Smart Farming: A Step towards Techno-Savvy Agriculture

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ABSTRACT

Agriculture is the backbone of Indian economy, with two-thirds of our population depending on farming and its agro-products for livelihood. There are many problems affecting the farmers, leading to large number of farmer suicides across India. Some of these problems are in our control to solve through timely expert advice such as what fertilizers and pesticides to apply - when and how, what crops to be grown along with the main crops or on rotation basis to increase yield, side-businesses that can be taken up etc. Over the last two decades, there has been vast amount of research addressing problems specific to the Indian farming sector, but the suggested best practices and outcomes of this research has remained largely with the scientific community. They have not been put to practice by the Indian farmers. The current solution provides generic solution to a community of farmers and not personalized services. This paper proposes a set of farmer friendly services which use technology to bridge the existing wide gap between the expertise of agro-scientists and the transfer of this knowledge in a personalized way to the Indian farmers, so it can be put to use effectively. The paper also presents the statistical benefit of taking the expert advice of agricultural experts of University of Agricultural Sciences (U.A.S) by the farmers of a Sapota farm in Sulikunte, a farming village in rural Bangalore.

General Terms

Smart Farming; Cloud computing; Regression; Prediction; Registration.

Keywords

Farming; Expert Advice; Yield Prediction; Web Services; Mobile Services; Side Business; Market Locator.

1. INTRODUCTION

Agriculture is the science, art and practice of cultivating the soil, producing crops, raising livestock and the preparation and marketing of the resulting products. As the definition indicates 'agriculture' is a science, but farmers are not scientists! Therein lays the huge gap between scientific knowledge available by the experts and the practical application of this knowledge by the actual farmers; for whom the scientific research was conducted to find solutions to their operational issues and problems[1][4]. Indian farmers face a multitude of problems. Some of the issues faced, such as irregular monsoons and insufficient rainfall, are not in the realm of problems that can be addressed by technology, as of now. But, there are numerous problems that can indeed be solved with proper advice to farmers, at the right time. For example, farmers can be advised about the availability of alternate watering resources, location of places to procure affordable fertilizers and pesticides, details of funding agencies with a comparative analysis of the loan repayment options. They can be empowered with the know-how of markets to supply the agro-products avoiding the heavy dependency of middle-men, a menace to the supply-chain of agro-goods today. They can be made to acquire essential farming skills such as how to maximize yield by growing compatible crops, along with the main ones, various crop rotation strategies depending on the location, soil.

2. PROPOSED SOLUTION

The digital divide between rural and urban India is slowly but surely decreasing with farmers getting familiar with mobile and internet applications. But, to the best of our knowledge, there is no application, which is personalized, catering to the specific needs of a farmer. The proposed solution attempts to do just that. A wide range of services are provided to the farmer and the gram panchayat users of a locality who are closely associated with the farmers. All these services are personalized, meaning, the information appearing on the user interface, are relevant to the farmer who uses the application. Personalization of the farmer services is achieved by capturing the location of the farm, so that data relevant to that location can be given, rather than general information. The various personalized services provided in the proposed solution are described in the subsequent sub-sections.

2.1 Registration Service

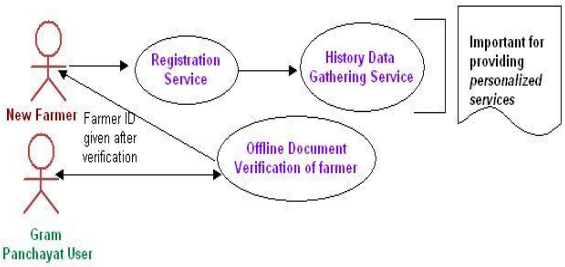

Figure 1. Use Case depicting the Registration Service

This service enables new farmers to register into the system. The details captured are - farmer's land location details, soil type, crops grown, amount invested by the farmer for seeds, pesticides and fertilizers in last three years, the crop yield, income or loss incurred for each crop etc. This 'history' data gathered is important for the other farmer friendly services of the system.

2.2 Yield Prediction Service

This predicts the yield a farmer can expect. A 'Regression Model', is used where data is utilized to identify relationships among variables. These relationships are used for predictions.

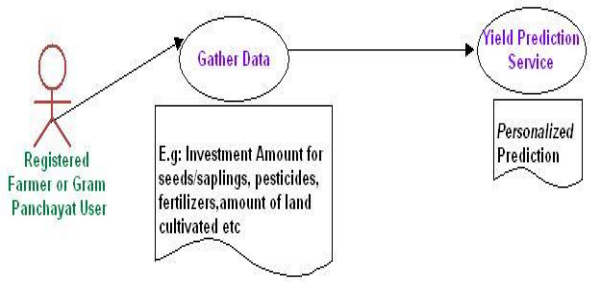

Figure 2. Use Case depicting the Yield Prediction Service

Here, a multiple regression model [2], with many independent variables is used. The following predictions are done, based on two profiles of the farmer's land, namely, soil profile (soil type, nutrients present) and land profile (land area and location). a) The investment on fertilizers, seeds etc for a given soil and land profile, to get 'p% 'yield,' n months later, for a specific crop.

b) The yield that can be got, for a farmer's soil and land profile with the amount of fertilizers and pesticides applied.

c) A comparative analysis of the yield that can be got for a particular soil and land profile, if different types of crops fit for that profile are cultivated, instead of the regular type.

2.3 Market and Storage Locator Service

Service This service is used to locate the local and export markets, near the farmland, for the farmer to sell and store his produce hygienically. This service is personalized for each farmer, based on the location of his farmland, and presents relevant results useful to him.

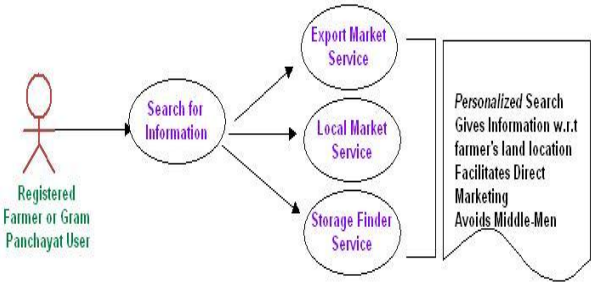

Figure 3. Use Case depicting the Market and Storage Locator

This is one step towards direct marketing of the agro-products, avoiding the current corrupt chain of middle-men. They are like vultures, demanding high brokerage fees for facilitating selling the agro-products, cultivated by the farmer with his sweat and blood. Sometimes, this brokerage fees is so high that the farmer has no option but to hoard his produce in his backyard, in unhygienic conditions, prone to insects and pests.

2.4 Expert Advice Service

Figure 4. Use Case depicting the Expert Advice Service

This service aims to bridge the gap between the vast amount of knowledge with agricultural scientists and the percolation of this know-how to the farmers. Currently, in India, there is vast amount of research done by agriculturalists, focused on addressing the problems of the farmers, but the outcomes and best practices of this research does not reach the end beneficiary. As shown in Figure 4, there are four types of personalized advices given by the current system, i.e., crop rotation strategies that can be applied to the farmer's soil and land profile; amount of pesticides and fertilizers to use for various stages of crop growth; methods of preparation of cultivable land; alternate crops that can be grown along with the main crops or during the interim period between crop growing seasons; and the apt side-businesses that can be adopted by the farmer, to augment his profits, depending on his land location and type of crop grown.

2.5 Crop Monitoring Service

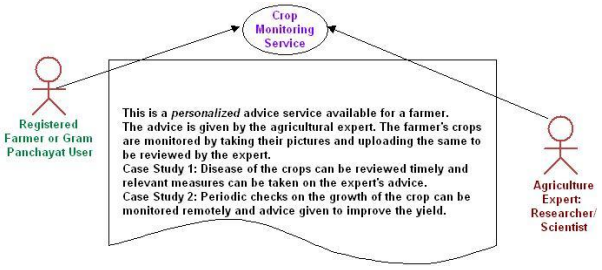

Figure 5. Use Case depicting the Crop Monitoring Service

In this service, the agricultural expert gets to view the various stages of crop cultivation, starting from preparation of the cultivable land, through pictures uploaded from the mobile application provided by the system. This application is available with the end user, namely, farmer, gram panchayat worker or cooperative society personnel, all of whom are stake-holders for the farmland and its produce. As shown in Figure 5, the experts, now facilitated with the actual pictures of the crop are in a better position to impart their expert advises. For example, methods to adopt in order to rectify diseases in various parts of the crop or proportion of fertilizers to be used in the cultivated land. Thus, this service aims to put to use the outcome of the research done by the agricultural scientists and experts of India. It also eliminates the need of the agricultural experts to physically visit the cultivated land and offer their advises and expert opinions face-to-face to

the farmer, gram panchayat worker or cooperative society personnel; thereby avoiding the tremendous cost involved in such interactions. Heavy dependency on such face-to-face interactions by the farming community, especially in remote and rural parts of India, is the root cause of the current problem of increasing suicide rates among the farmers [5][7][6].

3. EFFECT/OUTCOME OF EXPERT ADVICE

Table 1.0 Expenditure and Benefit With and Without Expert Advice for the fruit crop sapota in the year 2011.

Soil Type and condition (RF / ID)	Yield(quintals/acre)		Cultivation Cost (Rupees)
	Without Expert Advice	With Expert Advice	
Red Loamy Soil - RF	14 - 23	19 - 27	4000-6000
Red Loamy Soil - ID	12 – 18	16 - 23	6000-8000
Red Sandy Soil - RF	10 - 15	14 - 20	6000-8000
Red Sandy Soil - ID	8 - 12	13 - 17	8000 - 10000

3.1 Face to Face Expert Advice:Case Study

Table 1 summarizes the benefits got with face-to-face expert advice from the agriculturalists of University of Agricultural Sciences (U.A.S), G.K.V.K Bangalore in growing the fruit crop sapota, in a farming village, Sulikunte in rural Bangalore. These scientists have been hand-holding the farmers of this village for the last 6 to 7 years. The benefits of this association were seen last year, when the sapota trees started giving fruit. The native soil of Sulikunte is sandy, to which red soil is mixed to increase the quality of the cultivable land. In the traditional method without expert advice, there was no scientific method applied right from preparing the land for cultivation or at any stage of growing the crops. The whole process was based on intuition or look and feel of the soil or crop. We present here a cast study on one expert advice given by the U.A.S scientists to the farmer.

Advice given: To prepare the cultivable land The agricultural experts of U.A.S educated the farmers that the soil condition can be of two categories, namely Rain-fed(RF) and Irrigated Dry(ID). The sandy soil of Sulikunte could be prepared into four different types, namely, red loamy soil-RF, red sandy soil-RF, red loamy soil-ID and red sandy soil-ID. As shown in Table 1, from past statistics the U.A.S experts knew that the best soil for growing sapota is red loamy soil-RF. But, since the soil native to Sulikunte was sandy, the land was prepared for cultivation by adding a proportionate amount of red soil, so the soil type became red sandy soil. The monsoons played less havoc in that part of the village, so they chose to depend on the cheaper mode of irrigation, namely, Rain-fed (RF), thus keeping cultivation cost under control. Similar advices were given on measures to prevent damage due to pests, soil nutrient management during water-logged and drought conditions, steps to take during adverse climatic conditions such as high or low temperature and humidity, amount of micro-nutrients (zinc, magnesium, iron, gypsum etc) to be added during for varied stages of the sapota sapling's growth, pheromone trap installations for attracting male insects to expedite fruit production etc.

3.2 Expected Outcome of Online Expert Advice

An elementary estimate is presented here, about the benefits of expert advice, if the proposed system is deployed.

Average extra yield per acre = 4 quintals per acre

Price per quintal = Rs. 900 per quintal

Extra benefit per acre = 4 x 900 = Rs.3600

Average size of the farm = 5 acres per farmer

Extra benefit per farmer = 5 x 3600 = Rs.18000

Extra benefit for 1000 farmers = Rs.180,00,000(Rs.180 Lakhs)

Consider a case where the 1000 farmers are aided by 5 agricultural experts, 20 cooperative society personnel, computers, mobile phones, digital cameras etc. A rough estimate of this budget is Rs.120 Lakhs, out of which approximately Rs.90 Lakhs is the cost of the equipment and software. Let the equipment cost be spread over a period of 2 years, then the cost of equipment per year comes to Rs.45 Lakhs.

Total Expenditure per Year = Working Expenses + Equipment Cost. That is, Rs.30 Lakhs + Rs.45 Lakhs = Rs.75 Lakhs.

Overall Net Benefit per Year with the proposed system = Extra Economic Benefit – System Cost. That is, Rs.180 Lakhs – Rs.75 Lakhs = Rs.105 Lakhs approximately per year.

4. CONCLUSION

This funded project is a long term project, spread across three years. The project is currently in the first year, with tasks such as gathering the requirements and developing a prototype model of the five farmer friendly services described above. This prototype will be demonstrated for validation and review to the University of Agricultural Sciences (U.A.S) Gandhi Krishi Vigyan Kendra (G.K.V.K) campus, Hebbel highway, Bangalore and Agricultural Development and Training Society (ADATS), Bagepalli 100km north of Bangalore. With the help of these two authoritative agrarian organizations, the project will be deployed in the Sulikunte farming village in rural Bangalore, where field research study described in Section 3.1 was conducted. In the next phase, these farmer friendly services will be deployed on the IBM Smart Cloud Platform with both web and mobile clients. An appropriate data mining tool will be used to decrease the response time to process the large current and history data. One of the major issues farmers face is intermittent availability of water, many a time in the middle of the night. While the aforementioned cloud based application development is going on, next year, tasks involving requirements gathering to address this issue of water management will be done and the solution will be implemented as the last and third phase of the project.

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