VILLAGE-LEVEL ESAGU: A SCALABLE AND LOCATION-SPECIFIC AGRO-ADVISORY SYSTEM

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ABSTRACT

Since 2004, by extending the developments in ICTs to agriculture, an effort is being made to build personalized agricultural advisory system called *eSagu* (The word Sagu means cultivation in Telugu language). The *eSagu system* aims at providing farm-specific agricultural expert advices to the farmers in a timely manner at regular intervals (week to fortnight depending on criticality of crop advice), throughout crop growing period. The expert advice is generated by agricultural experts based on the latest information about the crop situation received in the form of both digital photographs and corresponding feedback text. The impact results show that the expert advice helped the farmers to improve the crop production efficiency by encouraging integrated pest and nutrient management. It was also found that the farmers have realized considerable monetary benefits by reducing the quantity of fertilizer application, pesticide sprays, besides getting the additional yield. From 2011, efforts are being made to make it more cost-effective and improve the coverage. To deliver the location and crop specific advice for all the crops and the farmers in a cost-effective manner, the notion of village-level agricultural expert advisories is being contemplated based on the assumption that the farms belong to given village and adjoining villages (village cluster) having common farming situations face similar crop production problems. In this paper, we will explain the background, system architecture, operational procedure and discuss the advantages and issues of village-level eSagu system.

Keywords: *Agro-informatics, Precision Farming, IT for Agriculture, GIS, Data Mining.*

1. INTRODUCTION

Print media such as newspapers, magazines, and books, and communication media like radio, television and telephone are being used widely to disseminate information or knowledge to masses. Normally, these methods disseminate information in an ad-hoc and generalized manner. Currently, research is going on to investigate improved information dissemination methods by exploiting the recent developments in information and communication technologies (ICTs). Efforts are being made to disseminate functional information through search engines, websites/portals, question/answering systems, publish/subscribe systems, topic directories, discussion forums, information blogs and call centres. It was proposed that developing information systems to deliver personalized information service to each individual is one of the problem areas (Silberschatz and Zdonik, 1996). Progress in database, data warehousing, data mining (Kargupta *et al.*., 2008), mobile, and internet technologies are enabling mass customization and personalized information services (Pine, 1993).

During last decade, research efforts are being made to develop personalized agricultural advisory system to improve the utilization and performance of agricultural technology to improve the farm productivity of Indian farmers. It can be observed that agriculture crop dynamics are influenced by multiple factors such as the type of the crop, location, and weather. To improve agriculture productivity, farmers need integrated agricultural advice that consists of advice for crop protection and production problems besides risk mitigation steps. It is often claimed that, the knowledge delivered through agricultural extension is the cheapest input in bringing a noticeable increase in agricultural output through judicious use of inputs, cost minimization and sustainability. In the field of agriculture, agriculture extension specialization deals with the dissemination of both advanced agriculture technologies and experts' advices to the farming community.

To resolve the crop husbandry related problems, Ministry of agriculture, Departments of agriculture, Ministry of Information Technology, Agricultural and Horticultural Universities are making efforts to facilitate the advances in agricultural/horticultural technologies to reach farmers through print and electronic media; organizing seminars and workshops; Web Portals; Kisan Call Centres etc. Efforts are being made to reach farmers through gatherings, newspapers, magazines, journals, seminars, broadcast media and Websites. In addition efforts (digital green, 2009; aaqua, 2012, Kisan Call Centres, 2012) are being made to provide functional information to farmers. However, there are issues with

these systems such as lack of coverage, accountability, timeliness, relevance, quality, personalization, utility, usability. So, more research efforts are required to devise an effective agro-advisory system.

Since 2004, investigations are going on at IIIT, Hyderabad, India (IIIT-H, 2012) to develop a personalized agro-advisory system called eSagu by extending the developments in ICTs. The eSagu is an IT-based personalized agro-advisory system in which the farmers receive agricultural expert advice to each farm at regular intervals in Telugu language. The eSagu system aims at providing agricultural expert advices to the farmers in a timely and personalized manner. In eSagu, the agricultural experts generate the advice by using the latest information about the crop situation received in the form of both digital photographs and text. The expert advice is delivered to each farm on a regular basis (typically once in a week/two weeks depending on the type of crop) from sowing stage to the harvesting stage.

The eSagu system recognized as an innovative IT-based extension model to help farming community in improving crop productivity through protecting crops. The system has been operated over several years on large number of crops by providing agricultural expert advice to each farm at regular intervals. The analysis of advices have revealed interesting information: given the same crop and same area, not all farms are facing the same problem. The problems of the crop depend on the location and the stage of the crop. But, at the same time, several farms of the same crop are receiving the same advice. In addition, by interacting with the farmers, it was observed that farmers need more cost-effective system without compromising on personalization and localization. Based on these observations we have developed a comprehensive advice delivery system called village-level eSagu. In this paper we explain the background, system architecture, operational procedure and discuss the advantages and issues of village-level eSagu system.

The paper organization is as follows. In the next section, we will discuss the related work. In section 3, we explain the overview of eSagu. In section 4, we will explain the observations of eSagu project and propose the framework of village-level eSagu. In section 5, we will explain the advantages and issues. The last section contains summary and conclusions.

2. RELATED WORK

In (Saravanan, 2010), the comprehensive survey of IT-based agriculture extensions efforts have been provided. Several organizations and government departments have built web portals. There are research efforts to build agriculture information delivery systems like eSagu, aAqua, Kisan Call Centres, and Digital Green. Ministry of agriculture, Indian Council of Agricultual Research, Departments of Agriculture, Agricultural universities, Ministry of Information and Communication Technology are making efforts to facilitate the advances in agricultural technology to reach farmers through print and electronic media; organizing seminars and gatherings; Websites; and Kisan Call centres. Overall, it can be concluded that from the survey provided in (Saravanan, 2010) several efforts are being made and more research efforts are required to build a comprehensive agro-advisory system. Recently, an effort (Krishna Reddy *et al*., 2012), has been started to investigate the building of ICT-based agro-meteorological advisory system to improve the efficiency of agromet advisory bulletin preparation and dissemination process by exploiting both agriculture and information technologies. In that system location-specific risk management steps will be disseminated to the farmers based on weather prediction.

In this paper, an effort has been made to propose an extension to eSagu system. The summary of research related to eSagu is as follows. Since 2004, by extending the developments in ICTs to agriculture, an effort is being made to build personalized agricultural advisory system called *eSagu* to improve the utilization and performance of agricultural technology to improve the crop productivity under Indian farming situation (eSagu, 2012). The *eSagu system* aims at providing farm-specific agricultural expert advices to the farmers in a timely manner. The expert advice is generated by agricultural experts based on the latest information about the crop situation received in the form of both digital photographs and text. The expert advice is delivered to each farm on a regular basis (typically once in a week) from the sowing stage to the harvesting stage. The eSagu system has been implemented on several crops on different regions and encouraging results were obtained. The initial framework was presented in (Krishna Reddy and Ankaiah, 2005). The impact evaluation for the implementation was presented in (Krishna Reddy *et al*., 2005; Venkateswar Rao *et al*., 2012; Ratnam *et al*., 2006). The technology issues and content development issues were explained in (Krishna Reddy *et al*., 2007). The data analysis results on the advisory data is provided in (Uday Kiran *et al*., 2009). The framework proposed in this paper is presented based on the implementation experience of eSagu from 2004.

3. OVERVIEW OF ESAGU SYSTEM

In eSagu, rather than visiting the crop in person, the agricultural scientist delivers the expert advice by getting the crop status in the form of digital photographs and other information. The description of eSagu is as follows (Figure 1): The *farmers* are the end users of the system and may be illiterates. A *coordinator* is an educated and experienced farmer who is stationed in

the village. The coordinator is able to visit the farm without much difficulty. Each coordinator is attached to *eSagu local centre* which contains few computers and a computer operator. *Agricultural Experts* possess a university degree in agriculture and are qualified to provide expert advice based on their wide field exposure and knowledge. *Agricultural Information System* is a computer based information system that contains all the related data. *Communication system* is a mechanism to transmit information from farms to agricultural experts and vice versa. However, the advices (text) can be transmitted from the main system to the local centre through dial-up Internet connection.

The operation of eSagu is as follows. A team of agriculture experts work at the eSagu (main) lab (normally in a city) supported by agricultural information system. One eSagu local centre (few computers and one computer operator) is established for a group of about ten to twenty villages. Educated and experienced farmers (who are from the villages) work as coordinators. Depending on the crop, each coordinator is assigned with a fixed number of farms. The coordinator collects the registration details of the farms under him including soil data, water resources, and capital availability and sends the information to the main eSagu system. After registering the farm, the coordinator visits the farm at regular intervals and collects crop observation data. The duration of visits depend on the crop type and crop stage. Every day, the coordinator visits a fixed number of farms and takes four to five photographs for each farm. In addition, the feedback form is filled-in by coordinator which contains the details of the crop problems and feedback from the farmer regarding previous advice. The data is uploaded through Internet. The Agricultural experts, with diverse background (Entomology, Pathology, Agronomy…) at the eSagu (main) lab analyze the crop situation with respect to weather, other agronomic practices, pest problems and prepare expert advice for each farm. At the local eSagu centre, the advice is downloaded electronically through a dial-up Internet connection. The coordinator collects the advice prints out and delivers it to the concerned farmer. If the farmer has the internet access, he/she can download the advice. The advice is also transmitted through SMS. In this way each farm gets the proactive advice at regular intervals starting from pre-sowing operations to post-harvest practices.

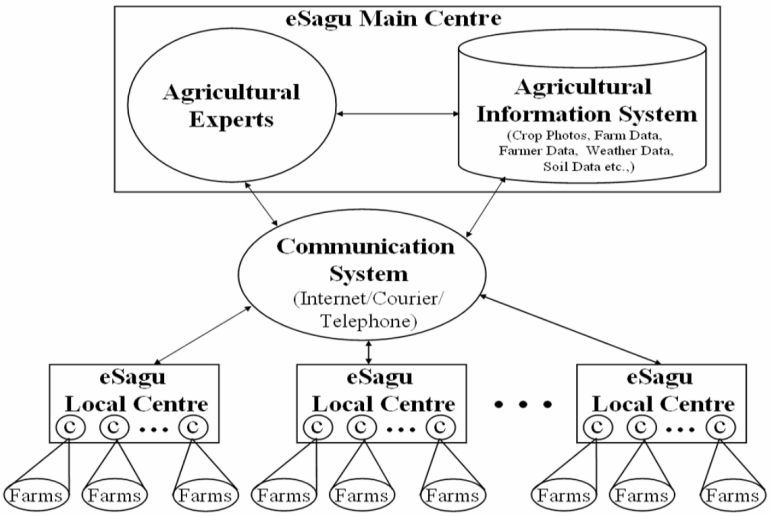

Fig. 1: The Parts of eSagu System Here, 'c' Indicates Coordinators at eSagu Local Centres. Bi-Directional Arrow Indicates Information Flow

Table 1: Deployment Details of eSagu Project

Year	*Villages*	*Farmers*	*Advices*	*Crops*	*Major Crops*
2004–05	3	1051	15,000	1	Cotton
2005–06	40	5094	36443	32	Cotton, Ground nut, Maize, Rice, Sunflower, Redgram, castor, Chilli, watermelon, Tomato, Turmeric, gherkin, onion.
2006–07	149	2779	26969	27	Cotton, Ground nut, Maize, Rice, Marigold, Redgram, Blackgram, Greengram, Sugercane, Sunflower, Chilli, Mango, Potato, Brinjal, Ladyfinger, chrysanthemum, crossanda, Tomato, Turmeric.
2007–08	203	7135	31484	36	Cotton, Ground nut, Maize, Rice, Sunflower,Chilli, Mango, Potato, Citrus, Tomato, Turmeric
2008–09	41	1101	4080	8	Cotton, Ground nut, Maize, Rice, Chilli, Brinjal, Mango, Citrus
2009–10	91	1400	7613	11	Cotton, Maize, Rice, Redgram, Chilli, Brinjal, Mango, Citrus, Clove, Cucumber, Watermelon

The eSagu prototype is being developed from 2004. The details of deployment are shown in Table 1. The impact results show that it is possible for the agricultural expert to provide the expert advice based on the crop photographs and other information. It was also found that the expert advice helped the farmers to improve the agricultural efficiency by encouraging integrated pest and nutrient management through judicious use of pesticides and fertilizers. The impact study shows that the farmers have realized considerable monetary benefits by reducing the quantity of fertilizers and pesticide sprays, and in getting the additional yield.

4. VILLAGE-LEVEL ESAGU

4.1 Observations of eSagu Implementation

It can be observed that agricultural advice will be delivered for each farm at regular intervals in eSagu system. The system was operationalized since 2004 on several crops. The system is very effective in improving the farm productivity and providing other benefits. However, when efforts are being made to scale the system, several issues have been faced:

- The eSagu system significantly benefitted farmers cultivating input intensive crops such as cotton chilies, mango and citrus. For food crops (like cereals, pulses and oilseeds) the profit increase is not as much as in case of cash crops. However, there is overall considerable profit improvement.
- We have analyzed the advices delivered for 1051 cotton farms of three villages in 2004 through data analysis methods (Uday Kiran *et al*., 2009). It was observed that several farms are facing the same problem and, at the same time, considerable number of farms are facing distinct problems in any week during crop cycle period.
- In India, majority of farmers are poor and marginal. The farmers and other stakeholders have felt that the operational cost of personalized advice delivered under eSagu system is high.

4.2 The Proposed Village-Level eSagu System

Based on the above observations, it was felt that we should make innovations to eSagu system with the following objectives:

- The system should be accessible to all levels and types of farmers.
- The notion of personalization and localization should not be compromised.
- All crops (input, knowledge intensive, commercial and food) should be covered.
- The system should be cost-effective.
- The system should enable and encourage community discussion and participation thereby knowledge empowerment at different levels of farming.

To meet the above objectives, the notion of village-level eSagu (VL-eSagu) is being designed. The main objective of village level eSagu is to deliver the location and crop specific advice for all the crops and the farmers in a cost-effective manner. The basic idea of the system is as follows. It is well established that the farms belong to certain village and the adjoining villages having common farming situations face similar production problems. In VL-eSagu, similar to eSagu system, the agro-advices are being delivered based on the digital photographs. It is assumed that the problems and issues of the crop in those villages are akin to the sample farms. For each major crop, we select a sample number of farms and provide eSagu advice to the sample farms at regular intervals. The advice is disseminated to all the farmers by displaying on noticeboards in the village and adjoining villages.

The major steps of VL eSagu system operation are as follows: registration of farmers and identification of sample farms, capturing of farm observations and uploading to eSagu portal, advice delivery by subject matter specialists and advice dissemination to farmers. Similar to eSagu, agriculture scientists deliver the advice. The coordinators are required to send crop problems in the form of digital photographs. The coordinator possesses a digital camera, computer, printer and has access to the Internet facility. The required number of noticeboards will be deployed in each village. At first, a group of five villages with similar farming situation will be identified. About thirty to fifty sample farms (five to ten sample farms for each of five major crops and five farms for other minor crops) will be identified. Sample farms will be identified such that they represent diverse farming situations. During the operational period, as and when the cultivation of new crop starts, five to ten sample farms will be registered for that crop by identifying the corresponding farming situations. The coordinator visits each of the sample farms once in ten days and captures the farm situation through digital photographs and feedback of farmers/coordinator textual information. The coordinator also fills in a feedback form and takes the photograph of that form. The coordinator uploads the observations to eSagu portal using Internet facility. The agricultural experts access the digital photographs of sample farms sent by coordinator and enter the agricultural advice into the eSagu portal. The agricultural advice is prepared based on the digital photographs and other information specific to farms in the concerned villages. It consists of solutions to the crop problems

and best agricultural practices concerning to that village. The coordinator accesses the eSagu portal and downloads the crop-specific advice summaries. The coordinator takes the multiple prints of the advice summaries and displays the advice in the noticeboards in these five villages. The coordinator also distributes the advice to the progressive farmers. All the farmers in five villages get access to agriculture advice through noticeboards at regular intervals throughout the crop growing period.

5. ADVANTAGES AND ISSUES

In addition to retaining all the advantages of eSagu system, the proposed VL-eSagu system is a more comprehensive system due to the following additional advantages:

1. *The knowledge provided by the proposed system is location specific:* It can be observed that the agriculture problems are location-specific. The proposed system identifies the crop problems at the village-level and provide mitigating steps to the farmers of a cluster of villages.
2. *Knowledge is delivered in a timely manner:* The crop photographs arrive once in a week/two weeks for each of the sample farms depending on the criticality of advice to given crop. In addition, farmers can send their crop problems by contacting the coordinator so that system does not allow the problem to grow out of proportion or controls and make efforts to mitigate the problem by identifying it at the early stage itself.
3. *The proposed system covers all the farms/farmers:* As the proposed system captures the problems of sample number of farms for major crops in five villages (cluster) and these villages are from the same farming situation, it is highly probable that other farms also face similar problems. So, most of the farm problems will be covered.
4. *The proposed system is accessible to all the farmers:* This is an important aspect of the proposed system. As the location-specific knowledge is displayed on the common platforms like noticeboards which are accessible to all the population of the village, all the farmers including poor and marginal farmers can access the advisory information and save the crop by taking corrective steps.
5. *The advice is delivered throughout the year:* As the proposed system delivers the advice by considering sample farms, the advice is delivered throughout year as sample farms exist even a few farmers cultivate in any season.
6. *The system is cost-effective:* Overall the system is more cost-effective as compared to eSagu system. The human resources (coordinator and agriculture scientists) will be covering more villages and farmers. Overall, the cost of information delivery is reduced significantly over eSagu system.
7. *The knowledge is delivered at community level:* Disseminating the knowledge at community level enable mutual sharing and discussion and leads to right practice. By catalyzing the community sharing and debate, mutual sharing of knowledge and other resources will be improved.

Even though VL-eSagu system possesses additional advantages, the following issues are to be resolved. These issues will be investigated as a part of future work:

1. As the advice is specific to village level, it may not be totally applicable to all the farms in a village. The assumption that most of the farms face similar problems and issues faced by sample farms should be verified through implementation.
2. The advice is disseminated through noticeboards and other platforms which are easily accessible to farming community. Other avenues of disseminating the advice, in addition to noticeboards, have to be investigated.
3. It is assumed that the farmers will see the noticeboard and map the problem faced by his/her own farm with the problem/solution mentioned in the noticeboard and able to carry out the corrective steps. Appropriate awareness should be provided to poor and marginal farmers.

6. CONCLUSIONS AND FUTURE WORK

Like water, finance, inputs and marketing facility, the knowledge of best agricultural practices is crucial for better farming. We have been investigating the development of an IT-based personalized agro-advisory system, called eSagu, since 2004. By developing and implementing the system over several years, it was felt that Indian farmers need eSagu, to identify the timely detection and resolution of crop health problems in a timely manner. By providing the agricultural advice to each farm at regular intervals from sowing to harvesting, it has been demonstrated that the eSagu enhances the farm productivity and reduces the input cost. It also encourages IPM and INM practices by early detection of crop health problems.

The experience of implementing eSagu over the years indicated that it is required to investigate more scalable system and reduce the cost of information delivery without compromising the location-specific nature of advice delivery. We have proposed an extended system called Village-Level-eSagu in which eSagu will be operated for representative sample of farms belongs to a group of five villages and the corresponding expert advice is disseminated to noticeboards in

the five villages. Through the proposed system we have made an effort to preserve the advantages of eSagu and at the same time improve the scalability and coverage. However, there are several areas of improvement. As a part of future work, we are planning to implement village-level eSagu and evaluate its benefits to farmers and society.

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