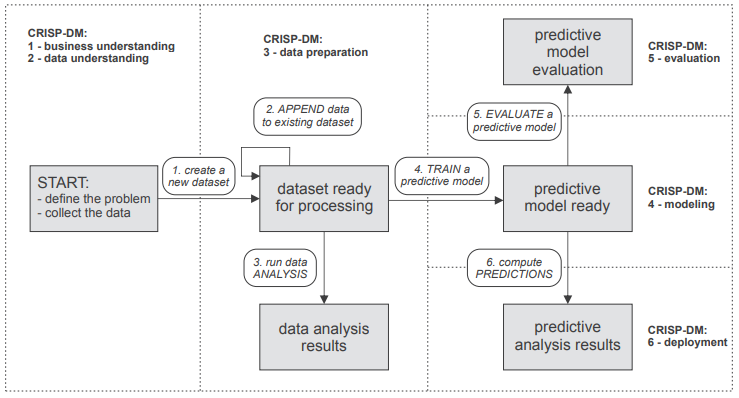
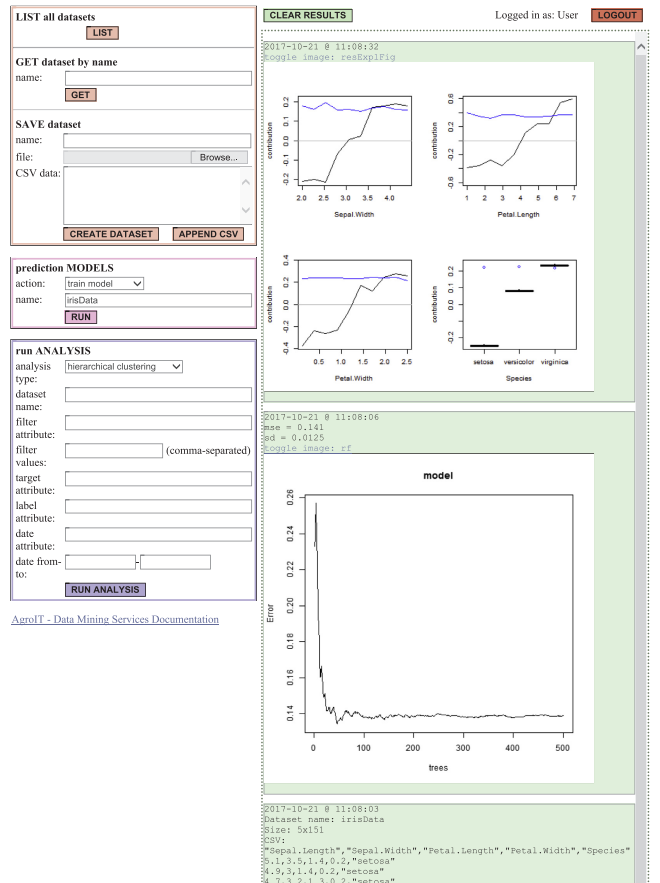
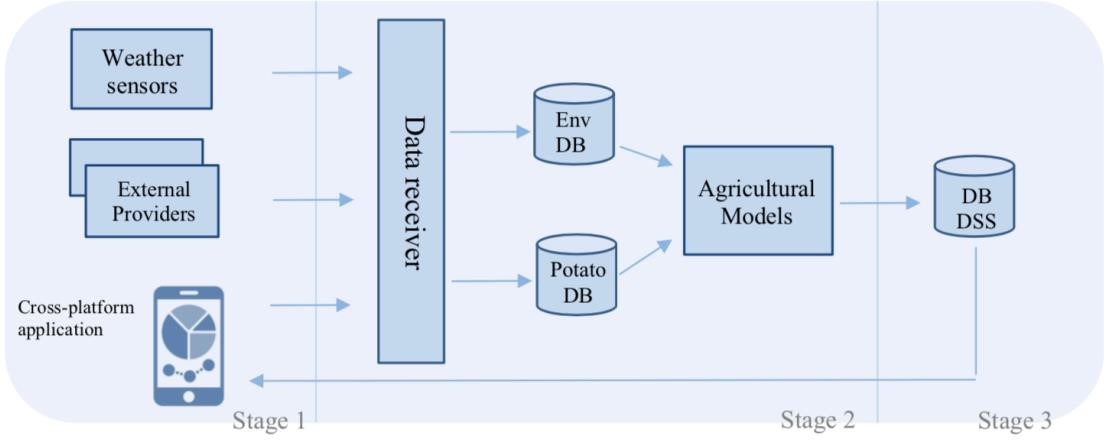
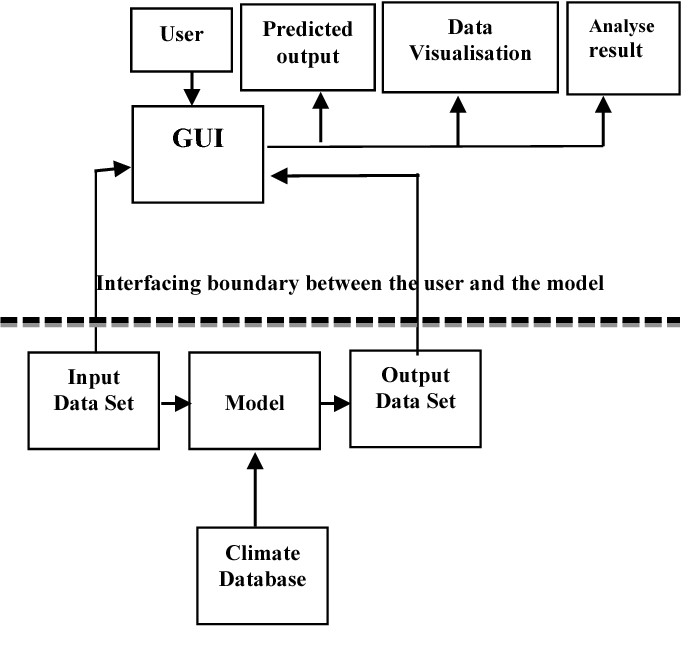
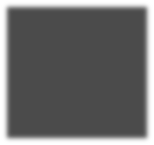
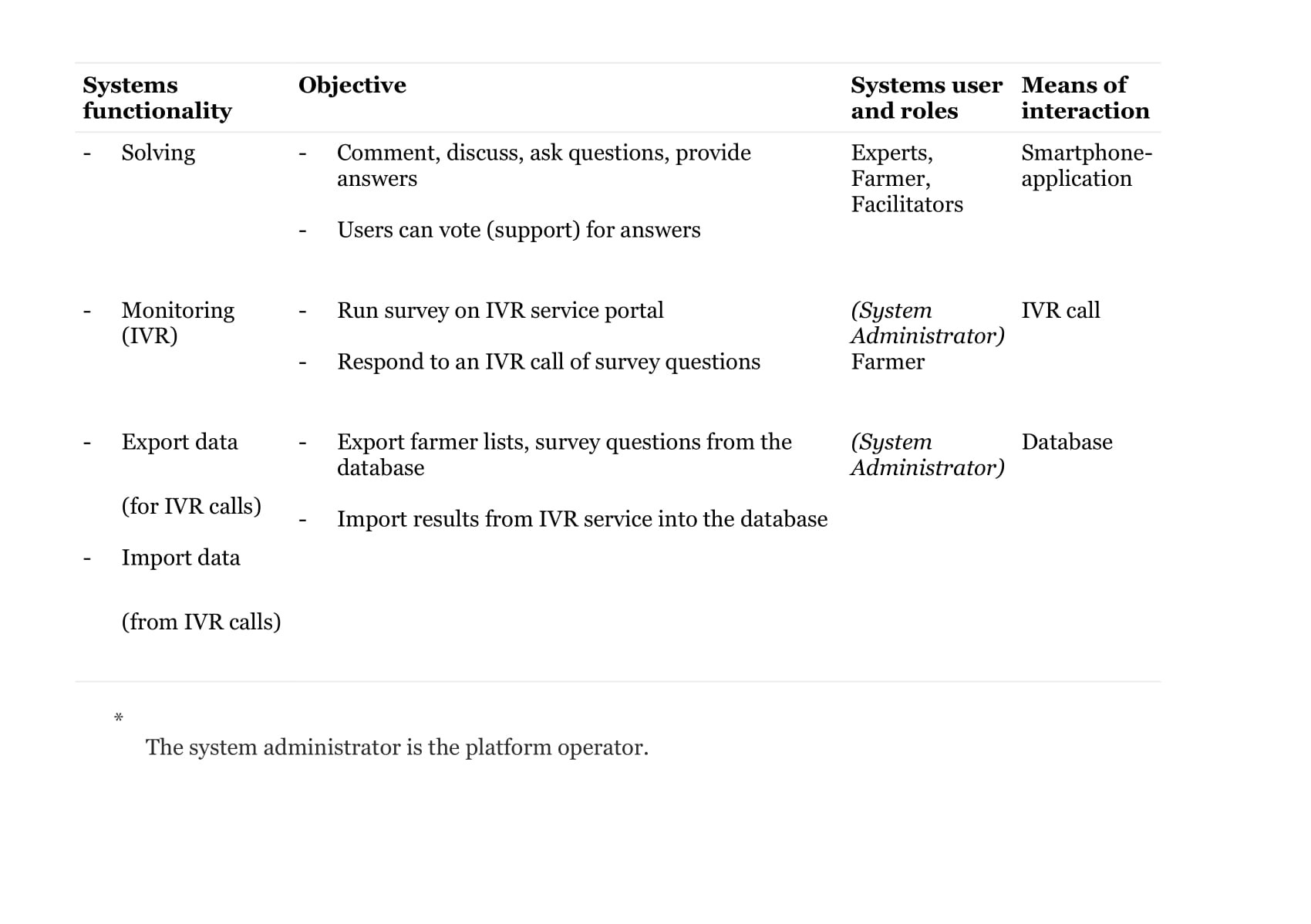
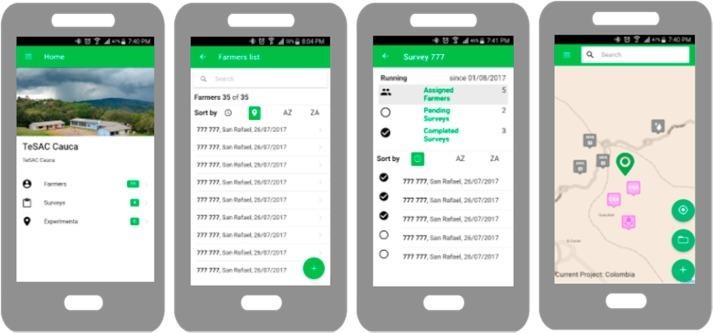
**Related Studies**

1. **Crop Models: Important Tools in Decision Support System to Manage Wheat Production under Vulnerable Environments**
   1. **Abstract:** Decision support systems are key for yield improvement in modern agriculture. Crop models are decision support tools for crop management to increase crop yield and reduce production risks. Decision Support System for Agrotechnology Transfer (DSSAT) and an Agricultural System simulator (APSIM), intercomparisons were done to evaluate their performance for wheat simulation. Two-year field experimental data were used for model parameterization. The first year was used for calibration and the second-year data were used for model evaluation and intercomparison. Calibrated models were then evaluated with 155 farmers’ fields surveyed for data in rice-wheat cropping systems. Both models simulated crop phenology, leaf area index (LAI), total dry matter and yield with high goodness of fit to the measured data during both years of evaluation. DSSAT better predicted yield compared to APSIM with a goodness of fit (R2) of 64% and 37% during evaluation of 155 farmers’ data. Comparison of individual farmer’s yields showed that the model simulated wheat yield with percent differences (PDs) of −25% to 17% and −26% to 40%, Root Mean Square Errors (RMSEs) of 436 and 592 kg ha−1 with reasonable d-statistics of 0.87 and 0.72 for DSSAT and APSIM, respectively. Both models were used successfully as decision support system tools for crop improvement under vulnerable environments.
   2. **Discussion:** Comparison of crop simulation models can be used for assessing their ability to predict crop phenology, growth, development and yield. A single model can give promising results in a certain region and specific agro-ecological environments, but a multi-model comparison approach could be reliable for yield estimation and uncertainty analysis among models. DSSAT-CERES and APSIM-wheat differ to some degree regarding their equation structure. CERES-wheat is complex for some processes while APSIM-wheat also shows the complexity by interacting various inputs, including phosphorous, soil residues, soil-water dynamics interactions.
   3. **Reference:** Wajid, A., Hussain, K., Ilyas, A., Habib-ur-Rahman, M., Shakil, Q., & Hoogenboom, G. (2021). Crop models: Important tools in decision support system to manage wheat production under Vulnerable Environments. *Agriculture*, *11*(11), 1166. https://doi.org/10.3390/agriculture11111166
2. **AgroDSS: A decision support system for agriculture and farming**
   1. **Abstract:** Decision support systems, data analysis and data mining have become significant tools for improving business in professional world. The emerging technologies are making the precision agriculture omnipresent and allow potential for enriching it with computer-assisted decision support systems for farm management. In this paper we describe a novel system AgroDSS that bridges the gap between agricultural systems and state-of-the-art decision support methodology. The described system is intended for integration into the existing farm management information systems and provides a cloud-based decision support toolbox, allowing farmers to upload their own data, utilize several data analysis methods and retrieve their outputs. The implemented tools include predictive modeling with explanation, accuracy evaluation, time series clustering and decomposition, and structural change detection. They can help users make predictions for simulated scenarios and better understand the dependencies (interactions) within their domain. We apply the AgroDSS system on a case study of pest population dynamics, illustrating the potential for its use.
   2. **Discussion:** The AgroDSS system uses data mining approaches to determine useful information from large volumes of data such as trends, patterns and distributions. This allows for better understanding of data and help predict future impacts of different actions. The farmers as well provide information for the system and the problems would like answers to such as seasonality analysis.
   3. **AgroDSS workflow:**
   4. **AgroDSS UI:  
      **
   5. **Reference:** Rupnik, R., Kukar, M., Vračar, P., Košir, D., Pevec, D., & Bosnić, Z. (2018). AgroDSS: A decision support system for agriculture and farming. Computers and Electronics in Agriculture. doi:10.1016/j.compag.2018.04.001
3. **Model for Predicting Rice Yield from Reflectance Index and Weather Variables in Lowland Rice Fields**
   1. Primary focus was to present and optimize a multi-purpose forecasting model that manages farming resources such as fertilizer and irrigation water supply through an effectiveness analysis on in-season estimations of rice yield in northwest Cambodia by comparing yield estimates between two active-sensor tools and determining which was far more suitable for rice-yield production:
      1. Weather data and vegetation cover information was measured using **Canopeo, GreenSeeker-NDVI** and a generalized additive model (**GAM**):
         1. **Canopeo**: A free-for-use active sensing mobile application tool that employs spectral RGB values to determine plant health and to estimate crop biomass that can be used to estimate a crop model that showcases extensive crop-canopy attribute ranges (to possibly predict a relationship between biomass estimates and yield-related traits in specific crops).
            1. Yield prediction models are noted to improve through long time weather data series as it provides an estimate of crop yield in advance under weather-based influence, especially on vegetative growth and development.
         2. **GreenSeeker-NVDI:** A commercial handheld device used to measure the normalized difference vegetative index (NVDI).
            1. The NVDI is a prediction model conventionally used to estimate rice biomass at critical growth stages on small-scale rice fields.
         3. **GAM**: Explores the non-linear relationships between the dependent variables and the independent variables since the relationships depend linearly on unknown, smooth functions of some predictor variables. As such, the main focus was on the interference from these smooth functions to determine a relationship between predictors and the response variable.
            1. The study presented its GAMs by plotting fitted smooths against yield, which would hypothetically clarify crop-vegetation indices-weather interactions.
   2. The study compared both yields using Canopeo and GreenSeeker-NVDI used on data from on-farm field experiments in the rice growing regions between 2018 to 2019, alongside average temperature and cumulative rainfall that were calculated at panicle initiation and pre-heading stages when the crop cover index was measured. A generalized additive model (GAM) was made through transformed data of grain yield with canopy cover predictors and weather data.
   3. Overall, it was determined that the Canopea index model explained 65% of the variability in yields through the input data and the NVDI-weather model only explained 62% of the variability.
   4. The researchers concluded that Canopea was a far more flexible and effective tool for small-scale rice farmers within their locale to improve limited farming resources management, such as fertilizer, in terms of performance and accessibility.
   5. **Reference:** <https://www.mdpi.com/2077-0472/12/2/130>
4. **DSS LANDS: A Decision Support System for Agriculture in Sardinia**
   1. The goals of this DSS were as follows:
      1. optimize the resources management through reduction of certain inputs (e.g., chemicals and naturals resources, etc.)
      2. predict crop risk situations (e.g., diseases, weather alerts etc.)
      3. increase the quality of decisions for field management
      4. reduce environmental impact and production cost; integrating different and specific modules for monitoring the main crop productions in Sardinia (citrus, artichoke, wheat, corn, olive, potato, peach, tomato, rice, vine)
   2. The prototype DSS collects, organizes, integrates and organizes several types of data with different mathematical models. It comprises of three components:
      1. An integrated system for semi-real time monitoring of crop components and storage of their data;
      2. A models system which performs through several mathematical and forecasting models a cross and dynamic analysis of different types of data. This allows strategies to be employed in the field to avoid risks of damaging production;
      3. A cross-platform application used by LAORE technical and farmers to upload crop data collected during the field survey and to visualize the up-to- date information for managing the cultivation in the form of alerts and decision support. This allows farmers to access the application without worrying about the device in use. All information given by the application is in graphic format that uses visual aids to relay information immediately, effectively and unambiguously. Internet connectivity also allows timely updating of the features once new analysis results are available.
   3. The system underwent a test in 2018 in the spring in hopes of forecasting and evaluating the risk of potato blight, which devastates potato crops all over the world including Sardinia. It was determined that within the region, climate change such as rains occurring in frequent proximity of one another, high humidity and abrupt temperature changes were the leading cause of hampered potato production.
      1. The researchers employed two predictive models: **Negative Prognosis model** and **Fry model**.
         1. The **Negative Prognosis model** predicts the period where the blight is not likely to occur alongside determining the perfect time frame to introduce blight treatment. Accurate prediction was achieved using the following data: hourly temperature (°C), relative humidity (%), and rainfall (mm). The model then calculates the risk values and the accumulated risk values which allow for further analysis into the specific date to begin the first treatment.
         2. The **Fry Model** was employed to estimate treatment after the first introduction by calculating the spraying intervals by analyzing blight units and fungicide units.
            1. Blight units are calculated according to the number of consecutive hours that relative humidity is greater than or equal to 90%, and average temperature falls within any of six ranges (< 3, 3-7, 8- 12, 13-22, 23-27 and >27 C).
            2. Fungicide units are calculated based on daily rainfall (mm) and time since last fungicide application. Decision rules about when fungicide should be applied are generated based on cumulative blight units or fungicide units since last spray.
   4. Summarily, the researchers were able to determine the best criteria to use for the implementation of their DSS project, focusing on local conditions, which proved that the methods they employed were effective into furthering their goals into the production of this system.
   5. **RRL**: In a study by Gianni Fenu and Francesca Maridina Malloci in 2020, an agricultural decision support system, named DSS LANDS, was developed with the goals of optimizing the resources management, predicting crop risk situations such as diseases, increasing the quality of decisions for field management, and reducing environmental impact and production cost. The decision support system integrates 3 sub-systems for monitoring the main crop productions in Sardinia: (1) an integrated system for monitoring and storing the weather and farmer data, (2) a models system that performs several mathematical formulas and forecasting models, and (3) a cross-platform application that allows farmers to upload crop data or visualize information needed in managing crop cultivation.  
        
      DSS LANDS was tested in 2018 to tackle the risk of a potato disease outbreak that happened in Sardinia. Using two disease prediction models, the system was able to forecast the period in which it is appropriate to carry out treatments useful against the disease. To achieve an accurate prediction, the system receives, manages, and stores with fixed frequency the hourly temperature, humidity, winds, and degrees of the day. After receiving the input parameters, the Negative Prognosis model calculates with different formulas the risk values and the accumulated risk values. The Fry Model then calculates the spraying intervals based on the blight units and fungicide units. Both experiments outlined the best criteria for applying the fungicide and blight treatments.
   6. **Reference**: https://hightechjournal.org/index.php/HIJ/article/view/39/pdf  
       Fenu, G. & Malloci, F. M. (2020). DSS LANDS: A Decision Support System for Agriculture in Sardinia. HighTech and Innovation Journal. ISNN 2723-9535. Vol 1, No 3. DOI: 10.28991/HIJ-2020-01-03-05
5. **Mobile Based Agricultural Management System for Indian Farmers**
   1. **Abstract:** Agriculture is one of the most powerful tools to eradicate hunger and poverty from the world. Technology has been playing an essential role in the agricultural sector of developed economies, but when it comes to developing and under-developed nations, there is a need to bridge the gap between technology and agriculture. The efficiency in the crop productivity and optimum utilization of resources is a challenge that can be addressed with technological advancement. This study aims to create a knowledge-based system (KBS) in the form of a mobile application to help the Indian farmers for improvement in their agricultural practices and increasing crop productivity. A prototype mobile application, ‘Farm-n-pedia,’ is used to fulfill the informational needs of the farmers and provide a tool for agriculture management using a single platform. This agricultural knowledge mobile application provides accessibility and personalization, which is long desired by the farmers. It enables the users to access any information they want from all around the globe, get personalized expert guidance, know about the latest farming techniques and technology, and increase agricultural productivity.
   2. **Focus:** To aid farmers in India using a mobile application that has a Knowledge-Based System (KBS). The prototype is called “Farm-npedia.” The main features of the system include the user being able to obtain key information regarding crops and agriculture based on the KBS and can also show proper tips and tricks regarding the latest farming techniques.
   3. **Reference:** <https://link.springer.com/chapter/10.1007/978-3-03049757-6_11>
6. **Exploring Different Architectures to Support Crop Farmers with a Mobile Application on Pesticide Control** 
   1. **Abstract:** The MobiCrop app, which is a distributed mobile application has been proposed to aid crop farmers with timely decision making on the applicability of pesticides (i.e., which pesticide to apply, when, where, and how to apply them). Due to the vast amount of pesticide and crop data, the application is designed following the three-tier architecture technique which comprises the mobile devices, a cloud-hosted middleware, and cloud-based database. The idea is to enable the mobile device to retrieve the needed pesticide data from the back-end and when necessary, part of the data can be stored on the mobile through caching for offline accessibility. However, constantly updating the mobile cache through data polling is costly for the wireless bandwidth and energy usage on the mobile. Also, it is difficult to update the stale cache data when there is no wireless connectivity. Hence, this work explores three architectural designs of the MobiCrop app which are the: 1) the standalone (network independent), 2) distributed architecture through data offloading, and 3) distributed architecture through data partitioning.
   2. **Focus:** A mobile application to aid farmers about pesticides. The prototype of the system is called “**MobiCrop**.” Its features include a three-layer deployment which includes mobile nodes, cloud-hosted middleware, and cloud-hosted database server which contains information regarding pesticides to their assigned crops. This system also supports offline accessibility for the information for reliability.
   3. **Reference:** <https://www.proquest.com/openview/a73656b74fa9d1545361996346ef17c8/1?pq-origsite=gscholar&cbl=1686342>
7. **Proposed decision support system (DSS) for Indian rice crop yield prediction**
   1. **Abstract:** Rice crop production provides more than 40% to overall crop production in India and is essential in ensuring food security. Its production is reliant on favorable climatic conditions. Improving the ability of farmers to predict crop productivity under different climatic scenarios, can assist farmers and other stakeholders in making important decisions in terms of agronomy and crop choice. This paper proposes a decision support system prototype for rice crop yield prediction for Maharashtra state, India. A Graphical User Interface (GUI) has been created in Java using NetBeans tool and Microsoft Office Access database for the ease of farmers and decision makers. The interface allows for the selection of the range of precipitation, minimum temperature, average temperature, maximum temperature and reference crop evapotranspiration and predicts the expected class of yield viz., low, moderate or high. The ranges of the parameters were calculated by using historic data from the study area. The classes for the yield were defined as low with 0.15 to 0.60 tonnes/hectare; moderate with 0.61 to 1.10 tonnes/hectare and high with 1.11 to 3.16 tonnes/hectare. The proposed prototype could be used for a bigger dataset and wider study area to predict the crop yield. This will provide a guide to the farmer to assist in decision making on potential crop yield for particular climatic scenario.
   2. **Focus:** A prototype created to guide farmers and assist in the overall potential yield of crops for different weather, season, and climate scenarios. This project’s features focus on the GUI which can aid farmers by giving information on expected crop yield depending on the climate’s precipitation and temperature.
   3. **Reference:** <https://ieeexplore.ieee.org/abstract/document/7801205>
   4. **Figures**:
      1. Flowchart describing the interactions between the model and the graphical user interface (GUI)



1. **GeoFarmer: A monitoring and feedback system for agricultural development projects**
   1. **Abstract**: Farmers can manage their crops and farms better if they can communicate their experiences, both positive and negative, with each other and with experts. Digital agriculture using internet communication technology (ICT) may facilitate the sharing of experiences between farmers themselves and with experts and others interested in agriculture. ICT approaches in agriculture are, however, still out of the reach of many farmers. The reasons are lack of connectivity, missing capacity building and poor usability of ICT applications. We decided to tackle this problem through cost-effective, easy to use ICT approaches, based on infrastructure and services currently available to small-scale producers in developing areas. Working through a participatory design approach, we developed and tested a novel technology. GeoFarmer provides near real-time, two-way data flows that support processes of co-innovation in agricultural development projects. It can be used as a cost-effective ICTbased platform to monitor agricultural production systems with interactive feedback between the users, within pre-defined geographical domains. We tested GeoFarmer in four geographic domains associated with ongoing agricultural development projects in East and West Africa and Latin America. We demonstrate that GeoFarmer is a cost-effective means of providing and sharing opportune indicators of on-farm performance. It is a potentially useful tool that farmers and agricultural practitioners can use to manage their crops and farms better, reduce risk, increase productivity and improve their livelihoods.
   2. **GeoFarmer design as a geospatial cloud-based system**: GeoFarmer employs a layered design with a modular component system that communicates with a central cloud application, which contains a central database where all data is compiled. The backend of cloud applications also interacts with external components and services. The modular structure and multilayer architecture make it easier to create single components for specific usability scenarios, such as a simple user interface for novice users and a more complex interface for experts.
   3. **Reference**: <https://www.sciencedirect.com/science/article/pii/S0168169918308433>
   4. **Web dashboard**: The GeoFarmer dashboard is a management tool and integration platform for collecting data in the field. It is the central tool for managing GeoFarmer geographical domains and data. Only registered users with moderator role can log in to the dashboard and access their geographic domains (projects). The moderator creates new surveys and questions, and he approves facilitators that requested a facilitator role through the smartphone application. Collected survey data and results are accessible on the dashboard; the moderator can create public links of results and share them on the internet. The moderators manage the discussion process of smartphone-application users, i.e., set parameters or control user access to the discussion process thus ensuring a free exchange of information between users. Although the facilitators, experts, and farmers do not use the dashboard, their ability to communicate depends on it being well managed.   
        
      
   5. **Smartphone application**: Facilitators and experts use the smartphone application during fieldwork activities while interacting with farmers. Farmers can also use it as an individual user. It is the central data-collection tool (Fig. 5). The smartphone application is simple and optimized for fieldwork usage. After user registration and login, the user can send a request to be a facilitator in a specific geographic domain, which requires approval from the moderator in the web-dashboard, or he logs in as an individual user (farmer).  
      
2. **BrAPI—an application programming interface for plant breeding applications**
   1. **Motivation**: Modern genomic breeding methods rely heavily on very large amounts of phenotyping and genotyping data, presenting new challenges in effective data management and integration. Recently, the size and complexity of datasets have increased significantly, with the result that data are often stored on multiple systems. As analyses of interest increasingly require aggregation of datasets from diverse sources, data exchange between disparate systems becomes a challenge.
   2. **Results**: To facilitate interoperability among breeding applications, we present the public plant Breeding Application Programming Interface (BrAPI). BrAPI is a standardized web service API specification. The development of BrAPI is a collaborative, community-based initiative involving a growing global community of over a hundred participants representing several dozen institutions and companies. Development of such a standard is recognized as critical to a number of important large breeding system initiatives as a foundational technology. The focus of the first version of the API is on providing services for connecting systems and retrieving basic breeding data including germplasm, study, observation, and marker data. A number of BrAPI-enabled applications, termed BrAPPs, have been written, that take advantage of the emerging support of BrAPI by many databases.
   3. **Availability and implementation**: More information on BrAPI, including links to the specification, test suites, BrAPPs, and sample implementations is available at https://brapi.org/. The BrAPI specification and the developer tools are provided as free and open source.
   4. **Reference**: https://academic.oup.com/bioinformatics/article/35/20/4147/5418796
3. **A Decision Support System for Sustainable Agriculture: The Case Study of Coconut Oil Extraction Process**
   1. **Abstract:** The high demand of information and communication technology (ICT) in agriculture applications has led to the introduction of the concept of smart farming. In this respect, moving from the main features of the Fourth Industrial Revolution (Industry 4.0) promoted by the European Community, new approaches have been suggested and adopted in agriculture, giving rise to the so-called Agriculture 4.0. Improvements in automation, advanced information systems and Internet technologies allow for farmers to increase the productivity and to allocate the resources reasonably. For these reasons, agricultural decision support systems (DSS) for Agriculture 4.0 have become a very interesting research topic. DSS are interactive tools that enable users to make informed decisions about unstructured problems, and can be either fully computerized, human or a combination of both. In general, a DSS analyzes and synthesizes large amounts of data to assist in decision making. This paper presents an innovative decision support system solution to address the issues faced by coconut oil producers in making strategic decisions, particularly in the comparison of different methods of oil extraction. In more detail, the adopted methodology describes how to address the problems of coconut oil extraction in order to minimize the processing time and processing cost and to obtain energy savings. To this end, the coconut oil extraction process of the Leão São Tomé and Principe Company is presented as a case study: a DSS instance that analyzes the problem of the optimal selection between two different oil coconut extraction methods (fermentation-based and standard extraction processes) is developed as a meta-heuristic with a mixed integer linear programming problem. The obtained results show that there is clearly a trade-off between the increase in cost and reliability that the decision-maker may be willing to evaluate. In this respect, the proposed model provides a tool to support the decision-maker in choosing the best combination between the two different coconut oil extraction methods. The proposed DSS has been tested in a real application context through an experimental campaign.
   2. **Discussion:** The paper presents a decision support system for sustainable agriculture. In more detail, the main goal of this study was to design a DSS solution capable of supporting farmers in making the best choice between different production methods. In this respect, moving from the case study of the coconut oil extraction process, the primary objective was to propose a procedure whose application context can be easily extended to all production processes, where processing times, costs and energy consumption need to be evaluated. The DSS is responsible for evaluating the company production needs and, on the basis of the quantity to be produced, estimated production time, costs and energy consumptions, provides the necessary information to the right selection of the production process.   
        
      The DSS is responsible for evaluating the company production needs and, on the basis of the quantity to be produced, estimated production time, costs and energy consumptions, provides the necessary information to the right selection of the production process. In the specific case of study, the DSS has been validated through an experimental campaign. In this respect, the DSS performance has been evaluated for different values of the weight in the objective function. The computational results show the validity of the extraction coconut oil method based on fermentation as the best choice for coconut oil producers. At the same time, the validation activity shows that, when the processing time of the fermentation-based approach is higher than the standard one (i.e., a high production is needed), the standard approach is preferable. In this regard, the proposed approach provides a tool (fully integrable in smart production architecture for Agriculture 4.0) to support the decision-maker in choosing the best combination between different production methods.
   3. **Reference:** Gagliardi, G., Cosma, A. I. M., & Marasco, F. (2022). A Decision Support System for Sustainable Agriculture: The Case Study of Coconut Oil Extraction Process. Agronomy, 12(1), 177. MDPI AG. Retrieved from http://dx.doi.org/10.3390/agronomy12010177
4. **Research on Decision Support System of E-Commerce Agricultural Products Based on Blockchain**
   1. **Abstract:** The market information of e-commerce agricultural products has the characteristics of complexity and time lag. It is often difficult for producers to obtain and accurately grasp the real-time market information in time, resulting in economic losses under the information asymmetry. From the perspective of agricultural product producers, combined with the application layer of new blockchain technology and the basic platform and service platform of e-commerce information platform, an e-commerce agricultural product decision support system, which is based on blockchain technology and centered on blockchain database, is constructed. The system consists of three sub-systems: e-commerce agricultural product information service platform, inventory information feedback platform and logistics information feedback platform, and it completes the collection, sorting and output of these three kinds of information under the support of blockchain system, so as to help agricultural producers make correct decisions and achieve the purpose of promoting agricultural product sales and increasing farmers' income.
   2. **RRL:** The system uses blockchain technology to collect, analyze, and process the data, feedback the market supply and demand to the agricultural producers, so as the solve the economic losses caused by the differing knowledge of agricultural producers in terms of prices. The system has 5 main structures, the E-commerce agricultural product information service platform, the Inventory information feedback platform, the logistics information feedback platform, the blockchain information entry and sorting, and the information collection, analysis, and interaction of the blockchain database.   
        
      The e-commerce information service platform collects and processes consumer browsing data, analyze potential customer groups, and analyzes consumer demand preferences. The monthly, quarterly, and annual market sales situation of each region is also collected and shown to agricultural producers to help them make correct decisions and maximize profits. They can also upload their own production processes to the platform. As for the inventory information feedback platform, it collects and matches inventory information in different regions in order to monitor product surplus. The logistics information platform on the other hand, collects logistics data in order to see logistics trends, which can solve the problems of untimely distribution of agricultural products, high transportation cost, and long transportation cycle. The blockchain information entry and sorting system will then collect the data from the above three platforms and will process and analyze the data.   
        
      The information collection, analysis, and interaction of blockchain database collects and arranges all these information and presents the data in the form of charts. It can also provide the market supply and demand of agricultural products, all while keeping the information authentic because of blockchain technology. The sorted and analyzed market information will be used by agricultural producers through the e-commerce service platform, and the cycle begins again.
   3. **Reference:** https://www.computer.org/csdl/proceedings-article/ecit/2020/590200a024/ 1lgPE7uCZfq  
       Xie, C. & Xiao, X. (2020). Research on Decision Support System of E-Commerce Agricultural Products Based on Blockchain. 2020 International Conference on E-Commerce and Internet Technology (ECIT). Zhangjiajie, China, 2020 pp. 24-27. doi: 10.1109/ECIT50008.2020.00013
5. **Prediction Of Crop Yield Using Machine Learning**
   1. **Abstract**: Looking at the current situation faced by farmers in Maharashtra, we have observed that there is an increase in suicide rate over the years. The reasons behind this includes weather conditions, debt, family issues and frequent change in Indian government norms. Sometimes farmers are not aware about the crop which suits their soil quality, soil nutrients and soil composition. The work proposes to help farmers check the soil quality depending on the analysis done based on data mining approach. Thus, the system focuses on checking the soil quality to predict the crop suitable for cultivation according to their soil type and maximize the crop yield with recommending appropriate fertilizer.
   2. **Focus**: The system aims to help farmers to cultivate proper crop for better yield production. To be precise and accurate in predicting crops, the project analyzes the nutrients present in the soil and the crop productivity based on location. It can be achieved using unsupervised and supervised learning algorithms, like Kohonen Self Organizing Map (Kohenon’s SOM) and BPN (Back Propagation Network). Dataset will then train by learning networks. It compares the accuracy obtained by different network learning techniques and the most accurate result will be delivered to the end user. Along with this, the end user is provided with proper recommendations about fertilizers suitable for every particular crop.
   3. **Link**: https://d1wqtxts1xzle7.cloudfront.net/56030057/IRJET-V5I2479-with-cover-page-v2.pdf?Expires=1653054398&Signature=VM6IEXIMV4IheBXmIgWDKQ0odw Rcb~K~hCHE80OCdPuH5l00yaEGGQhAbPl8kNsChPCARwkbm5Kp04lGd9OZ48YtJRkM-xq8wtmkRT65Tf9tQRhoVE~wPy2CZADdOZC4v5MDw2VRN0JhJscrXFIR5kLs ~6pbkWr5mvqP1Mp-PwYySKJMOEQw4KUq0YP~ev5vimn47zAh7jzcx21qpKMA-Hs3vvxuuse2CWHbnSgUe-vJv63TmwzFqnWMqYQfoUr3KemMuBxH98i4M3gZ4 b05Fwx5ycEs2R6rVYVHBvEjCK9EbtxLxyzlHr~3OlDzRqrCZK-l5zLRnkybNQ6Jk4BTjg \_\_&Key-Pair-Id=APKAJLOHF5GGSLRBV4ZA
6. **An Approach for Prediction of Crop Yield Using Machine Learning and Big Data Techniques**
   1. **Abstract:** Agriculture is the primary source of livelihood which forms the backbone of our country. Current challenges of water shortages, uncontrolled cost due to demand-supply, and weather uncertainty necessitate farmers to be equipped with smart farming. In particular, low yield of crops due to uncertain climatic changes, poor irrigation facilities, reduction in soil fertility and traditional farming techniques need to be addressed. Machine learning is one such technique employed to predict crop yield in agriculture. Various machine learning techniques such as prediction, classification, regression and clustering are utilized to forecast crop yield. Artificial neural networks, support vector machines, linear and logistic regression, decision trees, Naïve Bayes are some of the algorithms used to implement prediction. However, the selection of the appropriate algorithm from the pool of available algorithms imposes challenge to the researchers with respect to the chosen crop. In this paper, an investigation has been performed on how various machine learning algorithms are useful in prediction of crop yield. An approach has been proposed for prediction of crop yield using machine learning techniques in big data computing paradigm.
   2. **Focus:** From the literature, it is understood that the weather inputs such as rainfall, temperature, humidity in addition to non-weather inputs namely soil moisture, pH, salts in soil (nitrogen, phosphate, potassium, organic carbon, calcium, magnesium, sulphur etc.), crop type and seed variety are fed as input to the prediction model. Initially the raw data is preprocessed to remove erroneous and unformatted noisy data. Then, the processed input is furnished to the prediction model. By comparing the performance metrics of different machine learning models, Artificial Neural Network and Support Vector Machine based prediction models are found to be more suitable for crop yield prediction. It is proposed to using big data techniques at two different stages, namely, (i)preprocessing and (ii) prediction. When prediction is taking place in different data nodes with a parallel programming model, it may enhance the performance of prediction. So, it is proposed to determine how big data techniques are useful in enhancing the prediction of crop yield.
   3. **Link:** <https://deliverypdf.ssrn.com/delivery.php?ID=226125090117007066064118022125124065052057047032095057123113009088087086088102117027096101058032022062055109092082013006124112114054094081027096021105018111123094099050048056029089100072120092000026007023071119080126097113111000015117092088101007004078&EXT=pdf&INDEX=TRUE>
7. **‘Fruchtfolge’: A Crop Rotation Decision Support System for Optimizing Cropping Choices with Big Data and Spatially Explicit Modeling**
   1. **Abstract:** Deciding on which crop to plant on a field and how to fertilize it has become increasingly complex as volatile markets, location factors as well as policy restrictions need to be considered simultaneously. To assist farmers in this process, we develop the web-based, open-source decision support system ‘Fruchtfolge’ (German for ‘crop rotation’). It provides decision makers with a crop and coarse manure fertilization management recommendation for each field based on the solution of a single farm optimization model.
   2. **Focus:** “Fruchtfolge” is built in an effort to create a user-centered, simple to use DSS to provide profit maximal field specific cropping choices and fertilization strategies.  
        
      In the underlying manuscript, the researchers presented the web-based DSS ‘Fruchtfolge’ (German for crop rotation) which supports farmers in making optimal crop and crop management choices in a complex environment. Fruchtfolge provides its users with a crop recommendation and a coarse manure application strategy for each of their fields, automatically incorporating big data from multiple sources related to farm, location, and management characteristics. By combining these datasets, a highly detailed single farm model is created and solved in real-time in the background, without requiring extensive user input.
   3. Diagram

      Description automatically generated**Systematic overview of Fruchtfolge:**Three main steps are required in order to receive a first optimization result by the DSS. First, the user needs to initially sign-up on the website choosing a password, providing an E-Mail address as its user-id and the address of the farm premises. The address is required for the calculation of farm-to-field distances at a later stage. Like other web services, upon completion of the initial signup, users can later login again to the DSS using their E-Mail address and password and find all so far entered input and results. In a second step, users are asked to enter their so-called customer reference number (CRN, ZID number in Germany) which is available for every farm having applied for direct payments under the EU Common Agricultural Policy. Subsequently, the necessary data to optimize a cropping plan is downloaded automatically in the background and combined to a first version of the mixed integer linear programming (MILP) model without further action required from the user. Once this initial model is solved, the user is presented with the optimal cropping plan in a table and a map view with supporting graphs. In addition, a so-called fertilizing planning sheets as required by the FO are generated. Next, the user can adjust input parameters such as prices, costs, yields, or crop share constraints and re-run the model.
   4. **Reference:** Pahmeyer, C., Kuhn, T., & Britz, W. (2021). “Fruchtfolge”: A crop rotation decision support system for optimizing cropping choices with big data and spatially explicit modeling. Computers and Electronics in Agriculture, 181, 105948. doi:10.1016/j.compag.2020.105948
8. **INTELLIGENT DECISION SUPPORT SYSTEM FOR SMART AGRICULTURE**
   1. **Abstract:** The designed decision support system integrates various environmental factors such as moisture, temperature, soil nutrition level, pest sound frequency and soil PH to formulate and estimate individual crop watering requirement. System is smart enough to start and stop irrigation automatically considering human expert opinion learning through feedback provided. System will also provide alert and recommendation on water soluble fertilizer and pesticide requirement for individual crop. Soil condition can be analyzed for preprocessing before prediction to determine water retention ratio, soil nutrition ratio so that the accuracy of the system can be increased. Geographic location based customized fertilizer, pesticide and watering need prediction can be used to make suitable predict for specific region and weather.
   2. **Focus:** DSS with IOT design for water monitoring, fertilizer and pesticide recommendation approach which supports internet based real time data (environmental factors) collection to formulate, estimate and automate individual crop watering and nutrition requirement considering human expert opinion learning through feedback provided.
   3. Diagram

      Description automatically generated**Proposed Architecture:** Proposed system architecture is shown below with two main modules preprocessing and prediction. Data collection phase collects data from sensor about crop, soil and weather. In preprocessing various soil and weather parameters are used for further complex computation. Prediction phase involves algorithm for prediction of three main components for plant growth i.e., fertilizer, water and pesticide.
   4. **Reference:** Dabre, K. R., Lopes, H. R., & Dmonte, S. S. (2018). Intelligent Decision Support System for Smart Agriculture. 2018 International Conference on Smart City and Emerging Technology (ICSCET). doi:10.1109/icscet.2018.8537275
9. **D-Risk: A decision-support webtool for improving drought risk management in irrigated agriculture**
   1. **Authors**: David Haro-Monteagudo, Jerry W. Knox, Ian P. Holman
   2. **DOI**: https://doi.org/10.1016/j.compag.2019.05.029
   3. **Abstract**: Drought constitutes a significant production and business risk in agriculture, particularly for those enterprises dependent on irrigation to deliver high quality continuous supplies of fresh produce to the retail sector. Whilst most farmers are well attuned to managing short term weather-related crop risks, they lack access to tools that can support medium-term decision-making and risk management strategies under conditions of increasing water scarcity and climate uncertainty. This paper describes D-Risk, an intuitive online webtool designed to help farming enterprises easily understand their existing and emergent drought and irrigation abstraction risks and thereby support more robust decision-making regarding future changes in crop planning and water resources infrastructure investment.
   4. **RRL**: D-Risk is a decision support webtool that combines data availed from climatology databases, location-specific farm data and farm level input data to assist in formulating irrigation and crop management strategies through a comprehensive analysis of complex abstraction (water diversion done through irrigation) and drought-related risks. The study employed a synthetic dataset of 100 equally-probable baseline weather series to derive the annual maximum potential soil moisture deficit (PSMDmax), referred to as the agroclimatic index. Crop and soil related linear regressions between irrigation need and the PSMDmax were used to determine a theoretical irrigation need on both an annual and monthly basis. The webtool’s design decisions provided its target farmers an extensive representation of their baseline drought risk and thus allowing them to evaluate the strengths and shortcomings of certain decisions (ex. Reducing total irrigated area, changing irrigation schedules) they may take in order to adapt to such risks.
   5. The functional webtool may be viewed here: <https://www.d-risk.eu/index.php>
10. IrrigaSys: A web-based irrigation decision support system based on open source data and technology
    1. **Authors**: Lucian Simionesei, Tiago B.Ramos, Jorge Palma Ana R.Oliveira, Ramiro Neves
    2. **DOI**: <https://doi.org/10.1016/j.compag.2020.105822>
    3. **Abstract**: IrrigaSys is a decision support system (DSS) for irrigation water management based on online, open-source tools. The aim of this paper is to describe the structure of IrrigaSys and how it is implementation at the plot scale. The DSS includes remote access to local meteorological stations for weather conditions, a meteorological model for weather forecast, the MOHID-Land model for the computation of the soil water balance and irrigation scheduling, and a database for data repository. Despite its complexity, the data necessary to run IrrigaSys is minimal, and include as mandatory input information on the location of field plots, crop type, sowing and harvest dates, soil texture, irrigation method, and daily/weekly applied irrigation depths. Based on this information, the system automatically downloads the weather data from the meteorological station located closest to the agricultural plot, as well as the weather forecast for the seven incoming days. The soil water balance is then computed from sowing to the present date (updating always the system with newly acquired information) as well as the recommended irrigation schedule for the incoming week. Results are made available via a web interface, a mobile app, a SMS, and email. The IrrigaSys further provides the Normalized Difference Vegetation Index (NDVI) computed from the most recent Sentinel-2 imagery available with a resolution of 10 m. The IrrigaSys was developed in close cooperation with the Water Board from the Sorraia Valley irrigation district, southern Portugal, supporting 103 plots of 30 farmers over the last 5 years. This stakeholder has been fundamental for successfully running the system. This paper further discusses the main strengths and limitations of IrrigaSys, with the latter being naturally associated with difficulties in providing reliable estimates for all field plots based on limited data.
    4. IrrigaSys is a primarily web-based decision support system that was developed to focus on assisting water irrigation management at a plot-based scale, providing optimized irrigation schedules, soil water balance, weather forecast and satellite images on a weekly basis. The data needed to retrieve results included the location of the agricultural field, the crop type, the sowing and harvest dates, the soil texture and the characteristics of the irrigation system in each plot. IrrigaSys was not shown to be connected to sensors remotely, thus it was deemed integral to receive daily or weekly irrigation depths for the sake of output reliability.
    5. IrrigaSys was designed to sustain six components:
       1. An online platform for system administration, management and output visualization
       2. A vadose zone model (MOHID-Land) for computation of soil-water dynamics and irrigation scheduling
       3. A meteorological module for the hindcast and forecast of weather data
       4. An SQL database for data repository and management of model inputs
       5. A remote sensing module for complementing the system’s outputs with satellite data
       6. Dissemination platforms for facilitating users access







