Computation of Agriculture: Analytics for Agriculture

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ABSTRACT

Computation of Agriculture is a concept to encourage sustainable growth of agriculture and rural development. The concept is anticipated through an analytically enabled digital platform, "e-Rural Services". The platform helps to capture data through digital means and process through advanced analytical models to provide valuable insights from the data. It helps to reduce uncertainty in farming business and enhance productivity. The agri-business services through analytical tools and engaging multiple corporations make the application economically viable and encouraging. The public and policy making institutes will be interested to monitor periodic developmental metrics and suggest strategies for sustainable growth. Thus the stakeholders of entire eco-system are encouraged to be participated in the developmental process through this analytical platform, modernizing the farming systems and encouraging the youths in agriculture.

Keywords: Analytical Models, Digital applications, Developmental Goals

1. Introduction

Agriculture is the noblest profession in the world. The livelihood feeds the world. The farmers are the key contributors for the food securities of nations and the world. Technological innovations have changed the urban livelihood and business. But the countryside life has been enriched but not at the pace of urban world. The discrepancies in the standards of living have given birth of multiple problems, including shift from agriculture profession. This has direct bearing to the food security. The situation is more miserable in under-developed and developing countries, where farmers have limited resource and small and marginal land size. It is very difficult for them to combat against modern challenges in agriculture; climate change, increase in disease and insect pests incidences, decrease in soil fertility, water scarcity and market dynamics. The rural youth feel very much discouraged to have agriculture as their future profession. This is a matter of concern for all of ours existence.

Agriculture business needs to be modernized.The data science and digital technologies can revolutionize the ways of business in agriculture as it is observed in urban space. With increase in population and decrease in resources it is needed to adopt precision farming tools and optimize farming through scientific means. The modern technologies being cost effective, it is challenging to adopt for the small and marginal farmers. The farmer cooperatives and groups are not even successful due to various socio-economic and political issues. Considering the challenges it is very likely that the data science can group probable friendly farmers through a virtual platform, to facilitate in agri-business activities.

It has been envisioned to modernize the living standards of the rural world through computation of agriculture data and provide analytical insights on farming business strategies through e-Rural Services platform.The metrics measured on farming livelihood development is targeted to address the indicators of United Nations developmental goals. This helps the regional and national institutes to reap the benefit of the farmers' data. The agri-business information can be suitable for the corporations in agriculture to improve their sales with useful insights on demand and supply. The farmers the key beneficiaries will be provided with basic agricultural productivity information; crop selection based on soil, weather and available resources, disease and insect pests alerts through weather modelling, weather forecast alerts and market information. Each of the stakeholders' participation in the platform will make the digital eco-system economically viable and sustainable. The periodic self-initiated updates on the farmers' data will be helpful to monitor, identify and uplift the weaker zones of the society. The data collection is facilitated through mobile phone technologies which is mostly accessible.

2. e-Rural Services Platform

The "e-Rural Services" is a digital platform for agricultural and rural development. It is an integrated platform to collect sanitizes and store data, analyses and disseminates information. The services related to the initiative aredesigned for the major stakeholders of the agri-business. The farmers are the key beneficiaries with basic agriculture information, livelihood developmental support from institutes and farming business support from corporations.The platform is believed to be economically self-sufficient and sustainable with more data and information related services.

The platform is divided in three components; Data Collection, Data mining through Analytical models and Reporting (Figure 1).

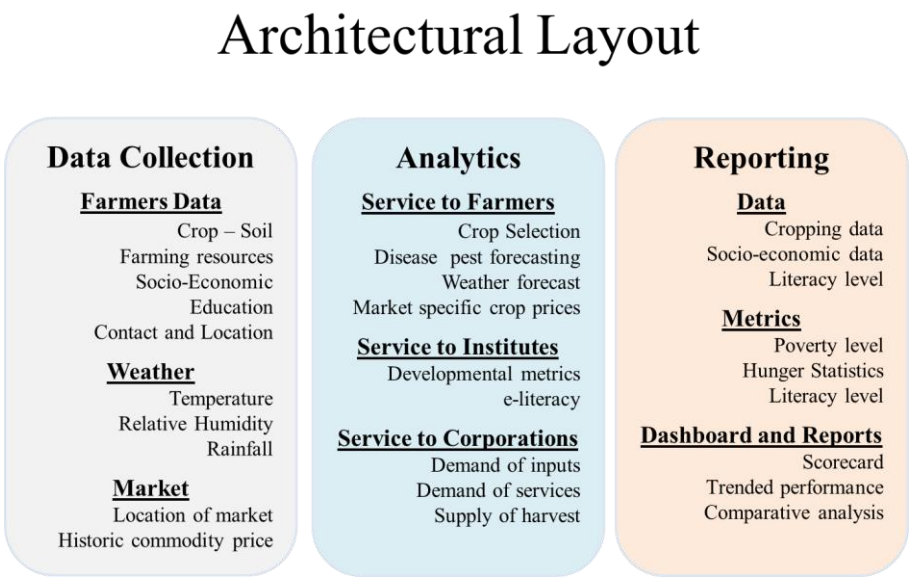


Figure 1: *Architectural Components of e-Rural Services*

The platform is a web-based application. It facilitates the users and operators to function irrespective of location and time.This helps in improvement of the services and penetrates to the remote locations. The internet connectivity and smart phone technologies may not be affordable to all the farmers. It is being bridged through farmer- agents, who can enrol multiple farmers in the application. The information on cropping practises and weather are facilitated through SMS and voice calls. It eliminates the immediate requirement of IT gadgets and subscriptions.

The initial services on agri-business prompt the farmers to enrol and update in the digital platform. Information related to agricultural activities and resources and weather data will abreast to build the models to provide precision services for cropping practises. The market location and trended crop-prices will help to locate best revenue of the harvests. The input requirements (seed, fertilizer, pesticides, farm machineries etc.) for cropping practises will help the corporations to assist the farmers with competitive prices and in right time. It will help the agri-input companies to maintain the customer loyalty and the farmers to be advanced in their farming productivity with new products. The available harvests can trigger the output agriculture services to procure harvests at field with best prices. It will eliminate the intermediate business exchanges, thus providing improved pay-off.

The information related tocropping practises, socio-economic and education will help to derive useful insights related to the livelihood development of the location. It will be an interest of the policy making institutes to improve the metrics, which contribute to the overall development of the Nation.

The digital platform is operated seamlessly with the support of advanced analytical models and modern tools on information technologies which enable to provide useful insights and presentable automated reports. The information for the farmers through SMS, voice call, mobile app messages are very simple to understand and executable. They are encouraged to connect with system for further clarification and information.

3. Description of components of e-Rural Services Platform

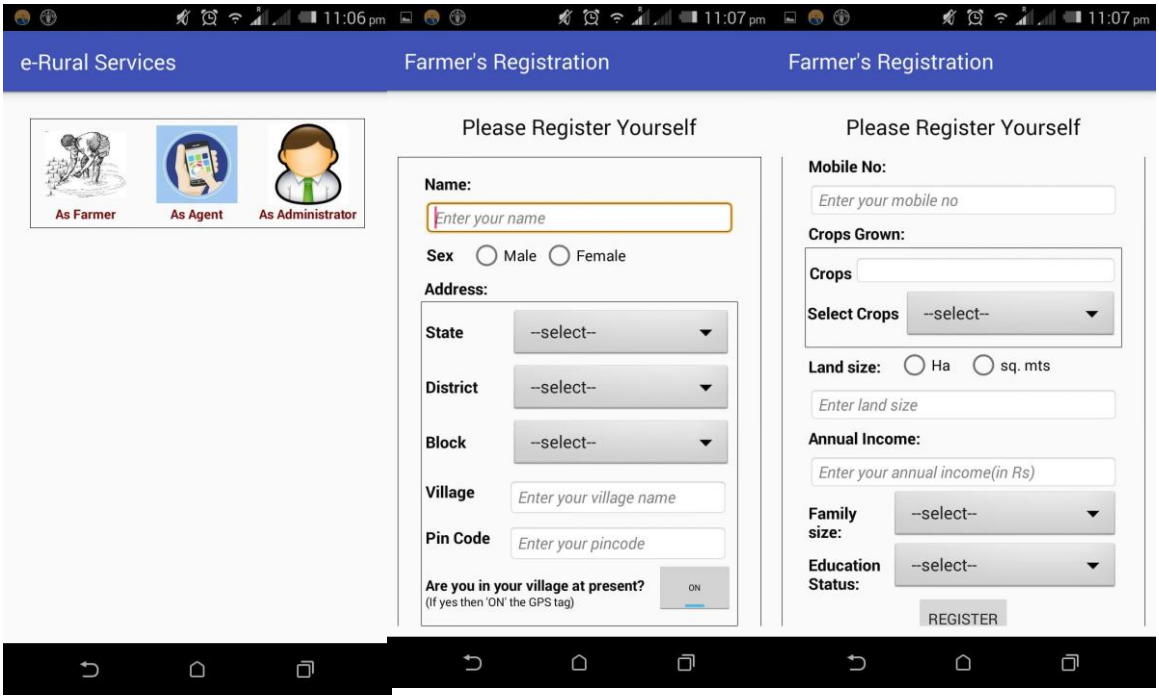
The components of the digital platform are represented as Data Collection, Analytical processing of the data and Reporting (Figure 1). The components are enabled to be connected with each other for automated processing, real time output generation and information dissemination. Each of the modules is depicted in details in the following sub-headings.

3.1 Data Collection

The data collection and periodic updates on data from the users are the fuel for analytical engine of the platform to be functional. The good data collection is one of the major challenge for operation of the functionalities. The digital means of data collection will facilitate to reduce costs and with increase data quality. The data assortment is done under following heads –

a) Farmers'Data –The farmers' data are collected through the mobile application. Farmers' friend and agents in fields helps for initial registration process. The registered farmers are being connected with the system through voice calls and SMS. Since most of the data fields are pre-defined and selective there are less chances of data entry errors.
b) Weather Data – The historic and predicted weather information are being pulled from government sources and transmitted through the system. The weather information are required for model building exercises for recommendation on agricultural services. With growth of services and farmers' empowerment automated weather stations can be installed for more precise forecasting services.
c) Market Data – The regional level local market locations and crop prices data are being fetched through farmers' network. The recognized market places and the prices are recorded in government websites. Those data are pulled for analysis and transmission to the respective location specific farmers. Online markets can be linked to the platform to provide best bid to the farmers.

The mobile application has been explored for data collection from the farmers. The application can be operated as Farmer, as Agent and as Administrator (Figure 2), demonstrating different data requirements. The operational hierarchies are needed for effective communication management enabling good data collection and viability (Figure 3).



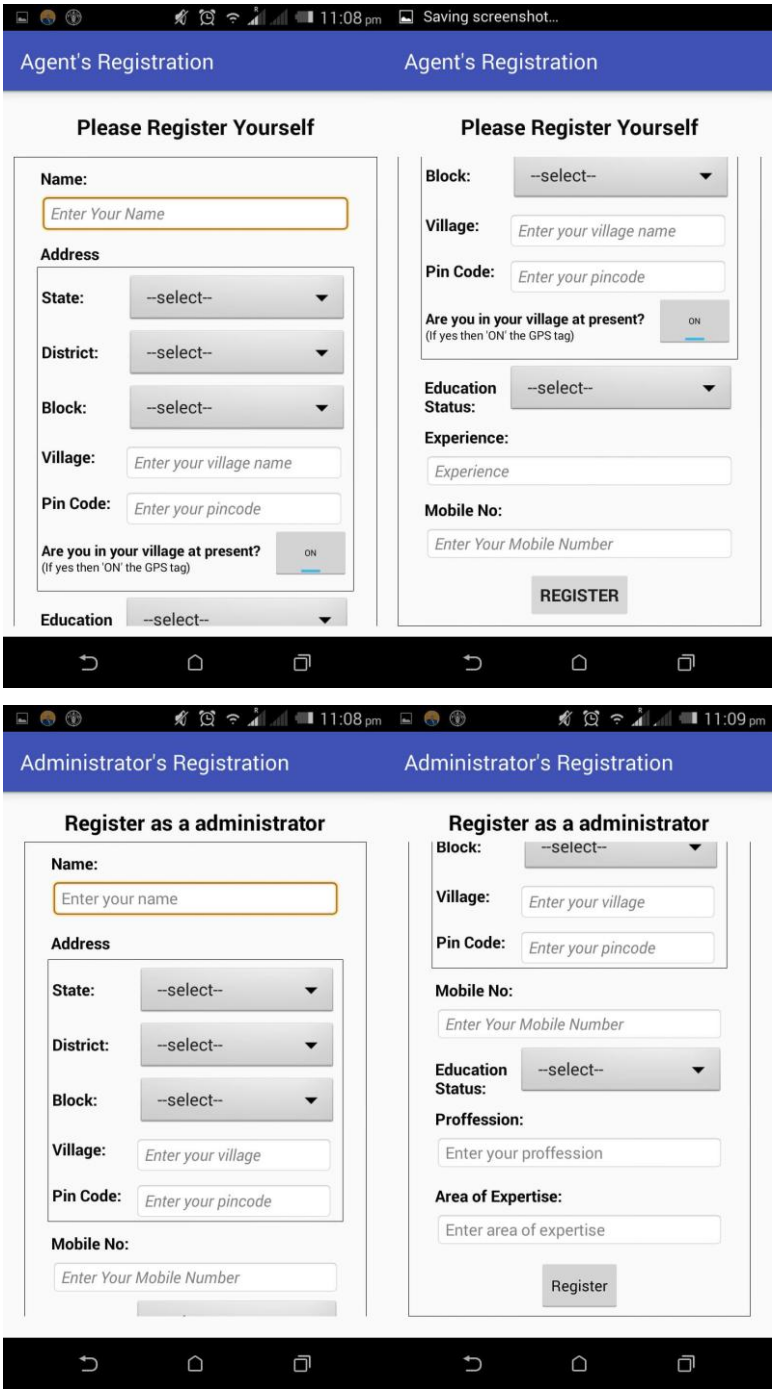


Figure 2: *Mobile Application screen shots for registration of different operators*

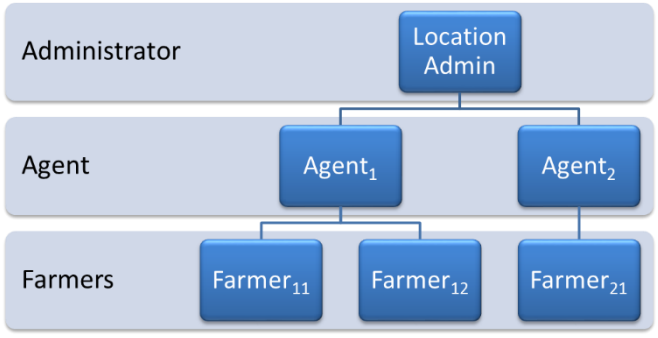


Figure 3: *Operational hierarchy for communication management*

3.2Analytics

The services provided to the different stakeholders are based on data analytics. This enables the farming business eco-system to be viable and transparent. Following are the brief description on the analytical modules based on the stakeholders.

a) Service to Farmers –The analytical infrastructureisdesigned to process varieties of services through data modelling. The data being gathered are subject to undergone through sanity checks (through trend and growth analysis) and cross-validation for exceptional entries. It is then processed for further inferential operations. Following are the current focus points –
   i. Crop Selection:Crop selection is done based on the available resource information and probable weather conditions. Linear programming and regression based models are being explored to determine best profitable crop for the cultivator.
   ii. Disease and insect pests forecasting: The weather based models are developed to forecast incidences of crop specific disease and insect pests and strategies to control them. The machine learning (Logistic regression and Artificial Neural Network) and differential equation based techniques are explored for model building.
   iii. Weather Forecast: Forecast for weather parameters like temperature, relative humidity and rainfall are subscribed through weather portals of government and other agencies.
   iv. Market specific crop prices: The right market search and price forecasting are one of the important services for the farmers. The time series forecasting mechanism (ARIMA and Spline regression) approach is being explored. The best market search is based on distance of the field to farm and profit margins.

b) Service to Institutes – The rural and agriculture development institutes comprising of public and private domains will be interested to know the performance metrics for the group of the farmers. The data being updated periodically will help to gauge the developmental trends.The developmental metrics focussed on first two goals of Millennium Development Gaols; Eradicate Extreme Poverty and Hunger (Goal 1) and Achieve Universal Primary Education (Gaol 2). The goals are followed as No Poverty (Goal 1), Zero Hunger (Goal 2) and Quality Education (Goal 4) under Sustainable Development Goals (SDGs). –
   i. Developmental Metrics:
      a. Proportion of population below $1.25 (PPP) per day

$$P_0 = \frac{1}{N} \sum_{i=1}^{n} I\ y_i \leq z\ = \frac{N_p}{N} \quad (1)$$

where I(.) is an indicator function that takes on a value of 1 if the bracketed expression is true, and 0 otherwise. If individual consumption or income (yi) is less than the poverty line (z), then I(.) is equal to 1 and the individual is counted as poor. Np is the total number of the poor. N is the total population. As followed in MDGs indictor definition.

      b. Poverty gap ratio

$$P_1 = \frac{1}{N}\sum_{i=1}^{N}\left(\frac{G_n}{z}\right), G_n = (z - y_i).I(y_i \leq z) \quad (2)$$

where the poverty gap (Gn) is the difference between the poverty line (z) and income or consumption for those who are poor (the non-poor have a poverty gap of zero). I(.) is an indicator function that equals 1 if the bracketed expression is true, and 0 otherwise. N is the total population. As followed in MDGs indictor definition.

      c. Proportion of population below minimum level of dietary energy consumption

This indicator has been defined within a probability distribution framework. As followed in MDGs indictor definition.

$$P(U) = P(x < r_L) = \int_{x<r_L} f(x)dx = F_x(r_L) \quad (3)$$

where,
P(U) is the proportion of undernourished in total population;
(x) efers to the dietary energy consumption or intake;
r_L is a cut-off point reflecting the minimum acceptable dietary energy consumption;
f(x) is the density function of dietary energy intake; and,
Fx is the cumulative distribution function.

d. Literacy rate of 15-24 year-olds, women and men
Literacy rates are computed by dividing the number of people aged 15–24 years who are literate by the total population in the same age group, the result is then multiplied by 100. As followed in MDGs indictor definition.

$$LR_a^t = \frac{L_a^t}{P_a^t} \times 100 \quad (4)$$

LR_a^t= Literacy rate of age group "a" in year "t"
L_a^t = Literate population of age group "a" in year "t"
P_a^t= Population of age group "a" in year "t"

ii. e-Literacy:The metrics defined to measure the level of e-Literacy for sharing of knowledge for agri-business. It is the ratio the farmers registered did self-registration and maintains smart phone and internet to the total no. of registered farmers. It is also a measure of economic prosperity to avail advance knowledge through modern tools.

c) Service to Corporations

The corporations can explore the experience of direct trading with the end consumers through the digital platform. Following metrics can be useful for managers of the corporations.

i. Demand of Inputs:The farmers' agricultural input requirements can be based on forecasted models for the crop section and pesticide requirements. Fertilizer module being integrated can be an area of interest. Agricultural machineries can be placed at farmers' utilities based on the crop stages information.

ii. Demand of Services: Various services can be explored for the farmers to improve the crop productivity and financial improvement. It can be the initiatives of various input companies to place their product and improve farmers' loyalty. Financial services from banks and insurance institutions can aid the farmers to advance in their agri-business.

iii. Supply of Harvest:Harvest gathering information will be interests for the retail chains and various food industries. Farmers and the food services can mutually be benefitted eliminating intermediate business exchanges.

3.3Reporting

The reporting service from the platform is one of the most important modules of the digital platform. It enables the users to take benefit of the data for their respective businesses improvement encompassing around public, private and personal sectors. The agri-businesses, mostly the personal sector, are the largest sector in terms of employment. But the sector suffers from less revenue due to uncertainties in farming business and improper management. The reporting section is aimed to provide insights and opportunities to improve the sector's performance. It will help the farmers to increase their efficiencies. The public and private sectors contributions will enhance the improvement.

The reporting of the information has been categorized under following heads –

a) Data:The processed data on cropping activities, socio-economic informationand literacy will be helpful for the responsible authorities to perform personalized studies.
b) Metrics: The automated metrics generated on the data processing will benefit all the sectors, in particular the public sector design policies for countryside development.
c) Dashboards and Reports: The dashboards and reports are the vital to monitor the periodic progress.

4. Conclusion

The "e-Rural Services" is a platform to perform agricultural analytics and provide services to different agri-business stakeholders. The digital platform can serve as an automated monitoring system to gauge periodic agricultural development. The farmers being engaged with the system for agricultural and business services, helps to inflow of data in the platform. With the passage of time it is envisioned as a self-serviced, economically viable and sustainable analytical-digital platform for agriculture. The platform being in service for public, private and personal sectors of the rural ecosystem, the penetration of the services to maximum farmer population is highly expected. It will encourage development in every aspect of country side life. Thus stabilizes uniform sustainable growth of the Nations.

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