Decision Support Systems and Automated Systems for Agricultural Applications

The detailed information on DSS , automated systems, contingent planning and crop calendars has been given. All these systems help farmers to take timely and appropriate contextual decisions. These also help in Agricultural planning.

Automated Systems

Automated system are a combination of both software and hardware that is designed and programmed to work automatically without the need for a human operator to provide inputs and instructions for each operation. Automated system are used in a wide range of applications like control and monitoring systems, data security applications, factory automation systems, automated message response systems, Automated Agriculture input systems and so on. These systems take several system and environmental events as input and perform operations based on conditional decision making and specific control logic.

Some of the benefits of automated system are:

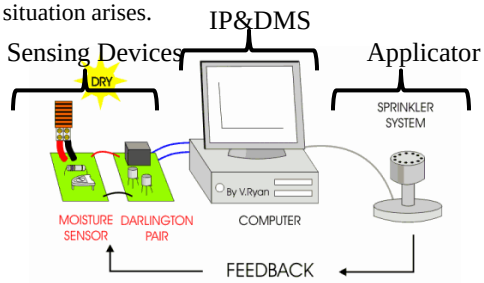
Eliminates the risk of human errors
Improves user productivity
Provides standardized operations
Provides better operations management and logging
Saves labor, time and cost
Increases the accuracy and precision of the job
Increases the availability, performance and reliability of the services delivered.

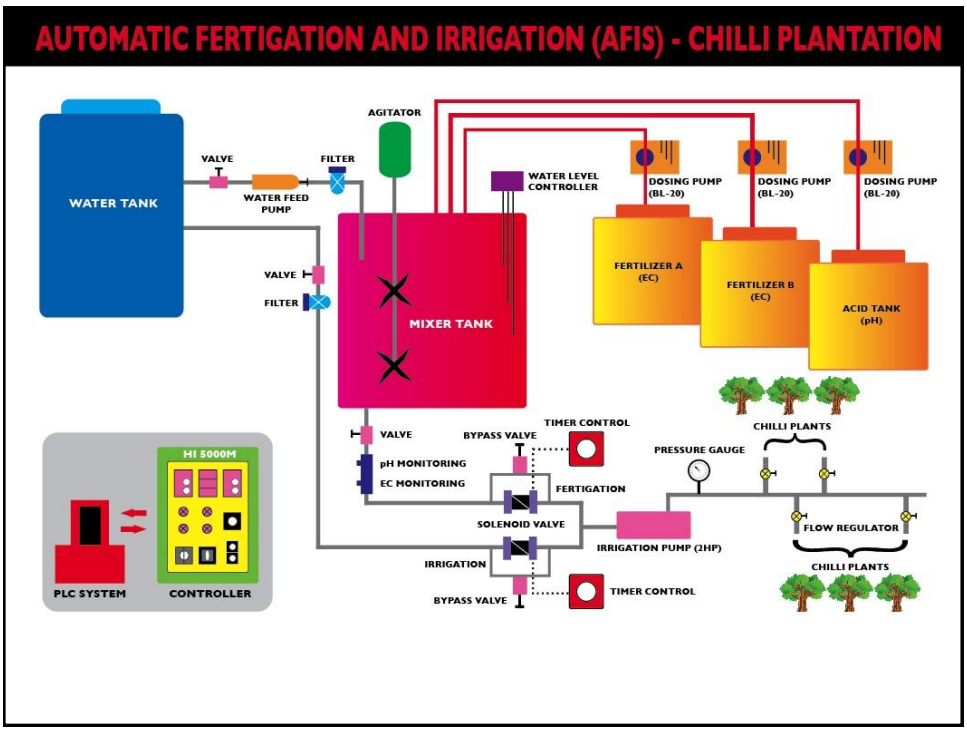
Some disadvantages are:

Possible security threats/vulnerability due to unattended extreme conditions
Unpredictable or excessive development costs.
High initial cost.
Displaces workers due to job replacement.
Leads to further environmental damage and could compound climate change.

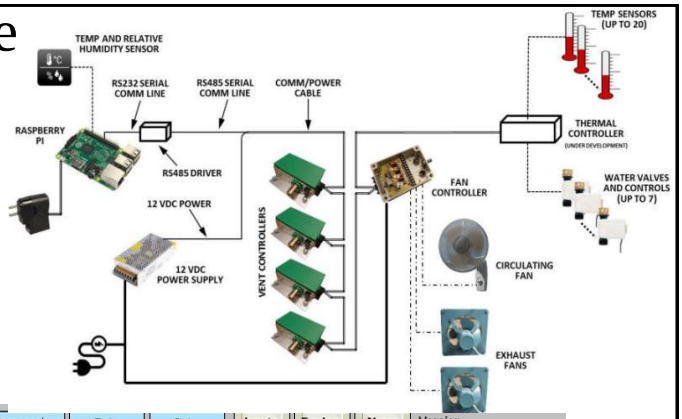
Automated Systems in Agriculture

The Automated input system for Agriculture is a computer operated hardwares and software system, which automatically sense the field conditions, analyze the data, makes decisions and initiate the inputting system like auto-fertigation system, auto-irrigation system etc. The systems works without a human operator or with limited human interventions to provide inputs and instructions for each agricultural operation. Automated System in Agriculture usually have three components: i) sensing devices /system for providing information on field conditions such as sensors for soil, moisture, soil temperature, nutrients and atmospheric conditions etc, ii) Information Processing (IP) and Decision Making System (DMS; it is brain or core of the entire system)- this system gets the information from the field and process; it makes the decisions by following set rules and direct the applicators for application of a specific input iii) applicator for giving agri-input to field: it receives directions from IP&DMS and applies inputs to the field or part of field as the situation arises.





Greenhouse Controller



Wind Speed	Wind Direct.	Temperature	Rain	Solar	Inputs	Backup	Alarm	Version
6 mi/hr	S	79.8 °F	No	325 W/M^2	Outputs	Restore	Options	3.5. 3.6 D

Zone	Temp. °F	Humidity %	Heating	Vent 1 % Open	Vent 2 % Open	Fan	Louvers	CO2 ppm	HID Lights	Shade %	Hot Water °F
1	83.5	63.3	Heat 1	5	0 S	Cool 2	Cool 2		On	27	#
2	80.0	64.2	Off	5	0 S	Cool 2	Cool 2		Off	8	#
3	78.8	63.8	Heat 1	0 N	5						#
4	78.3	64.3	Off	5	0 S						#
5	84.1	63.8	Off	5	0 S						
6	83.0	64.2	Off			Cool 1	Cool 1		Off		
7	0.0	0.0	Off								
8	0.0	0.0	Off								

Mobile Apps

A mobile application, most commonly referred to as an app, is a type of application software designed to run on a mobile device, such as a smartphone or tablet computer. Mobile applications frequently serve to provide users with similar services to those accessed on PCs. Apps are generally small, individual software units with limited function. This use of app software was originally popularized by Apple Inc. and its App Store. Apps that are not preinstalled are usually available through distribution platforms called app stores. They began appearing in 2008 and are typically operated by the owner of the mobile operating system. Mobile apps were originally offered for general productivity and information retrieval, including email, calendar, contacts, stock market and weather information. However, public demand and the availability of developer tools drove rapid expansion into other categories such as agriculture, governance, Public Distribution System (PDS), e-market, transportation etc.

Mobile Apps Components

Activities: An activity is the first stepping stone is building an Android user application. It provides the space to the user for doing anything and everything. For example, opening a contact, dialing a caller, etc. A window is provided to each activity where user interfacing is done. Generally, every Android application has more than one activity. There is one "main" activity. All other activities are child activities. There is a stack called back stack. Whenever, a new window is started, previous activity is pushed to the back stack and it is stopped until the new activity is done. As soon as the back key of your device is pressed, new activity is popped out of stack and destroyed. Now previous activity resumes.

For example, when you send SMS, you open the messenger and send message. Assume this to be your current activity. When you press back key, it should resume the previous activity (your own home screen).

Mobile Apps Components

Service: It does not provide user interface. It does long running operations in background. Service doesn't terminate even if the component which initiated it got terminated or switched to another application. A service can be connected to a component which can even do inter process communication (IPC). For example, when you receive your email updates in inbox it is a service. You get the notification of new e-mail.

Content Providers: These Android components bring the object oriented functionality to the system. It provides content of one process to another hence it acts as an interface. It provides gateway to access data from a structured set. It is this object which is going to receive the requests retrieves the results and returns the result. Android has content providers which manages video, audio, etc. These content providers are internal to android applications. For example, custom searches on device require content providers

Mobile Apps Components

Intents and Broadcast Receivers

Android Intents are the communication medium .i.e., app components send messages to one another like you do with your friends. It is a messaging object. It can be used to query an action from another app component. Android Intent can be used to initiate a new activity or get result from another activity. **Android Broadcast** is a message which spreads out when any event occurs. They are received by apps. Android Intents can be used to deliver broadcasts to other apps. For example, when your device boots up or switched on system generates a broadcast to all apps. There should be a procedure or should be something which can receive these broadcasts. These receptors are called broadcast receivers.

Android App widgets

Android App widgets are the small application views. These views can be embedded into other applications. They can receive updates on periodic basis. A **widget** is a quick view of your app's functionality and data.

Mobile Apps: Types

Native apps live on the device and are accessed through icons on the device home screen. Native apps are installed through an application store (such as Google Play or Apple's App Store). They are developed specifically for one platform, and can take full advantage of all the device features.

Web apps are not real applications; they are really **websites** that, in many ways, *look and feel* like native applications, but are not *implemented* as such. They are run by a browser and typically written in HTML5. Users first access them as they would access any web page: they navigate to a special URL and then have the option of "installing" them on their home screen by creating a bookmark to that page.

Hybrid apps are part native apps, part web apps. (Because of that, many people incorrectly call them "web apps"). Like native apps, they live in an app store and can take advantage of the many device features available. Like web apps, they rely on HTML being rendered in a browser, with the caveat that the browser is embedded within the app.

Often, companies build hybrid apps as wrappers for an existing web page; in that way, they hope to get a presence in the app store, without spending significant effort for developing a different app. Hybrid apps are also popular because they allow cross platform development

Mobile Apps in Agriculture

Agricultural mobile app is a small version of the software that can run of small devices (usually androids) and provides the desired information to farmers, which is important for sowing operation to harvesting and to marketing. These mobile apps are in general interact in regional language and designed to break the literacy barrier and deliver the information in the most simple manner. Several thousands of farmers across the world have been benefited by mobile apps.

The six most important mobile apps popular in India are:

1) Kisan Suvidha

Launched by the PM Narendra Modi in 2016 to work towards empowerment of farmers and development of villages., It provides information on current weather and also the forecast for the next five days, market prices of commodities/crops in the nearest town, knowledge on fertilizers, seeds, machinery etc. The option to use the app in different languages makes it more widely accessible.

Mobile Apps in Agriculture

2) IFFCO Kisan Agriculture

This app was launched in 2015 and is managed by IFFCO Kisan, a subsidiary of Indian Farmers' Fertilizer Cooperative Ltd. Its aim is to help Indian farmers make informed decisions through customized information related to their needs. The user can access a variety of informative modules including agricultural advisory, weather, market prices, agriculture information library in the form of text, imagery, audio and videos in the selected language at profiling stage. The app also offers helpline numbers to get in touch with Kisan Call Centre Services.

3) RML Farmer – Krishi Mitr

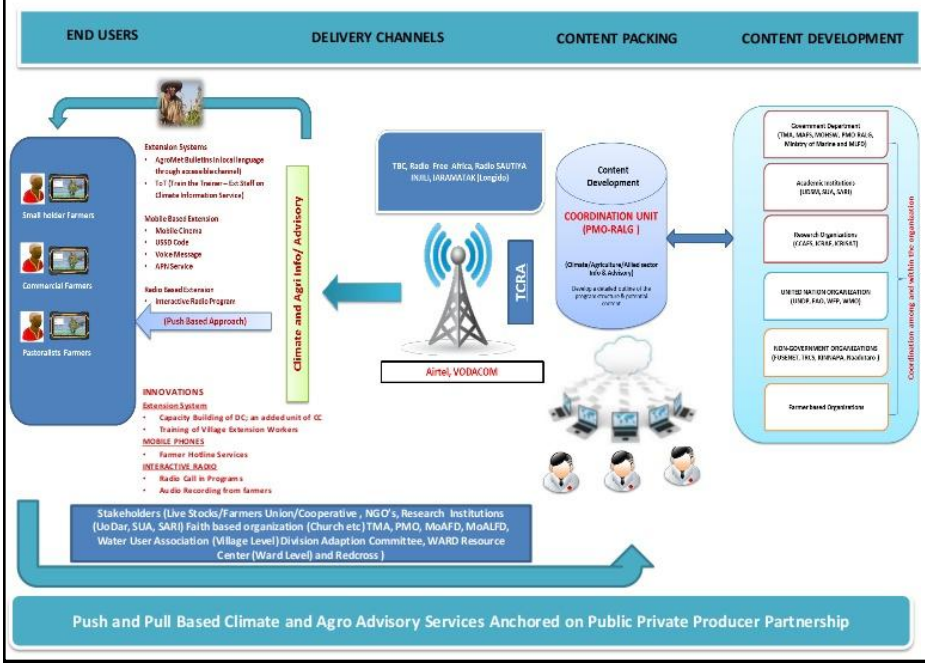
RML Farmer is a one of its kind agricultural app where farmers can keep up with the latest commodity and mandi prices, precise usage of pesticides and fertilizers, farm and farmer related news, weather forecast and advisory. Its also provides agricultural advice and news regarding the government's agricultural policies and schemes.

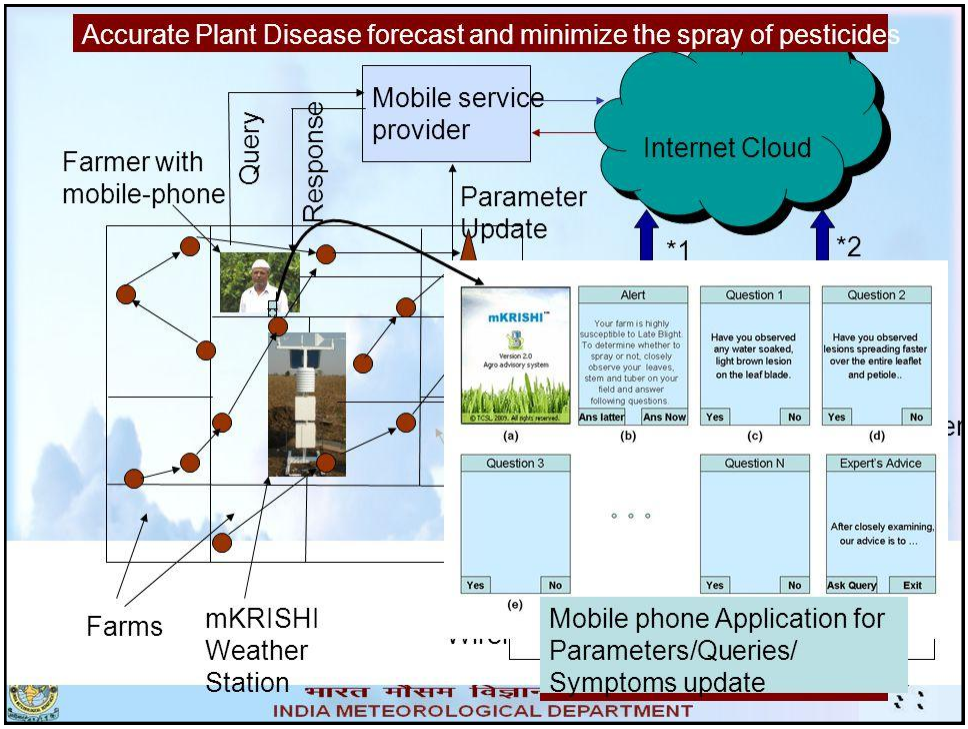
Mobile Apps in Agriculture

4) Pusa Krishi
This app was launched in 2016 by the Union Agriculture Minister and aims to help farmers to get information about technologies developed by Indian Agriculture Research Institute (IARI), which will help in increasing returns to farmers. The app also provides farmers with information related to new varieties of crops developed by ICAR, resource conserving cultivation practices as well as farm machinery and its implementation will help in increasing returns to farmers.

5) **Crop Insurance**
The app helps farmers to calculate insurance premium for notified crops and provides information cut-off dates and company contacts for their crop and location.

6) **AgriMarket**
Launched along with the Crop Insurance app by the government of India, the app has been developed with an aim to keep farmers abreast of crop prices and discourage them to go for distress sales. Farmers can get information related to prices of crops in markets within 50km of their own device location using the AgriMarket Mobile App.





Decision Support System

A decision support system (DSS) is a computer-based application that collects, organizes and analyzes data to facilitate timely and contextual decision-making for management, operations and planning. A well-designed DSS aids decision makers in compiling a variety of data from many sources.

Types of DSS:

A **communication-driven DSS** enables cooperation, supporting more than one person working on a shared task; examples include integrated tools like Google Docs.

A **data-driven DSS** (or data-oriented DSS) emphasizes access to and manipulation of a time series of internal company data and, sometimes, external data.

A **document-driven DSS** manages, retrieves, and manipulates unstructured information in a variety of electronic formats.

A **knowledge-driven DSS** provides specialized problem-solving expertise stored as facts, rules, procedures, or in similar structures, like logic based AES.

A **model-driven DSS** emphasizes access to and manipulation of a statistical, financial, optimization, or simulation model. Model-driven DSS use data and parameters provided by users to assist decision makers in analyzing a situation; they are not necessarily data-intensive like Crop Simulation based Agriculture Expert System.

Component of Expert System

Three fundamental components of a DSS architecture are:

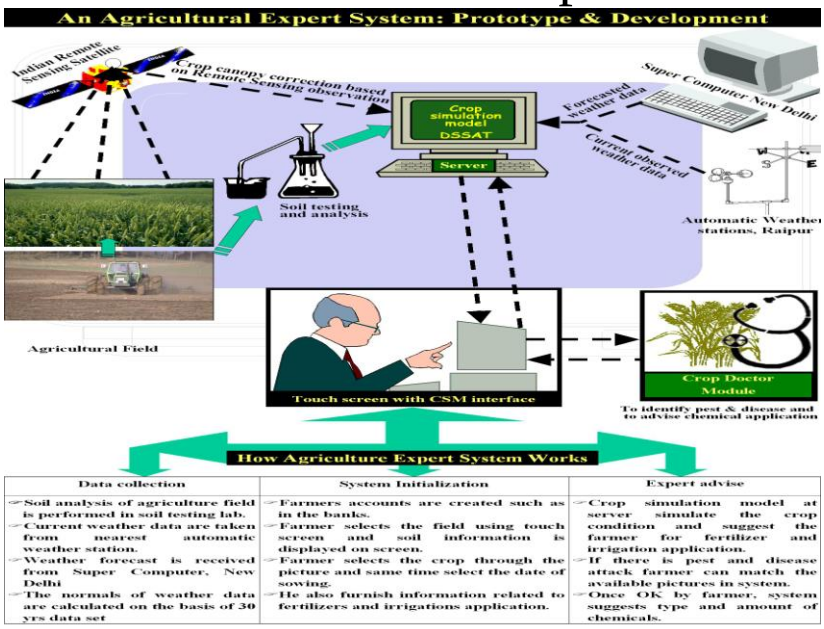
i. the database (or knowledge base),
ii. the model (i.e., the decision context and user criteria)
iii. the user interface.

The users themselves are also important components of the architecture

Agriculture Expert System

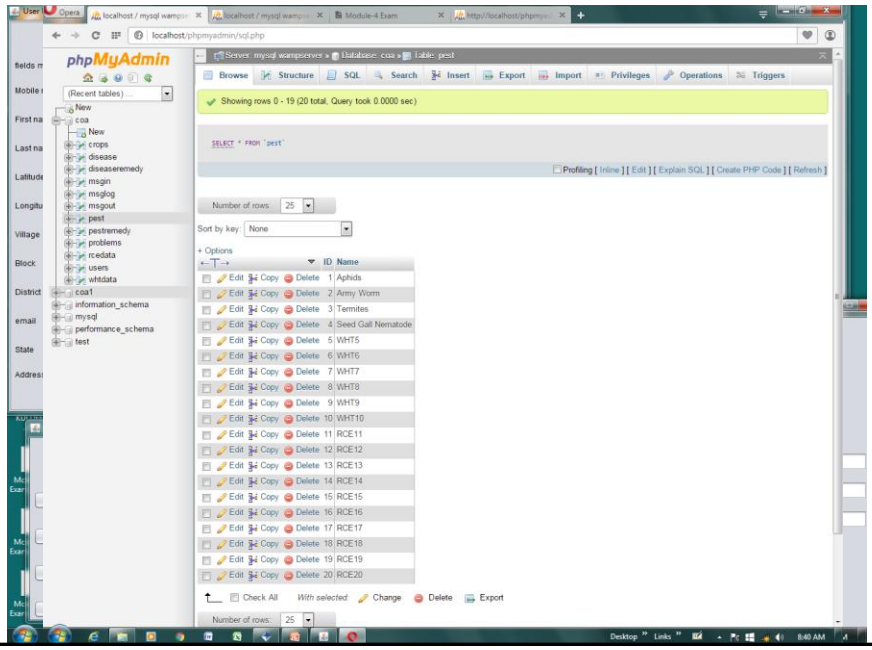
An Expert System (ES), also called a Knowledge Based System (KBS), is a computer program designed to simulate the problem-solving behavior of an expert in a narrow domain or discipline. The expert system could be developed for decision-making and location specific technology dissemination process. An expert system is software that attempts to reproduce the performance of one or more human experts, most commonly in a specific problem domain, and is a traditional application and/or subfield of artificial intelligence. Expert systems helps in selection of crop or variety, diagnosis or identification of pests, diseases and disorders and taking valuable decisions on its management. The expert system which developed earlier were more of text based and could be utilized only by the extension officials and scientists. However current expert system are highly dynamic and provide attractive GUI (graphical user interface).

AES: An Example



Data collection	System Initialization	Expert advise
Soil analysis of agriculture field is performed in soil testing lab. Current weather data are taken from nearest automatic weather station. Weather forecast is received from Super Computer, New Delhi The normals of weather data are calculated on the basis of 30 yrs data set	Farmers accounts are created such as in the banks. Farmer selects the field using touch screen and soil information is displayed on screen. Farmer selects the crop through the picture and same time select the date of sowing. He also furnish information related to fertilizers and irrigations application.	Crop simulation model at server simulate the crop condition and suggest the farmer for fertilizer and irrigation application. If there is pest and disease attack farmer can match the available pictures in system. Once OK by farmer, system suggests type and amount of chemicals.

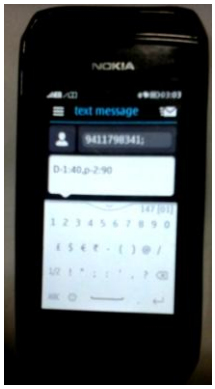
DiPMMS: Android Apps



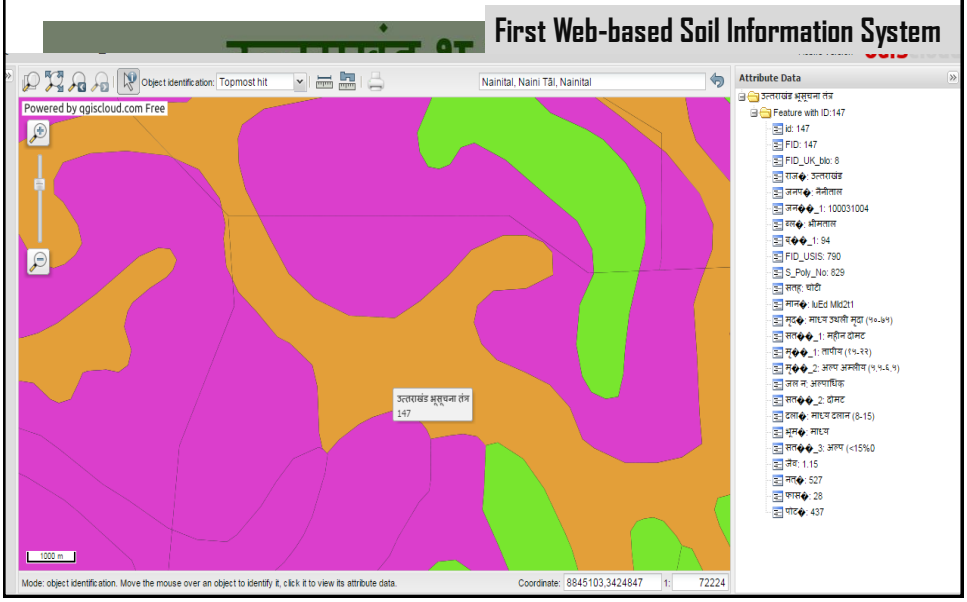
DiPMMS: Text messaging

Prototype of Disease and Pests Monitoring and Management System Developed (DiPMMS)

The performance of Innovative Yellow Rust Monitoring System has been tested on independent data set.



Web Based Soil Information System for Uttarakhand



Contingent Crop Planning

Contingency plan can be defined as a plan aimed and executed for an outcome other than in the usual or expected plan. In other words, it is frequently used for risk management when an exceptional risk in future. In general, the change in sowing or planting time of crops, change in seed rate, change in schedule of fertilizer use, use of short duration varieties, improved crop genotypes form the core component of contingency crop planning.

Contingency Planning:Example

Farming Situation	Crop	4 Weeks Delay	Varieties
Rainfed lower hills/foot hills	Rice - Wheat	Rice can be replace by grain cowpea/ bhindi/ corriander	Cowpea - Pusa Komal,lobia - 1042 Bhindi - Prabhani kranti,Pusa Sawani Coriander : Pant Haritima
Rainfed lower hills/foot hills	Soybean - Wheat	Soybean can be replace by grain cowpea/ bhindi/ corriander	Cowpea - Pusa Komal,lobia - 1042 Bhindi - Prabhani kranti,Pusa Sawani Coriander : Pant Haritima
Rainfed lower hills/foot hills	Maize - wheat	Maize can be replaced by grain cowpea/ bhindi/ corriander	Cowpea - Pusa Komal,lobia - 1042 Bhindi - Prabhani kranti,Pusa Sawani Coriander : Pant Haritima
Rainfed mid hills	Upland Rice - Wheat	Upland Rice can be replaced by horse gram or Buck wheat	Horse Gram : Local,VLG - 1 Buck wheat : PRB - 3
Rainfed mid hills	French bean - Wheat	Frenchbean can be replaced by bhindi/ corriander	Cowpea - Pusa Komal,lobia - 1042 Bhindi - Prabhani kranti,Pusa Sawani Coriander : Pant Haritima
Rainfed High hills	Barnyard/Finger millet - wheat	Delayed sowing of Finger millet	Delayed sowing of Finger millet VLM - 324,VLM - 149
Rainfed High hills	Potato - Wheat	Potato can be replaced by vegetable pea	Potato can be replaced by vegetable pea PSM - 3,VLM - 10,VLM - 7

Crop Weather Calendar

Crop weather calendar is a comprehensive guide for farmers. It is a tool that provides information on average weather of every week, planting, sowing and harvesting periods of locally adapted crops in a specific agro-ecological zone. It also provides stage-wise pest disease infestation information. This information is crucial for proper and timely planning of agricultural activities. Information on crop, its stages and the week by week weather during the crop season is essential for proper management of agriculture. Thus, farm operations planned in conjunction with weather information are very likely to curtail the costs of inputs and various field operations.

Crop Weather Calendar: An Example