E-AGROMET: AN OVERVIEW OF THE ARCHITECTURE

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ABSTRACT

India meteorological department (IMD) is disseminating agromet advisory bulletins, which contain possible weather related risk mitigation measures, to farmers and other stakeholders through about 130 Agro Meteorological Field Units (AMFUs). The AMFUs prepare district-level agromet bulletins based on weather forecast and existing crop status information, The eAgromet is an ICT-enabled agro-meteorological advisory system. The objective of eAgromet is to improve the efficiency of agromet advisory bulletin preparation and dissemination process by exploiting advances in both agriculture and information technologies. In this paper, we explain the background, basic ideas, the components and functionality of the eAgromet prototype.

INTRODUCTION

In agriculture, the crop production dynamics are influenced by multiple factors such as the type of the soil, crop variety, location, weather and management practices. To improve crop productivity, farmers need integrated farm advice that consists of advice for crop protection and production problems, and appropriate risk mitigation measures based on the weather pattern experienced and experiencing by crop.

To help farming community in carrying out weather-related farm management practices, India meteorological department (IMD) is implementing a project called "Integrated Agromet Advisory Service". As a part of this scheme, IMD is issuing agromet bulletins, which contain risk management steps for crop and livestock management, based on the weather forecast twice in a week (Tuesday and Friday) up to 5 days. The agromet advisory bulletins provided by IMD are very unique and complements other efforts of improved agriculture technology transfer methods.

To improve the process of preparing and disseminating agromet bulletins, IMD has initiated a research project in collaboration with IIIT, Hyderabad, India and Agromet Cell, Achraya NG Ranga Agricultural University, Hyderabad, India, to investigate the building of an IT-based agro-meteorological advisory system, called eAgromet. The main objective is to improve the efficiency of preparation and dissemination of agromet bulletins by exploiting developments in agriculture, and information and communication technologies. The effort has started in the year 2011. A basic model of eAgromet has been developed. In this paper we discuss the basic idea, components and functionality of eAgromet.

RELATED WORK

In India, the National Center for Medium Range Weather Forecasting (NCMRWF)/IMD, Ministry of Earth Sciences is providing agro-meteorological advisory service based on the medium range weather forecast to the agriculture community on a regular basis. Starting from five units in 1991, NCMRWF/IMD has established about 130 agro-meteorological advisory units and subsequently IMD has taken over and started giving district wise medium range forecast since June 2008. The impact analysis (Rathore.L.S and Parvinder Maini, 2008) has showed that the weather-based agro-meteorological service is able to reduce the cost of cultivation by 2 per cent to 5 per cent. It was also observed that the advices have improved the yields of various crops. It was also suggested that there is a need to develop a computer-based decision support system and to automate the process of advice dissemination process.

The forecasting of rainfall and temperature distributions can substantially contribute to increased agricultural productivity and farmer livelihood (Meinke and Hammer 2000, Jones *et al.*, 2000). The Agricultural

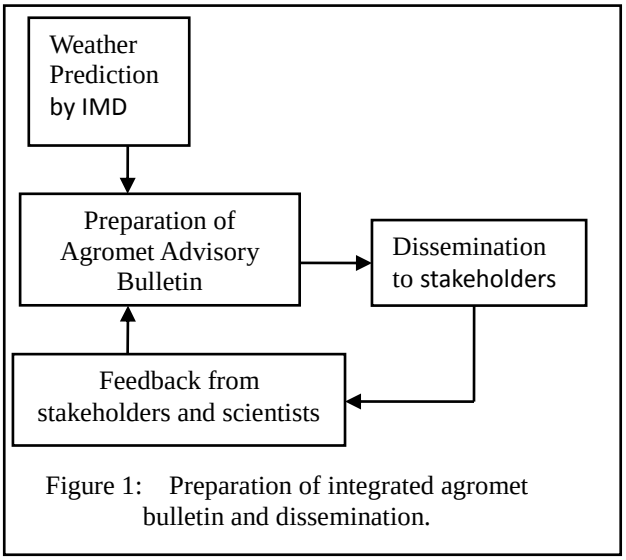
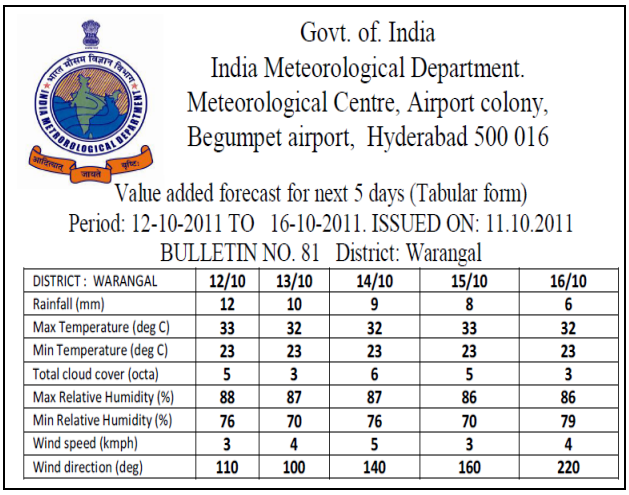


Figure 1: Preparation of integrated agromet bulletin and dissemination.

Production Systems Simulation (APSIM) model developed in Australia has been widely accepted for climate risk management in Agriculture (Meinke *et al.*, 1999). CERES-Rice and WOFOST models were used to simulate the phenology and yield of low land rice in Telangana region of Andhra Pradesh (Reddy *et al.*, 2008) which helps in taking timely farm management decisions.

In India, to resolve the crop protection and production related problems, ministry of agriculture, departments of agriculture, agricultural universities, department of information technology are making efforts to facilitate the advances in agricultural technology to reach farmers through print and electronic media; organizing seminars and gatherings; Web sites; and telephone. Some of efforts include, aAqua, Kisan Call Centers, Digital Green, and eSagu (Krishna Reddy and Ankaiah, 2005; Ratnam, Krishna Reddy and Reddy, 2006).



Govt. of. India
India Meteorological Department.
Meteorological Centre, Airport colony,
Begumpet airport, Hyderabad 500 016

Value added forecast for next 5 days (Tabular form)
Period: 12-10-2011 TO 16-10-2011. ISSUED ON: 11.10.2011
BULLETIN NO. 81 District: Warangal

DISTRICT : WARANGAL	12/10	13/10	14/10	15/10	16/10
Rainfall (mm)	12	10	9	8	6
Max Temperature (deg C)	33	32	32	33	32
Min Temperature (deg C)	23	23	23	23	23
Total cloud cover (octa)	5	3	6	5	3
Max Relative Humidity (%)	88	87	87	86	86
Min Relative Humidity (%)	76	70	76	70	79
Wind speed (kmph)	3	4	5	3	4
Wind direction (deg)	110	100	140	160	220

Figure 2. A sample weather forecast

AGROMET ADVICE PREPARATION PROCESS

The process of agromet advice preparation is divided into four parts (Figure 1).

(i) **Weather prediction by IMD (input)**

The input to the system is the medium range weather forecast at district level from the IMD, which is being received twice a week on Tuesday and Friday, for five days period. The forecast is communicated to about 130 AgroMet Field Units (AMFUs) located at State Agriculture Universities (SAUs) and institutes of Indian Council of Agricultural Research (ICAR). It consists of the predicted values for the following variables concerning each AMFU: minimum temperature (Tmin), maximum temperature (Tmax), relative humidity (RH), rainfall (RF), cloud cover (CC)/radiation (R), wind speed (WS) and wind direction (WD). The sample weather forecast is shown in Figure 2.

(ii) **Preparation of agromet advisory bulletin.** The expert team at AMFUs consisting of scientists from different disciplines of agriculture meets every week on both Tuesday and Friday, and prepares the agromet advisories for different districts, by analyzing how the weather forecast, and the previous few weeks weather conditions confluence the crop status. Figure 3 shows the sample agromet bulletin for the weather forecast given in Figure 2.

(iii) **Dissemination to stakeholders**

The agromet bulletins are put onto the web sites of IMD and university and circulated to press. In addition, these are disseminated to farmers, Krishi Vignan Kendras (KVKs), and non-governmental organizations (NGOs) through e-mail and telephone.

(iv) **Feedback from stakeholders and scientists**

A group of scientists interact regularly with the farmers to get the feedback which will be used to refine the agromet advice.

THE OVERVIEW OF E-AGROMET SYSTEM

After discussing the issues with existing system, we listed the objectives of the proposed system. Next, the notion of weather deviation which is the core concept of the proposed system is explained. Subsequently, the components and operation of eAgromet are discussed.

Issues with the existing system

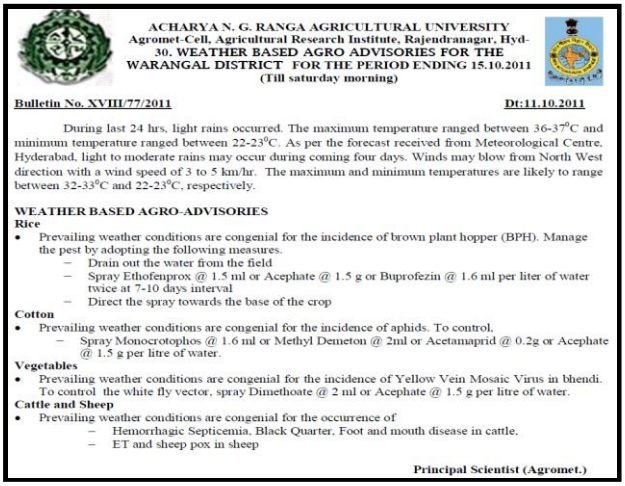
There are several issues with the existing process of preparation of agromet bulletins. The process is human dependent and consumes significant amount of human effort. There is a possibility of providing generic advice. It requires significant effort and coordination to cover all the crops. It is also difficult to prepare the agromet bulletin by considering several crop-, phenophase-, field-, and weather-specific dynamics at a given location and time.

Objectives of eAgromet

After observing the various issues with the existing system operation, the objectives of the eAgromet system are formulated as follows.

- The efficiency of the agromet bulletin preparation process should be increased.

- The agromet bulletins should be searchable and reusable.
- The system should be replicable, and
- The system should be simple to understand and operate.



ACHARYA N. G. RANGA AGRICULTURAL UNIVERSITY
Agromet-Cell, Agricultural Research Institute, Rajendranagar, Hyd-30. WEATHER BASED AGRO ADVISORIES FOR THE WARANGAL DISTRICT FOR THE PERIOD ENDING 15.10.2011
(Till saturday morning)

Bulletin No. XVIII/77/2011 Dt:11.10.2011

During last 24 hrs, light rains occurred. The maximum temperature ranged between 36-37°C and minimum temperature ranged between 22-23°C. As per the forecast received from Meteorological Centre, Hyderabad, light to moderate rains may occur during coming four days. Winds may blow from North West direction with a wind speed of 3 to 5 km/hr. The maximum and minimum temperatures are likely to range between 32-33°C and 22-23°C, respectively.

WEATHER BASED AGRO-ADVISORIES

Rice
- Prevailing weather conditions are congenial for the incidence of brown plant hopper (BPH). Manage the pest by adopting the following measures.
  - Drain out the water from the field
  - Spray Ethofenprox @ 1.5 ml or Acephate @ 1.5 g or Buprofezin @ 1.6 ml per liter of water twice at 7-10 days interval
  - Direct the spray towards the base of the crop

Cotton
- Prevailing weather conditions are congenial for the incidence of aphids. To control,
  - Spray Monocrotophos @ 1.6 ml or Methyl Demeton @ 2ml or Acetamaprid @ 0.2g or Acephate @ 1.5 g per litre of water.

Vegetables
- Prevailing weather conditions are congenial for the incidence of Yellow Vein Mosaic Virus in bhendi. To control the white fly vector, spray Dimethoate @ 2 ml or Acephate @ 1.5 g per litre of water.

Cattle and Sheep
- Prevailing weather conditions are congenial for the occurrence of
  - Hemorrhagic Septicemia, Black Quarter, Foot and mouth disease in cattle,
  - ET and sheep pox in sheep

Principal Scientist (Agromet.)

Figure 3. A sample agromet bulletin (only highlights are shown)

Concept of weather deviation

The notion of weather deviation is conceptualized to build eAgromet. The process of agromet bulletin preparation starts after receiving the weather prediction values data on some date. Let 'df`' represent the day of forecasting, 'pd' represents past duration which is the number of days preceding to 'df', and 'fd' represents the forecasted duration.

At first, the term "weather summary (ws)" is defined as follows. Let `d' be the duration in days. The weather summary of for a duration d, ws(d) is given in Definition 1.

Definition 1: Weather summary for a duration `d' (ws(d)): For each day we receive values for Tmin, Tmax, RH, RF, R, WS, and WD. The notation ws(d) is the summary values for Tmin, Tmax, RH, RF, R. WS, and WD variables over duration `d', i.e., ws(d)=(s(Tmin), s(Tmax), s(RH), s(RF), s(R), s(WS), s(WD)). Here, the notation s(x) indicates the summary of weather variable `x' for duration `d'.

Given df, the change in the weather from pd to fd is captured through the notion of "weather deviation", which is defined in Definition 2.

Definition 2: Weather deviation wd(df): Given df, the weather deviation is indicated by wd(df) which is equal to <df, ws(pd), ws(fd)>, where ws(pd) denotes the weather summary of the past duration and ws(fd) denotes the weather summary of the forecasted duration. Note that the df is a part of fd. The past duration is divided into 7 days intervals and ws is computed for each interval. By replacing ws(pd) with ``ws(-n),.., ws(-2), ws(-1)'', the definition of weather deviation for a given df is as follows: wd(df): <df, ws(-n),.., ws(-2), ws(-1), ws(fd)>. Here, ws(-n) indicates the weather summary of n'th previous week with reference to df.

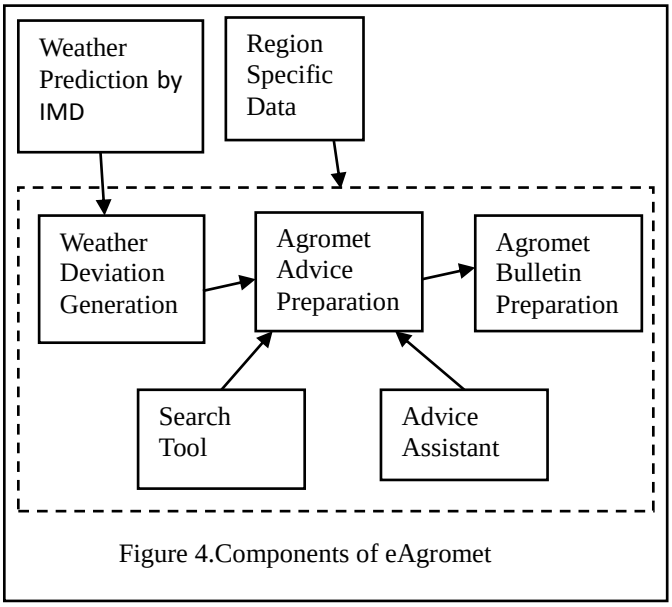


Figure 4.Components of eAgromet

EAGROMET SYSTEM AND OPERATION

The notion of weather deviation is one of the central concept in eAgromet. Based on this concept, other modules have been designed. Overall, the eAgromet system consists of the following components (Figure 4): (i) Region specific data (ii) Weather deviation generation (iii) Advice Assistant (iv) Search tool (v) Agromet advice preparation (vi) Agromet bulletin preparation.

(i) Region specific data
It contains region details. Also, the details of all crops (phenophase and cardinal/critical/favorable weather values) are entered. The details of scientists and stakeholders are entered into the system. The historical weather data (normals/long period averages) of that region is entered. The data is being used by all the other components.

(ii)Weather deviation generation
Based on the weather forecast on certain df, the past weather and predicated weather data is entered and the corresponding weather deviation is generated.

(iii) Advice assistant
For each crop and phenophase, the possible risk management steps are entered by visualizing a different combinations of weather situations.

(iv) Search tool
Given a crop and weather deviation, a search tool extracts similar advices from the history of agromet advices.

(v) Agromet advice preparation
After forming the weather deviation for a given df, the affect of weather deviation on the crops is visualized by agromet expert. By analyzing the effect of both past and predicted weather on a

given crop, one or several types of the following effects on the phenophase of the crop are identified: normal or no effect, cold effect, heat effect, drought effect, dry atmospheric effect, humid atmosphere effect, per-humid atmosphere effect, flooding effect, moisture effect, fog effect, dew effect, cloudy effect, sunny effect, wind speed effect, and wind direction effect. For each of the above identified effect(s), the advice is prepared for the following applicable categories on that phenophase: preparation (field, seed bed); sowing/ planting/ transplanting; inter-cultivation; management of fertilizer, nutrient water pest, decease and weed management; harvesting; and post-harvest handing of the crop produce in crop production.

Agromet expert uses both search and advice assistant tools for preparing agromet bulletins.

- **Use of search tool:** After forming the weather deviation, given the phenophase of the crop, the search tool displays similar advices which have been delivered in the preceding years, in a ranked manner. With search tool, the past agromet advices can be reused.
- **Use of advice assistant tool:** The agromet expert can consult advice assistant tool while preparing agromet advice. Based on the weather summary data of weather deviation, the advice assistant tool displays appropriate risk management steps.

(v) Agromet bulletin preparation,

The agromet bulletin for a given region is the combination of advices of the crops in that region. Based on df, the weather deviation is formed and advices for al the crops have been entered. Based on df and region, all the advices are combined in an appropriate manner for developing the agroment bulletin.

CONCLUSIONS

In this paper the basic model of eAgromet system is explained. The prototype is built by considering rice and cotton crops and weather situations of north telangana and south telangana agro-climatic zones. The agromet experts have prepared the agromet advices using the prototype. The overall feeling by agromet experts is very positive. The system is very easy to use and can be deployed in any region. They can enter the agromet advices without any difficulty. The system is able to display the similar advice.

As a part of future work, we will make effort to refine the system by considering more crops and livestock in different agro-climatic regions. It is hoped that, for a given crop and region, after entering agromet advices for a few years, the effort to prepare new agromet bulletin could be reduced significantly due to efficient search. It is possible to develop a system to generate automated agromet advice for a given crop with minimum human intervention.

REFERENCES

aAqua:Almost all questions answered. http://aaqua.persistent.co.in/aaqua/forum/ index, May 2009.

Digital Green, http://www.digitalgreen.org/, May 2009.

eAgromet: An IT-based Agro-Mateorological Advisory System, 4 Feb 2012, http://eagromet.in.

eSagu: An IT Based personalized agro-advisory system', 12 Dec. 2008, http://www.esagu.in.

Jones, J.W., Hansen, J.W., Royce, F.S., and Messina, C.D., 2000. Potential benefits of climate forecasting to agriculture. *Agriculture, Ecosystems and Environment* 82, 169-184.

Kisan Call Centers, http://www.manage.gov.in/ kisan/default.htm, June 2009.

Krishna Reddy, P., and Ankaiah R. (2005) `A Framework of information technology based agricultural information dissemination system to improve crop productivity', Current Science, vol. 88, no. 12, pp. 1905-1913.

Meinke, H., Hammer, G.L., and Selvaraju, R., 1999. Using Seasonal Climate Forecasts in Agriculture – The Australian Experience. 'Proof of Concept' or 'Taking the Next Step: Concept Adaptation'? International Workshop on Climate Prediction and Agriculture (CLIMAG). Geneva, 27-29 September 1999.

Meinke, H., and Hammer, G., 2000. Experiences in Agricultural Applications of Climate Predictions: Australasia. In: Proceedings of the International Forum on Climate Prediction, Agriculture and Development. IRI-CW/00/1. International Research Institute for Climate Prediction, Palisades, New York. Pp. 52-58.

Rathore.L.S and Parvinder Maini, 2008: Economic Impact Assesment of Agro-Meteorological Advisory Service of NCMRWF, Report No. NMRF/PR/01/2008, 104pp, Published by NCMRWF, Ministry of Earth Sciences, Government of India.

Ratnam, B.V., Krishna Reddy, P., and Reddy, G.S., (2006) `eSagu: An IT based personalized agricultural extension system prototype - Analysis of 51 farmers case studies', International Journal of Education and Development using ICT (IJEDICT), Vol. 2, No. 1.

Reddy, D.R., Sreenivas, G, Mahadevappa, S.G., Rao, S.B.S.N and Varma, N.R.G. 2008. Performance of CERES and WOFOST models in prediction of phenology and yield of rice in Telangana region of Andhra Pradesh. Journal of Agrometeorology (special issue – part I) : 109-110.