System for Polyhouse Farmers and Consultants

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Abstract

Although traditional farming is prevalent in India, now new farming technology like polyhouse farming provides better income [1]. Farmers require expert guidance to use this new technology of polyhouse farming. In this paper we propose a system which provides online interaction between farmers and the consultants. This enables the consultant to provide better services to more farmers, which can in turn bring the cost of hiring a consultant down. Such a "high-tech and high-touch" solution can optimally leverage the benefits of technology and human capabilities and could prove to be more effective than fully automated solutions in the longer run.

1. Introduction

Agriculture and allied sectors contributes 24% of the total GDP and provides employment to around 67% Indian population [2]. Indian farmers face several challenges such as small land holding, poor yields due to reliance on inefficient methods of farming, too much reliance on natural phenomena such as rainfall and lack of knowledge of modern methods of agriculture.

Polyhouse farming is an alternative new technique in agriculture gaining foothold in rural India. It reduces dependency on rainfall and makes the optimum use of land and water resources. A typical, traditional farm of 500 square meters would generate an estimated annual income of Rs. 10,000 to 20,000, compared to estimated annual income from similar sized polyhouse of Rs. 45,000 to 50,000 [3]. Potentially, polyhouse farming can help the farmer generate income around the year growing multiple crops. This also helps them spread their risks.

Polyhouse farming enables cultivation of crops that can give maximum yield on specific days (e.g. roses on Valentine's day) and exotic crops that can't be normally grown in Indian conditions (e.g. coloured capsicum, broccoli, mushrooms). It also enables cultivation of regular crops off-season, thus fetching the farmer a higher price (e.g. tomato, chilli, capsicum, brinjal, cucumber, cabbage, cauliflower).

Polyhouse farming entails construction of a metal structure covered by polythene. Parameters such as moisture, soil nutrients and temperature in the polyhouse are controlled to ensure timely and abundant yields.

Typical polyhouses are from 500 square meters to 10,000 square meters, which makes them suitable for farmers with small land holding. The polyhouse also differ in terms of cost. Government of India gives 50% subsidy for low cost polyhouses, 20% for medium cost polyhouses and 10% for high cost polyhouses as an incentive [1], [4]. Information for the installation of the Polyhouse is provided by various agriculture universities, District Central Nurseries and also by private consultants [5]. Currently, farmers from the states of Himachal Pradesh, Punjab and Maharashtra are taking interest in polyhouse farming [6].

Polyhouse farming process requires expertise in three areas - construction of the structure, cultivation techniques and marketing. Within cultivation, the pre-harvest techniques include irrigation, providing fertilisers, pesticides and micro-nutrients, maintaining temperature, humidity and sunlight in the polyhouse, cutting, pruning and cleaning practices and controlling pH and electrical conductivity of the soil. The post-harvest techniques include cutting, storage cooling chambers and transport by cooling vans.

The government as well as private polyhouse construction companies provide practical training to the farmers for a month or two. However, this short training is not sufficient to understand the complex polyhouse farming techniques, particularly the pre-harvest techniques.

This has given rise to a new profession of a polyhouse consultant. While the farmers do the actual work, the consultant provides the schedule of tasks on an ongoing basis. The consultant frequently visits the sites for investigating as well as scheduling the production cycle and reviews soil sample reports. Depending on the area of the polyhouse, a consultant charges between Rs. 30,000 to Rs. 50,000 per year. Such services are also provided by the companies that erect polyhouses.

However there are several challenges in this model. The consultant needs to physically visit the polyhouse 1 to 4. This limits the number of farmers he can service and his geographical spread, though some consultants serve farmers in a radius of 500 km. But as the distance increases, the contact between the consultant and the farmer reduces. All this adds up to the consultant's cost and limits the number of farmers one consultant can serve.

2. Polyhouse Automation

Polyhouses have reached a high level of automation. Some commercial polyhouse systems automatically monitor and control several environmental parameters including inside air temperature, relativity humidity, soil pH value and electrical conductivity. A farmer can set reference values and then the system maintains these values automatically [8].

However such systems are very expensive. A low- to medium-cost polyhouse could cost between Rs. 125 to Rs. 500 per square meter in India, whereas a high-cost, fully-automated polyhouse costs Rs. 2,000 per square meter [1], [8]. Most Indian farmers cannot afford such high costs. Moreover, automation is not a major problem in Indian polyhouses, since labour is not very expensive. On the other hand, lack of expertise is a major problem for Indian farmers and it would get enhanced if a fully automated system is to be installed.

A "high-tech and high-touch" solution that optimally leverages the benefits of information and communication technologies and human capabilities could provide an alternative solution.

Preliminary work for such a system was done by Rokade [9]. He proposed a system that acts as a go-between polyhouse farmers and consultants. He designed a device that represents the farmer side of the system. Through it, the consultant suggests daily activities to the farmer. The device can measure the internal polyhouse parameters with relatively low-cost sensors. If these parameters cross the desired limits set by the consultant, the device warns the farmer.

The device has an audio visual interface to enable even semi-literate farmers to use the product. It plays alarms and instructions as spoken words as well as displays text. The device displays photographs of materials needed for the polyhouse (such as fertilisers, pesticides and micronutrients) to minimise confusions during procurement. The device enables two-way off-line communication between the farmer and the consultant to resolve problems. The farmer can shoot pictures and send to the consultant.

We extended this work by designing the product from the consultant's view. We also made some changes to the device interface so that it can run off a standard mobile phone. We started the project with a first-hand understanding of polyhouse farming through contextual inquiries. The next section describes our findings. Next, our design proposals for the consultant's and farmer's interfaces are described. Our design was iteratively improved upon through 3 iterations of design and user feedback.

3. Contextual Inquiry

We conducted contextual inquires over three different states Maharashtra, Gujarat and Tamil Nadu. Users included 18 farmers (of which 5 were polyhouse farmers and rest were traditional farmers) and 3 consultants. All farmers had mobile phones in their family and had been using it for more than a year. Apart from that most of them had exposure to TVs and radios. Consultants had mobile phones and an exposure to net browsing.

Polyhouse farmers typically had 0.1 acres (about 500 square meters) of land where they grew at least three crops each year. All of them were small land holders. None of them had formal education in agriculture; however all had attended a training program by an agricultural university. The polyhouse structures were installed either by a university or a private company.

After the polyhouses were erected, polyhouse consultants started providing services to framers on an ongoing basis.

A consultant typically visits the site 1 to 4 times a month depending upon the crop production cycle. He decides a schedule for fertilisers, pesticides, fungicides and micronutrients to be followed until his next visit. Fertilisers and micronutrients are to be mixed with water and supplied through drip irrigation. In case of rose cultivation the consultant splits the fertilisers and micronutrients into two tanks (A and B). In other cases, there is only one tank. Pesticides and fungicides are to be sprayed directly on the plant. Consultants also note down the regular practices that need to be followed such as cleaning, cutting, pinching of roses etc.

He writes a schedule in a notebook which is kept with the farmer. Consultants have different patterns to write the schedules and this may lead to occasional confusions in the minds of the farmers.

A typical daily schedule of the farmer starts with harvesting the ready crops and sending them to the market (harvesting is a regular practice around the year in a polyhouse). Then the farmer adds fertilisers and micronutrients to the soil. The farmer checks crops regularly for detecting diseases. The farmer takes soil samples once or twice a month to check pH of soil, electric conductivity, relative humidity and temperature to a nearby soil testing laboratory. Some polyhouses are installed with small sensors for detecting all these parameters.

The farmers typically buy supplies once a month. Procuring poor quality supplies (fertilisers, micronutrients, pesticides etc.) may damage the crops. Sometimes a farmer may buy supplies on the recommendation of a neighbour (particularly if the neighbour had had a good yield). At other times, he may buy a cheaper substitute. The substitute may not have the equivalent concentration or required quality. The problem is enhanced because the consultant rarely suggests a specific brand name for supplies. The local agriculture development officer, manufacturers, and retailers help farmers buy the correct brand of supplies that match the schedule provided by the consultant.

When the farmer notices an unknown symptom, the farmer immediately calls the consultant for help. Sometimes affected crop samples are sent to the consultant. The consultant may visit the farmer on a short notice or suggest remedial action on the phone.

Thus the consultant does the calculation and long term planning for controlling internal environment whereas the farmer does the job of measurement and adjustment on day to day basis.

4. The Consultant's Interface

Consultants are either faculty members in an agricultural university or agricultural graduates living in cities or large towns. They usually have access to an Internet connected computer and are familiar with English. We therefore propose an application that offers a web-based interface for the consultant on a desktop PC in English. Some of the consultants used a slow dial-up connection – hence we propose that the consultant should be able to use the interface in an offline mode.

The landing page of the consultant's application shows a dashboard for each farmer (figure 1). Each dashboard summarizes the current week's schedule for each of the farmer's crops and a report of activities. It shows whether or not the fertilizer schedule has been followed by the farmer and also lists links to the most recent communication between the farmer and the consultant. Dashboards of farmers with pending tasks or queries automatically scroll to the top of the page (just like messages in an inbox of an email application). The left margin also has an alphabetical list of all the farmer customers. When the consultant clicks on the name of a farmer, the page on the right automatically scrolls to the dashboard of that farmer.

From the dashboard, the consultant can drill down to the detailed schedule for that farmer (figure 2). The detailed schedule allows the consultant to view the past schedule and change the future schedule for all activities including fertilisers, pesticides, micronutrients, and general practices like cutting, shedding, pinching and cleaning.

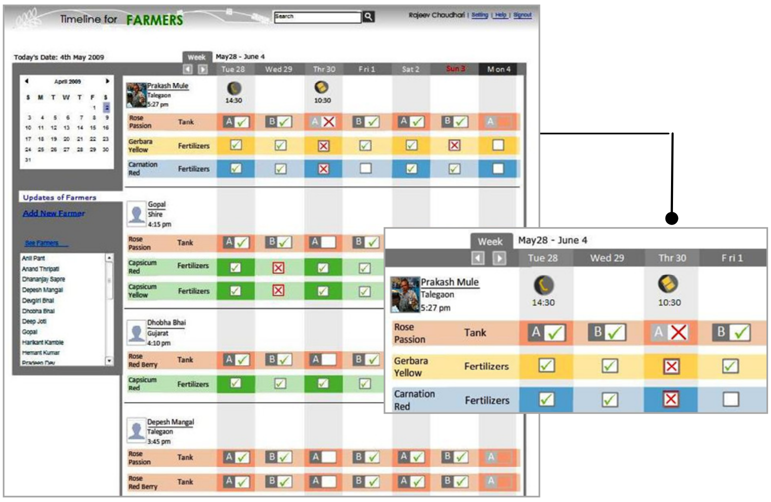

Figure 1. The landing page of the consultant shows a dashboard for each farmer. The green tick indicated that the schedule activity was completed by the farmer.

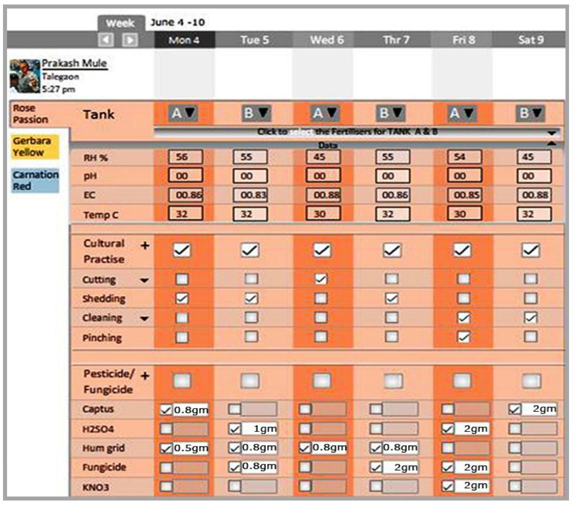

Figure 2. The schedule of farmer is prepared by selecting through checkbox.

Both on the landing page as well as on the detailed schedule, the consultant can scroll to the left to see past and to the right to see future. The system records phone discussions between the farmer and the consultant and stores pictures sent by farmers. These can be accessed by clicking the corresponding icons on the dash board or the detailed schedule page.

5. The Farmer's Interface

In rural areas use of personal computers have a limited penetration, whereas the mobile phone penetration has been growing exponentially [7]. Most farmers that we met had access to mobile phones. But they had little or no exposure to the web and little knowledge of English. We therefore propose a mobile phone based Marathi interface for the farmers.

The farmer's mobile phone is provided with a new application that replaces the usual desktop of the farmer's phone. The schedule prepared by the consultant is sent to farmer's mobile phone. At all times, the desktop summarises the farmer's schedule for the day and the next day or two (figure 3). In this summary view, each scheduled activity is represented by an icon. If the activity has been completed, the icon is filled in green colour. If the activity is unfinished, it stays grey.

The farmer can scroll the dates horizontally and drill down to the detailed schedule for the day. The detailed schedule shows icons as well as text of the task and allows the farmer to mark the completion of each task. The farmer can mark each activity as finished, or carry forward the activity for the next day or leave it unfinished. If on a day there are activities from the earlier day that were unfinished and not carried forward to the next day, the desktop will show the earlier day and its unfinished activities as well as the current day.

Figure 3. The farmer's interface – desktop and detailed each crop schedule.

From the detailed schedule, the farmer can drill down further to understand the task details (figure 4). On this screen detailed instructions are displayed as well as read out.

In cases the task involves supplies, such as a fertiliser or a pesticide, the farmer may drill down to get more details about that fertiliser or pesticide. Details include the name of the manufacturer(s), images of the pack(s), pack sizes, price(s) and address(s) and phone number(s) of the nearest supplier(s). The farmer can call a supplier directly from this screen. While the consultant's interface showed the same data with generic terms throughout, for the farmers, it uses generic names on the task details screen but includes generic name as well as the brand names on this screen.

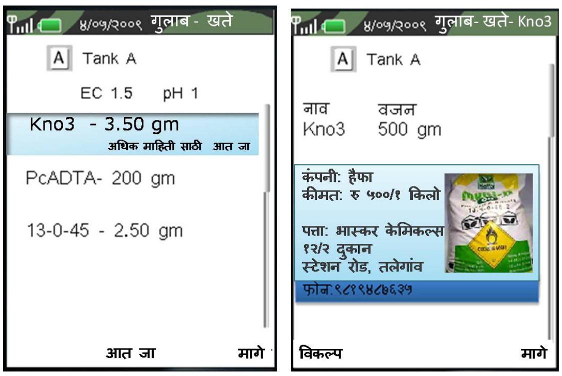

Figure 4. Task details and supply details.

Usually farmers finish their routine polyhouse tasks by 2 pm each day. If the farmer has not marked the tasks completed by then, the interface reminds the farmer at this time and requests for updates. All data is automatically updated into the consultant's landing page.

6. Evaluation

Initial contextual inquiries resulted in overall understanding but little contextual data. Based on our initial understanding, and the proposal in [9], we developed prototypes for both interfaces and tested with users. Though the fidelity of the prototype was low, actual data of farmers was displayed in the prototypes. Users were given tasks to perform in the form of scenarios. Consultants were asked to prepare a schedule for farmers, view updates made by farmers, view their history and profile. Farmers were asked to identify the day's schedule and mark completed tasks.

In all, we tested 3 versions of prototypes with 3 farmers and consultants each. After each evaluation we improved the prototypes based on the findings and took them back to the users for another round of evaluation. The designs presented above are from the most recent iteration.

7. Findings and Conclusions

The farmers liked the idea of receiving the daily schedule and getting consultant's advice on the phone on an ongoing basis. In the early version of the farmer's interface, the farmers were confused with the feature of taking pictures and voice recording. Farmers wanted information about supplies such as manufacturers, suppliers, contacts etc. When we provided this information in our next version, they felt that this will reduce the confusions that they face currently while buying supplies.

The consultants felt that the product would allow them to manage the farmer's schedules better. The consultants liked the access to the history of the schedules that they have provided in the past. They felt this will help them do learn from their past mistakes and give better decisions in future.

8. References

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