Framework to Leverage Cloud for the Modernization of the Indian Agriculture System

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Abstract: **In India, Information and Communication technology (ICT) is being used vastly as a tool in almost every sector like education, health, media, etc. But if we talk about Indian agriculture, ICT is still to be exploited for its benefits. Many initiatives have been taken by Government of India to promote and introduce ICT in agricultural field. On comparing to its counter developing countries like China, Japan, etc. where advanced ICT technologies like IOT are being implemented in agriculture sector, we find that for India still there is a long road ahead to travel. This paper proposes a cloud deployment model "Agri- assistant", which provides agriculture related information assistance to Indian farmers living in rural areas, facing financial and connectivity constraints. The model leverages the existing Government services and mobile service to provide a solution to existing scenario with minimum burden on farmer's pocket.**

Keywords: **ICT, Agri-Assistant, *eAgriculture, AGRI-CLOUD,* Cloud Deployment.**

I. INTRODUCTION

India has an agriculture-based economy, 43% of India's territory remains employed in agricultural activities as against 11% in the world. Agriculture accounts for 14% of the nation's GDP, about 11% of its exports [1]. India has two faces, one that contributes to country's economic growth- India, while other where most of the country lives – Bharat. Both have changed dramatically since independence but the pace of growth has not been uniform. Agriculture is the largest provider of livelihood in rural India, about half of the population still relies on agriculture as its principal source of income and it is a source of raw material for a large number of industries.

Presently, India ranks second highest worldwide in farm output. It not only is the largest producer of tea, mangoes, sugarcane, banana, turmeric, milk, coconut, pulses, ginger, cashew nuts, & black pepper but also is the second highest producer of wheat, rice, sugar, vegetables, fruits, groundnut and cotton. It accounts for 10 percent of the world's fruit production [3].

India has the potential to become the food supplier of the world as it has the cultivable land, 20 agro-climatic regions, 46 soil types, well developed agribusiness system and all the seasons for production of all varieties of crops [4].

Agricultural development is vital in our country since, not only a vast majority of the workforce derives their livelihood from it but it also holds important share in Indian economy. Post WTO agreements; the Indian Government has taken many initiatives to bridge the knowledge gap to achieve faster and more inclusive growth by introducing ICT in agriculture sector [5].

High population growth, increased cost and inefficiency have been posing threat to food security in India, as many farmers are quitting rural areas for easy life in urban areas. In recent years many efforts have been done to implement ICT within agriculture sector. One such example is eAgriculture being implemented in Odhisa. Though there have been inclusion of information network services in India showing technological growth in this sector, still the whole level is low as compared to other developing countries in this sector like china [6].

In his work, Zhang [21] proposes a platform for construction of digital agriculture in China using IOT. The prospect of implementing IOT in the Indian Agriculture scenario seems bleak as of now. Half of the farmers in India are illiterate and only marginal of them are educated up to Higher Secondary [22]. This poor academic background and weak financial condition of farmers has slowed down the digitization of Indian Agriculture System. In this paper we propose a deployment model, which will provide ICT based information assistance to farmers in decision making. This model is built taking eAgriculture as base, inculcating the concept of cloud computing and already existing services being provided by Government of India.

The rest of this paper is organized as follows. Section II includes literature review, followed by Section III, which outlines modernization in Indian Agriculture. Section IV, presents analyses of two existing models i.e. eAgriculture and Agri-Cloud. In Section V, we propose a new deployment model for assisting farmers in decision making followed by Section VI, which throws light on benefits of proposed model, leading to conclusion in Section VII.

II. LITERATURE REVIEW

The white paper by IFFCO [2] outlines that by improving the quality of information used by farmers in decision making, one can improve quality of rural life as well as farm productivity. Hence ICT as indirect tool can be exploited for uplifting the

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current state of Indian Agriculture. The paper also throws light on the fact that scattered attempts can't meet the goals; the call of hour is that industries with major stake in agriculture sector should join hands to provide information.

In his work, K.Venkataramana [7] highlights the fact that ICT is being practiced in various sectors, but not used vastly in Agriculture sector. He has designed Agri-Cloud model along with Agri-Cloud framework to provide assistance to farmers, but its deployment is being processed.

Grameen Intel Social Business launched a project eAgriculture in Odhisa, India which is currently making vibes in agriculture sector. Its report [6] shows that in just 14 months, eKutir established 12 kiosks, serving a total of 6,000 farmers and improving their productivity by 300%. Each kiosk is run by a local entrepreneur who serves farmers within a 5 kilometer radius. This project has not only contributed to Agriculture sector but has also introduced employment opportunities.

III. MODERNISATION OF INDIAN AGRICULTURE

The face of agriculture throughout the world is changing rapidly particularly after WTO agreements came into existence. In the context of agriculture, the potential of IT can be exploited as [2]:

- *A direct tool*

  IT's direct contribution to agriculture is being realized through Precision farming, which directly contributes to productivity using IT techniques, techniques of remote sensing using satellite technologies, geographical information systems.
- *An indirect tool*

  IT can also be used for empowering farmers to take informed and quality decisions which will have overall positive impact.

In India innovative farming techniques are being practiced, easy access to finance, access to internet connectivity and mobile phones are made available in rural areas. Though its positive impact can be seen, as rural lifestyle in India is under transformation phase but at same time one cannot neglect the fact that poverty still exists.

Financial conditions of majority of farmers in India presently do not allow them to adopt precision farming technique. On other hand, the indirect benefits of IT in empowering Indian farmer are significant and remain to be exploited, as an urgent need of reliable sources of information is being felt among them.

IV. EXISTING MODELS

Despite the fact that agriculture plays a very vital role in Indian economy, its significance is fading away because of various challenges posing the sector. Lack of timely information is one of the major challenges being faced by Indian farmers.

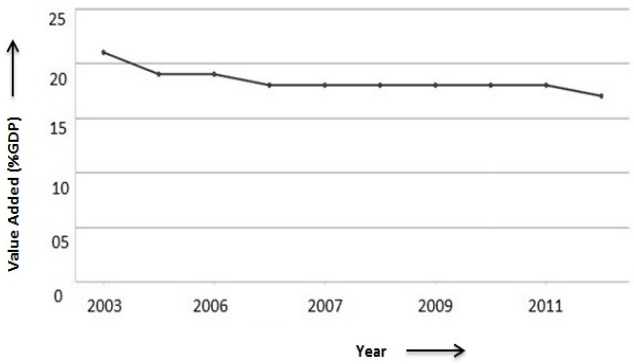

Fig. 1. Indian Agriculture, value added (%GDP) [17]

Introducing Information and Communications technology (ICT) in agriculture sector has opened new doors for agricultural productivity, competitiveness and rural growth. Many initiatives have been proposed and implemented to sail through prevailing situation. Two of them were studied during the course of research:

A. *eAgriculture*

A successful private initiative developed by Grameen Intel Social Business and partners in the state of Odisha. The goal was to not only improve productivity but also connect a wide array of local and regional stakeholders to form a mutually beneficial value chain.

In just over one year, the eAgriculture project helped 6,000 farmers increase their incomes as much as 300 percent, and created job opportunities for local entrepreneurs [6]. This project exemplifies how technology can be used to improve the livelihoods of small farmers. During the course of analyses, it was felt that few issues will impede its large scale implementation:

1) *Availability:* There can be a scenario that entrepreneur isn't available or isn't able to devote required time to a client farmer.
2) *Work Load:* If we talk about farmer to entrepreneur relationship, there exist many to one dependency. Many farmers will be depending on a single entrepreneur for assistance, increasing the load of work for him. This would finally lead to availability issue.
3) *No Central Database:* Absence of centralized database is another limitation.
4) *Connectivity Issue:* As we know, though modernization has hit rural areas, still internet connectivity is an issue of concern. So, entrepreneur office or kiosk is built in areas with internet connectivity, which means that in many cases such offices are established at a distance from villages where poor farmers live.

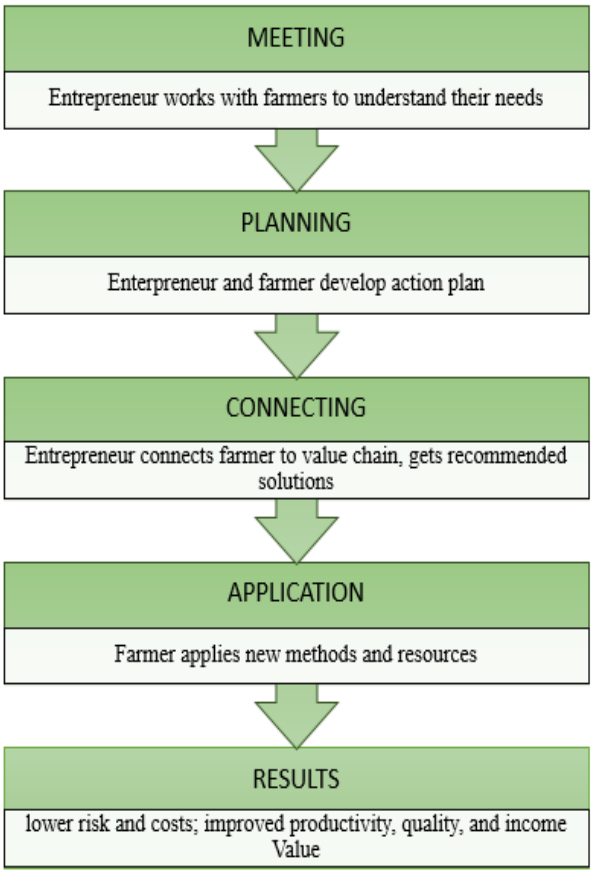

Fig. 2. The eAgriculture Solutions

5) *Travelling Expense:* Connectivity issue directly leads to burden on farmer's pocket as he has to travel to a particular place to get assistance.

B. AGRI-CLOUD

In recent years, the face of ICT technologies went under reconstruction as new concepts are flooding this domain. One of the promising subdomains of ICT which is being implemented in every sector of the developing nations is Cloud Computing.

Cloud Service Models: It provides Information Technology as a service to users, allowing them to make use of Xaas i.e. X as a service, where X can be software, platform, infrastructure or anything without the need to know the physical location and configuration of the system that delivers these services. These are known as Cloud Service models [9].

Cloud Deployment Models [8]: These are of following types:

- *Public cloud:* The cloud infrastructure is made available to the general public or a large industry group and is owned by an organization selling cloud services.
- *Private cloud:* The cloud infrastructure is operated solely for an organization. It may be managed by the organization or a third party and may exist on premise or off premise.
- *Community cloud:* The cloud infrastructure is shared by several organizations and supports a specific community that has shared concerns (e.g., mission, security requirements, policy, and compliance considerations). It may be managed by the organizations or a third party and may exist on premise or off premise.

NIST [8] defines Cloud computing whose main design aim is to provide convenient, on-demand, network access to a shared pool of configurable computing resources (e.g. networks, servers, storage, applications, and services), which can be rapidly provisioned and released with minimal management effort or service provider interactions. Cloud can be deployed in public, private or hybrid models which provides services in various forms like Software as a Service-SaaS Platform as a Service-PaaS and Infrastructure as Service-IaaS at cheaper cost. Thus, Cloud computing as tool, if implemented successfully can improve the current situation of Indian agriculture.

In his work, Venkataramana [7] has proposed and designed Cloud based model for assisting farmers in analyzing crop diseases, getting required suggestions and finding appropriate fertilizers in an easily understandable natural languages. Its assistance is not limited to farmers only; it is designed for stake holders in agriculture field to provide precise and accurate information, promising data security at the same time. The deployment of this model is proposed future work.

V. PROPOSED MODEL

This paper proposes conceptual deployment model named "Agri-assistant" taking eAgriculture concept as base, inculcating the concept of cloud computing and leveraging existing services being provided by Government of India.

- *Introduction to Agri-assistant*

  As the name suggests, this model will provide assistance to poor and uneducated farmers, by bridging the knowledge gap using technical advancement in ICT domain. The main objective of the model is to implement ICT as an indirect tool for assisting farmers to take informed and quality decisions to not only improve productivity but for overall positive development. This model not only focuses on exploiting the technological advancement but at the same time makes sure that no financial burden is added on poor farmer by making use of cheapest available resources and already existing services being provided by the Government of India.
- *Components of Agri-assistant*

  The model is divided into four parts, Information Storage System, Administrating & Maintenance system, Government Repositories and Farmer Interface Devices.

A. *Information Storage System (ISS)*:

To achieve the objective of assisting farmers in decision making, a centralized database is required. The USP of this model is that it will create a centralized farmer database by allocating every registered farmer with a Farmer ID (FID). The FID will be structured as <State ID. District ID. Unique farmer number>. ISS is basically private cloud owned by Central Government, which will provide Paas to store all the agriculture related data, which will be accessible to all the users at anytime and anywhere. It includes the following databases:

1) *Farmer Database:* It provides farmer information such as name, contact no., FID, cultivating area, main crop, etc. This helps in alarming farmers of upcoming natural calamity via SMS Portal [10].
2) *Help Desk*: This database maintains solutions to common and frequently asked problems.
3) *Video Library:* This database will store relevant videos from net or being provided by Digital Green. It is an NGO which has pioneered a novel process of creating local videos of farmers speaking on agriculture practices in their area [11].

B. *Government Repositories*

This model uses existing Government of India repositories using internet access.

1) *NICRA*: National Initiative on Climate Resilient Agriculture (NICRA) is a network project of the Indian Council of Agricultural Research (ICAR) launched in February, 2011. The project aims to enhance resilience of Indian agriculture to climate change and climate vulnerability through strategic research and technology demonstration. This website also provides online weather information including [12]
    - Online Weather Station
    - Crop Weather Outlook
    - Daily rainfall situation
    - Rainfall deficit districts
2) *IMD:* Indian meteorological department (Ministry of Earth Science, Government of India) is responsible for weather forecasting and alarming for upcoming natural calamities like flood, cyclone, thunderstorm, etc. In addition to these, there are separate divisions to deal with specialized subjects like Agriculture Meteorology [13].
3) *CGWB*: Central Ground Water Board, a subordinate office of the Ministry of Water Resources, Government of India. One of its major activities is monitoring of ground water levels and water quality. The Board regularly publishes scientific reports based on the data generated through various investigations for dissemination to the stakeholders. These include State and District hydrogeological reports, ground water year books and atlases, ground water user maps and guides/manuals/pamphlets on various aspects of ground water management [14].
4) *AMD:* The prime objective of Agricultural Meteorology Division of IMD is to minimize the impact of adverse weather on crops and to make use of crop-weather relationships to boost agricultural production. It includes service to agriculture, crop yield forecasting, etc. [15].
5) *DOF*: Department of Fertilizers comes under the ambit of the Ministry of Chemicals & Fertilizers. The main objective of Department of Fertilizers is to ensure adequate and timely availability of fertilizers at affordable prices for maximizing agricultural production in the country [16].
6) *Farmer Portal*: It is launched by Government of India. Presently it is in beta version; full version in different language is under development. This is one stop shop for farmers when it comes to pesticides, seeds, fertilizers, etc. [18].
7) *DAC*: Department of Agriculture and Cooperation is responsible for effective transfer of latest crop production technologies to farmers under various crop development schemes backed by remunerative prices for various crops through enhanced minimum support prices [20].

C. *Administrating & Maintenance system:*

This forms the middleware between farmers and ISS. It includes hierarchy of administrative offices at state level and district level. The ones at district level have Information support systems. The support staff connects with farmers via call or SMS portal to assist them with their problems in their native language. State level systems are responsible for maintaining local database and updating the same to centralized database.

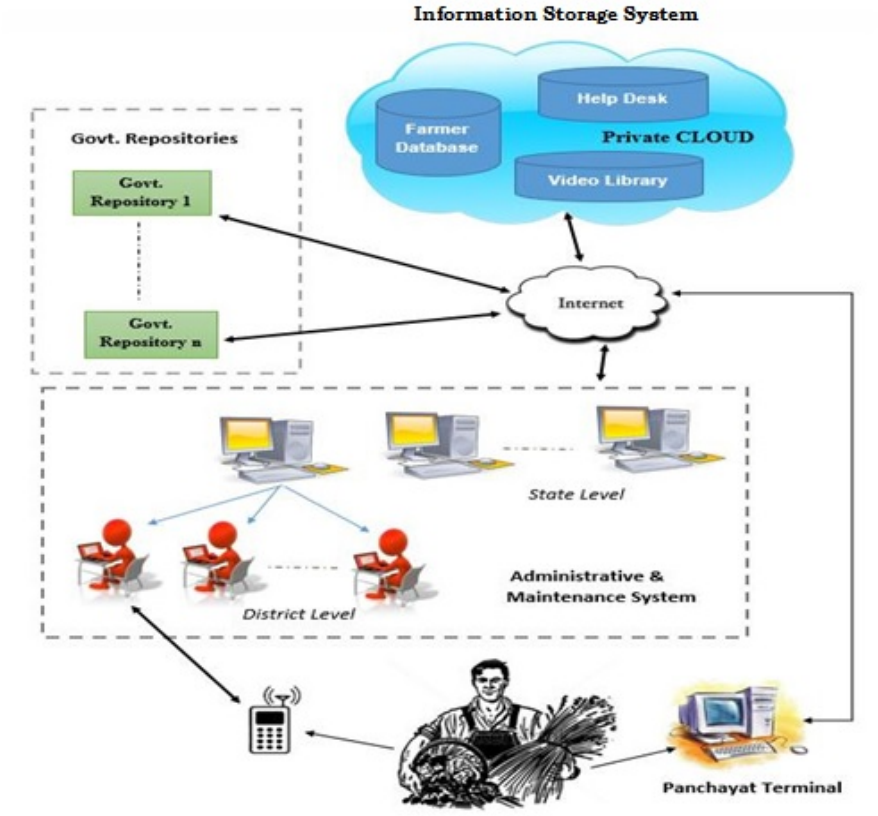

Fig. 3. Agri-assistant

Services being used to connect with farmers are:

1) *Mobile Services:* Mobile phones are omnipresent and cost effective means to revolutionize agriculture in India. According to the Government of India census 2011, mobile penetration in rural India stands at an astounding 51% [11]. Though farmers have never heard the term ICT, but are familiar with mobile services. Thus, mobile services are incorporated in the model.
2) *SMS Portal:* This is the recently (Sep. 2013) launched service by Government of India for uplifting face of agriculture. It is created by the Department of Agriculture & Cooperation for disseminating relevant information, giving topical & seasonal advisories and providing services through SMSs to farmers in language of the State [10].

D. *Farmer Interface Devices:*

This model uses devices which are either easily available or cost effective or are allocated by Government of India.

1) *Mobile Devices:* Voice based communications technology is seen as a powerful, feasible and effective medium in given scenario where farmers are poor and illiterate [11]. This model proposes pocket friendly mobile devices (Nokia 1100 or its upgraded version) as the prime connecting interface, which connects the farmer with Agri-assistant via dedicated helpline number. Mobile devices help the farmer in acquiring information from ISS from anywhere, at any time using their FID's.
2) *Panchayat Terminals:* Government of India has sanctioned 1 PC with internet connection to every Panchayat [19]. These can be used to conduct knowledge sharing sessions by screening videos from digital library.

The communication between the components of Agri-assistant is shown below. The Fig.4 shows flow of communication between an already registered farmer with Farmer ID and an administrative officer at Administrating & Maintenance system layer. The Fig.5 shows only a part of communication when a new farmer is allotted with Farmer ID.

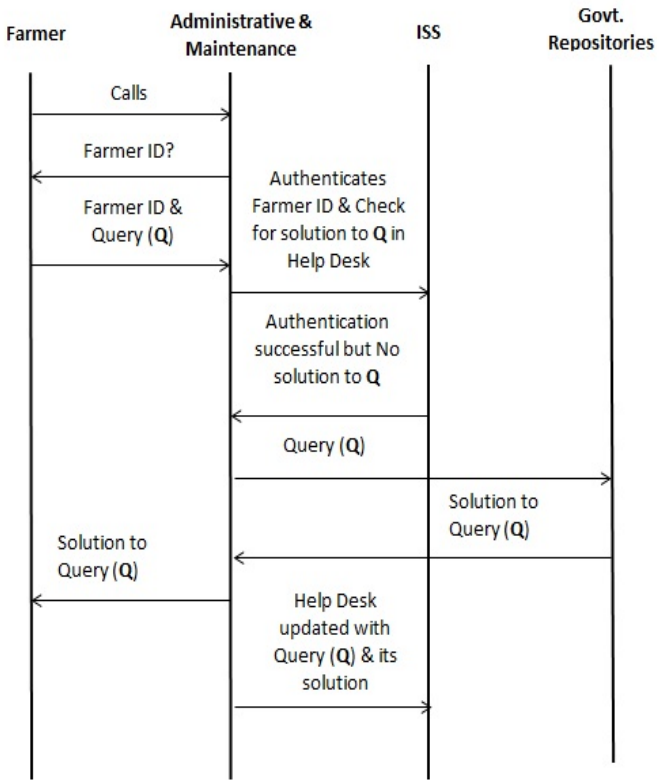

Fig. 4. Communication between Farmer having Farmer ID and Administrative officer

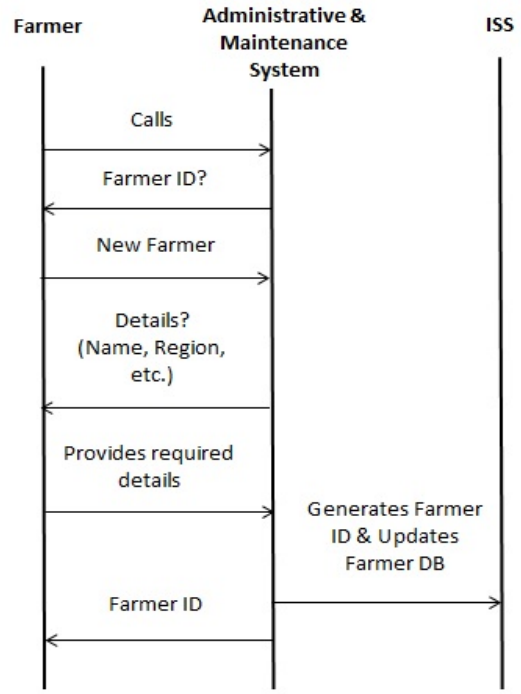

Fig. 5. Allotment of Framer ID

VI. BENEFITS OF PROPOSED MODEL

This model incorporates benefits of Cloud computing while leveraging Government provided services.

1) *Data management:* The data will be stored centrally and managed by a team of professionals, guaranteeing organized data management.
2) *Data Access*: Using this model, farmer can access information from anywhere, anytime using FID and helpline number.
3) *Common Platform for Problem solving:* The model provides Help Desk, which maintains database for all the problems reported with appropriate solutions. This will include problems faced by farmers throughout India, hence providing a common interface for agriculture related problem solving.
4) *Security:* Since we are using private cloud for storage, data is stored centrally with enhanced security level.
5) *Centralized Farmer Database:* This model will provide Government with the database of all the farmers throughout India, which can be used for reference in framing policies and implementing new projects in agriculture sector.
6) *Adding to economy:* Successful implementation of model will improve farming productivity, which will in turn improve agriculture sector. Being an agrarian economy, this improvement will be reflected in overall development of Indian economy.
7) *Local languages:* Providing solutions to problems in native language using SMS Portal or via call is one of the USP of the model.
8) *Pocket Friendly:* This model requires farmer to own basic configuration mobile (Nokia 1100), which is pocket friendly and also makes use of existing repositories of Government of India.

VII. CONCLUSION

Introduction of ICT in the agriculture sector is not new to the world. Developing country like China is exploiting the latest technologies like cloud computing and Internet of Things to make direct contribution to agricultural productivity. This is more apt for farming taken up on corporate lines, as it requires capital investment. Contrary to this, the financial conditions of the farmers living in rural India do not allow usage of these pervasive technologies for improving India's agriculture sector. This paper proposes a cloud deployment model, Agri- assistant to assist farmers in efficient decision making which in turn will improve not only the farm productivity but will also help agriculture sector to grow.

This model makes use of Cloud computing, pocket friendly resources and Government Services to bridge the digital divide between illiterate farmer and recent ICT technologies. For the present scenario this model is a solution, but with the technological advancement and improvement in financial

conditions of Indian farmers, technologies like IOT (sensors, RFID's, etc.) can be inculcated in proposed model.

REFERENCES

[1] Department of Agriculture and Cooperation, "State of Indian Agriculture 2012-13", *Directorate of Economics and Statistics*, Ministry of Agriculture, Government of India, Rep. 2012-13.

[2] S.C. Mittal, "Role of Information Technology in Agriculture and its Scope in India", *Fertilizer Association of India (FAI) Forum*, Apr. 2002.

[3] "Agriculture and Food Management", *Economic Survey 2012-13*,Ch-08.Internet:http://indiabudget.nic.in/es2012-13 /echap-08.pdf.

[4] N. Viswanadham, "Can India be the Food Basket for the World?" *Achieving Rural & Global Supply Chain Excellence- The Indian Way*, GLAMS Research Publications, Ch-01, pp.10, 2006.

[5] Dr. A.K.Choubey, "ICT Initiatives in Agriculture by Government of India" *FAI Workshop*, 10-8-2009.Internet:http://www.faidelhi.org/training/Workshop

[6] Intel, "eAgriculture: Using Technology to Empower Farming Communities", *Intel World Ahead Program*, Intel, India, Case study, 2012. Internet: www.intel.in /content/dam/www/public/../eagriculture_program_cs.pdf

[7] K..Venkataramana and Dr.M.Padmavahamma, "A Design of Framework for AGRI-CLOUD", *IOSR Journal of Computer Engineering*, ISSN: 2278-0661Volume 4, Issue 5, pp. 01-06, Sep.-Oct. 2012

[8] Peter Mell and Timothy Grance, "The NIST Definition of Cloud Computing", *NIST Special Publication* 800-145, pp. 2, Sep. 2011.

[9] Bill Loeffler, "Cloud Computing: What is Infrastructure as a Service".Oct.2011 Internet: http://technet.microsoft. com/en-us/magazine /hh509051.aspx.

[10] "Launch of Kisaan SMS Portal". *Press Release,* Ministry of Agriculture, India, Sep. 2013, Internet: http://agricoop.nic.in/imagedefault/whatsnew/smsportal.pdf .

[11] "Social networks for Agriculture Revolution", *Blog Gramvaani*, 14 Jul, 2013. Internet: http://www .gramvaani.org.

[12] Indian Council of Agricultural Research, "National Initiative on Climate Resilient Agriculture (NICRA)". Government of India. Internet: www.nicra-icar.in.

[13] Ministry of Earth Science, "Indian meteorological department". Government of India. Internet: www.imd. gov.in

[14] Ministry of Water Resources, "Central Ground Water Board". Government of India. Internet: www.cgwb. gov.in

[15] Indian meteorological department, "Agricultural Meteorology Division". Government of India. Internet: www.imdagrimet.gov.in

[16] Ministry of Chemicals & Fertilizers "Department of Fertilizers". Government of India. Internet: http://fert.nic.in

[17] World Development Indicators, "Indian Agriculture, value added (%GDP)", World Data Bank, World Bank. Internet: http://www.worldbank.org

[18] Ministry of Agriculture, "Farmer Portal". Government of India Internet: http://farmer.gov.in

[19] "Scheme of Village Knowledge Centre", *CAPART*, Internet: capart.nic.in/scheme/vrc.pdf

[20] Government of India, "Department of Agriculture and Cooperation". Internet: http://agricoop.nic.in

[21] Weimei Zhang, "Study about IOT's Application in " Digital Agriculture" Construction", *Electrical and Control Engineering* (ICECE), IEEE, pp. 2578 – 2581, 2011. DOI: 10.1109/ICECENG.2011.6057405

[22] D. G. Chandra and D. B. Malaya, "Role of eAgriculture in Rural Development in Indian Context ", *Emerging Trends in Networks and Computer Communications (ETNCC), IEEE*, 2011. DOI: 10.1109/ETNCC.2011. 6255913