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Submission date: 30-Jun-2020 03:47PM (UTC+0530)
Submission ID: 1351738850
File name: paperVersion1.4.pdf (520.36K)
Word count: 2757
Character count: 14560

"Farmer Connect" – A step towards enabling Agriculture 4.0 efficiently

Abstract— We demonstrate the use cases of *"Farmer Connect"*- A Progressive Hybrid Application meant to ease out many primary low-level concerning issues in agriculture like a proper price margin for farmers, expanding the reach of traditional import-exports (from a region base system to a nation-wide system), reducing post-harvest crop wastage, connecting the buyer and the seller directly by eliminating the middlemen, forecasting prices of agriculture commodity accurately using Machine Learning, etc. This all small steps eventually helps in increasing the per capita income, brining changes in the agriculture sector and finally creating a roadmap to efficiently enable Agriculture 4.0. Currently we use networking on a heavy basis, whether it is LinkedIn for the tech guys or Social Media platforms like Instagram, Facebook, Twitter, Tinder for dating etc. through which we can connect with people on a global scale, hence making new contacts which eventually directly affects in our business or other personal gains. But there's no such platform when it comes to the case of farmers or the Food Industries!! Then why not build a robust system which can connect the Farmer, the Dealer, Retailer and even large corporations together on a national or a global scale? This allows the farmer to find the right buyer at a competitive price across the nation and at the same time the dealer can buy good quality products through a single platform! Even the large corporations can get in touch with the farmers and buy products directly through them hence limiting the intermediaries which eventually is a win-win situation for both the farmer and the corporation. Combining all of this, we have developed a Progressive Hybrid Application which contains information of various Farmers, Dealers, Retailers, Corporations, Transport Service Providers, Cold Storage Facilities in lieu to connect all of them together. This directly results into situation where farmer no longer need to store their crops in cold storage or any other locations (or minimal use) as they can get buyers from across the nation. Hence, even reducing the major food wastage in logistics and cold chain section.

Keywords—Agriculture, Machine Learning, Hybrid Application, Dynamic Price Prediction

I. INTRODUCTION

Agriculture plays a crucial role in the economy of developing countries and provides the main source of food, income and employment to their rural populations. According to FAO (2000), it has been established that agriculture accounted for 23% of GDP, and employed 59% of the country's total workforce in 2016. In 2016, NSSO published a report which gives an annual income of farmers in India between July 2012 and June 2013. According to the report, an average agricultural household earned INR 6,426 per month, or INR 77,112 (1,020 $) per year, in India. Nowadays, farmers are putting more efforts to get more profits from the crops. The Government of India also supports farmers to provide different subsidies on seeds, pesticide etc. Farmers work hard for their crops but during the time of selling, to get maximum profit from the crop they fail because the intermediator, traders, transportation cost and process to sell crops will lower the actual price drastically [1]. It is very difficult for the farmer to find the maximum profit market to sell the crops as the selling process is limited only to local regions for the majority of the farmers. For example, a farmer from Banaskantha district of Gujarat has a produce of the cotton crops and wants to sell it out with minimum transportation cost and avoid the middleman, then the issue arises - how a common man can find contacts on a national or an international scale to ship his products out from a local platform? How can farmers achieve 100% profit from their crops? Nowadays, farmers are changing with technology and accessing information globally from agricultural commodities. In the digital era of agriculture, the government and other private companies have built dynamic platforms and free API's (Application Programming Interface) to see the market price of crops, historic insights etc. All such platforms use Data Mining, Machine Learning and Big Data Analytics to generate meaningful insights, forecast the price and recommend the related market rate for the crop selling [2]. Hence here we propose a system that provides the farmer with an interface to sell their produce and connect with the buyers at a national or an international level. Currently, we use networking on a heavy basis, whether it is LinkedIn or Social Media platforms like Instagram, Facebook, Twitter etc. through which we can connect with people on a global scale. But, there is no such platform when it comes to the case of farmers or Food Industries! Hence, building a corporate robust system which can connect the Farmer, the Buyer, Retailer and even large corporations together on a national or a global scale can be considered as one of the vital work for the overall development of agriculture industry. This allows the farmer to find the right buyer at a competitive price across the nation or globally and at the same time buyer can buy good quality products through a single platform! Combining all of this, we have developed a Progressive Hybrid Application which contains information(willingly) of various Farmers, Buyers, Retailers, Corporations, Transport Service Providers, Cold Storage Facilities in lieu to connect all of them together. This directly results in a situation where farmers no longer need to store their crops in cold storage or any other locations

(or minimal use) as they can get buyers from across the nation. Hence, reducing the major food wastage in the logistics and cold chain section. It is hard to put a figure to how much food is lost and wasted in India today due to lack of adequate infrastructure, however, a report by a UN body, FAO, puts wastage in fruits and vegetables as high as 45% of produce (post-harvest to distribution) for developing Asian countries like India. Here we design a simple interface that works on mobile, SMS to upload the produce details and respond via phone and SMS(taking care of digital divide).

II. RELATED WORK

A lot of research work has been conducted in the past to predict the best price of crops using various Time Series

algorithms. If we talk about data mining then, crop prediction can be formulated into a multidimensional regression job. There are multiple regression tools, different analysis techniques and data mining algorithms compare with each other and discuss future improvements [3]. In another related research work, agriculture-related market data are extracted from different web sites and are designed into a decision-making prototype for agriculture products [4]. Initially, the web scraping task turned out very tedious but with advents in the python programming language, it made it easy for developers to provide handy libraries. A web crawler has been designed to extract the market price in time series and a machine learning model performs the price forecasting[5][6]. There are various Python modules and analysis methods developed to read the static & dynamic web pages and extract the specific region based information and stored into a mapped table for further analysis[7]. Different forecasting techniques in agriculture and application of the rule-based system and neural network is discussed previously in paper[9].

III. Architecture/Workflow of System

The very first entity of architecture is the farmer, who will interact with the proposed first component, a Hybrid Application which works on any kind of web browser, phone (Android or iOS) and even through offline messaging services. Farmers can get connected with the GUI interface and receive updated crop price information and interact with the buyer. The second module of the architecture is the Machine Learning/Deep Learning model to generate the dynamic price prediction of crops by analyzing past data. The data will be represented to the application and utilized by farmers to make related decisions for selling crops at a better rate or wait for a profitable market price in future.

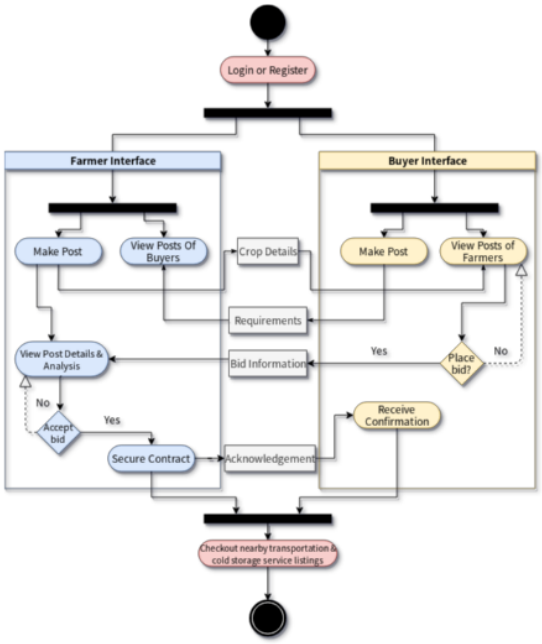

Fig. 1. Activity Diagram

Component-I
A browser-based and mobile-based interactive application, through which farmers can interact with and access the market price of the different crops in regional and across the state.
Component-II
A second component is quite complex as it is the heart of the system. Basically, it is the programming model to extract the related information of crops, selling, buyers and seasonal data and perform decision making predictions for the farmer. This model runs in the backend and processes the huge data related to market crop prices.

Component-III
It's the farmer himself/herself. Whatever the result is returned by the model used as decision making to gain profit by the farmer. It might be possible that a farmer gets a buyer and his/her bid accepted by the buyer or may not. Farmers can wait if prices are not in his/her favor. The couple of decisions a farmer can take as a result of the framework.

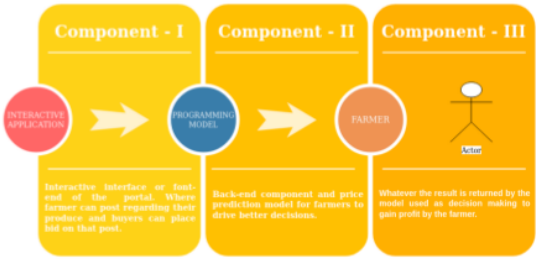

Fig. 2. System Architecture

IV. High-Level Overview on Application Features

A. *Progressive Hybrid Application*

In today's scenario, There are almost 74% (approx. 1026 Million) population of India obtain at least one mobile phone. Which clearly states that any solution should be available on a mobile platform as well. Hence, we have used the concept of Progressive Hybrid Application.

We have built PWA (Progressive Web Application) which can run as a simple desktop website as well as the mobile application. As farmers don't have desktop computers but they can access all the functionalities directly from their mobile. And vendors or business persons can conveniently use the website from a desktop computer or mobile application.

B. *Online Bidding Platform*

An Online Bidding Platform has been added as a feature into the application with the sole purpose of giving the farmers an opportunity to get a better price rate for their crop produce. The farmer can post details regarding his/her crop produce with the type of produce and minimum expected price range. Further an "Urgency" status flag can also be assigned depending on the farmer's urgency to sell the crop . The posts 7 different farmers will be sorted into different categories based on the type of "crop" e.g. wheat, paddy etc. Interest buyers of a particular crop can bid on the farmers post. The farmer can further choose the right buyer for him/her depending on the price or the amount of produce being purchased and can interact with the buyer on the platform

itself. This ensures that both the parties can have a fair part of their share.

C. Post On The Interface via SMS

Keeping in mind the current scenario in India where not every farmer has the privilege for internet or smartphones, we provide a simple messaging service through which the farmer can post the details regarding his crop produce just using a simple text message. The notification regarding interested buyers and updates will also be sent as a text message which eases out the hurdles of not having a smartphone or a reliable internet connection.

D. Dynamic Price Prediction And Market-Wise Analysis

Analyzing past data of a particular crop for a particular region and recommending the correct viable price to the farmer. One of the main challenging issues of designing such a system to export goods on a national/international scale can be the variably changing price on the basis of demand-supply, region, seasons, abrupt climatic changes etc. The reason why this issue is of paramount importance in our scenario is due to the low literacy level of farmers specifically in developing countries. Most farmers have the knowledge of crop prices only of their particular region but when they try to sell their goods overseas or in a different state, due to lack of proper connections and trustful sources they might not get the actual price and can be exploited. Hence here we tackle this issue by incorporating the use of Time Series forecasting methodologies like Auto-Regressive Integrated Moving Average (ARIMA) which takes into account factors like the past year price for a certain crop, seasonality trends, market trends etc. All these data are available for public use on https://data.gov.in (Indian Govt website) and are regularly updated. They also provide the dataset as an API request which serves our purpose for integrating it in a software and at the same time the Machine Learning model (Time Series forecasting methodologies) can be run on real-time basis hence giving the user a proper estimate of the price range. This new model eliminates the role of middle man hence giving the framer more profit range and more transparency to the buyers as well. Different Machine Learning and Data Mining algorithms like the Apriori's Algorithms, Hashing, FP Growth etc. can be used as well for further insights. Statistical methods like Kalman Filters can be used for short-term forecasting.

The dataset contains attributes like Region Details, Markets per Region, The Commodity, Variety (subtype of commodity), Grade (type of produce), Min Price (Rs/Quintal), Max Price (Rs/Quintal), Modal Price and the Price Date. From our experiments, we show that using Moving Average and Weighted Moving Average ARIMA models works best in almost all the cases as the mean of the data does not show major changes. Our aim is to predict the Modal Price which gives the farmer an estimate what their produce price should be. This is attributed to the fact that agricultural commodities show very less variation in terms of price changes.

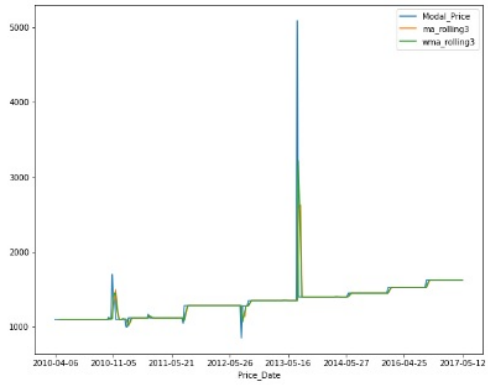

Fig. 3. Crop Price forecasting using ARIMA Model

E. Push Notification To Nearby Buyers

Whenever a farmer posts details regarding his/her crop produce, all nearby buyers within a district or region are sent push notification regarding the post. The reason behind this is that the interested buyer can know regarding the produce and can approach the farmer directly. This also helps farmers to sell their crops in time.

Fig. 4. Use case diagram

V. EXPERIMENT & RESULTS

A. Web Application

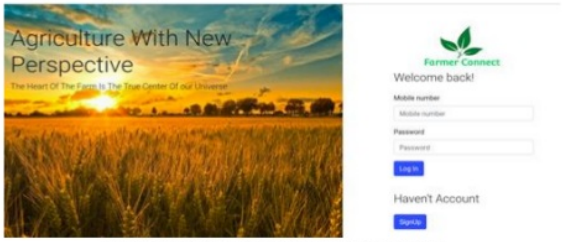

Fig. 5. *"Farmer Connect"*-Farmer Login Portal

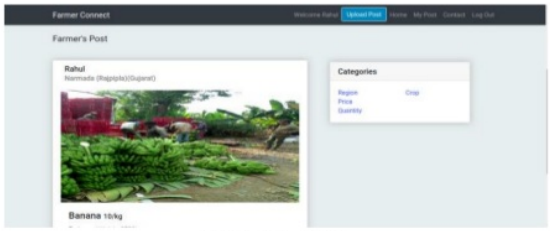

Fig. 6. Buyer's Feed

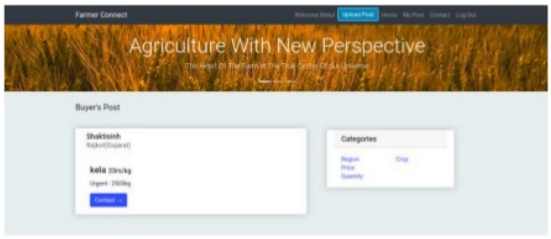

Fig. 7. Farmer's Feed

B. Mobile Application

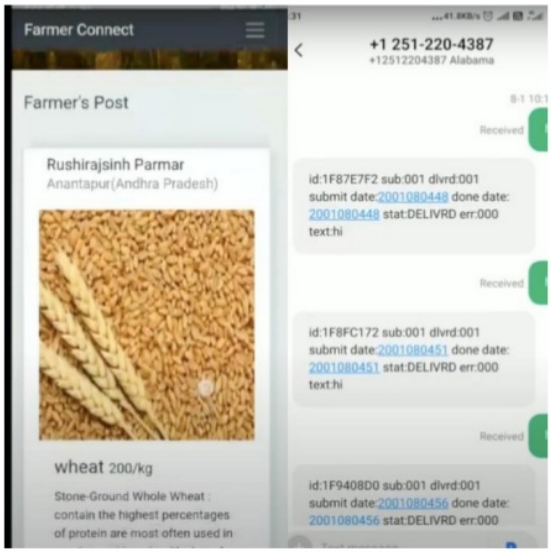

Fig. 7. Mobile Application Feed (Left), simple SMS service to post (Right)

VI. CONCLUSION

If developed this application perfectly and deployed at a large scale can help to solve various issues like lowering food wastage, viable commodity prices to the farmer etc. as all the food and agriculture industries can be linked to each other in perfect harmony. Use of Statistical Analysis and Machine Learning model helps the user to predict the price of crop based on previous seasonality trends. In future scope of the application, incorporating the concepts of Blockchain for the secure transaction between the farmer and the buyer can be an added advantage.

ACKNOWLEDGMENT

This project is carried out as an open-source project mainly for the benefit of the farmers and the whole Agriculture and Food Industries at large. This being a very neglected topic, remains a concern of paramount importance for the humanitarian development aspect.

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