Implementation Of GIS in Agriculture: A Boon To Sustainability

Ankita Mohapatra

School of Computer Engineering
Kalinga Institute Of Industrial
Technology   (KIIT) Deemed to be
University,   Bhubaneswar,   Orissa,
India. ankita.anks94@gmail.com

Kumar Devdutta

School of Computer Engineering
Kalinga Institute Of Industrial
Technology(KIIT) Deemed to be
University, Bhubaneswar, Orissa,
India. kdevduttafcs@kiit.ac.in

Bhabani Shankar Prasad Mishra
School of Computer Engineering
Kalinga Institute Of Industrial
Technology(KIIT) Deemed to be
University, Bhubaneswar, Orissa,
India. bsmishrafcs@kiit.ac.in

Abstract—**Sustainable Agriculture has been identified as one of the most important elements of the Sustainable Development Goal. The entire world is striving relentlessly to achieve it. In the 21st-century communication/ digital communication has been the major breakthrough and act as a driving force to research, development, living & well being. The Importance & impact of IT on agriculture attains high priority. Further, Introduction of Geographic Information System [GIS] has brought a revolution in communication. To see the collaboration of IT with different sectors may be challenging. Agriculture is one among them. Agriculture is known as the backbone of India's economy. It is a traditional sector which is vital to the survival of modern man. The collaboration of the traditional sector with the modern idea is E-Agriculture.The purpose of this paper is to get a clear view of the growth of agriculture sector by direct and indirect observations and experiences from the governance of IT in the rural sector of Odisha.**

Keywords—*E-Agriculture, Geographic Information System, Vertical Farming, Organic Farming, Intensive Farming.*

I.   INTRODUCTION

India is one of the largest agri-producer in the world. . Agriculture helps to improve the economy of India in various direct or indirect ways. Food is the regular production of the agriculture and it also provides raw materials for a large section of industries. By adopting new methodology or new technology can make the agriculture more worthy.

In India, Odisha is one of the major agricultural state.Here,more then 60% population engaged with agriculture and agriculture related industries. Odisha have 87.46 lakh hectares cropped area.Out of cropped area 18.79 lakh hectars are irrigated[1]. Major part of odisha depends upon the rain for water feddIn odisha's agriculture economy climate and soil play a vital role.Agriculture is sustenance of the life of the people.Today Agriculture science have a major challenge to supply enough food to growing human civilization.

In Odisha, the agro-climatic conditions are suitable and favourable for the production of different types vegetables,fruits and spices. The state is ranked fourth in terms of production of vegetables and contributes about three percent of total flower production in the country. Rose, gladioli, marigold and tuberose are the main flowers that contributes for the three percent. Variety of farming process[2] are adopted by farmers. Those are-

A.   Subsistance farming

Mostly subsistance farming is used by rural area people. In this farming process, most of the yield is consumed by the farmer's own family. Farmers are following traditional methods for farming, they have small farm area, Irrigation is generally not available to them therefor the amount of produced yield is not very high.

B.   Shifting Agriculture

In this farming process, Farmers cleared a piece of forest land by felling trees and burning of trunks and branches. Then after grown of crops for 2 to 3 years, they shift their farm to another piece of the forest because the land is abandoned as the fertility of the soil decreases.This farming process is known as the podu in Odisha.

C.   Plantation Agriculture

It is an industrialized agriculture and export-oriented agriculture. It produces monocultures cash crops for export. Plantation farming is a bush of tree farming. This type of farming mainly found in the hilly area.

D.   Intensive Farming

This type of farming has been possible in irrigation area. Farmers invest high-level inputs and get high-level output per cubic unit of agricultural land area. Farmers use fertilizers and pesticides on large scale and high yielding variety of seeds to improve the growth of yield. It is also known as industrial agriculture.

E.   Dry Agriculture

It is a farming process for non-irrigated areas and farmers are planting drought-resistant crops to get a good amount of yield.Key elements of effective dryland agriculture are

Capturing and Conservation of Moisture, Effective Use of Available Moisture, Soil Conservation, Control of Input Costs.

F. Mixed & Multiple Agriculture

This farming process is referred to the cultivation of crops and raising of animals simultaneously. In multiple farming, farmers are able to grow two or more crops together. This type of farming requires good rainfall or facilities or irrigation.

G. Crop Rotation

In this farming process to maintain the fertility of the soil, growing of number of Crops one after the other in a fixed rotation is required As per the local soil conditions and the experience and the understanding of the farmers, the selection of crops for rotation is done.

H. Terrace Cultivation

Farmers commonly used to farm on hilly or mountainous terrain. They cut that peice of sloped plane into a series of successively receding flat surfaces or platforms. Soil erosion is also checked due to terrace formation on hill slopes.

II. CURRENT TRENDS

The amount of the chemical (pesticides/fertilizers) consumption is increased and therefore production and productivity of crops has been increased. This trend is more evident in developed and industrial countries. The growth of the population is accompanied with change in food habits and rising concerns for food quality.According to the United Nation Projection's estimation: By 2030 world population could reach 8.6 billion[3], thus 2.25 percent will be the expected rate of increase in world population over the next 13 years. When globalization has affected food systems, At the same time excessive use of chemicals is not desirable in agriculture.Therefor current trends of Agriculture have created a concern for environmental problems for the preservation of environment, biodiversity and soil quality.

In recent trend there has bean a phenomenal rise in agriculture like organic agriculture, vertical farming and intensive agriculture [4] to accommodate the heavy demands of increasing world population and also accommodate the rising concern for environmental related issues. Vertical farming helps in meeting the food & other demands of the swiftly growing urban population. On the other hand Organic farming helps in increasing the harmony between the environment and anthropogenic activities done for Agriculture.

A. Vertical Farming

Vertical Farming is used to produce more yields faster, therefore farmers use conventional Vertical Farming methods such as hydroponics and aeroponics.Hydroponics is the method of growing plants without soil, using mineral nutrient solutions in a water solvent. And Aeroponics System provides plants with an enclosed air and water/nutrient ecosystem. It is a commercial farming whereby plants, animals, and other forms are cultivated. And the produced output is used in food, fiber, fuel or other products or services. The urban area people are adopting the vertical farming in large scale. It is a step ahead of technology from greenhouses. Vertical farming can feed the demands of the food supply.

Vertical farming is not adopted by all farmers because open-field agriculture depends upon the solar energy to grow. But in vertical farming, it depends upon the artificial lights to absorb the energy, which relies on electricity. Another demerit of artificial lamp which is used for Vertical farming is that the "grow lamps" which is the artificial light source, emits heat, which can cause harm to plants if they are placed too closed to them. So the plants need to be kept at a minimum distance, and the indoor space should be cooled to compensate the heat caused by the lamps. Therefor in vertical farming light-emitting-diode(LED) is used. Adopting the vertical farming depends upon the weather condition of the world and all crops are not suitable for this farming technique. Lack of knowledge is also an issue behind the non-adoption of this technique.

Advantages- Vertical farming can produce yield year-round. It is allowing households to grow their fruits and vegetables while also recycling water and soils. This farming trend is environment-friendly, it reduces the dependency on land resources. It helps in conservation and recycling of natural resources. It produces organic crops in large-scale production.

B. Organic Farming

It is also known as ecological agriculture or biodynamic agriculture. The intention of adopting this farming technique is to do not harm the environment. Organic farming relies on the use of resistant crops, crop rotation , use of predators to control pests in a natural way. According to the survey 37.5 Million Hectare is cultivated organically worldwide. Organic agriculture restricted the use of synthetic fertilizers and pesticides. To adopt the Organic farming, awareness is increased.

Organic farming is highly labor intensive. The required amount of organic inputs are not available at the right time. Lack of awareness is also a reason behind not adopting this technique.

Advantages- It makes good impact on the interaction between agro-ecosystem and environment. Organic farming is not harmful for the environment and health of the people as it uses organic inputs.

C. Intensive Framing

It is a farming technique in which high inputs of fertilizer, pesticides, labor and big size of the land is used to maximize agricultural produce or yields. This technique concentrates on getting more output yields by using high input strategies.

It makes the environment harmful by excessive use of agro-chemicals. The produced foods contain high an amount of invisible pesticides which is a risk for the human body. The chemical inputs may be the cause cancer or many diseases. Intensive farming makes very hard for traditional farmers to compete.

Advantages- Intensive Farming is the farming technique in which the production of crop yields is high. It means more variety of yield can be produced. It supplies sufficient food according to the growing population.

III. CHALLENGES

A. Inadequate knowledge on modern farming

B. Insufficient logistic support

C. Improper field preparation

D. Enfeeble transportation

E. Unorganized/unsystematic storage

F. Deficient saling of crops

G. Traditional approach to saling through mandi or direct sales to local vendors

H. Scarce financial resouces

IV. PROPOSED SOLUTION

Considering the aforesaid challenges , the following e-agri-governance system has been proposed that caters to the need of the farmer in a much better, faster and safer way as compared to the traditional manual system where getting all relevant realtime information was a major challenge.
To formalise the solution in a technical framework the following activities were taken place :

A. Literature survey
B. Direct interaction with the farmers
C. Collecting informations from blogs, forums, portals
D. Making a field survey using questionnaire.
E. Having a series of brainstorming session with the agri-research group

Having a thorough study on the problems faced by the farmers and proposed solutions by researchers :

A. Research Paper 1

Author/s has made a study/research on Precision Farming[5] an integrated, information and agricultural management system that is designed to improve the whole farm production efficiency.

B. Research Paper 2

Author/s has made a study on GIS systems which is used to increase the accuracy of satellite images data with the help of data collected from location experimental data.

C. Research Paper 3

Author/s has made a study on use of GIS which has flooded almost every field in the engineering, natural and social sciences, offering accurate, efficient, reproducible methods for better analyzation of spatial data.

It was decided to develop a GIS [6,7] based enterprise system which can help the farmer to overcome the afore said problems. Implementation of GIS will help the system to capture the location based information which is very vital to the farmer . The enterprise application will collect the followings:

A. Farmers profile

Farmers profile will aid the system to get to know about the agri/farming history of the farmer and it's changing trend in adopting to new crop/methodology/tools/techniques and adherance to Information Technology.

B. Family profile

It supports the system to study the factors that influences/impacts the agri/farming activity[9].

C. Land

Land information is very vital to agriculture. The entirity depends on the land preparation for agriculture. Considering the current climatic condition, analyzing the existing eco system the land/soil health may deeply get impacted. It needs to be updated at regular interval so that the application may provide the realtime dynamics for agriculture to the farmer.

D. Crop

Vivid research in crop farming taing place round the globe. New methods of farming for high yeild crops has become a mandate by global agri-forum. Crop update has become a necessity for the farmers to avoid crop crisis in harvesting.

E. Logistics & transportation

Procurement of Agri- ingredients , raw materials is a herculian task for the farmer. Remote access to theis is very limited , even today , it is not accessible for which the farmer spend a lot for gtimely delivery which hardly happens. Logistics 7 transportation information will help the farmer to find the nearest trading centre and transport option to avoid delay in the procurement process.

F. Financial Institution/ Banks

The life of agriculture is residing in finance. Fund deficity in agriculture may bring a disaster to the entire crop life cycle. Information about the financial institutions, their offerings, govt. Subsidies, other financial assistance in a realtime environment is a priceless service to a farmer. Compiled information about financial services in demography based agriculture sector is hardly found.

G. Clinical Support

Because of ecological imbalance, intense pollution, crop harvesting is badly affected. Many a times , farmers are not able to understand the right cause. Clinical assistance on demand is highly unreachable. Crop crisis may result in loss of crop, loss of life, loss of enthusiasm to get into agriculture and many more. The application will provide online location assistance, will connect the farmer to the clinicians, reasearchers to get timely support and guidance to manage to bring the crop cycle to a stable & sustainable mode.

H. Legal aid

Now a days, the country is witnessing catastrophe in agriculture arena. Because of ecological imbalance, natural calamity is destroying the agriculture & it's support system. More worse the situation is when the farmers are being derived of getting justice in the right time. Sometimes ignored. This happens because of lack of access to legal system and more importantly getting timely advice from the legal machinary. This application will extend timely support to the affecteds. This will not only minimise the loss but also strengthen the system.

I. Insurance

Agriculture insdurance provisioning is one of the greatest act of democracy in the 21st century by govt. Of India. But the provisionings are not same based on crop, location and many other parameters. Unfortunately the farmer community is not aware of everything . Many a times they fail to claim even though they do deserve compansestion in some form or the other. Insurance agencies and the agents misguide the insurance holder as they are not properly informed about the benefits and the process of availing the benefits. This application would fill the gap realtime with a comparative analysis based on numerous factors such as location, crop type, season, demography and etc.

J. Agri initiatives by Govt. And Non-Govt organisation

To promote agriculture, to support agriculture, to do research on agriculture, to resue the farmers - Mostly Govt. And Global non-govt. Organisations come forward to encourage, assist the agri-community in many ways sucb as supply of equipments, supply of seeds, imparting training on farming, seldom financial aid. But it is experienced that, it is very difficult to materialize in a larger mass as the agri-community is not aware of it, often they fail to know the eligibility cruiteria as getting information is a majoe constraint. This application will diseminate information and help the system to reach the unreachable.

V. THE PROCESS FLOW

To get the information about the farmer location, the farmer has to insert the farmer id/location/Adhar no.After getting the information system will fetch the information of land properties. Then farmer will perform an operation by selecting the interested crop for respective location[8]. According to the input of farmer's interest system will show the crop life cycle. If the crop life cycle is suitable for the farmer then the farmer will go head to other operation otherwise farmer can select the crop again. After the selection of crop, the Geographic Information system[10,11] will help to capture the information about near location for logistics, transportation, storage, financial institution, clinical support, and govt initiatives. If farmer will comfortable according to the information then the farmer will freeze the property information as per the crop life cycle otherwise farmer can select another crop as per there land information. How to and where to store the crop after harvesting the system will suggest and shows the fetching information about there nearest buyer or seller .then farmer can freeze the deal with the respective buyer or seller and terminate the process.

VI. THE PROCESS OUTCOME

This enterprise application can embedded with machine Learning and deep learning so that the system will be capable enough to monitor and manage many of the activities without human intervention by claiming high accuracy and transparency. Further this can be instructed & the service rendered in text, audio, audio-visual mode to assist the farmer so that the ametuer users can handle it without any difficulty.

VII. IMPLIMENTATION

The proposed solution will be implemented broadly in two phases.

A. At the initial phase The field staff will provide information at regular interval and on-demand to the end-users[agri-community].

B. The field staff will provide hand-holding support for a period of time to ensure that the end users are able to use the application by themselves partially.

C. Call center facility will facilitate to increase the usability index of the users

D. During course of time the end-users will be used to the application.

VIII. SOLUTION ARCHITECTURE
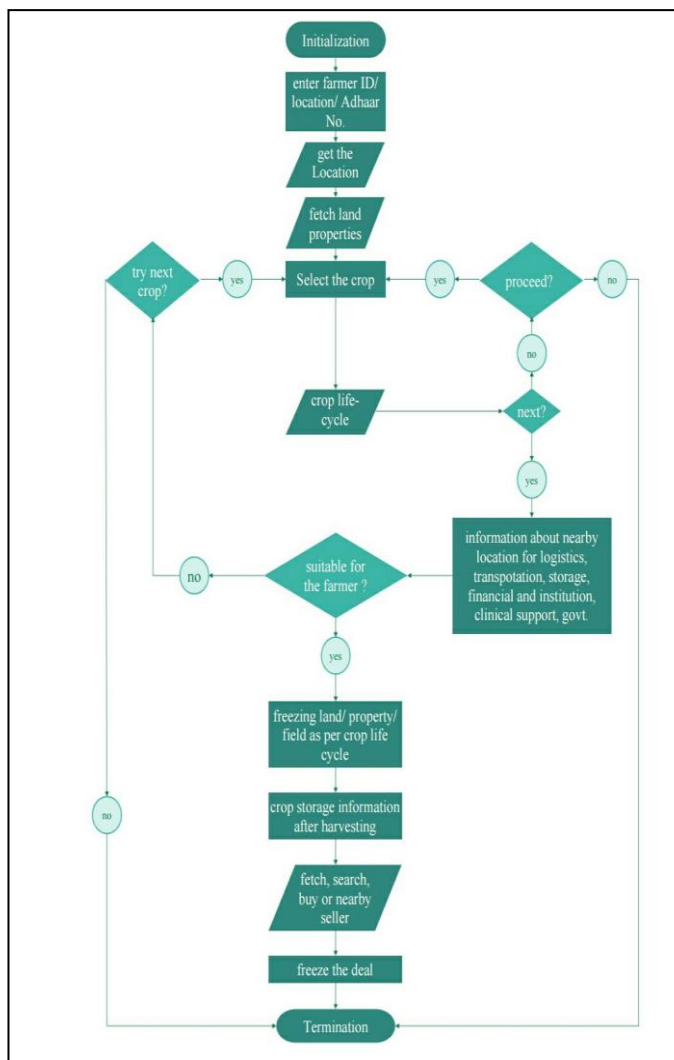
IX. CONCLUSION

There is no denying the fact that the proposed solution will meet the requirement and fill the gap considerably. But, still there are challenges to overcome.

A.   *Technical challenges:* Application usability, device compatibility, browser support, realtime update of service patches/ 3rd party services, network handshaking, information security, transaction reliability, effortless maintainability leads to future R&D correspondence.

B.   *Design & Operational challenges:* Information in a user readable form/format/ usable composition is a major challenge as the behavioural aspect changes based on demography. To formulate a generic interaction sequence and understandable content, The system has to thoroughly understand the behaviour before freezing the requirement.

C.   Interaction policies/business rules: It is more than difficult to identify the data constraints, transaction protocols, composition policies, hence opens the door to a great deal of research .

References.

[1]http://creativeodisha.com/GeneralInformation/Agriculture-in-Odisha

[2]http://www.civilsdaily.com/blog/the-8-major-types-of-farming-systems-in-india/

[3] https://www.un.org/development/desa/publications/world-population-prospects-the-2017-revision.html

[4] Garg, A., and R. Balodi. "Recent trends in agriculture: vertical farming and organic farming." *Adv Plants Agric Res* 1.4 (2014): 00023.

[5] Magaya, A., et al. "A spatially based field specific crop recordkeeping system prototype for farmers." *Ethiopian Journal of Environmental Studies and Management* 10.3 (2017): 351-360.

[6] Tayari, Elham, Amin Reza Jamshid, and Hamid Reza Goodarzi. "Role of GPS and GIS in precision agriculture." *Journal of Scientific Research and Development* 2.3 (2015): 157-162.

[7] Sonti, S. H. "Application of Geographic Information System (GIS) in Forest Management." *Journal of Geography & Natural Disasters* 5.3 (2015): 1-5.

[8]Mohanraj, I., and J. Naren. "An architectural framework for e-agricultural system." *Computing for Sustainable Global Development (INDIACom), 2016 3rd International Conference on.* IEEE, 2016.

[9]Chen, Xu, et al. "Research of real-time agriculture information collection system base on mobile GIS." *Agro-Geoinformatics (Agro-Geoinformatics), 2012 First International Conference on.* IEEE, 2012.

[10]Weidong, Zhuang, Wang Chun, and Han Jing. "Development of agriculture machinery aided guidance system based on GPS and GIS." *World Automation Congress (WAC), 2010.* IEEE, 2010.

[11]Zhu, Zhiqing, Rongmei Zhang, and Jieli Sun. "Research on GIS-based Agriculture Expert System." *Software Engineering, 2009. WCSE'09. WRI World Congress on.* Vol. 3. IEEE, 2009.