

# A Framework to leverage Cloud for Modernization of Indian Agricultural Produce Marketing System

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## ABSTRACT

In India, Information and Communication technology (ICT) is being leveraged as a modernization tool in almost every sector of economy such as health, education, and transportation. But when we consider the agricultural scenario in the Indian context, we realise that the ICT remains to be exploited to accrue its invaluable benefits. In recent times, the Government of India has introduced several initiatives to promote the application of ICT in agriculture sector. But when we compare the scale of ICT application in Indian agriculture sector with other developing countries like China, Brazil, etc., we find that application of ICT in Indian agriculture is yet to be applied on a significant magnitude. In this paper, we propose a cloud deployment model “Agri-Bridge”, which provides access to agricultural market related information to farmers facing market connectivity constraints and acute capital shortage. Also, this model will operate as a bridge between the farmers and consumers within the existing agricultural produce marketing chain. This model utilizes the existing Government services, Agricultural Produce Marketing Committee (APMC) databases, retail market sources besides leveraging cloud computing, mobile phone services and Internet services to provide a solution to the problem of lack of access to real-time market information to the farmers, hence modernising the Indian agricultural produce marketing system.

## General Terms

Design, Human Factors, Economics, Measurement, Management.

## Keywords

ICT, Agri-Bridge, *e-Choupal*, *Agmarknet*, e-Agriculture, *AGRI-CLOUD*, Cloud Deployment.

## 1. INTRODUCTION

India remains an agrarian economy even after 67 years of its independence with agriculture continuing to be the primary source of livelihood for about 49% of the populace. Additionally, agriculture sector still contributes about 14% of the country's GDP [1]. At present, India is placed at the second position worldwide in agricultural output. Besides being the largest

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producer of sugarcane, milk, pulses, mangoes and tea, India stands out to be the second highest producer of rice, wheat, sugar, fruits, vegetables and cotton [2].

In India, majority of farmers face lack of access to relevant market information about latest crop prices and consumer preferences, required to make well-informed decisions. Further, high marketing costs discourage them from direct participation in agricultural markets. Consequently, the contribution of agriculture sector towards the nation's overall GDP is constantly declining [3]. Access to timely and accurate market information about current prices and consumer demands enables the farmers to compare the prices being received from the government against the current market prices. Thus, information lies at the centre of agricultural marketing and the most efficient way for enabling information access is through application of ICT.

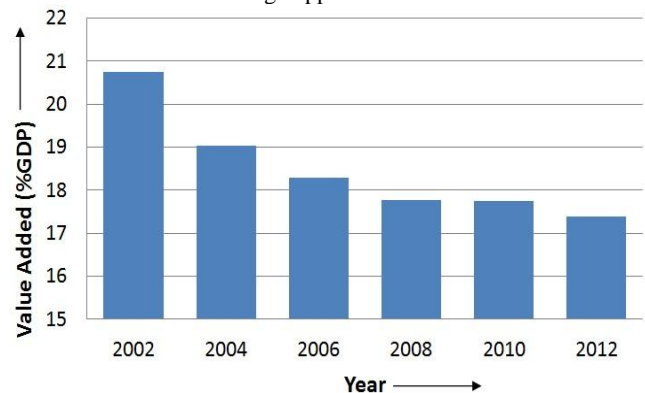


Figure 1. Indian Agriculture, Value Added (%GDP) [3]

In the face of globalization, agriculture is experiencing a major shift in the way it is being practised all over the world, India being no exception to this transition. As a result of WTO agreements, the Indian Government has introduced a slew of ICT initiatives in agriculture sector to boost agricultural productivity and achieve inclusive growth [4]. In recent years, there have been many ICT initiatives by corporate and government bodies to modernize the agricultural marketing system. But, India still lags behind in digitization of agricultural marketing in comparison to other developing countries like China [5].

In the Indian agricultural context, the use of ICT is still in its infancy and has a huge potential waiting to be exploited for dissemination, storage and management of market information. Thus, India needs appropriate design, deployment and implementation of latest ICT interventions such as cloud computing to revolutionize the agricultural marketing sector, thus enabling the farmers to maximize price realization for their produce.

Cloud computing is an emerging technology which is increasingly being deployed in all the sectors worldwide. As per the definition of NSIT [6], cloud computing is an IT tool that ensures convenient, ubiquitous, on-demand network access to a shared pool of configurable computing resources (e.g. servers, networks, storage, services, and applications), which can be instantly provisioned and released with minimal management effort or cloud service provider interaction. Cloud may be deployed as private, public, community or hybrid models providing services through Software as a Service (SaaS) or Platform as a Service (PaaS) or Infrastructure as Service (IaaS).

Cloud computing is a technology that can simplify the delivery of IT services, without the need for users to know about the underlying complexities and most importantly, those services may be accessed at any time and from any location at reduced costs. In addition, the cloud offers key features such as flexibility, multitenancy, elasticity, resource pooling, and scalability of resources and services. Hence, cloud computing, if implemented successfully can be leveraged for modernization of Indian agricultural produce marketing system.

In this paper, we propose ICT based deployment model, which will provide market information access to farmers, enabling prudent decision making. This model leverages cloud computing, mobile phones and web services besides making use of existing Government services and other market information sources. The proposed model intends to bridge the existing information gap that exists for the Indian farmers through providing them with easy and timely access to useful agricultural market information, thus helping them maximize price realization for their produce. Further, the proposed model seeks to minimize consumers' expenditure on purchasing essential food commodities by facilitating direct purchase from the farmers.

The rest of this paper has been structured as follows: Section 2 focuses on literature review followed by Section 3 which analyses the existing models. Further, Section 4 proposes a cloud deployment model for delivering up-to-date agricultural market information to farmers followed by Section 5, which outlines the prototype designing of web portal and Section 6 mentions the advantages offered by proposed model, ending up with Section 7 which summarizes the paper.

## 2. LITERATURE REVIEW

The discussion paper by IFPRI [7] throws light on the major challenges to flow of market information required by Indian farmers. The paper also throws light on present ICT initiatives offered by public and private sector, focussing on providing information extension services to the farmers. The paper concludes by stating that design of any information flow system needs to be based on farmers.

In his work, Sonu Gupta [8] discusses several attempts to leverage IT as a tool in agricultural marketing. Also, the author concludes that use of IT can modernize the Indian agricultural marketing scenario and empower the farmers by providing access to latest market information.

In research work done by K.Venkataraman [9], he puts forward the concept of AGRI-CLOUD that leverages the concept of cloud computing to provide information assistance to farmers through experts and Government officials in their local languages.

In [10], Karuna Chandraul proposes a framework architecture to design and implement a Cloud based agriculture solution that boosts agricultural production and assists in information supply to farmers and research labs.

## 3. EXISTING MODELS

Although, the agriculture sector remains to be a source of livelihood for majority of Indians, but today the farmers are facing severe challenges, lack of access to timely and relevant information being the most prominent one. During the course of research, many ICT initiatives introduced and executed by corporate and government bodies to modernize the Indian agricultural marketing system were studied, but some of them need to be discussed:

### 3.1 E-Choupal

E-Choupal is a successful initiative by ITC Limited with the goal not only to connect directly with rural farmers over the Internet to facilitate procurement of agricultural products like wheat, soybeans, coffee, and prawns, but also to overcome challenges posed by Indian agriculture sector. E-Choupals have computers installed with Internet connectivity in rural areas to provide free access to real-time agricultural marketing information, including mandi prices and agricultural knowledge to the farmers to enable them to directly negotiate the sale of their produce with ITC Limited [11].

Launched in 2000, ITC Limited has 6500 e-Choupals already in operation in 10 states and empowering about 4 million farmers, with plans to achieve the target of 20,000 e-Choupals that will cover 1,00,000 villages in 15 states and empower 15 million farmers [11]. This project has successfully leveraged ICT to improve the quality of agricultural products, and boost farmers' income levels, but it was felt that some shortcomings are impeding its pan-India implementation:

#### 3.1.1 Scalability

As the E-Choupal is specifically for farmers producing soybeans and wheat; it needs to be scaled up to include procurement of other agri-products too.

#### 3.1.2 No Central Database

Lack of central databases would impede its nation-wide success.

#### 3.1.3 Over-reliance on Internet Services

Besides the Internet services, mobile phone services also need to be leveraged as it provides an affordable and portable means of communication for the farmers.

#### 3.1.4 Availability

As every e-Choupal is operated by a Sanchalak (village computer operator), thus it is possible that he or she may not be available to the farmers at all times.

#### 3.1.5 Work Load

There exist many to one dependency between farmer and Sanchalak. Thus, many farmers are dependent on a single sanchalak for information services, increasing the work load on him or her.

## 3.2 Agmarknet

Agmarknet is an ICT based project launched in March, 2000 by Indian Government to provide Internet connectivity to agricultural wholesale markets for collection, aggregation and dissemination of information related to prices and arrival of agricultural products to benefit the farmers and other stakeholders. This project is being implemented in collaboration with National Informatics Centre, Directorate of Marketing and Inspection, State Agricultural Marketing Board/Directorate and various Agricultural Produce Marketing Committees [12].

Agmarknet web portal is accessible to all stakeholders and provides information relating to prices, arrival of about 400 agricultural products and 3000 varieties in 12 different languages besides English on daily basis, covering about 3200 markets nationwide [12]. Although, this project has brought a substantial change in existing agricultural market information dissemination services, but during our analysis it was felt that it lacks the following characteristics:

#### *3.2.1 No Farmer-Consumer Connectivity*

Lack of connectivity between farmers and consumer groups results in lack of virtual trading of agricultural products among them.

#### *3.2.2 No Comparison of Prices across Market Supply Chain*

The prices of agricultural products being shown at Agmarknet are just limited to APMCs and do not provide a comparison of market prices at various levels in the market supply chain.

#### *3.2.3 Inefficient Data Collection*

Inefficient, irregular and inaccurate data entry at various Agmarknet nodes provided at APMCs across the country is impeding wide-scale success of this project.

#### *3.2.4 No Cloud Storage*

The ICT has undergone a remarkable transformation resulting into latest technological interventions such as cloud computing and internet of things. Although the Internet of Things does not fit into the current state of affairs in Indian agriculture sector, but the immense potential of cloud storage needs to be tapped for the modernization of Indian agricultural marketing system.

## **4. PROPOSED MODEL**

This paper puts forward conceptual deployment model referred to as “Agri-Bridge” which leverages cloud computing, mobile phone services and web services, besides utilizing the existing Government services and available agricultural market information sources. As the name suggests, this model will bridge the existing information gap being faced by the farming community in India by leveraging the advancements in the ICT sector. The prime objective of the proposed model is to extract the indirect benefits of implementing ICT tools in the Indian agricultural produce marketing sector. This model will provide would assist the farmers to take well-informed and correct decisions by providing affordable access to accurate and timely market information by using basic mobile handsets via toll-free helpline number. This would not only boost the income levels of the farmers but also contribute to the overall productivity of the agriculture sector. The Agri-Bridge model comprises of five components, Data Storage Subsystem, System Administration, Information Sources, Virtual Market and Interface Devices.

### **4.1 Data Storage Subsystem (DSS)**

The proposed model inculcates the technological benefits of cloud computing for modernization of the Indian agricultural produce marketing system. To achieve this goal, DSS is implemented as a private cloud with the ownership rights lying exclusively with the Central Government. The private cloud would offer platform as a service (PaaS) to store all the agricultural market related data that can be accessed by all users from anywhere and at any time. To achieve the objectives of the model, central databases need to be developed and managed. The USP of this model is that it will create and update 4 central databases. The DSS contains the following databases:

#### *4.1.1 Agricultural Market Database*

This database stores the data related to prices and available quantities of all agricultural products, state-wise, district-wise and APMC-wise. This database is formed by collecting and aggregating the data from government MSP records, APMC databases and retail market sources.

#### *4.1.2 Farmer Database*

This database records the farmers’ information such as name, mobile no., location, farm acreage, main crops. The model will generate a unique Farmer ID number (FIN) for each registered farmer. Each FIN will be structured as: <State ID Number. District ID Number. Unique Farmer Number>.

#### *4.1.3 Consumer Database*

Also, the consumers can register themselves to participate in virtual trading, each of whom will be assigned a unique consumer ID number (CIN) which will be structured as <State ID Number. District ID Number. Unique Consumer Number>. The consumer here refers to individual consumers as well as consumer groups.

#### *4.1.4 Help Desk*

This database stores the solutions to common issues and frequently asked queries raised by the users. Also, this database offers an e-library consisting of multimedia content related to agricultural marketing strategies and farmer success stories. This database is regularly updated by the system administrators to ensure its consistency with the latest agricultural market scenario and associated problems.

## **4.2 Information Sources**

This model utilises the following information sources to create and update the aggregated agricultural market database:

#### *4.2.1 Government MSPs*

This data relates to Minimum Support Prices (MSPs) being offered by the Government to the farmers for different agricultural products.

#### *4.2.2 APMC Databases*

From these databases, the data related to prices and procurement quantities for different agricultural products in APMCs across the country is extracted and transferred into the aggregated agricultural market database.

#### *4.2.3 Retail Market Sources*

The data related to latest retail prices of agricultural products across different locations of the country is extracted from sources such as select organised retail chains like Reliance Fresh, Big Apple, Safal, and individual market reporters.

## **4.3 System Administration**

The system administration acts as the interconnecting layer between DSS and the stakeholders such as farmers and consumers. The administrative hierarchy includes personnel at state level and district level. The staff at the district level is equipped with sufficient information support systems to assist the farmers in decision making related to marketing of their agricultural products. The district level personnel connect with the farmers and consumers via dedicated toll-free helpline number and SMS portal and the information assistance services are provided in local languages. The role of state level personnel is to maintain and update the local and central information databases. The administrative and support staff is providing services through the following media:

#### 4.3.1 Mobile Telephony

The Government of India Census Report 2011 states that 51% people in rural India have access to mobile phones [13], thus providing for an affordable means of communication that can be leveraged to modernize the agricultural produce marketing system. Accumulated evidence suggests that mobile-based market information systems have a great potential of accelerating agricultural growth and farmers' income levels. The farmers can avail assistance services from the system administration by the use of mobile phones and dedicated toll-free helpline number.

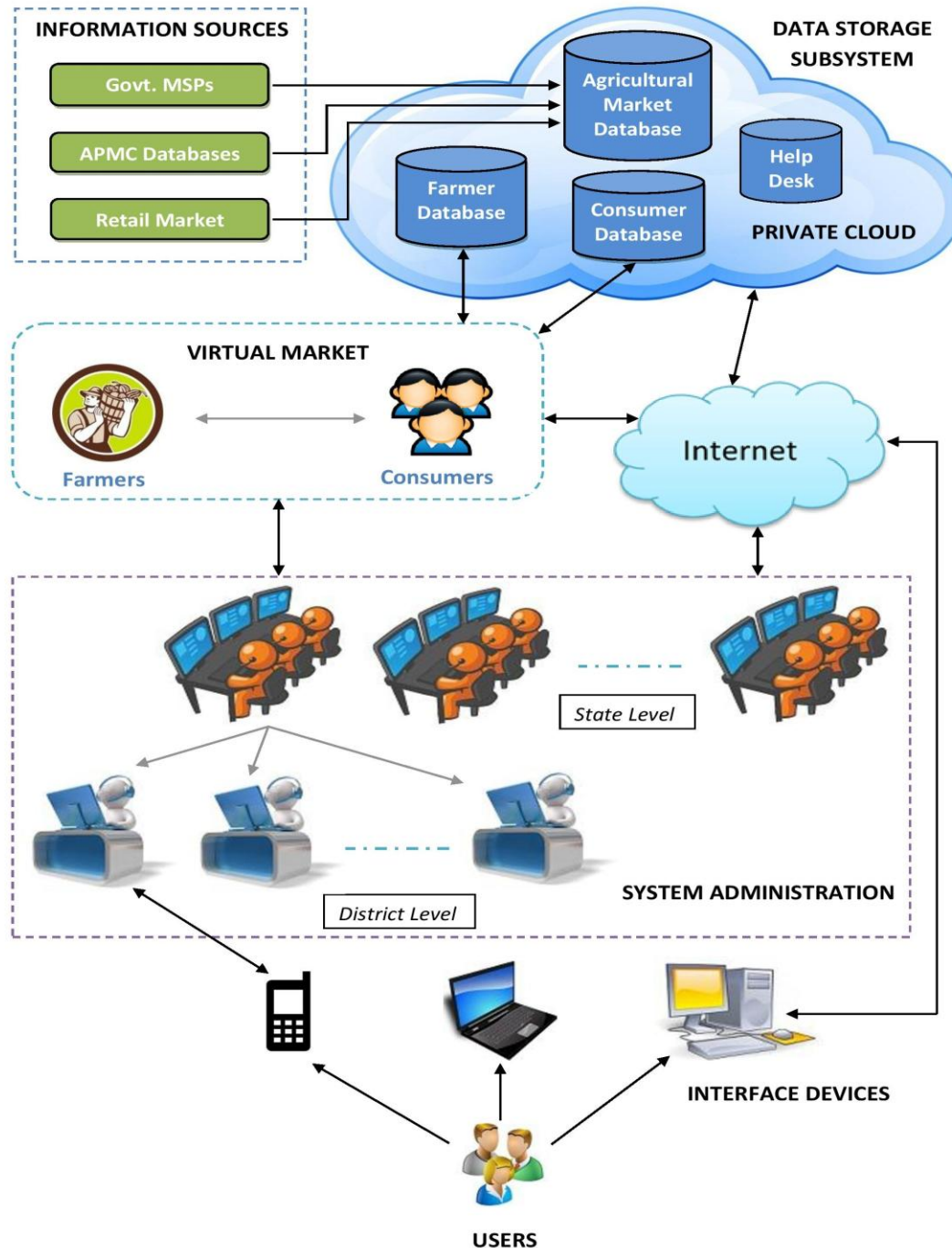


Figure 2. Agri-Bridge

#### 4.3.2 SMS Portal

The Department of Agriculture and Cooperation, Ministry of Agriculture has recently unveiled Kisaan SMS service for dissemination of useful and timely information, including topical and seasonal advisories and market related information, thus delivering information services to farmers through SMSs in the State's local language [14]. Our model proposes to extend this SMS service to registered consumers, thereby informing them about prices of essential food commodities across the market supply chain.

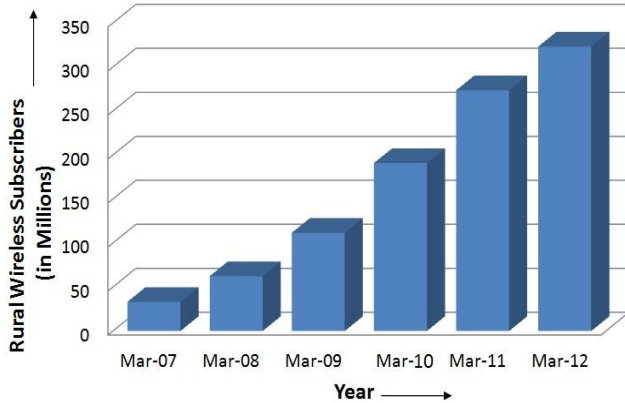


Figure 3. Rural Wireless Subscribers [15]

### 4.4 Virtual Market

Another important model component is the virtual market which would enable virtual trading between farmers and consumers through use of web portal and mobile phones. This would result into higher price realization by the farmers for their produce whereas the consumers will benefit by direct procurement of required agricultural products from the farmers at lower prices as compared to retail market prices. Such networking would be facilitated through the following services:

#### 4.4.1 Mobile Phone Services

The farmers and consumers can register themselves with the system administration through the use of mobile phones over dedicated helpline number to reap the benefits of virtual trading.

#### 4.4.2 Web Portal

The dedicated web portal will contain comprehensive agricultural market information besides providing an alternative medium to register and participate in virtual trading. The farmers will be able to access the web portal through Internet-enabled panchayat terminals [16] whereas consumers can use their own interface devices.

### 4.5 Interface Devices

The proposed model allows the use of the following interface devices for accessing the information services:

#### 4.5.1 Mobile Phones

In the present Indian agricultural scenario, mobile phones are regarded as the most affordable and effective medium of communication for the farmers. This model incorporates financially affordable mobile devices as one of the interface

devices to connect the farmers with system administration of Agri-bridge via the dedicated helpline number. These mobile devices enable the farmers and consumers to access required market information from DSS through system administration via the toll-free helpline number from any location and at any time.

#### 4.5.2 Panchayat Computers

To achieve e-connectivity of Panchayats, Ministry of Rural Development, Government of India has initiated projects aimed to provide computers as well as internet connectivity to all the 2,36,000 Panchayats across the country [16]. These can be used by the farmers to access the web portal and help desk services, besides organising knowledge sharing sessions.

#### 4.5.3 Other Devices

The consumers may choose to access the web portal using internet enabled wireless devices such as laptops and smartphones or through a desktop computer with Internet connectivity.

The interaction among the components of Agri-Bridge has been depicted graphically. The Fig.4 shows sequence of communication during the allotment of Farmer ID Number (FIN) to a farmer. The Fig.5 depicts the communication flow between a registered farmer with allotted FIN and administrative personnel at System Administration.

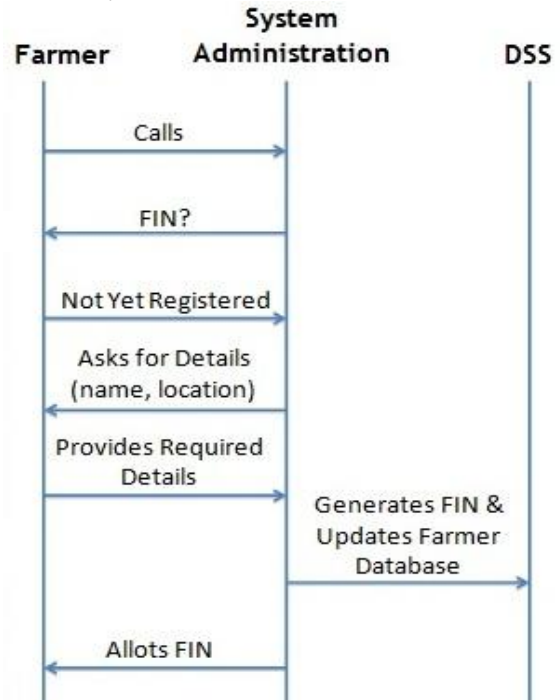


Figure 4. Allotment of Farmer Id Number (FIN)

## 5. DESIGN OF WEB PORTAL

The proposed model Agri-Bridge incorporates a web portal to achieve the main objective of empowering the farmers and consumers of agricultural products by disseminating comprehensive agricultural market information. The design process of web portal includes the following steps:

### 5.1 Data Extraction



In the first step, the data related to prices and quantities of different agricultural products is extracted from information sources including Government Minimum Support Prices, APMC Databases and Retail Market Sources.

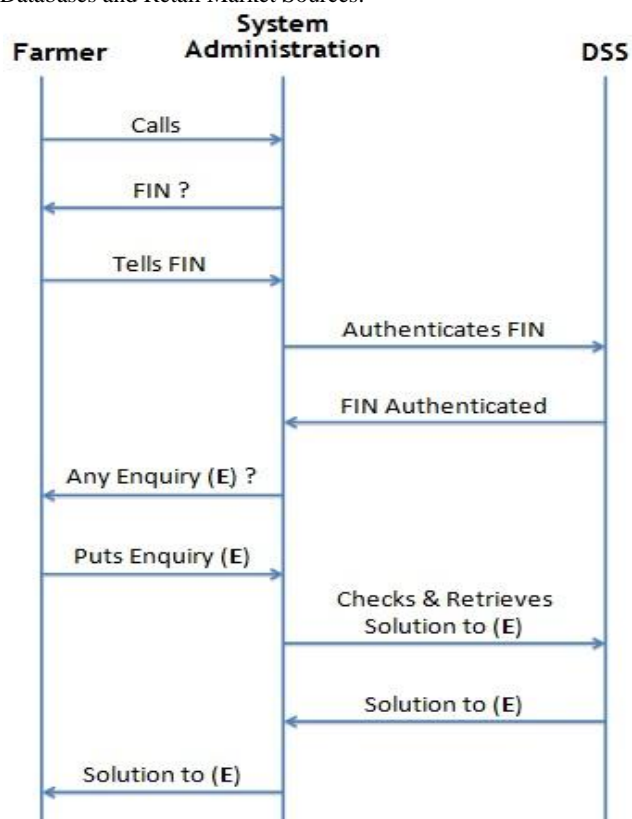


Figure 5. Communication between Farmer having FIN and Administrative Personnel

## 5.2 Data Aggregation

After data extraction process, the data is aggregated to be put into the agricultural market database of DSS. The uniqueness of our model lies in the fact that it provides a comparative view of the prices and other market statistics for various agricultural products throughout the market chain.

## 5.3 Data Presentation

In this step, the aggregated data is uploaded onto the web portal. To make the data presentable and understandable, the web portal will employ several visualization tools such as bar graphs, pie charts, tables and tickers to provide the latest market information including APMC and retail market prices of agricultural products across various locations of the country without the users having to dig into the entire database. Also, the web portal will provide comparison of inter-state, inter-district and inter-APMC prices of all agricultural products besides displaying periodic trends of prices on weekly, monthly, quarterly and yearly basis. The farmers will be accessing the web portal through Panchayat computers [16]; hence the web portal provides information to them in their own local languages. The prototype of the web portal implemented for the proposed model Agri-Bridge has been shown in Fig.6 and Fig.7.

## 6. ADVANTAGES OF PROPOSED MODEL

In addition to inherent benefits of deploying the Cloud as an ICT tool, the proposed model leverages existing market information sources and Government services to offer several advantages:

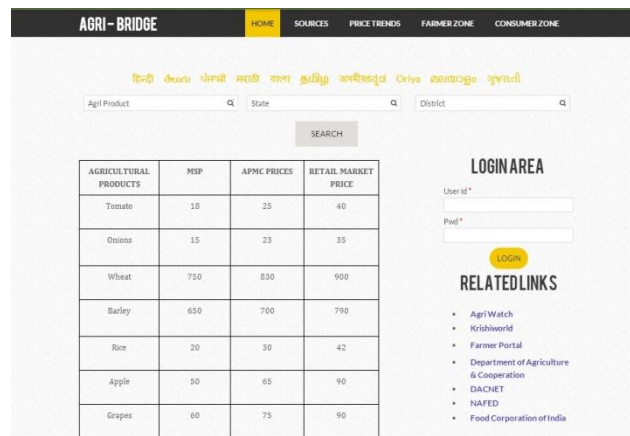


Figure 6. Comparative View of Prices on Agri-Bridge Web Portal [17]

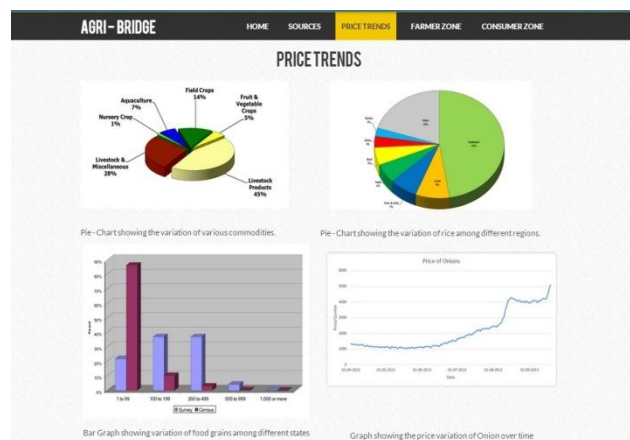


Figure 7. Display of Price Trends using Visualization Tools on Agri-Bridge Web Portal [17]

### 6.1 Efficient Data Management

The centralized database will be managed by technical personnel, thus delivering efficient data management.

### 6.2 Easy Access to Market Information

In this model, farmers across the country will have easy access to market information round the clock from their own location through FIN and dedicated helpline number or web portal. Precise and accurate market information will result into informed market decisions, improved negotiation ability, better price realization and higher income for the farmers.

### 6.3 Security

The deployment of private cloud for centralized data storage enhances the overall security of database by incorporating multiple levels of security.

### 6.4 Scalability

A private cloud offers scalability as it allows adding more servers or processing ability when necessitated by growing business demands.

## 6.5 Cost Reduction

Standardization or automation of IT resources and services cuts down on operational costs by relieving the IT personnel from resource management activities having little or no value, allowing for prime focus on customer services.

## 6.6 Centralized Databases

This model will result into centralized databases for agricultural market information, farmers and consumers.

## 6.7 Aggregated Data

The uniqueness of this model is that it provides an aggregated view of data related to prices and quantities of all agricultural products at different points of the market chain.

## 6.8 Localization

The model provides latest market information in local languages through mobile phone services and web portal.

## 6.9 Affordability

The farmer can access the market information from DSS via dedicated helpline number by using a low-cost mobile phone.

## 6.10 Boost in Economic Growth

This model, if implemented successfully, will boost agricultural productivity, leading to growth in agriculture sector, thereby resulting in positive impact on overall Indian economy.

## 6.11 Consumers fight Inflation

This model maintains consumer database to facilitate networking and virtual trading between farmers and consumers to assist consumer groups in procuring agricultural products at comparatively lower prices than market prices.

## 7. CONCLUSION

Application of ICT has brought great dividends to the agriculture sector worldwide. In developing countries such as China, latest ICT interventions including cloud computing and Internet of Things are being increasingly deployed to revolutionize the agriculture sector. In contrast, India is yet to realize the full potential of ICT in boosting agricultural productivity. Although, India has all the favourable conditions and resources required to become the highest food producer worldwide [4], but successful implementation of latest ICT technologies remains a pre-requisite.

This paper proposes a cloud deployment model “Agri-Bridge” to provide market information services to farmers, enabling efficient decision making which will not only ensure better price realization for their produce, but also boost the agricultural productivity. In addition to cloud computing, the proposed model leverages mobile phone services, web services, existing Government services and available market information sources to bridge the existing information gap being faced by farmers and consumers in the present scenario. With technological prowess and better farmer incomes, technologies such as Internet of Things, RFID and WSNs may also be harnessed to benefit the Indian agriculture and overall economy.

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