eSagu: An IT-Based Personalized Agricultural Extension System-- A Prototype Experience*

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ABSTRACT

The growing trend towards commercial crops with ever changing technology packages necessitate a transformation in the existing agricultural extension system with emerging technologies like IT.In this context IIIT , Hyderabad has developed and implemented eSagu, a Web Based Agricultural Expert Advice Dissemination System in Atmakur mandal, Warangal district during 2004-05 covering 1,051 cotton farms. eSagu system of extension has succeeded in acquisition of infrastructure and human resources as envisaged and proved its organizational ability in coordinating different branches for a smooth functioning on proposed lines. Wholistic information in the form of clear images of crop (through digital photographs and zooming) and other information i.e. soil, weather, crop history has helped scientists to provide effective advice. The system was able to offer collective expert advice from one place with in 24 hours of response time to the farmers at the other end. Further, it is only the information that moved, while the farmers and scientists remained at their respective working places. The system has proved its technical efficiency in terms of pest identification and prediction with appropriate advices based on IPM practices to all sections of farmers. In the process of information dissemination, the system was able to provide 20,000 advices and accumulated 1,11,000 crop photographs in a period of one year. In the field of research it was able to identify new pests like stem borer and early detection of Gray Mildew disease and share the information with other research agencies. As an experiment, the project has tested feasibility and acceptability of IT for tapping its potential as an alternative to the existing extension system. It also offers scope for further reduction in the cost of delivery of advice provided a cluster based approach is adopted in the future.

Keywords: Information and Communication Technologies for development (ICT4D), eSagu, eAgriculture, IT and rural development, Agricultural extension, Information dissemination, Digital divide, Last-mile problem, personalization, scalable systems.

1.0 Introduction

Indian agriculture since mid-eighties has witnessed significant changes in the cropping pattern particularly from coarse cereals to that of commercial crops [12]. Simultaneously, in view of the fast changing seed varieties, new crops, complex technology, yield potentiality and high investment, the farmer has to be active and alert throughout the year to cope with the situation [13]. These technology packages have become largely knowledge based, input intensive and information driven necessitating greater skills and knowledge on the part of the farming community. However, in the absence of these skills and knowledge, the farmers are facing multitude of problems in the form of excessive use of chemical inputs, cost escalation, unvialability of crops leading to severe crisis in agriculture [9][10]. One of the major reasons for such a situation is inadequate extension services that have become a critical and indispensable input in the emerging crops. Further, it is well recognized that the present agricultural extension has to transform itself from its simplistic accent on yield enhancement by increasing some limited inputs to that of adopting wider range of inputs, practices and develop skills in their more efficient use [11]. To sustain agricultural growth, a regular flow of new technology that is creative, dynamic and responsive to changing needs and circumstances must be maintained [19]. It is often claimed that agricultural extension is the cheapest input in bringing about a noticeable increase in agricultural output and has now become vital for judicious use of inputs, cost minimization and sustainability. Given the limitations of public extension and its mode, resource crunch there is a need to strengthen the extension services with the help of emerging technologies. The emphasis is placed on formulation of extension based on inherent production risks in different agro-ecological zones, cultural and socio-economic characteristics of communities [17][18].

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The existing technology development and transfer systems in India including the human resources and infrastructure are outmoded causing serious technology gaps and slippage there it needs to be updated on priority basis [16]. It is in this context, studies have mentioned the capabilities of Internet in disseminating information to farmers [14] application of IT to motivate and educate the farmers at every stage of cultivation [13] and emphasized the need to examine the feasibility and acceptability of IT for tapping its full potential [15].

By exploiting advances in information technology [1][2], an effort has been made at International Institute of Information Technology, Hyderabad (India) to develop an IT-based personalized agricultural extension system (eSagu) to improve agricultural productivity by disseminating a fresh expert agricultural advice to the farmers, both in a timely and personalized manner. An eSagu prototype for 1051 cotton farms covering749 farmers has been developed and implemented in three villages of Oorugonda, Gudeppad and Oglapur in Warangal District, Andhra Pradesh. The results of the project are very impressive. The results show that it is possible for the agriculture experts to deliver the advice by seeing the crop status information in the form of digital photographs and text information. The agricultural expert can more effectively deliver the expert advice as compared to the advice provided by visiting the crop in person. The expert advice has helped the farmers to improve input efficiency by encouraging Integrated Pest Management (IPM) methods, judicious use of pesticides and fertilizers by avoiding their indiscriminate usage. In this paper an attempt is made to explain the development and experiences of the eSagu prototype system.

The model of eSagu is explained in the following section. Section 3, is devoted to explain development and operation of eSagu prototype and operation. In section 4, the results and advantage of eSagu system are analysed. In section 5, the experiences of agricultural experts, coordinators and farmers are discussed. The last section contains conclusions along with observations.

2.0 Introduction to eSagu

The main aim of eSagu is to build a cost-effective and personalized agricultural extension system to deliver timely personalized expert advice to each individual farm at regular intervals (for example, once in a week) from the sowing stage to the harvesting stage, i.e., the system should deliver the expert advice to each individual farm situation once in a week to each farmer's door-step.

Let us consider building system to provide such service by extending the traditional method. Note that the agricultural expert should visit and see each individual farm to provide personalized expert advice. In such a system, the agricultural scientist spends most of the valuable time on traveling and moving in the fields. As a result, one agricultural scientist can only visit a few farms in a day. More agricultural scientists should be employed to cover more farms. However, India has a large pool of agricultural scientists with appropriate expertise, but it is difficult to build a scalable and cost-effective system, which will provide personalized expert advice to each farm in the traditional system.

International Institute of Information Technology, Hyderabad had proposed architecture for alternative system [5] by exploiting the developments in information technology such as database, Internet, and photographic technologies. In the proposed system (we call eSagu) instead of agricultural expert visiting the crop, the crop situation is brought to the agricultural expert using both text and digital photographs. In eSagu ("Sagu" means cultivation in Telugu language) the agricultural expert delivers the expert advice by getting the crop status in the form of digital photographs and other information rather than visiting the crop in person. Note that several farmers in India are illiterate or have a low level of education. It is difficult for them to send the crop situation to agricultural experts using cameras. Therefore, this problem was intended to overcome by assigning such a work to educated farmers in the villages as intermediaries (coordinators) who will send the crop situation of several other farms. eSagu contains five parts (Figure 1) - (i) Farms (ii) Coordinators (iii) Agricultural experts (iv) Agricultural Information System (AIS) and (v) Communication System. These parts are explained briefly.

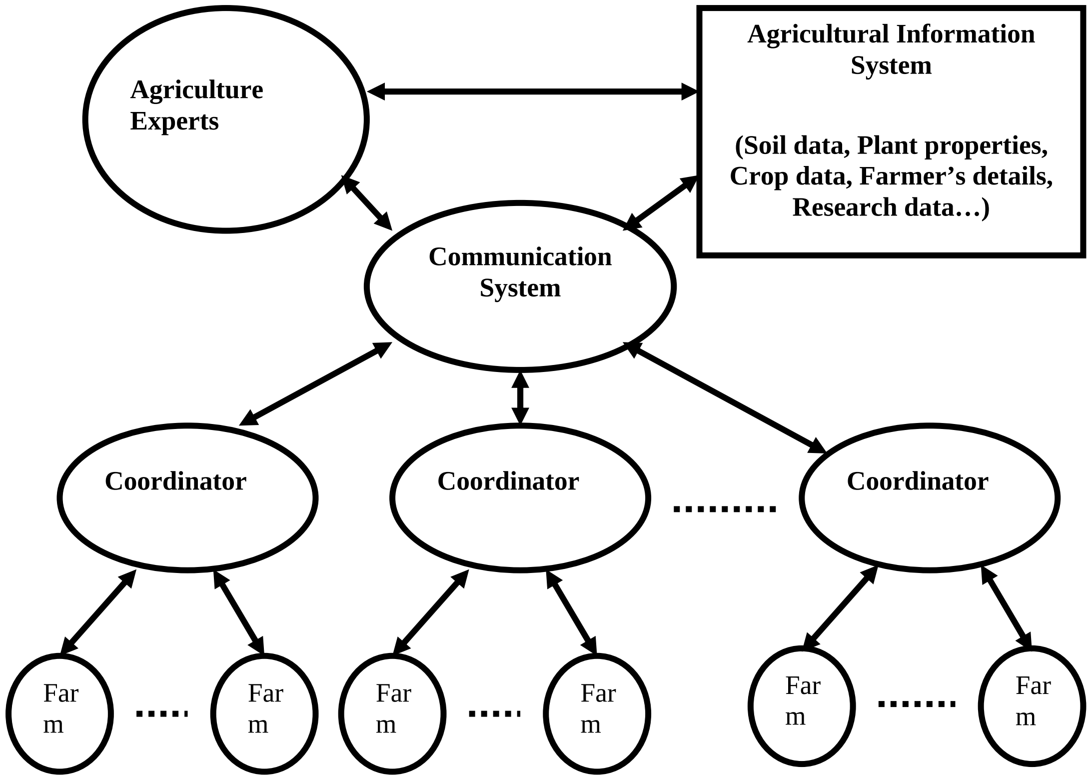

Figure 1: eSagu system (Double arrow indicates information flow/interaction)

(i) **Farms (farmers):** Farms belong to farmers who are the end-users of the system. The farmers could be illiterate and speak a local language. They are not expected to use the system directly. However, if they are educated and have Internet connection, they can use the system themselves.

(ii) **Coordinators:** A coordinator is associated with a group of farms. The coordinator possesses agricultural experience and possesses basic data entry skills. Training in data entry skills will be imparted to the coordinator, if required. He/She visits the crop fields of the farmers entrusted to him/her and enters the relevant data through text-based forms and photographs into the system. Also, when the system produces the advice, the coordinator gets it in the following day. There after, he contacts the concerned farmer, explains the advice and encourages him to follow the advice.

(iii) **Agricultural Experts (AEs):** AEs are individuals who possess scientific agricultural knowledge. Normally, they possess graduation/post-graduation/doctoral degrees in agriculture science with field experience. AEs use research data, soil data, historical data, weather data and other relevant information to generate appropriate recommendation and store this advice in the system.

(iv) **Agricultural Information System:** It is a computer-based information system that contains the related information. It contains the details of each farmer with corresponding soil and crop information. It also contains information about the status of the crop, which is sent in the form of digital photographs and text by the coordinator every week. Also, from the available agricultural technology, the details of various crops (such as the level of pest resistance, requirement of water, and so on) are maintained.

(v) Communication System: It is a mechanism to transmit the farm situation to agricultural experts and corresponding advice from agricultural experts to farmers. A coordinator captures the crop status through digital photographs and field observation. Transmission of digital photographs requires a large bandwidth. If the facility to transport photographs through electronic means does not exist, alternative modes to send the photographs (such as courier, by person and so on) could be employed. However, transmission of the expert advices (text) from agricultural experts to farmers requires very little bandwidth and can be transmitted in an online manner using existing telephone system.

Operation of eSagu:

The operation of the system is as follows. Several farms are assigned to each coordinator. For each farm, the coordinator collects the registration details, which includes details about family, soil, water source capital availability and so on. Also, the coordinator visits the farm on a weekly basis and sends the crop status and farm operation details in the form of text and digital photographs through communication system. By accessing the soil data, farmer's details, crop database, and the information sent by the coordinators, the AEs enter the advice into the system. The advice contains the steps the farmer should take to improve crop productivity. The coordinators get the advice by accessing the system through Internet and explain the advice to the farmer.

3.0 eSagu prototype for 1051 farms

IIIT, Hyderabad has implemented a prototype of eSagu by delivering advice for 1051 cotton farms and 749 farmers, the main elements of which are discussed below.

3.1 Building up of prototype system

Building of prototype system consists of several steps. These steps include crop and location selection, infrastructure procurement and the selection of farmers, coordinators and agricultural experts. These steps are explained in the following paragraphs.

3.1.1 Crop and location selection:

Cotton has emerged as the primary crop in Warangal District during the last few years and has been facing lot of problems in inputs such as seeds, fertilizers, and pesticides and therefore is chosen for this experiment. One more reason for selecting cotton crop is that it is more prone to pests and diseases. It was mentioned in several research reports that due to the following of arbitrary cultivation methods, several farmers have lost the cotton crop and incurred heavy debts [9][10]. Also, cotton is a cash crop and requires a reasonable amount of capital and systematic following of crop management techniques.

Location: Three villages are being selected in which cotton is a major crop for last 15 years. These villages fall in the Northern part of Andhra Pradesh state in India (Figure 2). The three villages, Oglapur, Oorugonda, and Gudeppad are at the distance of about 10 kilometers from Warangal (Andhra Pradesh, India) district head quarters. The agricultural experts stay at Hyderabad, capital of Andhra Pradesh state in India. The Warangal is situated 157 Kilometers North-East of Hyderabad.

Figure 2: Main system is located in Hyderabad and villages are located at 10 kilometers distance from Warangal city.

3.1.2 Identification of farmers, coordinators and AEs:

The scientists have provided expert advice to all the cotton farms in Oglapur, Oorugonda, and Gudeppad villages. Almost all the farmers who grow cotton crop in the selected villages are included in the project. The crop season is from July 2004 to March 2005.

Fourteen progressive and educated farmers from these three villages are appointed as coordinators by conducting written test and interviews. The educational profile of the coordinators ranges from SSC to post-graduation. They are the farmers who have about five to twenty years of experience in cotton cultivation.

Five agricultural experts with masters/doctoral degree in agricultural sciences from Acharya NG Ranga Agricultural University, Hyderabad, India were selected to form scientist group in eSagu. Out of the five Agricultural experts, one is specialized in Plant pathology, one in Soil science and Agricultural chemistry and rest of the three are in Agricultural entomology. All these agricultural experts possess about two years of field experience.

Three programmers were engaged to develop the database system at the main center and maintenance. One programmer was hired to operate computers at the village computer center.

3.1.3 Procuring of computers, digital cameras

The main computer system at Hyderabad is developed with one server and 11 desktop computers. A software system includes a database system is at the back-end and web interface as front-end. MySQL is used to develop database system and PHP is used to connect front-end and back-end applications. A computer center was developed at Oorugonda village with three desktop computers, one printer, and CD writer. One gas-based generator is kept for power backup. Digital cameras with 4-mega-pixel capability were handed-over to the coordinators. Appropriate training is given to coordinators to operate digital cameras.

3.1.4 Developing a database system and other forms

The details of the database system are given in Table 2. By applying database design methodology, we have developed several relational database tables. Farmer table contains the details about the farmer's family, education, address, and experience. Farm table contains the details of farm such as soil type, irrigation source, and identification marks. Advice table contains the details of advice delivered by AEs. Coordinator-Experts table contains the details of coordinator and AE association. Crop-observation table contains the details of crop observation photographs sent by the coordinator and Crop-observation-photos table contains corresponding photos information. Daily-weather table contains the weather details. The details regarding association of farmer and coordinator are stored in Farmer-Coordinator table. The soil details are stored in Soil-details table. Support-group table contains the details of other employees such as agricultural experts, programmers and administrative staff. Finally, Login table contains user names and passwords.

Several forms were prepared to collect different kinds of information. These include farmer registration form, land preparation form, sowing registration form and farm observation form. The details are given in Table 3. Farmer registration form is designed to collect the information regarding the family background and educational profile of the farmer. Land preparation form is designed to collect the details of the steps the farmer has taken to prepare the land. Sowing registration form is designed to collect the sowing details such as date of sowing and so on. Farm observation form is designed to know the details of farm operations every week. Through this form, the agricultural expert gets the feedback regarding the effect of the advice delivered during preceding week.

3.1.5 Communication System

The communication system is needed for two purposes: to transmit crop status photographs from village to the main system at Hyderabad and to transmit advice from the main system to the coordinators.

(A) Village to main system: Since each photograph size comes to 1MB, at a time about 1500 to 2000 photographs (or about 1GB to 2GB) are transmitted to Hyderabad. Internet facility is not available at villages. With the available bandwidth, it was not possible to transmit this information quickly. So the information was written on compact disks and these disks were being transported to the main system by hand.

(B) From the Main system to Village: The advice is in the form of text, which is downloaded by the programmer/ coordinators through telephone facility by accessing the system through Internet.

Table 1: Main details of Prototype System

Type	Value
Crop	Cotton
Location of Farmers	Oorugonda, Gudeppad, Oglapur Villages (Atmakur(M), Warangal(Dist.),A.P., India)
Location of the main system/ Agricultural Experts	Hyderabad, Andhra Pradesh, India
Distance between the main system to the village center	About 200 KM
Number of farmers	749
Number of farms	1051
Number of Coordinators	14
Number of Agricultural Experts	5
Number of programmers	3
Number of Digital Cameras	14
Infrastructure at Hyderabad	10 Desktop-Computers, Server, Printer, CD writer, Scanner, Office equipment
Infrastructure at Oorugonda	2 computers, CD writer, Printer, Generator, Weather meter, Rain gauge, Office equipment

Table 2: Details of the Database

Table name	Fields
Farmer	farmer_id, name, father-name, sex, age, start_date, DOB, experience, crop, background, address, photo, email, phno, details
Farm	farm_id, farmer_id, acreage, soil-type, irrigation, id_marks
Advice	advice_id, expert_id, observation_id, advice_date advice_details, status
Coordinator-Experts	Coordinator_id, expert_id, assoc_date, status
Crop-observation	Observation_date, observation_id, farm_id, status
Crop-observation-photos	Observation_id, photo-link, type
Daily-weather	date, location, max_temperature, min_temperature, max_humidity, min_humidity, rainfall
Farmer-Coordinator	farmer_id, coordinator_id, association_date
Soil-details	farm_id, texture, texture-type, ph, phrange, ec, ecrange, p2o5, p2o5range, nitrogen, phosphorous, potash, urea1, dap, mop1, urea2, ssp, mop2, org_fert
Support-group	user_id, job-title, name, father_name, age, start_date, dob, sex, experience, crop, background address, photo, web, e-email, phno, details
Logins	User-name, password, type

Table 3: Details of Forms

Type	Purpose
Farmer registration form	To collect information regarding farmer's details (name, address)
Land preparation form	To collect information regarding land preparation, organic manure and seed details
Sowing registration form	The details of the crop sowed (seed type, acreage, seed rate, spacing, fertilizers applied, inter-crop, border and trap crops.
Farm observation form	Used to report the farm status every week such as pests, diseases deficiency symptoms. Previous advice received and its feed back, and cultivation practices like irrigation, fertilizer application, weeding etc taken up in the last week.

3.2 Working of eSagu prototype

The first step in implementation of the project was employment of programmers, agricultural experts and coordinators. The development of the complete system such as infrastructure/equipment procurement, software system development, and forms preparation has been completed before operation of the system.

The operation of the system is divided into the following steps: (i) Farmer and farm registration (ii) Collection of the farm status information by coordinator (iii) Renaming of photographs at the village center (iv) Transmission of farm status information to the main system (v) Preparation of advice by agricultural experts (vi) Transmission of advice to the village (vii) Delivery of advice to the farmer. Steps (ii) to (vii) are performed every week for every farm. These steps are explained in detail below.

(i) Farmer and farm registration
The coordinator completes the farmer registration by filling-in the appropriate details using Farmer Registration form, Land Preparation form and Sowing Registration form. At first, the AEs have explained the details of the several forms and cultivation methods that should be carried out before sowing of the crop. The details of soil properties were collected through soil testing. All the details are entered into the main system.

(ii) Collection of farm status information by the coordinator
After filling in the sowing registration form, the agricultural experts know that the farmer has completed the sowing. From this time on-wards, the crop status is collected and sent to the agricultural expert once a week. To collect the crop status, the coordinator visits the farm and performs the following steps. He takes five to ten photographs of the farm. He fills-in the crop observation form and fills-in the corresponding fields that includes the details of pests and deceases and the steps taken by the farmer. Note that the coordinator takes the photographs of several forms in one trip. On a separate sheet, he records the details of farmer-id and number of photographs.

(iii) Renaming of photographs at the village
After taking the photographs, these are downloaded into local computer. The name of each photograph is renamed by associating farm identifier. The renamed photographs are written into CD.

(iv) Transmission of CDs to the main system
Since the data set is huge, the transportation by hand is reliable and fast option. At a time, two to three CDs are being brought to main computer system. The data set is uploaded on computer. The software system stores these photographs into respective farm directories for further processing by agricultural experts based n the farm identifier in the photograph.

(v) Advice preparation by agricultural experts

The agricultural experts enter the text-based advice into the main system by considering the following information.

(a) Farm status photographs. : These photographs taken by the coordinator by seeing the crop.

(b) Photograph of farm observation form: When coordinator visits the crop he also fills-in the form regarding the names/types of pests and deceases with percentage of damage and the steps taken by the farmer for preceding advice.

(c) History of farm: The list of crop status photographs and the received advices were maintained.

(d) Weather information: Daily weather information such as temperature, humidity, and rainfall are maintained.

(d) Soil test information: AEs can access soil test results.

(e) Sowing details: The sowing details such as date of sowing, crop variety and so on.

(vi) Transmission of advice to the village

Through the telephone connection, the programmer at the village center establishes connection with the main system and downloads the advice.

(vii) Delivering the advice to the farmer

The programmer at the village center prints the advice. Coordinator takes the advice and explains it to the farmer.

4.0 Main Results and Benefits

The system was in operation during Kharif 2004 from July 2004 - January 2005. The coordinators have visited each of 1051 farms once a week and sent the status photographs. The AEs generated the advice for each farm every week. The advice was delivered to the corresponding farmer. The main results of the project are listed in this section together with presentation of benefit flows from the project.

4.1 Main Results

(i) **Effective Advice Preparation**: The results show that it is possible for AEs to prepare effective advice based on the photographs. The following additional capabilities help AEs to provide expert advice more effectively than the traditional system.

> **(a) History of farm:** The history is a chronological arrangement of all the advices delivered to a particular farmer along with digital photographs of the crop and associated text starting from the sowing date/preparatory cultivation. It also contains the details of the steps taken by the farmer every week. With history, an AE can easily comprehend the problems of the crop and generate the corresponding advice. It adds an extra dimension to the system as it provides a ready access to a series of advices delivered along with adoption feedback and it will provide very useful information in formulating the current advice.
>
> In addition, weather parameters like temperature, humidity and rainfall details in the cropping area are being recorded and kept for ready access to the expert. It is very useful in predicting some pests. For instance, raising average daily temperatures favor the development of thrips, mites and whiteflies, sudden rains after a prolonged dry spell results in the emergence of adult moths of

cotton bollworms. The personal profile of the farmer with details includes extent of land holding, irrigation source, soil type, variety sown, manures and fertilizers applied etc. is also made available to the expert for ready reference. These details will make a base for advice making.

(b) Availability of several AEs with diverse background at the same place: Note that agriculture is a vast subject and has several faculties. In this system, AEs with different expertise (Entomology, Pathology, Soil science) are available at one place. The proposed system thus, is providing opportunity for an AE to discuss the problem with other agricultural experts and generate the appropriate advice.

(c) Zooming of Photographs: Zooming facility gives the clear picture of the exact crop status for best advice delivery. It is important to note that the photographs can be zoomed to get the finer details of pest and disease, which is difficult to identify clearly with naked eye. By zooming the photographs, the AE can predict the pest/disease/nutritional damage at very early stage. Zooming facility aids in identifying the stages of natural enemies to protect them for biological control of pests.

(d)Usage of Internet: AEs are using Internet extensively for giving expert advice. All the latest advances and innovations can be downloaded from the Internet. It facilitates the Agricultural experts in updating their knowledge in their respective fields of study.

(ii) **Acceptable round-trip response time:**

In this system round-trip response time (<farmer (farm) => coordinator => agricultural expert => coordinator => farmer>) is 24-36 hours. Normally, coordinator starts taking photographs in the morning by visiting several farms in one trip. In the same evening, the coordinator comes back to the village center handovers camera to the programmer. The corresponding CD reaches main center at Hyderabad by hand. Next day morning the advice is prepared which can be downloaded directly at the village center. The coordinator gives the advice to the farmer. To complete the cycle it is taking 24-26 hours. It has been found out that farmers are satisfied even they receive advice within two days. So it is possible to build the system with response time 24-48 hours with available resources. This shows that, we need not have a high speed Internet connection to villages to implement the system. By transmitting crop status data by hand or by courier, we can achieve satisfactory response time.

(iii) Scalability: Coverage of more farms by Agricultural Expert: As compared to traditional system, an AE can cover more farms in the proposed system due to the following reasons.

(a) In the proposed system, the AE spends the energy on giving expert advice only. As a result, more farms can be covered. In traditional system, AE spends his time on traveling and moving around fields.

(b) In the proposed system, AE can work round the clock.

(c) Preparation of advice is done in a standard manner. That is, agricultural experts can take reasonable amount of time to prepare the advice.

(d) Coordinators take the crop status without disturbing the farmer. They need not meet the farmer to get the crop status. However, the coordinator has to meet the farmer to explain the advice. As a result, it is taking equal amount of time for taking photographs and delivering advice.

4.2 Benefits

The implementation of the Project has revealed that it has a larger potential of offering benefits in several ways compared to the earlier systems of extension.

4.2.1 Farmers can cultivate crops like agricultural experts

In this system each individual farmer irrespective of his literacy level and extent of land holding can cultivate crops like an agricultural expert since his crop is under the direct supervision of an expert team of agricultural scientists. The expert team prepares location and crop specific crop plan well before the starting of the season with the help of a technical advisory committee. Soon after registration, this plan will be given to the farmer after making necessary modifications best suited to his farm based on the resources available with him. This kind of planning is very useful especially in organic cultivation where the farmer has to be pro-active rather than reactive. Fresh agricultural advisory will be flowing to the farmer on weekly basis based on the current crop status and feed back from him starting from pre-sowing time to post-harvest period with the help of a coordinator. Hence, farming will be more organized and systematic by this system

4.2.2 Availability of a team of diversified experts at a single place

Crop growth and development is simultaneously influenced by several abiotic and biotic factors. Some times, it is very difficult to diagnose the root cause of some peculiar problems. Often the symptoms of damage will be confusing or totally misleading. In such cases, we need a group of scientists of diverse background for a comprehensive analysis and understanding of the problem. In this system, a team of agricultural experts specialized in major disciplines like agronomy, soil science, agricultural entomology, plant pathology, horticulture and agricultural extension will be operating in an interactive mode at the central office which is as good as all these experts visiting the crop at a time. Otherwise, it is very difficult and expensive also to take all these experts to the farms at remote villages each time.

4.2.3 Saving of time, money and energy

Here, the agricultural experts are placed at one place and crop environment comes to them in the form of digital photographs and text images. Neither the experts nor the farmers should waste their valuable time and energy in traveling to each other either to push or pull the advice. Moreover, the farmers will be very busy in their day-to-day farm operations during peak season and hardly finds time to visit agricultural scientists or department officials to find solutions for their queries. Hitherto, the agricultural expert has to visit the farms even to know the crop is good and can visit relatively a few number of crop fields each day from dawn to dusk. In this system, the experts will spend very less time (few seconds) on good crop and relatively more time on problematic situations (few minutes) which facilitates him to cover more number of farms (few hundreds) each day. The crop status is available round the clock to the experts which enable them to work during night times also if necessary or more number of experts can be engaged with the same infrastructure in shifts that makes the system more cost effective.

4.2.4 More equipped for correct diagnosis of the problem

An agricultural expert needs a comprehensive information regarding soil parameters like soil type, pH, EC, nutrient status, quality of irrigation water; weather information like average daily temperatures, relative humidity and rain fall; history of farm operations performed during that season, endemic or perennial pest and disease problems, pesticides sprayed along with dosage and date of spray etc for right diagnosis of the problem. However, this information is seldom available with the farmers since majority of them are resource poor and illiterate to maintain farm records. Even though some in situ tests can be performed on the field itself to obtain nutrient status, pH, EC and irrigation water quality, it is expensive, cumbersome, time consuming and difficult to cover all the farms. But in this system, the experts are provided with crop data, soil data, weather data and farm history that can drive them towards precision in the process of right diagnosis.

4.2.3 Strong database to support decision-making

The agricultural experts at central office are provided with standard textbooks, agricultural journals, special publications and crop bulletins besides Internet. They collect information that is being disseminated via print and electronic media by different agricultural information centres, local agricultural research stations and state department of agriculture from time to time. The database also contains farm history, soil details, weather data, crop details, case sheet, photo bank and a digital library. Among these, the history of the farm is a vital component while making decisions. It contains each and every operation that is being performed in that crop field and shows how the crop was growing at each stage along with photographs and feed back from the beginning of the cropping season. Soil data will be useful to make decisions related to soil amendments, fertilizer recommendations and crop variety selection. For instance continuous application of complex fertilizers with NPK leads to accumulation of higher quantities of residual phosphorus in the soil making Zinc less available/unavailable to the plants. Hence it is wise to substitute complex fertilizers with straight fertilizers while reducing the quantities of phosphorus fertilizer based on the soil test results. Also, each crop prefers its own pH regime for optimum growth and development, however majority of the crops grow well in the pH range of 6.5-7.5 (neutral). We can make the soil more productive by applying lime or gypsum to bring the pH range best suited to that crop or selecting crop best suited to that pH range. Weather also is an important parameter that helps in predicting the pest and disease out breaks. For example, heavy rain after a prolonged dry spell triggers the emergence of adult moths of cotton bollworms from the soil and egg laying activity commences from the next day. Increasing average daily temperatures favours the development of sucking pests like thrips and mites in cotton crop. Low temperatures with associated drizzles favours the development and spread of leaf spots while water logging due to heavy down pour aggravates soil borne wilt diseases.

4.2.4 Zooming facility adds an extra dimension

The digital photographic technology facilitates zooming of images to several folds on the computer screen to have a close look at the things. The quality of images is good enough to observe pests and diseases even after zooming as the cameras contain large pixel size (4-5 mega pixel). Some times, the expert can also count the number of adults of sucking pests like white flies, aphids, thrips and mites per leaf to estimate economic threshold levels. It is also possible to identify the natural enemy populations that are feeding upon the pest colonies. Hence this facility adds an extra advantage to visualize the things that are commonly ignored with naked eye under field conditions.

4.2.5 Accountability to the farmer

Hitherto, farmers are more influenced by pesticide and seed market personnel, non-technical and inexperienced field staff, and intelligent pesticide vendors (motivated to exploit the farmers) than agricultural scientists and state department officials (employed to help the farmers). The field of agriculture has become free for all to advocate one’s own intelligence sans accountability. But there is an in-built accountability in this system as the agro-advisory developed by each expert is archived and delivered in the form of printed matter. Hence, the experts will be more watchful, pays maximum attention and takes utmost care while developing and submitting the advices. More over, the experts will be proactive and takes all possible precautions to avert the problematic situations by reminding the farmer about the operations to be taken up immediately on weekly basis. Therefore, this system has got more penetration and helps the scientific community to the reach all the farmers in remote villages besides developing credibility.

4.2.6 Capacitating rural livelihoods and employment generation

Agriculture is not only a science but also an art and hence should be both innovative and creative. Unfortunately, the educated youth in the villages are migrating to urban areas desperately searching for jobs. As a result, majority of the uneducated and undereducated are taking up cultivation as a source of livelihood. Even though these farmers are rich in their traditional knowledge acquired from their predecessors about the crops and cropping systems descended through ages, they are often struggling and frequently driven into crises when ever there is a paradigm shift in the crops and cropping patterns. The potential of the educated rural youth can be effectively tapped by actively engaging them in farm activities to help the farmers while helping themselves. Each computer center in a revenue village can generate employment for about a dozen educated and qualified youth. Also, women self help groups (SGHs) can be motivated to take up auxiliary sources of self employment like vermi-composting, mushroom cultivation, sericulture and apiculture under scientific guidance and regular monitoring by experts.

4.2.7 Documentation of success stories and content development

Indian farmers are being inherited with rich traditional knowledge of farming since ancient times. There are instances in the history of Indian farming where farmers got bumper yields by their adept crop husbandry (In 1850s, a farmer in Tanjore district of Madras province recorded about 150 bags of paddy per acre which is three times higher than what the farmers usually get in fertile paddy belts of India). Recently, the Indian Council of Agricultural Research (ICAR) has launched a nation wide project to document these indigenous technologies that made Indian farming sustainable through ages. Farmers, with their creativity and innovation do some experiments and often become successful. Most of the times, these success stories would go unnoticed as they lack proper record of the critical observations needed for scientific analysis and also the conditions under which they achieved that success. These success stories can be replicated in other areas also provided they are systematically recorded, documented and approved by the concerned experts after thorough analysis. This system facilitates not only documentation of such success stories but also a comparative analysis with similar situations in that area as it contains a comprehensive history of all the crops and varieties cultivated during that season. Moreover, a vast number of visuals related to pests, diseases, deficiencies, disorders, natural enemies of crop pests etc. will be generated on all the crops that can be used not only in agricultural extension but also in academics.

4.2.8 Aids in successful implementation of crop insurance scheme

Crop insurance has been an experiment in India even 20 years after its inception in 1984 as Comprehensive Crop Insurance Scheme (CCIS). The current National Agricultural Insurance Scheme (NAIS) is not an exception as setting up of a panel at national level to study crop insurance shortcomings in December 2004 evidenced it. The financial experience of the government with the crop insurance scheme has been disastrous as NAIS was operated on the basis of area approach and its group character had encouraged those wanting to take undue advantage of the scheme. It would appear that in many cases where the actual loss was serious, little or no compensation was paid. There are also cases where there was little loss but the compensation was based on block experience. NAIS was aimed at adopting a new technique of Small Area Crop Estimation Approach (SACEA) taking Gram Panchayat as unit of insurance. But, it failed to implement the same successfully. Adverse selection and moral hazard are the other constraints in successful implementation of crop insurance. In case of adverse selection, only those having the risk will take out crop insurance where the insured are more intelligent and aware of the risks than the insurer. Moral hazard is a case where the insured may change his behaviour because of being insured and take certain actions to collect the indemnity. All the above problems can be effectively addressed by this system as described below:

The unit of insurance can be brought down to micro level far below the Gram Panchayat i.e., if a farmer cultivates 4 or 5 different crops in different pieces of land, each piece of land can be treated as an independent unit.

(a) The history of each independent unit of land along with farmer, crop, soil and weather details will be available on-line and the insurer can access this data base at any time during that cropping season.

(b) Moral hazard can be minimized since the operations performed in each farm can be tracked from time to time in accordance with the agro-advisory delivered by the expert team of scientists.

(c) Adverse selection can also be countered effectively as the expert team evaluates and cautions the farmer about the crops that can be cultivable in that soil under prevailing weather conditions.

(d) Finally, this system helps both the insured and the insurer in settling the claims of indemnity as the damage due to natural calamities like hail storms, inundation due to floods, notified pests and diseases etc. is usually supported by visuals along the relevant weather data.

4.2.9 Maintenance of model farms by the coordinators

Even though the system develops and delivers the agro-advisory, the farmers seldom put the same into practice unless they experiment and experience the success. More than 50 countries are now adopting a learner-centered Farmer Field Schools (FFS) concept developed in Indonesia in 1989 across the world including India with an objective to make the farmers ‘the crop experts’ by helping them to sharpen their skills in the areas of observation and decision making. FFS is a field based learning experience of a group of farmers who meets regularly to observe, discuss, debate and plan strategies of crop production by themselves. The Farmer Field School meets at a specified crop field through out the cropping season in order that participants can observe and analyze the dynamics of the crop ecology under the guidance of a facilitator. Similarly, Coordinators in this system are none other than the progressive and educated farmers of the same village who can shoulder this responsibility. Moreover, they are the first persons to implement the advisory developed by the expert team in their own farms so as to be the role model to other farmers whom they are serving. As a result, the technology adoption rate will be higher than the normal.

4.2.10 Feedback helps to evaluate and improve the performance

The accuracy and effectiveness of the advices delivered by the expert team can be evaluated based on the feedback provided by the farmer each time. The field observation farm contains a provision to obtain information regarding last week's problem, advice delivered by the expert team, acceptance by the farmer and result of adoption or reasons for non-adoption. It also gives information about the practices adopted by the farmer that are not recommended by the expert team. The farmers can also interact with expert team over telephone when ever necessary. The information disseminated via print and electronic media lack feed back to find its relevance to a particular farm situation. Some live phone-in programmes that facilitate farmer-scientist interaction are now being organized via radio and television besides telephone based farmers call centers. But, such systems can address relatively few numbers of farmers (problems) as the expert sitting at the studio spends considerable time in obtaining the information needed to assess the situation before delivering the advice. Moreover, the expert has to take instant decisions based on the information provided by the person making the phone call even though it was found insufficient. However, the system under review has a comprehensive database regarding the farm and the farmer that is necessary to support decision-making. Also, the expert team has enough time to go through latest journals, contact eminent researchers and agricultural information centers before delivering the advice.

5.0 Experiences of prototype project

The implementation of the project has resulted into several experiences at the levels of Agricultural Experts, Coordinators and Farmers and these are shared here.

5.1 Experiences of Agricultural Scientists

The agricultural experts had exciting experiences while working with eSagu. Two of the five experts possessed doctoral degrees with 2-3 years professional experience at various levels in both research and extension. The other three are fresh post-graduates. But all of them have farming background. The members of the team were specialized in soil science, agricultural entomology, plant pathology and agricultural extension and were graduated from Acharya N. G. Ranga Agricultural University, Hyderabad, A.P, India.

5.1.1 Training the coordinators

Initial Training: The coordinators are selected based on both educational qualifications and experience in cotton cultivation. The first assignment started with procedures for soil testing and interpretation of the results. The training was in the form of interactive sessions. Their literacy levels ranged between SSC failed and M.A M.Ed. First, the coordinators are taught with the related technical terms in cotton cultivation that are useful for translating the advices into local language. It took little time for the scientists to give orientation about the package of practices, as they are very much knowledgeable about them. It is understood that they knew about major pests of cotton, their time of occurrence and the chemical options for their control. They are relatively poor when it comes to natural enemies of cotton pests. They are following some thumb rules for chemical sprays. There is no emphasis on economic threshold levels. They were taught about ETLs of different pests and methods of field scouting. They are imparted training in basic photographic techniques to produce quality photographs and instructed about the details to be taken care while taking photos of different pests and diseases to ensure clarity.

Weekly training: On- farm training sessions were conducted every Saturday in the initial two months where the performance of each coordinator during that week has been discussed and measures were suggested to improve their performance. They were taken to field visits with a dual purpose evaluating their fieldwork and also to get first hand information about crop situation and farmers response. During this visits the coordinators were assessed to show the scientists about the way they are scouting the crop field estimating the pest population and taking the representative photographs of each pest/disease.

Need based training: There after, need based field visits and training camps were organized depending on the complexity of the situations. Instructions were given to the coordinators daily along with set of advices and they are also contacted on telephone to give immediate clarification and suggestions.

5.1.2 Development of formats

The scientists felt no difficulty in identifying the pests, diseases and deficiencies by seeing photographs. But mere presence of the pest does not warrant any control. Scientists needed some critical information to the develop management strategies. To serve this purpose an observation format was developed in such a way that it should carry enough information about the farm details to reflect the crop status. Initially, the format was designed to provide information such as farm ID number, date of observation, problems with their respective damage levels, and other field operations like weeding, inter-cultivation, irrigation etc. to meet the data requirement of scientist to formulate an effective advice. In due course of time, the format was enriched by addition of feed back information. Here, scientists also record the data on the problem existed during the previous week, the advice delivered by the system, acceptance and adoption by the farmer, result of adoption or reason for non-adoption. It helped the experts to visualize the field problems so as the make the necessary adjustments in their management strategies to suit that farm situation.

5.1.3 Development of history, weather and case sheet

The scientists had delivered advices in the first two weeks based on the feed back available in the observation formats. When it comes to 3rd week scientists also wanted to know about the first week situation. As a result an arrangement was made to create a facility for the chronological arrangement of agro advisory delivered. Each observation contains feed back of the previous week only, but the history of the form contains all the observation forms with the corresponding photographs and advices delivered. This facility provides an opportunity to quickly go through a series of developments occurred in a particular farm before advocating the next advice. It also helped new expert to immediately set his hands on the crop whenever there is change of guard. Weather is the major factor that influences not only pest population dynamics but also the farm operations like fertilizer application and inter-cultivation especially in rain fed cultivation. Weather information helped us to solve some important problems. However, the operation of the system encountered some difficulties in obtaining and interpreting the weather information and a few of such difficulties are narrated here. Initially scientists had depended on ARS, Warangal for weather information, which is 12 km away from the project villages. It has been observed that the distribution of rainfall was not uniform and was found to be erratic. So a rain gauge, a digital thermometer and hygrometer are set up at the village computer center to record the rainfall, average daily temperature and the relative humidity. During the month of August, majority of the cotton fields showed stunted growth and yellowing of leaves. It was due to excess moisture in the soil that resulted from continuous showers during the preceeding week. The plants resumed full growth soon after inter-cultivation as advocated by the project scientists. The showers also brought significant reduction in aphid population that has been gaining momentum before the showers. The important pest predictions about American bollworm by scientists based on intermittent rains after prolonged dry spells were perfectly matched with the developments in the cotton fields. The weather information helped scientists to alert the farmers to avert building up of certain pests. When the operation reached 3rd month, it took scientists a long time to go through all the feed back farms to know about the type of control measures adopted by the farmers. Then scientists opened a case sheet for each farm to enter important operations and different chemicals sprayed along with date and dose that appear as dossier on the computer screen. It helped the experts to proscribe those options already exploited by the farmers. It also facilitates the intelligent usage of pesticide options to reduce the development of pesticide resistance in the potential pests.

5.1.4 Observation of new pest

The scientists had received some photographs showing wilting plants in isolated patches. The scientists suspected them for vascular wilt and directed coordinators to send some more photographs showing vertical cross section of stem and root system. Surprisingly, scientists found a new type of brilliant red coloured delicate larva with powerful biting and chewing mouthparts inside the stem. This kind of damage was not reported in A.P till now. Immediately the scientists rushed to the field, inspected the plants and recorded some interesting details. The scientists had also collected the larvae and pupae along with some infested plants. The scientists had taken these photographs to eminent cotton scientists like

Dr.T.P.Rajendran, Director, Regional Centre of CICR (Coimbattore), Dr.N.Hariprasad Rao, Principal scientist (Cotton), Lam, Guntur (ANGRAU) and Dr T.B.Gour, Professor, Dept. of Entomology, ANGRAU, Hyderabad. There were two different opinions; Dr.Rajendran said it might be the sesbania borer while Dr.Gour said it is the coffee stem borer. The scientists had reared the pest in the lab to see the adults and know the life cycle with the encouragement from Dr. Radhika, cotton entomologist, RARS, Nandyal (AP). The scientists found that the adult moth was differently featured in contrast to the sesbania borer. The sporadic incidence of this pest is found in all the 3 villages where the project has been implemented indicating that it might be spreading in other areas also.

5.1.5 Reaching farmers in times of crisis

The farmers in these villages faced a new threat in the form of grey mildew disease in the month of November. Continuous monitoring by the scientists helped them to spot the disease early and swing into action to alert not only the farmers in the Project area but also the state extension department. Even though it is a minor disease of cotton, it had devastated the crop not only in Warangal district but also in other cotton growing districts in A.P. According to one estimate by the agricultural scientists of the Project, the damage due to this disease is assessed at Rs.51 crores for the whole of Warangal District. The challenging task before the scientists has been that of convincing the farmers to apply the control measures. There were low cost control measures, but farmers were reluctant to use them due to the simple reason of farmers' misconception about the sulphur spray. The scientists had to conduct a few demonstrations to convince them. Some farmers' who followed this measure in the Project area could save the crop to the tune of 2 quintals per acre.

The farmers were reluctant to spray sulphur arguing that it will cause the severe flower and boll drop. Actually sulfur damages certain crops like cucurbits and hence they are called "sulfur shy", but cotton is not a sulfur shy crop. The farmers generally use sulfur to control powdery mildew on chilli crop and it causes severe leaf and flower drop in this crop. After spraying sulfur, the infected leaves and flowers drop (that happens anyway if they do not spray also) and the farmers perceived that it was because of sulfur spray.

Scientists have also observed varying responses from the farmers across the three Project villages. While farmers from Gudeppad village responded satisfactorily, the farmers from Oglapur responded moderately, the response from Oorugonda farmers was very poor. It seems they were least bothered about advice resulted from best efforts to convince them. Scientists were shocked when some farmers innocently asking them "Are you from Sulfur Company?" It shows the complete disbelief among farmers that nobody would give them a fair advice with out vested interests. Another interesting thing that came to the notice of the scientists was that the pesticide vendors cautioned the farmers not to go for sulfur spray with the false notion that it causes flower and boll drop as they were scared of the potential farmers agitations in the event of flower and boll drop and hence they did not want to take any chance. Majority of the farmers cannot differentiate people from the agriculture department, university and a private company. The influence of private company people and pesticide vendors on the farming community is very high for their intelligent monitoring.

5.1.6 An excellent opportunity for young scientists

The scientists with farming background grew in confidence as the days progressed. It had given them a virtual experience of cultivating cotton crop over large area with a variety of options. Virtually, scientists have gained the experience of all types of cotton varieties under both rain fed and irrigated conditions with different management options from organic cultivation to highly pesticide intensive farming. Scientists knew what was working and what was not under given set of conditions. The scientists had recorded hundreds of case studies that provide scope for further analysis. If this system is extended to all the crops under different agro climatic zones for 2-3 seasons, scientists can capture all types of situations at farmer's field level generating amazing data with vast number of case studies. Obviously, that would become "THE PLANT DOCTOR'S PARADISE".

5.2 Coordinator related experiences

In this three-tier system, coordinator no doubt plays a pivotal role not only in making the crops status reach the scientists, but also to convince the farmers to follow the advices. It is hoped that the young progressive farmers, if appointed as coordinators from within the village would maintain excellent relations with the farmers', thereby making the information flow meaningful and conducive for higher rate of adoption. A few of the coordinators' experiences are narrated below,

5.2.1 Literacy Levels

The literacy levels of the coordinators selected range between SSC to MA, B.Ed. It was observed that the quality of images was more or less equal once the coordinator leaned the basic techniques of camera operation. The coordinators with good understanding of English were found more comfortable while translating the advices to the local Telugu language. However, all of them required orientation training to the technical terms related to crop production and pest management. They have been provided with a small dictionary of technical terms prepared by the agricultural experts.

5.2.2 Age and Ability

The age of the coordinators selected range between 22 years to 56 years. But majority of the coordinators belong to age group between 25-35 years. All of them performed very well in covering the crop fields assigned to them as per calendar. However, two contrasting features were observed between younger and older generations. The young coordinators had shown greater enthusiasm in learning and experimenting new things while the old coordinators used to exhibit a little skepticism for the same. However, the old coordinators were more comfortable in convincing farmers to follow the advices while their younger counterparts felt embarrassed initially when ever they were cross questioned by some farmers. The coordinators grew in their confidence with the help of agricultural experts as the season progressed.

5.2.3 Coordinators becoming experts themselves

The coordinator should capture the farm status in the form of digital images and report the same to the agricultural experts. He should also collect the advices sent by the expert team and deliver the same to the corresponding farmer. However, some coordinators will be overdoing their job by making suggestions on their own as they were systematically trained by the agricultural experts on different aspects of pest, disease and nutrient management. They are also enriched with all the relevant information to boost up their confidence while facing the farmers. A coordinator was sacked for advocating own intelligence. They were explained that their job is analogous to a trained and experienced nurse helping a surgeon in the operation theatre (even though the nurse can perform the operation on her own, she is not entitled to do that). Such instances never reoccurred since then.

5.2.4 About some smart coordinators

Obviously, one must agree that the coordinators play a pivotal role and they are the pillars of this architecture. The experts assume that, what ever they report is true and deliver their goods based on the same. If the coordinators do something silly, then the entire system loses its ground. There are some instances where the coordinators behaved very smart to evade the work. One coordinator had sent photographs from the same field instead of visiting each and every field to take photographs. It is not possible to identify the field from which these photographs have been taken based on the photographs as such. But the digital photographic technology provides a rare and unique facility of recording the date and time of each individual photograph with an accuracy of 1/10 of a second when clicked. When we examined all the images taken in that particular day, it revealed the truth that how much time he had spent in each field, what was the interval between the successive photographs in the same field. The coordinator was immediately sacked for his mischief that also set the other coordinators right. The system also provides some other cross checks like the history provides a series of photographs showing the sequence of crop growth. Photographs can also be interpreted with the weather data such as wet soil and lush green canopy when it rained and dry soil and drooping canopy during dry spells.

5.3. Farmer related experiences

In the Project area, agriculture is the main occupation for 89 per cent of population and is followed by agricultural labour (5.75%) while the rest of them belong to rural artisans, businessmen and jobholders. Literates account for 62.5 per cent where majority of them had undergone primary education only. Farmers belong to different caste groups where backward class (BC) forms bulk of them with 42.7 per cent followed by scheduled caste (SC) and rest belong to all other castes.

5.3.1 Over coming initial skepticism

The farmers were very much skeptical about the eSagu initially. Their compliance to the advices was very poor. The system attacked this problem in three phases. In the first phase, big public meetings were conducted for farmers by inviting the senior scientists in the district, the Joint Director of Agriculture, president of a popular NGO and also the media. In addition, personal letters were also sent to each individual farmer by post explaining them about the project in detail and urging them to utilize eSagu to their fullest advantage. In the second phase, the system has organized small gatherings, group discussions, model demonstrations and field visits. This kind of interactions helped not only to gain farmers' confidence, but also to identify the adoption gaps besides providing first hand information. As a result, farmers started paying attention to eSagu experts. In the third phase, about a hundred selected farmers from these three villages were brought to the Agriculture lab at IIIT, Hyderabad. The farmers were very much convinced after visiting the lab. They had seen their farms on the web. Some of them checked their current farm status and expressed satisfaction. They had seen the literature that has been collected on cotton in the office library. They interacted with some of the best scientists over telephone from the lab. After this visit, the compliance rate of advices picked up momentum.

5.3.2. Farmers were not only isolated but also insulated:

Farmers in these villages were reluctant to share reliable information regarding cotton cultivation. There was lot of disbelief prevailing on what ever the information shared. During one of the group discussions, a farmer narrated his experience like this. There was meeting in their village at the beginning of the season to decide whether to cultivate Bt cotton or not. After hectic discussions, the gathering passed a resolution not to cultivate Bt cotton in that village. But, the persons who lead this meeting sowed Bt cotton with out informing anybody and reaped good crop at the end of the season. Some farmers are misleading others in certain aspects. For example, a farmer bought some powerful and costly chemical to control bollworms (spinosad). He transferred its contents into another bottle bearing label of some other pesticide intended to control sucking pests (imidacloprid). An illiterate fellow farmer collected that bottle, went to a pesticide vendor and bought the wrong pesticide. One of project experts also experienced the same phenomenon during one of his field visits. The experts enquired a farmer about the pesticide he has been spraying. He told some pesticide name. They observed some natural enemies dead. But the pesticide he was spraying should be safe to that natural enemy population. When insisted by the scientist, the farmers revealed that he brought some other pesticide in a used bottle. This surprising experience goes very much in contrary to the existing concept of transfer of technology by introducing it to some progressive farmers in the village. The farmers showing less interest neither to share nor to accept information from fellow farmers with trust. It is in this background, that the importance of eSagu model of extension could arrest this tendency in a gradual manner.

5.3.3 Farmers' present knowledge and skills about cotton cultivation were found inadequate

The knowledge and skills of farmers before the introduction of eSagu in these three villages regarding cotton cultivation were found inadequate. Their pesticide sprays were not need based but they were calendar based. Their knowledge on the modes of action of different pesticides was bare minimum as it was evidenced by their cocktail sprays containing pesticides with same mode of action with doses either much higher or much lower than the prescribed range. Their knowledge levels about nutrient management was also inadequate as it is evidenced by application of complex fertilizers even at boll maturity stage and crop plants were more often suffered with micronutrient deficiencies. However, they possess very good knowledge about the pesticides that can control bollworms and sucking pests. But their knowledge, particularly about diseases was found incomplete as they incurred considerable losses due to grey mildew disease and mealy bug both of them are a minor disease and a minor pest of cotton respectively.

5.3.4. Personalized and continuous advice brought credibility to eSagu

Note that in the prototype system every farm received agricultural expert advice every week continuously. Each farmer has felt that the system is at work for him only. Even though he/she does not visit the farm, the coordinator visits the farm and gets the crop status. Due to the personalized advice, the farmer felt confident and satisfied with the service provided to them through eSagu.

6.0 Observations

Based on the experience, it has been felt that several of the existing assumptions should be changed to build the IT based solutions to help the rural community in third world countries like India.

The assumption that the farmers have traditional knowledge gained through experience and therefore knows how to cultivate the crops is misplaced for at least input intensive and knowledge oriented new crops like Cotton. In fact farmers require expert advice to improve the probability of crop success by reducing the inputs. In case of India it is true that farmers used to cultivate traditional crops like rice and maize using known knowledge. However, farmers are cultivating cash crops like cotton, chillie, banana and they do not know proper cultivation practices. Advanced and timely knowledge is required to cultivate these crops. Every year, new kinds of existing pests and diseases and increasing resistance are emerging. In this scenario, the scientific advices assume significance which eSagu is capable of delivering.

The assumption that farmers will pull the information is incorrect. There are some approaches propagated by several sources/researchers that providing an Internet facility or call center will solve the problem. It may help very few farmers. However, for an illiterate farmer it will do nothing and leave them at the mercy of rich farmers who themselves do not know much. So there is a need to design the system that pushes information to each of the farmers in a personalized manner. This needs human touch that can interact with the farmers at their level and in their language similar to coordinators in the proposed system. The large farmer bias in the existing extension models can be corrected through eSagu model of extension where it covers every one.

The assumption that farmers share the knowledge mutually is proved to be incorrect at least in some instances. One key observation is that there is a growing competition and self-interest among the farmers and growing conception of social prestige is preventing the sharing of key information among the fellow farmers. Wherever the information and experiences are shared mutually among the farmers it is unlikely that they work uniformly across different farms, which have varied features. The eSagu is capable of delivering personalized advice based on the crop status as obtained from every farmer in an objective way.

At the end of the Project, the evaluation study reveals a positive response that the Project has impact on enhanced access and knowledge. The advices worked well in improving the yield and helped in reducing the usage of fertilizers and pesticides. Farmers felt usefulness of this project and they wanted a continuation and even expressed their readiness to pay for such services.

7.0 Conclusions

The kind of transformation that has been taking place towards commercial crops in Indian agriculture, characterized by rapid shifts in technology packages, demands precision farming with greater skills and knowledge on the part of the farming community. The present extension system that mostly geared to enhance yields by increasing limited inputs can’t cope up with the emerging wide range of inputs and practices and has to be updated on a priority basis. It is in this process the role of IT for building new mechanisms to provide information to farmers in a cost effective manner assumes importance.

The project eSagu, as implemented in Warangal district has succeeded in acquisition of infrastructure and human resources as envisaged and proved its organizational ability in coordinating different branches for a smooth functioning on proposed lines. Wholistic information in the form of clear images of crop through digital photographs and zooming and other information i.e. soil, weather, crop history has helped scientists to provide effective advice. The system was able to offer collective expert advice from one place with in 24 hours of response time to the farmers at the other end. Further, it is only the information that moved, while the farmers and scientists remained at their respective working places. The system has proved its technical efficiency in terms of pest identification and prediction with appropriate advice based on IPM practices to all sections of farmers. In the process of information dissemination, the system was able to provide 20,000 advices and accumulated 1,11,000 crop photographs in a period of one year. In the field of research it was able to identify new pests like stem borer and early detection of Gray Mildew disease and share the information with other research agencies. As an experiment the project has tested feasibility and acceptability of IT for tapping its potential as an alternative to the existing extension system. It also offers scope for further reduction in the cost of delivery of advice provided a cluster based approach is adopted in the future.

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