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**REVIEW ARTICLE** **OPEN ACCESS**

# Digital Agriculture

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**ABSTRACT**
*Digital Agriculture will play a key role in knowledge exchange, targeted recommendations, market integration and access to finance to make agriculture a profitable enterprise and attractive for youth. The digital revolution is changing the face of agriculture, with the zeros and ones that make up binary code set to become the most important tools for farmers worldwide. Highly automated tractors and combines equipped with a vast array of sensors are already traversing farmer's fields. Drones and satellites are likewise helping farmers work more efficiently by generating millions of relevant data points. Farmers are able to predict influences which affecting yields and respond more quickly to changes. So that they can prompt action to future change. With this background, the paper has been conceptualized.*
***Keywords:*** *Digital agriculture, precision farming, farmers, ICT*

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## INTRODUCTION

Over the last few decades massive technological development and opportunities have transformed people's lives. However, these opportunities have not benefited the agriculture sector in a significant way. Farmers and various other stakeholder of the agriculture value chain need significant amount of information. Digital agriculture will play a key role in knowledge exchange, market integration and access to finance to make agriculture a profitable enterprise.

Digital Farming describes the evolution in agriculture and agricultural engineering from Precision Farming to connected, knowledge-based farm production systems. Digital Farming makes use of Precision Farming technology, yet – in addition – also takes recourse to intelligent networks and data management tools. The aim in Digital Farming is to use all available information and expertise to enable the automation of sustainable processes in agriculture.

Precision Farming started when GPS signals were made available to the general public. Precision Farming enables vehicle guidance and site-specific monitoring and control. Combined with telematics and data management, Precision Farming improves the accuracy of operations and allows the managing of in-field (or in-herd) variations. The objective is to give each plant (or animal) exactly what it needs to grow optimally, with the aim to improve the agronomic output while reducing the input.

Prime Minister Narendra Modi launched Digital India on July 1, 2015 to create digital infrastructure for empowering rural communities, enabling digital delivery of services and promoting digital literacy. Given that 68 per cent of India's population is rural and agriculture is the main source of livelihood for 58 per cent of the population, one must consider the role of Digital Agriculture within Digital India. Digital Agriculture can be defined as ICT and data ecosystems to support the development and delivery of timely, targeted (localised) information and services to make farming profitable and sustainable (socially, economically and environmentally) while delivering safe, nutritious and affordable food for ALL. Rural connectivity will be key to providing low cost data and access to information. It would empower rural youth to realise their full potential, farmers to increase their profitability by accessing equitable markets and rural businesses to offer value added services

The digital revolution is changing the face of agriculture through 'digital earth' concept proposed in 1990.It is an expansion of the concept of precision farming which emphasizes on agricultural production procedure. This mitigates risk in agriculture. With this background, the paper has been conceptualized with the following objectives:

- To know the problems existing in Indian agriculture
- To understand the concept of Digital Agriculture
- To study the digital initiative by the government to address farmers problem

**REVIEW OF LITERATURE**

Antoni *et al*. [1] study investigates cotton farmers' perception about precision agriculture and how those perceptions impact adoption of the autosteer GPS guidance system. Autosteer adoption was found to be significant and positively related to the perceived future importance of precision agriculture. Results show that the attributes of the cotton picker are important factors in adoption of autosteer GPS technology.

Raghuprasrad *et al.* [2] conducted study on an analysis of knowledge level of farmers on utilization of ICT tools. The results revealed that nearly 70 per cent of farmers had high to medium level of knowledge about utilization of ICT tools and 30.83 per cent had low level of knowledge. Variables such as material possession, social participation, extension participation, mass media exposure and Cosmopoliteness had positive and significant relationship with knowledge of farmers about ICT tools at one per cent level of significance whereas; education and annual income had positive and significant relationship at five per cent level of significance.

Kudari [3] conducted study on perception of farmers about precision farming to analyze the impact precision farming on crop productivity and income. The results revealed that average yield of crop was increased and the income of the farmer was also raised after adopting precision technologies in sugarcane, cotton and chili crop. Crop productivity had positive and significant relationship with the perception of precision farming which means that those farmers who are more oriented towards higher crop productivity per acre were the one who had perceived the precision farming as most favorable.

**RISK IN AGRICULTURE**

Risk is an important aspect of the farming business. The uncertainties inherent in weather, yields, prices, Government policies, global markets, and other factors that impact farming can cause wide swings in farm income. Risk management involves choosing among alternatives that reduce financial effects that can result from such uncertainties.

1.Productin risk
2.Post harvest risk
3.Market risk
4.Ecological

**Production Risks**

Production risks relate to the possibility that your yield or output levels will be lower than projected. Major sources of production risks arise from adverse weather conditions such as drought, freezes, or excessive rainfall at harvest or planting. Production risks may also result from damage due to insect pests and disease despite control measures employed, and from failure of equipment and machinery such as an irrigation pump.

Strategies to manage production risks include:

- Follow recommended production practices.
- Diversify enterprises by growing different crop varieties and completely new crops.
- Expand production through more intensive growing practices or by planting more acreage.
- Purchase crop insurance coverage to stabilize income during times of loss.
- Adopt risk mitigating practices such as drip irrigation, tile drainage, trap crops or resistant varieties.
- Consider site selection - use fields less susceptible to frost or pests and rotate crops.
- Maintain equipment and keep facilities in good working condition.

**Post Harvest risk Risks**

The total loss due to poor post-harvest processing of agricultural products in India when valued in terms of monetary reflects a tremendous loss in the economy. Post-harvest losses of rice, wheat, sugarcane, pulses, oil seed, vegetables fruits and root crops due to inadequate processing and preservation. Foodstuff: Products edible by human beings; more specifically, the part fit for human consumption. In tropical countries, 75 percent of basic food comes from cereals and pulses. The remaining vegetable-based food is often supplied as roots and tubers particularly cassava, yam, taro, plantain, potato and sweet potato. In the food chain, quantities of food are usually expressed in terms of weight. Grains and seeds: Cereals, pulses and oilseeds grown in most climates and latitudes for

human consumption. The main cereals are wheat, maize, rice, barley, sorghum, millet, oats and rye. Pulses cover the various species of pea, bean, broad bean and lentil; and oilseeds cover soya, groundnut, sesame, rapeseed and sunflower. Post-harvest: The post-harvest covers the period that runs from exit from the field to the time of culinary preparation. For various reasons, it allows the straw and grain to dry fully. Harvesting may be delayed sometimes for months, as happens particularly with maize and rice in such cases it is referred as post-production verbally in order to indicate the link between harvesting and post-harvest operations. Food loss: Food loss refers to total modification or decrease of food quantity or quality which makes it unfit for human consumption

**Marketing Risks**

Marketing risks relate to the possibility that you will lose the market for your products or that the price received will be less than expected. Lower sales and prices due to increased numbers of competing growers or changing consumer preferences are common sources of marketing risk. Marketing risks can also arise from loss of market access due to a wholesale buyer or processor relocating or closing, or if a product fails to meet market standards or packaging requirements.

Strategies to manage marketing risks include:

- Develop a marketing plan with realistic sales forecasts and target prices.
- Form or join a marketing cooperative to enhance prices and guarantee a market.
- Increase direct marketing efforts to capture a higher price.
- Market through multiple channels or outlets to reduce reliance on a single market.
- Enter into sales or price contracts with buyers.
- Spread harvest and sales over the season by scheduling planting and considering storage.
- Conduct essential market research - understand your customers' needs and preferences.
- Purchase Whole-Farm Revenue Protection to cover unexpected decline of market price during the insurance year.

**Ecological Risks:**

In part, legal risks relate to fulfilling business agreements and contracts. Failure to meet these agreements often carry a high cost. Another major source of legal risk is tort liability - causing injury to another person or property due to negligence.

Lastly, legal risk is closely related to environmental liability and concerns about water quality, erosion and pesticide use. Strategies to manage legal risks include:

- Review business insurance policies and carry sufficient liability coverage.
- Choose a different business legal structure - a sole proprietorship is not always best.
- Understand business contracts and agreements - ask questions if you are unsure.
- Develop good relationships with neighbors and address their concerns.
- Use good agricultural practices to limit environmental risk.
- Know and follow State and Federal regulations related to your farming operation.

**DIGITAL AGRICULTURE**

Digital Agriculture can be defined as ICT and data ecosystems to support the development and delivery of timely, targeted (localized) information and services to make farming profitable and sustainable (socially, economically and environmentally) while delivering safe, nutritious and affordable food for ALL.

Digital agriculture is the use of new and advanced technologies, integrated into one system, to enable farmers and other stakeholders within the agriculture value chain to improve food production. Most of today's farmers make decisions such as how much fertilizer to apply based on a combination of rough measurements, experience and recommendations. Once a course of action is decided, it is implemented but the results are normally not seen until harvest time.

In contrast, a digital agriculture system gathers data more frequently and accurately, often combined with external sources (such as weather information). The resulting combined data is analyzed and interpreted so the farmer can make more informed and appropriate decisions. These decisions can then be quickly implemented with greater accuracy through robotics and advanced machinery, and farmers can get real-time feedback on the impact their actions.

**PRECISION AGRICULTURE**

Precision agriculture (PA), satellite farming or site-specific crop management (SSCM) is a farming management concept based on observing, measuring and responding to inter and intra-field variability in crops. The goal of precision agriculture research is to define a Decision Support System (DSS) for whole farm management with the goal of perfecting returns on inputs while preserving resources. Among these many approaches is a Phyto geomorphologic approach which ties multi-year crop growth stability/characteristics to topological terrain attributes. The interest in the Phyto geomorphologic

approach stems from the fact that the geomorphology component typically dictates the hydrology of the farm field.

The practice of precision agriculture has been enabled by the advent of GPS and GNSS. The farmer's and/or researcher's ability to locate their precise position in a field allows for the creation of maps of the spatial variability of as many variables as can be measured (e.g. crop yield, terrain features/topography, organic matter content, moisture levels, nitrogen levels, pH, EC, Mg, K, and others).

Similar data is collected by sensor arrays mounted on GPS-equipped combine harvesters. These arrays consist of real-time sensors that measure everything from chlorophyll levels to plant water status, along with multispectral imagery. This data is used in conjunction with satellite imaginary by variable rate technology (VRT) including seeders, sprayers, etc. to optimally distribute resources.

**Scope of precision farming in India**

The concept of precision farming is not new for India. Farmers try their best to do the things for getting maximum possible yield with information and technologies available to them but unless & until total information about their fields and advanced technologies are available, they cannot do precision farming in perfect sense. In India, major problem is the small field size. More than 58 percent of operational holdings in the country have size less than 1ha. Only in the states of Punjab, Rajasthan, Haryana and Gujarat more than 20 per cent of agricultural lands have operational holding size of more than four hectare. When contiguous fields with the same crop are considered, it is possible to obtain fields of over 15 ha extent in which similar crop management are followed. Such fields can be considered for the purpose of initiating the implementation of precision farming. Similar implementation can also be carried out on the state farms. There is a scope of implementing precision agriculture for crops like, rice and wheat especially in the states of Punjab and Haryana. Commercial as well as horticultural crops also show a wider scope for precision agriculture in the cooperative farms. Nearly two-third arable land in India is rain-fed. The crop yields are very low (≈1t ha-1) and very good potential exists for increasing productivity of rain-fed Cropping systems.

**Benefits of precision farming**

The concept of "doing the right thing in the right place at the right time" has a strong intuitive appeal which gives farmers the ability to use all operations and crop inputs more effectively.

More effective use of inputs results in greater crop yield and/or quality, without polluting the environment.

Precision agriculture can address both economic and environmental issues that surround production agriculture today.

**Drawbacks of precision farming**

- High cost: It has proven difficult to determine the cost benefits of precision agriculture management. At present, many of the technologies used are in their infancy, and pricing of equipment and services is hard to pin down.
- Lack of technical expertise knowledge and technology: The success of precision agriculture depends largely on how well and how quickly the knowledge needed to guide the new technologies can be found (India spends only 0.3% of its agricultural Gross Domestic Product in Research and Development)
- Not applicable or difficult/costly for small land holdings
- Heterogeneity of cropping systems and market imperfections

**Policy approach to promote precision farming at farm level:**

- Identify the niche areas for the promotion of crop specific precision farming.
- Creation of multidisciplinary teams involving agricultural scientists in various fields, engineers, manufacturers and economists to study the overall scope of precision agriculture.
- Promote the progressive farmers for precision farming technology who have sufficient risk bearing capacity.
- Encourage the farmers to study of spatial and temporal variability of the input parameters using primary data at field level.
- Provide complete technical backup support to the farmers to develop pilots or models, which can be replicated on a large scale.
- Pilot study should be conducted on farmer's field to show the results of precision agriculture implementation.
- Encourage the farmers to adopt water accounting protocols at farm level and to use of micro level irrigation systems and water saving techniques.
- Government legislation restraining farmers using indiscriminate farm inputs and thereby causing ecological/environmental imbalance would induce the farmer to go for alternative approach.

- Creating awareness amongst farmers about consequences of applying imbalanced doses of farm inputs like irrigation, fertilizers, insecticides and pesticides.
- Policy support on procurement prices, efficient transfer of technology to the farmers, formulation of cooperative groups or self help groups since many of the precision agriculture tools are costly (GIS, GPS, RS, etc.).

**Challenges In precision farming**

- Lack of Technical Expertise knowledge & Technology.
- Small land holdings.
- High - cost technology of PF systems.
- Internet Access.
- Illiteracy (Approx. 40%)

**Probable Strategies:**

- Farmer's co-operative
- Pilot projects
- Cheaper applications
- Joint effort of Researchers and Government
- Inexpensive way of acquiring images with camera in visible and infra-red bands using powered parachute

**ICT IN AGRICULTURE**

Information and communication technology in agriculture (ICT in agriculture), also known as e-agriculture, is developing and applying innovative ways to use ICTs in the rural domain, with a primary focus on agriculture. ICT in agriculture offers a wide range of solutions to some agricultural challenges. It is seen as an emerging field focusing on the enhancement of agricultural and rural development through improved information and communication processes. In this context, ICT is used as an umbrella term encompassing all information and communication technologies including devices, networks, mobiles, services and applications; these range from innovative Internet-era technologies and sensors to other pre-existing aids such as fixed telephones, televisions, radios and satellites. E-agriculture continues to evolve in scope as new ICT applications continue to be harnessed in the agriculture sector. More specifically, e-agriculture involves the conceptualization, design, development, evaluation and application of innovative ways to use ICTs in the rural domain, with a primary focus on agriculture. Provisions of standards, norms, methodologies, and tools as well as development of individual and institutional capacities, and policy support are all key components of e-agriculture.

**ICT Tools in Agriculture**:

- E-mail
- Portal
- Interactive expert system
- Internet browser
- Call centers
- Radio
- Television
- Video conferencing

**Digital Initiative by The Government**:

- eNAM
- Digital India
- mKISAN
- Kissan Call Centre
- NeGP-A
- Kissan Credit Card
- Krishidoot

**e-NAM**

National Agriculture Market (NAM) is a pan-India electronic trading portal which networks the existing APMC mandis to create a unified national market for agricultural commodities. The NAM Portal provides a single window service for all APMC related information and services. This includes commodity arrivals & prices, buy & sell trade offers, provision to respond to trade offers, among other services. While material flow (agriculture produce) continue to happen through mandis, an online market reduces transaction costs and information asymmetry.

Agriculture marketing is administered by the States as per their agri-marketing regulations, under which, the State is divided into several market areas, each of which is administered by a separate Agricultural Produce Marketing Committee (APMC) which imposes its own marketing regulation (including fees). This fragmentation of markets, even within the State, hinders free flow of agri commodities from one market area to another and multiple handling of agri-produce and multiple levels of mandi charges ends up escalating the prices for the consumers without commensurate benefit to the farmer.

NAM addresses these challenges by creating a unified market through online trading platform, both, at State and National level and promotes uniformity, streamlining of procedures across the integrated markets, removes information asymmetry between buyers and sellers and promotes real time price discovery, based on actual demand and supply, promotes transparency in auction process, and access to a nationwide market for the farmer, with prices commensurate with quality of his produce and online payment and availability of better quality produce and at more reasonable prices to the consumer.

**Digital India**

Digital India is a campaign launched by the Government of India to ensure the Government's services are made available to citizens electronically by improved online infrastructure and by increasing Internet connectivity or by making the country digitally empowered in the field of technology. The initiative includes plans to connect rural areas with high speed internet networks. Digital India consists of three core components, (a) development of secure and stable digital infrastructure, (b) delivering government services digitally, and (c) universal digital literacy.

Launched on 1 July 2015 by Prime Minister Narendra Modi, it is both enabler and beneficiary of other key Government of India schemes, such as BharatNet, Make in India, Startup India and Standup India, industrial corridors, Bharatmala, Sagarmala, dedicated freight corridors and UDAN-RCS.

**mKISAN**

As per TRAI data of May, 2014, though there are about 38 crore mobile telephone connections in rural areas, internet penetration in the countryside is still abysmally low (in single digit percentage). Therefore, mobile messaging is the most effective tool so far having pervasive outreach to nearly 8.93 crore farm families. mKisan SMS Portal for farmers enables all Central and State government organizations in agriculture and allied sectors to give information/services/advisories to farmers by SMS in their language, preference of agricultural practices and location.

As part of agricultural extension (extending research from lab to the field), under the National e-Governance Plan - Agriculture (NeGP-A), various modes of delivery of services have been envisaged. These include internet, touch screen kiosks, agri-clinics, private kiosks, mass media, Common Service Centres, Kisan Call Centres, and integrated platforms in the departmental offices coupled with physical outreach of extension personnel equipped with pico-projectors and hand held devices. However, mobile telephony (with or without internet) is the most potent and omnipresent tool of agricultural extension.

SMS Portal was inaugurated by the Hon'ble President of India on July 16, 2013 and since its inception nearly 327 crore messages or more than 1044 crore SMSs have been sent to farmers throughout the length and breadth of the country.

**Kisan Call Centre**

Agriculture extension services along with facilitation to farmers are the mandate of Agriculture Department everywhere in the country. Continuing fragmentation of land holdings and the increasing number of small holdings are creating challenges for the extension function from the viewpoint of input supply, transfer of technology, ensuring general awareness, etc. One-onone contact via extension services is now becoming practically difficult, and a shift towards the group approach is becoming inevitable. For speedy transmission of technology and latest technical updates to farmers, for resolving their diverse problems , an innovative means, namely, the KISAN CALL CENTRE, was established in Madhya Pradesh under RashtriyaKisan Vikas Yojna (RKVY) during 2008-09. After fulfilling all necessary formalities, the Govt of Madhya Pradesh, Department of Farmer Welfare & Agriculture Development, in coordination with SIAET, chose Indian Society of Agriculture Business Professionals (ISAP), as a partner. The responsibility of ensuring smooth functioning of the KCC was been entrusted to ISAP. KCC in the state started to function in Bhopal in September 2008.

- To facilitate farmers of the state to get information/solutions to their problems through use of the Toll Free Number 1800-233-4433.
- To provide technical inputs to farmers.
- To serve as a feedback mechanism for the policy makers.
- To forge strong Research Extension Farmer Linkages.
- The Kisan Call Center established in the state functions from 7am to 7pm every day. It comprises a 15-seater computerized answering system working in two shifts, i.e., 7am to 1pm and 1pm to 7pm.

**Kissan Credit Card**

**Objective:**

The scheme aims at providing adequate and timely cred it for the comprehensive credit requirements of farmers under single window for their cultivation and other needs as indicated below:

- To meet the short term credit requirements for cultivation of crops
- Post harvest expenses
- Produce Marketing loan
- Consumption requirements of farmer household
- Working capital for maintenance of farm assets, activities allied to agriculture, like dairy animals, inland fishery and also working capital required for floriculture, horticulture etc.
- Investment credit requirement for agriculture and allied activities like pump sets, sprayers, dairy animals, floriculture, horticulture etc.

**KRISHIDOOT**

An agricultural eBay of sorts has brought together more than 3 lakh farmers with 2000 buyers, including Reliance Fresh, Jubilant Foods, and ITC. Business is brisk.Sinceit kicked off eight months ago, the portal – "Krishidoot" – has received 35,000 queries. Farmers have sold 13,000 quintals of produce such as grain, vegetables, flowers and soyabean, worth Rs 2.5 crore, to their online buyers. And made up to 18% more money than before. In return, farmers are buying seeds, pesticides, crop insurance, godown space and even personal loans from the same portal.In 10 states where it is working, the APMC Act permits a corporate to buy directly from the FPO under a special license.

The sheer convenience has made it a winning concept. Queries can be texted, leaving no need for a computer. These are instantly matched with buyer demands.Reuters Market Light, which runs the portal on behalf of the Small Farmers Agri-business Consortium, a government-owned incubation company, follows up with personal calls to each party. The rest of the transaction – price, quality, delivery – is decided by buyer and seller offline on terms that are invariably better than usual. Easy. Efficient. Value-for-money. The techno-savvy supply chain for farm produce.

But rural online retail isn't the real story here. This portal is special because it is India's first agri B2B site. The 3 lakh farmers are shareholders in 300 farmer producer companies registered under the Companies Act. It is these companies that do business on Krishidoot.

These companies have one objective: grab maximum share of the consumer's rupee. So, through aggregating produce for negotiating power, value addition through pre-sorting, grading, sometimes even processing, long-term retail contracts, and smart technology like e-auctions, they try not to leave any money on the table for middlemen.

## CONCLUSION

In Indian agricultural scenario, it is difficult to adopt the precision technologies due to small size of land holdings which limits the gain from technologies. Research efforts along with Government support is needed to find out the applicability of digital technologies into agriculture. Digital technologies will be going to transform agriculture by providing digital information to overcome agricultural problems. Digital information increases the usage of technology by raising efficiency and dramatically reducing the transaction costs. Digital technologies overcome information problems that hinder market access for many small-scale farmers, increase knowledge through new ways of providing extension services, and they provide novel ways for improving agricultural supply chain management.

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