the seasonal climate information into the base of a context-specific agro-climatic service.

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CMC2-CanCM4
GFDL-CM2p5-FLOR-A06
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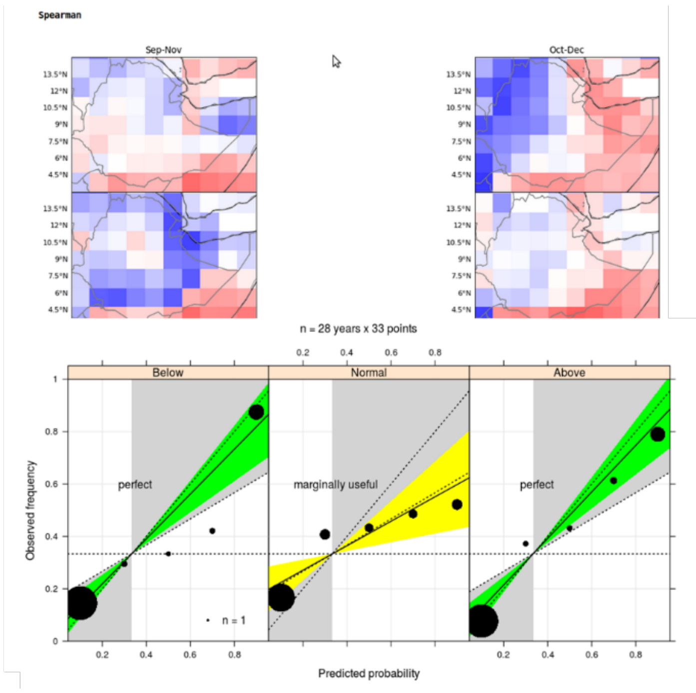
Figure 3. Seasonal Climate prediction sample using NexGEN approach



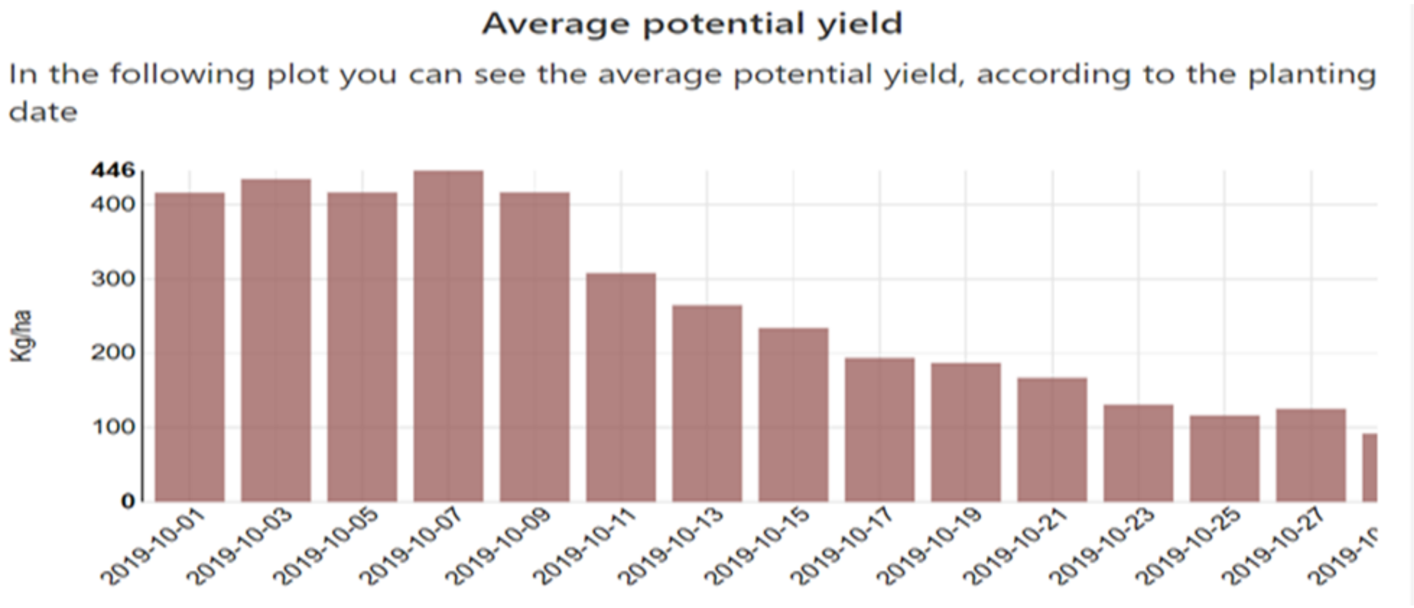


Figure 4. EDACaP sample for average potential yield prediction at different planting dates

EDACaP components

***Database*:** This is the foundation of the system, which was built using the Mongo database engine. This database, built using NoSQL technology, stores the parameters to execute the seasonal agro-climatic forecasts as well as the results that will be provided to users. This layer includes functions and queries to retrieve data. Both layers compose the data management system

Forecast App: This is a console application, allows data to be exported from and imported to the database and serves as the interface between the database and the forecast generation process (‘Forecast Generator’).

Website layer: it offers information to these users for visualization and reading.

Forecast Generator: Forecast generation is orchestrated by the ‘Forecast Generator,’ managing the crop-climate models described in the previous sections. It takes the raw data and parameters (crops and weather) from the database and makes them available to the rest of the forecast process. This includes the generation of probabilistic forecasts and daily weather scenarios that will be used by either the ORYZAv3 or DSSAT layers.

WebAdmin layer allows expert-level users managing forecast parameters (locations, crops, cultivars, and soils).

Web API layer: to shares historical and forecast data through a REST (Representational State Transfer) web service for end-users who wish to use the data for analysis. Other apps can be connected to access historical and forecast data using the API layer

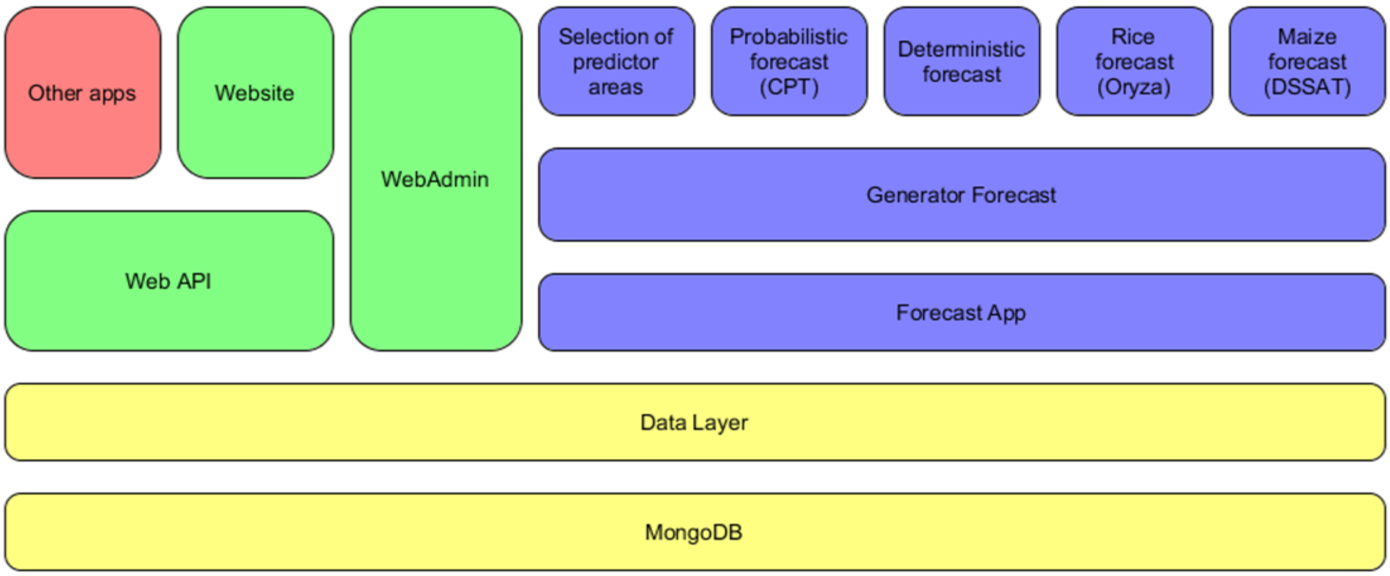


Figure 5. EDACaP system architecture

Hosting and operations

The EDACaP system is currently operational and hosted by EIAR and MoA at https://ethioagroclimate.org or https://ethioagroclimate.net. In collaboration with CIAT, CIMMYT, and CCAFS.

The technical components of the system were designed with scaling in mind and will accommodate themselves to other crops and the inclusion of additional data sources. The system architecture was designed in such a way that each component is a block, and the joined blocks create the system (with clear interfacing points). For example, the use of the NoSQL database system allows storing large amounts of daily weather data from both historical information as well as system-generated forecasts. This structure readily enables the addition of more localities or more weather data sources. Similarly, other crop models can be added to generate new agro-climatic forecasts.

National launch

A team effort led by the Ethiopian Institute of Agricultural Research (EIAR) in partnership with the Ministry of Agriculture (MoA) and the National Meteorological Agency (NMA), alongside numerous research centers and programs: the International Center for Tropical Agriculture (CIAT), the International Maize and Wheat Improvement Center (CIMMYT), the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) and the International Research Institute for Climate and Society (IRI), with support from the Agricultural Growth Program (AGP), the EDACaP had officially launched on 11th November 2019 at EIAR Head Office, Addis Ababa, Ethiopia

Figure 6. EDACaP Launching workshop participants

During the launching workshop, the government higher officials, researchers, extension officers, and media outlets participated. During his opening speech, HE Dr. Eyasu Abreha, Advisor to the Minister of Agriculture, said, “From paper, we have gone digital,” by emphasizing the road map of a national digital agricultural extension strategy. He also mentions the importance of translations of complex science to smallholder farmers to improve decision making on diverse elements, including the selection of crop fields and varieties, timing for planting and harvesting, ideal irrigation approaches, as well as measures to prevent pests and diseases through the digital agriculture

Dr. Kindie Tesfaye, Senior Scientist at CIMMYT also gives a detail presentation of how the multi-source data are translated into yield forecasts, agro-climate advisories and climate scenarios that are targeted to specific geographies and agricultural value chains, and disseminated to farmers through extension training, mobile technologies, early warning systems and multimedia. He also mentions the role of smallholder farmers, “*The farmer is the biggest decision-maker*.” As a country whose agricultural systems are highly dependent on rainfall, these digital interventions will serve as crucial decision support tools to manage climate risk and bolster the adaptive capacity of Ethiopia’s smallholder farmers. “Our effort must be in creating resilient agricultural systems that are not shocked by climate risks,” said Dr. Diriba Geleti, Deputy Director-General for Research at EIAR.

Finally, to making the workshop participants identify such a transformation possible following six key elements: boosting digital connectivity, sustaining tailored data services to smallholder farmers, making a strong business case, building enabling environments, scaling digital models, and finally evaluating progress in an ongoing manner.

Further reading

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