A framework of information technology-based agriculture information dissemination system to improve crop productivity

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The Indian farming community is facing a multitude of problems to maximize crop productivity. In spite of successful research on new agricultural practices concerning crop cultivation, majority of the farmers are not getting upper-bound yield due to several reasons. One of them is that expert/scientific advice regarding crop cultivation is not reaching the farming community in a timely manner. It is true that India possesses valuable agricultural knowledge and expertise. However, a wide information gap exists between research and practice. Indian farmers need timely expert advice to make them more productive and competitive. In this article, we have made an effort to present a solution to bridge the information gap by exploiting advances in information technology. We propose the framework for a cost-effective agricultural information dissemination system (AgrIDS), to disseminate expert agricultural knowledge to the farming community in order to improve crop productivity. AgrIDS is a scalable system which can be incrementally developed and extended to cover all the farmers (crops) of India in a cost-effective manner. It enables the farmer to cultivate a crop with expertise, as that of an agricultural expert, by disseminating both crop and location-specific expert advice in a personalized and timely manner. With AgrIDS, the lag period between research efforts and practice can be reduced significantly. Finally, the proposed system assumes great importance due to the trend of globalization, as it aims to provide expert advice which is crucial to the Indian farmer to harvest different kinds of crop varieties based on the demand in the world market.

ONE can observe that during the last decade progress in information technology (IT) is affecting all spheres of our life. Due to progress in hardware technologies, we are able to procure high-speed reliable computers with huge storage capacities at affordable cost. Also, database and data warehousing technologies can be used to store and retrieve large amounts of information, which can be coupled with Internet technology to deliver information instantaneously to the needy. Recent IT developments enable the maintenance of huge information (text, image, audio and video) repositories with negligible down-time. The stored information can be quickly extracted by millions of users simultaneously. Currently, Internet speed is doubling every nine months[1]. Within a decade, it will be possible to provide instantaneous connectivity (both ways) to millions of people (Indian population) enabling mass customization and personalized services. Also, data mining technology can be used to extract useful knowledge from huge databases and simulation technology can be used to predict into the future[2]. Such IT-based developments provide new opportunities to improve the utilization and performance of livelihood technologies such as agriculture, education, library, health and medical services, and artesian technologies. The research challenge here is to identify the areas where progress in IT could be used to improve the performance of these services and technologies, and build cost-effective IT-based systems that improve the living standards of the rural population (Figure 1). In this article an effort has been made to improve the utilization and performance of agricultural technology by exploiting recent progress in IT.

India's food production has improved significantly during the last three decades due to all-round efforts such as modernizing Indian agriculture, providing it with modern inputs like quality seeds of improved varieties, fertilizers and pesticides, better cultivation methods, application of modern tools and farm equipment, etc. The agricultural sector has today achieved total food self-sufficiency and also made the country a net exporter of agricultural produce[3].

However, Indian agriculture is still facing a multitude of problems to maximize productivity[3–7]. Due to several reasons, majority of the farming community is not getting upper bound yield, despite successful research on new agricultural

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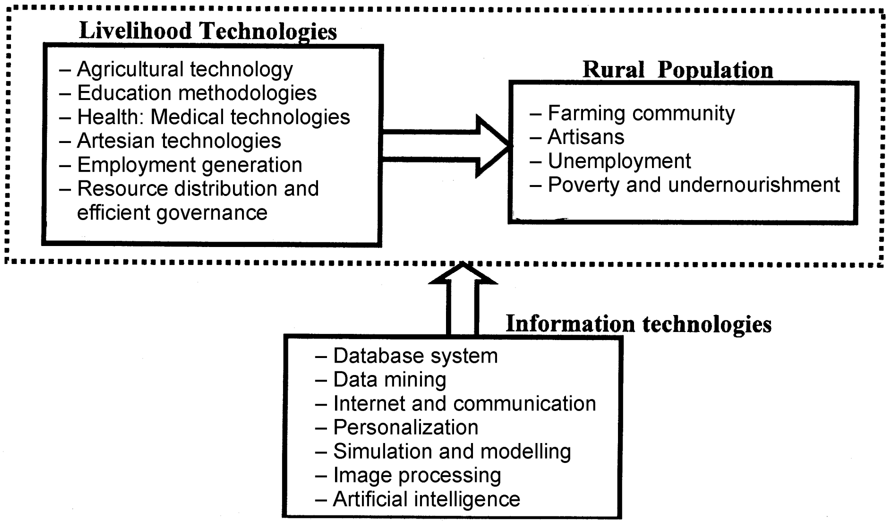

Figure 1. Extension of IT development[5] to improve performance of livelihood technologies.

practices, crop cultivars, crop cultivation and pest control techniques. Here, the term yield refers to the average farm produce. For instance, it can be measured in terms of tons per hectare in case of rice. The term upper bound yield refers to the yield that could be obtained using proper cultivation methods subject to advances in agricultural technology at that time. The upper bound yield may change with progress in agricultural research. One of the reasons is that the appropriate and timely scientific advice about farming is not reaching the farmers[8,9]. In this article, we propose a framework of an agricultural information dissemination system (AgrIDS)[10], by integrating both agriculture and information technologies. The proposed system aims to improve agricultural productivity by disseminating fresh expert agricultural advice to farmers both in a timely and personalized manner. In AgrIDS, the agricultural experts generate advice using both available agricultural technology related to the crop and latest information about the crop situation received through Internet in the form of both text and images (note that an image is a photograph taken by visiting the farmer's field; it is not a satellite image).

Some of the crucial benefits of AgrIDS are as follows. It is a scalable system, which can be incrementally developed and extended to cover all the crops (farmers) of India in a cost-effective manner. It enables the farmer to cultivate a crop with the same expertise as that of an agricultural expert by disseminating both crop and location specific expert advice. Also, since AgrIDS enables quick dissemination of research results to the needy farmers, the lag period between research effort and recommendation can be reduced significantly. Finally, the proposed system assumes great importance due to the trend of globalization, as it aims to provide expert advice which is crucial to motivate the Indian farmer to harvest different kinds of crop varieties based on the demand in the world market.

In the next section, we discuss the motivation, objectives, and scope of AgrIDS. Further, we discuss the system architecture and deal with the effectiveness of AgrIDS. We also estimate the rudimentary economic benefit with AgrIDS by considering the case of cotton farmers. In the last section, we draw conclusions and discuss future work.

Motivation, objectives and scope

In this section we first explain the motivation for AgrIDS. We explain how Indian agriculture is in crisis and discuss the drawbacks of the existing traditional information dissemination or agricultural extension systems. Next, we list out the objectives of AgrIDS and discuss its scope.

Motivation

Agriculture or farming is the backbone of India's economy, as two-thirds of the population live in rural areas and depend (directly or indirectly) on agriculture for a living. (Note that the term agriculture means the art or science of cultivating the ground, including the harvesting of crops, and the rearing and management of livestock. However, in this article the term agriculture indicates the harvesting of crops.) In India, revenue from farming is the only source of income for majority of the farming community. The main requirements to bring a crop to harvest are water resources and capital (to buy seeds, fertilizers, pesticides, labour and so on). For a crop, based on the availability of water resources, raising of the required capital is the main task for any farmer. (In this article we are not dealing with the issue of improving water resources. However, given the information about the availability of water resources, the proposed system aims to improve the productivity by providing suitable advice.) Majority of the farmers try to raise the required capital by compromising on the other necessary expenditure. When farmers are unable to raise the required capital themselves, they often take credit from other sources, including banks and private financial institutions. In this situation, survival of the farmer's family depends on the success of the crop as the repayment of credit hinges on the crop yield. If the crop fails even once, the farmer loses the capital money which is often taken as a credit. As a result, the farmer's family is pushed into an acute crisis causing severe stress[8,9]. Hence failure of the crop should be prevented with all the available resources at our disposal.

It can be observed that compared to the yield in other countries, yield of several crops in India is significantly low. Except for wheat, yield levels of other food grains in India are lower than those in China and the rest of the world (see Table 1). Farmers fail to get high yield due to failure of the crop due to several factors, including bad weather pattern; soil type; improper, excessive, and untimely application of both fertilizers and pesticides; adulterated seeds and pesticides; non-availability of required capital; lack of rainfall and water resources, and low prices for agricultural produce. In addition, plant growth is complex and depends on multiple factors such as crop type, soil type, weather and so on. Due to lack of plant growth information and expert advice, most farmers fail to get the upper-bound yield. Sometimes, the yield falls unexpectedly (for instance, due to a pest attack). Hence it is necessary to find solutions that improve the chances of crop success.

Clearly, the success of a crop depends on the degree of preventing the effect of the factors that disturb the crop. Some factors, such as bad weather and rainfall patterns are difficult to predict fairly in advance even with the current improvements in science and technology. However, the effect of several other factors on crop growth can be understood and the possible corrective steps can be taken using the current advances in agricultural technology. For example, the effect of improper, excessive and untimely application of fertilizers can be reduced by providing information about the amount and type of fertilizers required to get the maximum yield, given the type of soil and crop details. Also, information about type and dosage of the pesticide can be provided given the type of pest and the corresponding crop details. Thus by providing valuable information in advance for the cultivation of crops with the help of current improvements in agricultural technology, the effect of the several factors that disturb the crop can be reduced.

Table 1. Yield levels (kg/ha) of selected crops in India, China and rest of the world in 1997

Crop	India	China	World
Rice	1953	4241	2564
Wheat	2654	4087	2686
Cereals	2232	4844	2971
Pulses	587	1478	806
Food grains	1889	4735	2772
Potato	13003	10149	16130
Sugarcane	69737	75982	63324

Source: FAI, 1998.

Drawbacks of traditional system: Efforts are being made to improve agricultural productivity by facilitating the advances in agricultural technology to reach farmers through magazines and newspapers, broadcast media (radio and television), organizing seminars and group meetings, and through websites. Let us term this as a traditional method. The drawbacks of the traditional approach are as follows[11]:

(a) Irrelevance of the delivered information: Note that the advice is disseminated by considering a large community of farmers and a few crops at a time. It definitely helps a few farmers to know about the advances in agriculture and information related to improving the crop productivity. But for the majority of other farmers, the same advice is irrelevant as they are cultivating different crops. The system does not consider the cases at the individual farmer's level, as each farmer needs a distinct guidance for each crop that he cultivates.
(b) Inability of the system to cover all farmers: In addition, the system is out of reach of majority of farmers, who are illiterate or with low literacy level. Also, it is inappropriate to expect the farmers to keep track of the developments at the research level, because a typical farmer is normally busy taking care of day-to-day farming activities. As a result, majority of the farming community is deprived of proper advice about crop cultivation.
(c) Lack of avenues to improve performance: It can be observed that the traditional system is a one-way process, i.e. information is pushed to the farmer in one direction. Even though a farmer is not satisfied or requires more details, there is no way to improve the service. So the system does not provide an effective way to improve performance, for example, through feedback mechanism.
(d) Unaccountability regarding advice given by the system: In addition, being a one-way process, it is difficult to fix the accountability or responsibility regarding the advice the system is giving. That is, even if the advice does not translate into successful results or the farmer needs more details than what was provided, the system cannot provide the same effectively.

The drawbacks of the traditional system should be rectified to improve performance. Any improved system that we are going to propose should provide expert advice by responding appropriately, considering the case of each crop separately. The proposed information dissemination system aims to provide expert advice on a continuous (daily/weekly) basis by considering each crop situation separately. This means the advice will be personalized[12] with respect to the crop of each farmer. For instance, if the farmer raises the same crop in different kinds of soil, or at more places with the same type of soil, but with a few weeks delay, the system should provide the relevant advice accordingly. Also, if two farmers stay close to each other and cultivate the same crop, they should get appropriate but different advice based on the availability of water resources and other factors. Providing such a personalized and continuous advice to millions of Indian farmers and crops is difficult with traditional methods.

Objectives of AgrIDS

The main objective of the proposed system is to increase profitability of the farmers by increasing the efficiency of agricultural input and reducing the cost of production. This should be achieved by keeping the soil sustainable for long run (health of the soil). We can achieve these objectives by providing timely advice to the farmers in the following areas: pest warning and pest control; fertilizer use in terms of amount and timing; choice of crops to be based on soil tests and other information. It includes the information on cost, profit, and risk factors for various crops; scheduling of crop activities; weather information and type of crop to be raised by forecasting weather; marketing and strategic planning.

Scope of AgrIDS

Indian farmers suffer from a multitude of problems, such as lack of clean drinking water, proper health care, water resources (due to scanty or irregular rainfall) for farming, appropriate advice about farming, financial resources, and adulteration of seeds and pesticides, instability in pricing of agricultural produce and so on.

It is to be clarified that by using the proposed system, it is not possible to solve all the problems faced by the farming community. Our aim is to build a system that exploits the advances in IT to better help farmers to improve crop productivity. For example, the proposed system cannot help farmers if their crop dries up due to lack of water or their produce has no market. The proposed system is not aimed at providing solutions to resolve such situations. However, despite these factors, we believe that by providing timely expert advice to the farmers, we can resolve several situations that are disturbing the crop and improve productivity. For instance, some farmers use excess fertilizers hoping to get more yield and some farmers use excess pesticides due to lack of information. Sometimes, they take loans at higher interest rates to meet unproductive expenses and fall into a debt trap[8,9]. The proposed system is aimed at improving the situation of the farming community by providing fresh and expert advice to the farmers. By providing timely advice, the system aims to reduce the effect of the factors disturbing the crop (such as sudden pest attack) and maximize the yield.

It should be noted that all the problems faced by the farming community are crucial and should be resolved at the earliest. Crop failure (or low yield) is one of the most nagging problems. By considering Internet as a facility to transfer advanced agricultural knowledge to the farming community, we hope to reduce the crop failure problem. The IT component is a new addition to the existing methods. It is an effort to use the advances in IT to disseminate latest agricultural technology to the farming community for higher crop productivity.

The agriculture information dissemination system

We first explain the agricultural and information technologies. Next we explain the architectural and operational aspects of AgrIDS.

Agricultural technologies

In India, the Indian Council of Agricultural Research (ICAR)[13] is an autonomous apex national organization registered as a society, which plans, conducts and promotes research, education, training and transfer of technology for advancement of agriculture and allied sciences. It operates through 46 central research institutes, 4 national bureaus, 10 project directorates, 27 national research centres, 90 all-India coordinated research projects, 261 Krishi Vigyan Kendras and 8 trainers training centres. Also, around 31 agricultural universities have been established in different parts of the country to conduct research.

The field of agriculture is vast and has many specializations, including, agronomy, horticulture, soil science, plant pathology, entomology, agricultural economics, agricultural engineering, plant breeding and genetics, and agricultural extension. Among these specializations, agriculture extension deals with the dissemination of advanced agricultural information to the farmers. Agricultural experts (AEs) are required to provide advice on factors that affect crops and their effect on crop productivity. An AE possesses advanced nontrivial knowledge about management of crops, and the expertise to recommend possible steps based on the current crop situation.

As a result of intensive research, there is increasing knowledge regarding agriculture. Also, given a crop situation, we have a large pool of qualified agricultural scientists to provide appropriate advice to the farmers. In spite of this, majority of the farming community is practising old methods since research and scientific advice is not reaching the needy farmers in a timely manner. Also, as most of the farmers are illiterate or with little education, there is a large gap between agricultural research and its application, resulting in low crop yield. So, there is room to improve education and the method of dissemination of advanced scientific advice to the needy farmers in a timely manner.

Information technologies

Due to tremendous advances during the last decade, IT is today affecting all the spheres of human life. We can exploit these advances to design a cost-effective system to provide expert advice to farmers. Here, we explain some of the advances in IT that can be used to build AgrIDS.

(i) During the last three decades, database and data warehousing technology[14] has been developed, which can be used to store and retrieve large amounts of data (both text and image) efficiently at affordable cost.
(ii) Also, due to advances in networking technology we have Internet technology (or world wide web), which can be used to send information instantaneously to the farming community in parallel. Note that a farmer can have Internet connectivity[15], if he has a telephone. In fact, under AgrIDS, it is sufficient for a village to have a telephone connection so that Internet could be accessed.
(iii) Data mining techniques[16] can be used to extract the possible meaningful patterns for a large amount of data that could give potential useful advice depending upon the situation. Also, modelling and simulation technology can be used to model an ideal crop situation and predict the crop growth through extrapolation and other techniques by considering a specific crop environment.

AgrIDS architecture

One of the methods to provide the crop status to AEs is to facilitate them to visit each farmer's field on a daily or weekly basis, to understand the crop situation. Even though India has a large pool of agricultural scientists with appropriate expertise, it is difficult to cover all the farmers on a weekly/daily basis due to cost and time factors. Moreover, such a system will be expensive to build and maintain.

However, with IT revolution (mainly the database and web technology), it is possible to provide latest expert advice in a timely manner to the farmer and thereby reduce the effect of the factors that disturb the crop. By exploiting the advances in IT, we can enable the AEs to know about the status of the crop in a cost-effective manner. That is, rather than taking the AE to the crop, the status of the crop is brought to the AE through the Internet using both text and images. In this way we can build a cost-effective AgrIDS to provide advanced agricultural advice to the farming community.

AgrIDS can be divided into of four parts: (1) farmers, (2) coordinators, (3) AEs, and (4) agricultural information system (AIS). All parts are connected through the Internet. The architecture of AgrIDS is depicted in Figure 2.

Farmers: They are the end-users of the system, and form the bottom layer. They can be illiterate and speak a local

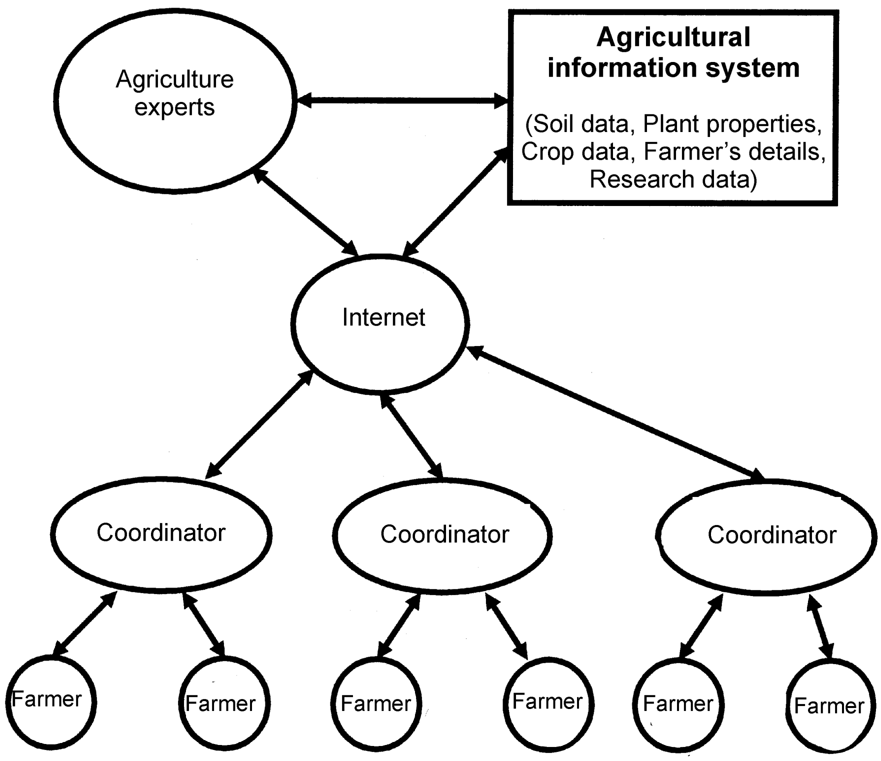

Figure 2. Agricultural information dissemination system. Double arrow indicates information flow.

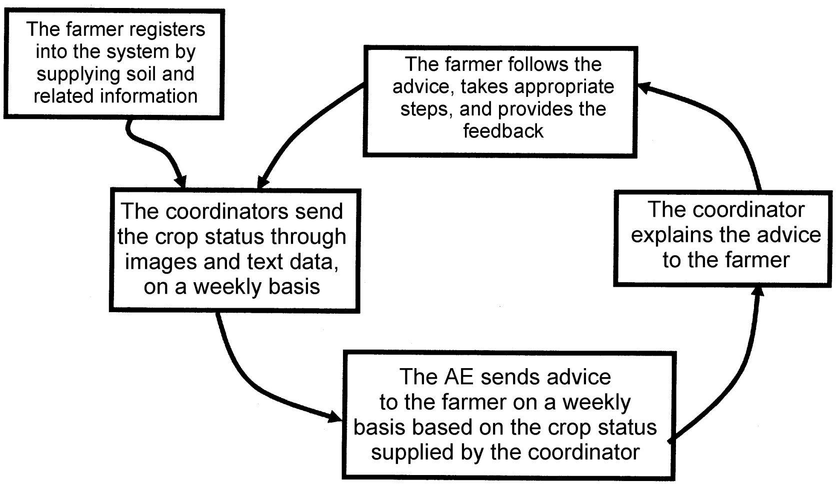

Figure 3. Depiction of AgrIDS operation.

language. They are not expected to use the system directly. However, if they are educated and have an Internet connection, they can use the system themselves.

Coordinators: A coordinator is associated with a group of farmers. The coordinator possesses agricultural experience and basic data-entry skills. Training in data entry skills will be imparted to the coordinator, if required. He visits the crop fields of the farmers associated with him and enters the relevant data through text-based forms and photographs into the system. Also, when the system provides the advice, the coordinator contacts the concerned farmer and explains the personalized advice to him in a timely manner.

AEs: They are agricultural scientists who give appropriate recommendation by interacting with the AIS. They use research, soil and historical data, and other information to generate appropriate recommendation and store this advice in the system. In the proposed AgrIDS, the AEs interact with the knowledge base and crop environment by staying at the same place; the AEs rarely visit the farmer's crop. Instead, the crop environment itself is provided to the AEs in the form of both text and images. So in AgrIDS, both the users and the AEs stay at their respective place of work; only information moves between them through the Internet.

Note that the coordinators transmit the status regarding the information to AEs through text and images (close photographs). One way to understand the crop situation through images is by viewing them carefully. In addition, we believe that the advances in image analysis can be used to provide effective advice. The existing image-processing technologies can be used to better understand the status of crops without physically visiting the fields.

AIS: It is a computer-based information system which contains all the related information. For example, it contains details about the farmer with corresponding soil and crop information. It also contains information on the status of the crop, which is sent in the form of images and text by the coordinator. Also, from the available agricultural technology, details of various crops (such as the level of pest resistance, requirement of water, etc.) are maintained. Building of AIS is the main research task in the system and requires collaborative effort among researchers from agriculture and information technology.

AgrIDS operation

The system works as follows (Figure 3). Each coordinator is associated with a group of farmers. The farmer registers into the system by supplying relevant information, including soil data, water resources, and capital availability through the coordinator. Also, a coordinator visits the crop on a daily or weekly basis and sends crop details in the form of text and digital photographs through the Internet. By accessing the soil data, farmer's details, crop database and information sent by the coordinators, the AEs prepare their advice. This contains the steps that the farmer should take to improve crop productivity. English is the main language used. AEs prepare their advice (which will be translated to the local language) and store it in the system. The coordinators obtain the advice by accessing the system through the Internet. They provide the necessary explanations to the farmer, get their feedback and enter it into the system using the Internet. In this way the system is expected to serve the farmers.

Effectiveness of AgrIDS

We expect that AgriIDS will bring several benefits. Here we discuss some of its merits and benefits.

Suitability for Indian situation

In the 1st century, a Roman farmer Varro is reported to have stated, 'Agriculture is a science which teaches us what crops should be planted in each kind of soil, and what operations are to be carried out, in order that the land may produce the highest yields in perpetuity'. Also, it can be noted that agriculture is a science and farmers are not scientists. By providing expert advice, the proposed system enables the farmers to cultivate just as well as agricultural scientists.

Note that the proposed framework is the first of its kind for the Indian situation. India still has a large illiterate farming community, whose members possess small landholdings. Since independence, we have produced a reasonable number of agricultural engineering graduates, who can play a role of agricultural experts. We also have a reasonably large population who have completed matriculation or intermediate-level, for the role of coordinators. So, for India, given the current situation the proposed three-tier system is the most appropriate that enables utilization of expertise and skills of literate population to serve the farming community.

Effective advice

The advice provided by AgrIDS is more effective compared to the traditional method. Due to the fact that it is a computer-based information system, it has several advantages over the traditional method. In AgrIDS, AEs provide advice similar to the traditional system. In addition, the database and data warehousing technologies enable storing of current and historical database that helps he AEs to access the relevant information instantly. Communication over the Internet reduces the cost of exchange of information significantly. Overall, the proposed AgrIDS improves the method of dissemination of advice for crop cultivation. Also, AgrIDS gives advice in a timely and personalized manner, based on recent status of the crop supplied by the coordinator through text and images.

AgrIDS facilitates the collection and maintenance of a large amount of historical data through database and data warehousing technologies, which is a significant improvement over the other methods. Also, advances in data mining technology can be used to find interesting and useful patterns in the data that can improve crop productivity by providing different types of advice. For example, having market data over 10 years, the system can advice the farmer about probable profits he may earn based on type of crop. Also, by forecasting the weather for the next year and combining it with knowledge of both national and international market demand, it can advice the type of crops to grow.

Scalability and economic sustainability

Using the traditional system, if we want to provide expert advice to all farmers, the AE has to visit each and every farm, which is difficult. However, in AgrIDS, the crop situation is sent to the AE in text-based forms and photographs. There are two crucial advantages. First, the AE spends his time productively for giving advice rather than travelling. Second, the AE spends little time for good crops and more time for bad crops. Since we are providing an advice by tracking the crop situation, at a time, there will be few bad crops. As a result, one AE can give advice about a number of crops. So, the proposed system is scalable with respect to the number of farmers, and is self-sustainable economically. Note that in AgrIDS, a coordinator manages a few farmers and an AE manages a few coordinators and the farmers associated with the corresponding coordinators. Due to the hierarchical nature of the organization, as the number of farmers increases, the number of coordinators increases gradually and the number of AEs increases slowly. So the system is scalable in the sense that the number of farmers serviced by the system can be increased by adding a few AEs. So, the complexity of the system is scalable with the number of farmers and crops. This system can be extended to all parts of India, covering every crop and every farmer.

Regarding economic sustainability, it can be noted that the amount the farmer pays to the system depends on the profit, risk and advice received from the system. If a farmer registers into the system, he will not incur any loss; he will save a substantial amount of money and effort by reducing the unnecessary expenditure (for example, on fertilizers and pesticides), due to the effective advice provided by the system.

The coordinators are not expected to provide expert advice. A farmer who was attended high school can do the job of the coordinator. For a coordinator, it is sufficient to know how to read and write one of the official languages of India. He will be trained appropriately by imparting minimum computer and the other skills required. Coordinators can be supported with appropriate salary per month. For example, consider a small AgrIDS with one AE. In this system, let the AE manage x coordinators and each coordinator manages y farmers. Also, assume that each farmer pays an amount z per month and the coordinator is supported with the amount c per month. The remaining amount $x(yz - c)$ can be used to support one AE and for other expenses. By giving appropriate values, one can observe that the AgrIDS is economically sustainable.

Easy (parallel and incremental) development

It is easy to develop AgrIDS. All available inputs, such as agricultural knowledge, agricultural experts, hardware and software (database and Internet technology) are available. Crop-specific AgrIDS can be developed in parallel. Also, for a given crop, location-specific AgrIDS can be developed for different agricultural regions of India. Each crop-specific AgrIDS can be started with a small number of farmers and expanded to other farmers incrementally.

Reducing the lag period between research efforts and recommendation

Currently, the lag period between a research effort to practice is significantly long, i.e. between 5 and 10 years, and the acceptance of what is recommended is poor in number and brief in life[7]. Also, it has been mentioned[7] that cutting short the lag period between initiation of a research effort and its acceptance by farmers, calls for collaboration of scientists in diverse disciplines.

We expect that AgrIDS will reduce the above lag period significantly. After building the system, any new invention or research result can be quickly disseminated to the required farmers through the Internet. So, AgrIDS brings together scientists and farmers, enabling farmers, to follow recent research findings to improve their crop productivity. Due to a quick feedback mechanism, the AgrIDS enables agricultural researchers to improve or fine-tune their research findings.

Globalization

It should be noted that the proposed system is relevant today due to globalization of Indian agriculture. In future, an Indian farmer has to compete with those from the rest of the world to sell his agricultural produce in local and the world market. In this situation, AgrIDS assumes importance, as scientific advice is essential to harvest the different kinds of crops based on the demand in the globalized world market, to improve the profitability of the Indian farming community.

Case study: Rudimentary analysis of the economic advantage

In this section we provide a rudimentary analysis of the economic advantage that the farmers will get with AgrIDS, by considering the case of cotton crop. We first explain the types of expert advice that would be helpful to farmers to improve cotton productivity. Next, we roughly estimate the economic advantage that the farmers obtain with the expert advice.

Types of expert advice

The following types of expert advice can be provided with AgrIDS in case of cotton crop.

– Using quality seeds, improved high yielding varieties, and hybrid seeds.
– Type and method of sowing and spacing, season and appropriate time.
– Timely cultivation and inter-cultivation methods.
– Methods of fertilizer application, dosage and time of application based on weather parameters in different areas.
– Remedial measures in nutrient-deficient symptoms, identification of deficiency symptoms.
– Advice under waterlogged and severe drought situation.
– Nutrient management under drought and waterlogged condition.
– Advice under adverse climate conditions like low and high temperatures, high relative humidity, waterlogged condition in black soils, *Fusarium* wilt management.
– Remedial measures to prevent square, bud, and boll drop under adverse conditions.
– Crop improvement practices, namely micro-nutrient (zinc, iron, megnesium, gypsum, etc.) and cultural practices, etc.
– Identification of pest damage, occurrence of pest load severity and remedial measures against sucking pests and bollworms.
– Pheromone trap installation for attracting male insects.
– Improved methods on IPM.
– Advanced techniques and methods of spray application.
– Techniques in cotton kapas picking and storage until disposal of produce.
– Marketing price fluctuations.

Rudimentary estimate of economic advantage

Table 2 shows details of expenditure and economic advantage that the farmer gets with expert advice by considering red and black soils. For each soil, two kinds of situation are being considered: Rainfed (RF) and Irrigated dry (ID). The cost of cultivation per acre is given in Indian rupees. Also, the yield per acre without and with expert advice is given in separate columns. The difference is the extra yield that the farmer gets with expert advice. Considering the cost of cotton as Rs 1500 per quintal, the extra benefit is calculated. Note that we have used conservative values considering the market situation in 2002.

For rudimentary estimate, by observing the values in Table 2, we conclude the following:

The average extra yield per acre (X) = 3 quintals per acre.
The price per quintal (Y) = Rs 1500 per quintal.
Extra benefit per acre = 3*1500 = Rs 4500.

We assume that the average size of the farm (cotton) (Z) = 3 acres per farmer.

Extra benefit per farmer = X*Y*Z = 3*3*1500 = Rs 13,500.
Extra benefit for 1000 farmers = 1000*13,500 =
Rs 1,35,00,000 = Rs 135 lakhs.

For instance, for 1000 farmers, the total estimated budget for the AgriIDS (five agricultural scientists + twenty co-ordinators + computers + digital cameras + others) works out to Rs 60 lakhs. The budget for recurring is about Rs 30 lakhs. The remaining cost is for equipment, which can be used over a long period of time. Suppose we assume the equipment cost is distributed over six years, then the cost for equipment per year comes to about Rs 5 lakhs.

So the total expenditure per year, including equipment cost = Rs 35 lakhs.

Thus the overall net benefit with the proposed system per year = Extra economic benefit – System cost = 135 – 35 = Rs 100 lakhs per year (approximately).

Table 2. Expenditure and benefit with and without expert advice for cotton crop with reference to the year 2003

Soil type	Situation	Cost of cultivation (Rs)	Yield without expert advice (quintals/acre)	Yield with expert advice (quintals/acre)	Extra yield (quintals/acre)	Extra benefit (Rs)
Black soil	RF	8000–10,000	10–12	13–16	3–4	4500–6000
Red soil	RF	6000–8000	6–8	8–11	2–3	3000–4500
Black soil	ID	10,000–12,000	12–15	17–22	5–7	7500–10,000
Red soil	ID	8000–10,000	8–10	11–15	3–5	4500–7500

Summary and future work

In this article, by integrating agriculture and IT, the framework for an IT-based agricultural information dissemination system is proposed. By exploiting progress in IT, AgrIDS aims to provide fresh and expert agricultural advice to needy farmers in a timely and personalized manner to improve crop productivity. AgrIDS also aims to increase the profitability of the farmer by increasing the efficiency of agricultural inputs and reducing the cost of production.

AgrIDS can be extended to cover all the crops (farmers) in India in a cost-effective manner. It enables the farmer to cultivate a crop with the same expertise as that of an agricultural expert. Also, the lag period between research effort and recommendation can be reduced significantly. Finally, it aims to motivate the Indian farmer to grow different crop varieties, based on the demand in the world market. Given the current agricultural situation and IT development in India, it is the right time to develop AgrIDS, that has the potential to improve the living standards of the Indian farming community.

To start with, we are planning to build the system for the following crops: cotton, chilies, sugarcane, tobacco. We will carry out a concrete feasibility study involving computer, agriculture, soil science, and social science researchers with respect to cotton crop. Next, we are planning to start a prototype system by selecting a group of farmers and provide advice about timing and amount of fertilizers to be applied, given the crop and soil details. The system will then be extended to provide advice on application of pesticides and other relevant information, by analysing the images and data about the crop which will be supplied by the coordinator. In addition to getting the crop status by viewing images, we are also planning to use the current advances in image-processing technology to analyse images to help the AEs prepare the advice. During the implementation of AgrIDS, we may encounter interesting research problems. Based on the results, the system will then be extended to cover more farmers and crops. Later, we plan to extend the system to provide advice by considering market and atmospheric data, and so on.

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