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ADVANCEMENT OF COMPUTER APPLICATIONS AND TECHNOLOGY FOR AGRICULTURE DEVELOPMENT

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Agriculture referred as the "backbone" of the GDP of the Indian economy, which involves more than half of the population directly or indirectly. It also generates employment opportunities within the country and earns foreign exchange from other countries. Agriculture and the natural resource base is put under serious pressure due to the current rising population (7 billion) of the world, which is expected to rise about 10 billion in 2050. An increase in demand for food due to the rising population generates several problems which contaminate the environment and the earth. The major challenges of agriculture in the present scenario are:

I. Bio-diversity is endangered due to deforestation and habitat fragmentation.
II. Contributions from land clearing, crop production, and excessive fertilization towards "Greenhouse emissions" have risen upto 1/3 of the global emissions.
III. Different nutrient cycles like nitrogen and phosphorous have been disturbed, which affected water quality, aquatic ecosystem, and marine fisheries.
IV. Depletion of fresh water resources with 80% of fresh water used in irrigation.

These harmful environmental impacts can be monitored along with high food production with the use of advanced technologies and computer applications. These advancements in computer applications are commonly used nowadays in agriculture and agronomy to monitor agriculture activities. This is because agriculture is a seasonal activity where productivity is mainly governed by the physical landscape as well as weather parameters and agricultural management practices. All the factors are highly variable in time and space. Moreover, productivity can change within a short time due to adverse growth conditions. Therefore, agriculture monitoring needs to be timely in order to utilize resources efficiently and enhance productivity in an effective manner. According to FAO (Food and

Agriculture Organization, 2011), the need for timeliness is a major factor underlying agricultural statistics and associated monitoring systems—information is worth little if it becomes available too late. Computer applications are useful for agriculture development help to overcome these barriers.

Advantages of Using Computer Application in Agriculture

There are several advantages of utilizing different computer applications and advanced technologies in agriculture, but the important ones are as follows:

- Providing a more timely and accurate picture of production and productivity of agriculture.
- Provide information about a large area in an accurate manner.
- Provide information about whether parameters of a particular area in a simple manner.
- It helps in identifying the vegetation vigor of a particular area and monitoring drought stress.
- also helps in assessing crop phonological development
- helps in gathering information about crop acreage estimation and cropland mapping
- Mapping of disturbances and land use/land cover changes.
- Helps in managing and controlling disease and pests occurring in specific areas.

Although scientific technologies are used in agriculture, information technology is being greatly used in this area. Technological advancements like satellite navigation, sensor network, grid computing, ubiquitous computing, and also context-aware computing are employed in the agriculture sector for improved monitoring and decision making capabilities. In evolution towards a sustainable agriculture system, it was clear that important contributions can be made by utilizing arising new innovations. These new technologies include Smart Agriculture, Precision Agriculture (PA), Variable Rate Technology (VRT), Precision Farming, Global Positioning System (GPS) Agriculture, Farming by Inch, Information-Intensive Agriculture, Site SpecificCrop Management etc. but all of them are sensor based. These sensor technologies and their networks are supporting agriculture practices in a very progressive direction. These technologies are discussed below in brief:

- **Global Positioning System (GPS)** - Satellite based system which gives exact location that provides continuous position information in real time while in motion.

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The satellite broadcasts signals which are received by GPS receivers to work out locations. This accurate location information allows crop and soil measurements to be mapped at any period. PS receivers, either carried to the field or mounted on implements, permit clients to get back to explicit areas to test or treat those regions. While purchasing a GPS receiver, its differential correction type and coverage area relative to the use area should be considered. Differential correction is the position correction provided by the uncorrected GPS signals when compared with land based satellites. Uncorrected GPS signals have an exactness of around 300 feet. The modified position accuracy is typically 63-10 feet.

- **Geographic information systems (GIS)**: Geographic information systems (GIS)are computer equipment and software programs that use feature attributes and location data to create maps. An imperative function of an agricultural GIS is to accumulate layers of information, like yields, soil survey maps, remotely sensed data, crop scouting reports, and soil nutrient levels.

- **Precision Agriculture**–Also known as satellite farming or site specific crop management (SSCM) can be called a farming management model based on observing, measuring, and responding to inter and intra-field variability in crops. Precision Agriculture is also known as satellite agriculture, as-needed farming and site-specific crop management. Precision agriculture is a concept of the modern world where different computer applications and resources can be used all together inefficient way to increase agriculture productivity by observing, analyzing, and supplying nutrients according to theneed of crops in the field. The end goal of precision agriculture is to maximize economic return by optimizing crop yield and minimizing environmental impact.

- **Smart Agriculture** – Smart agriculture is mainly another word used for Climate Smart Agriculture (CSA). It is mainly another approach of farming towards the changing of climate globally. It has basically three objectives:

  - ✓ Improving productivity of agriculture to maintain increased incomes, food security, and development.

  - ✓ Increasing adaptive capacity at different levels (from farm to nation)

✓ Reducing greenhouse gas emissions and increasing carbon sinks.

CSA and sustainable intensification highly complement each other. Intensification means accomplishing more significant returns through expanded data sources, further developed agronomic practices like drop irrigation, improved crop varieties and other innovations. Computer applications will be helpful in this intensification in a quick time.

- **Variable rate application-**It has three components: Control computer, Locator, and Actuator. The application map is stacked into a PC mounted on a variable-rate applicator. The computer utilizes the application map and a GPS receiver to coordinate a product-delivery controller that modifies the quantity and/or kind of product, according to the application map.

- **Remote sensing:** It is the assortment of information from a distance. Data sensors can essentially behand-held devices mounted on aircraft or satellite-based. Remotely sensed data provide a tool for evaluating crop health. Plant stress related to moisture, nutrients, compaction, crop diseases, and other plant health concerns is often easily detected in overhead images. Remote sensing can show in-season variability that influences agricultural productivity and can be used to make prompt management adjustments that boost current crop profitability.

  It has already been mentioned that all these technologies are mainly based on sensor technologies. Therefore, we should gather information about the sensor and their uses. There are many questions related to sensors, but the main question to the sensor is:

Why are Sensors Used in Agriculture?

Sensors can be defined as the innovations which are used to collect data on physical and environmental variables, and actuators are used to react to this data and offer feedback in order to maintain control over situations. Context is the data collected by sensors that characterize an object or environment and is used to identify individuals, locations, things, and their states. The context acquisition provides a valuable contribution in modeling situations of domains that have a variety of time variant attributes. Agriculture is also one such sector that has several requirements:

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I. Gathering of weather, crop, and soil information
II. Observing of distributed land
III. Various crops on a single piece of land
IV. Different fertilizer and water necessary to different pieces of uneven land
V. Diverse requirements of crops for different weather and soil Conditions.
VI. Preemptive solutions rather than reactive solutions

Size of sensors has been reduced due to advancements of technologies to the extent that that enabled them to be used in various spheres of human life. Several issues related to sensors are still in research. Wireless sensors and actuators are also required to acquire the necessary data and respond to various scenarios. A sensor is a device that can measure physical characteristics and turn them into signals for the observer to see. An actuator is an additional sort of component in the WSN. The addition of an actuator expands WSN's monitoring and control capabilities. These sensors and actuators are utilized in various agricultural services like irrigation, fertilization, pesticide spraying, animal and pastures monitoring.

- Irrigation- The artificial application of water to field crops for an increase in production is called irrigation. Different types of irrigation help inefficient utilization of water like drip irrigation, sprinkler irrigation etc. These irrigation types are mainly based on sensors.

  In Spain, Damas created and tested a remote-controlled, automatic irrigation system for irrigated land. The findings revealed significant water conservation, ranging from 30 to 60%. Self-propelled, linear-move and center-pivot irrigation systems require precise irrigation control. The system used wireless sensors to help with irrigation scheduling, utilizing remotely sensed data and weather data. In Portugal, for smart irrigation, a wireless data-gathering network was set up to collect climate data as well as soil moisture. With the use of sensors, irrigation water is managed to improve yield. Sensor-based irrigation system invented by Yunseop Kim. Using Bluetooth and GPS technology, soil moisture and temperature, meteorological information, and sprinkler location were all monitored remotely.

Fertilizer – Fertilizers are nutrient sources for plants in order to increase productivity and production of food grains. Researchers are working day and night for efficient utilization of nutrients with the help of computer applications. Cugati innovated an automated fertilizer applicator consisting of Input, decision support, and output modules using GPS technology, real-time sensors, and Bluetooth technology. D. Ehlert has also created a mechanical sensor(Pendulum meter) for site-specific fertilization. An integral optimal fertilization decision support system using wireless sensors LAN using IEEE 802.11protocol (Wi-Fi) and GPS analysis server.

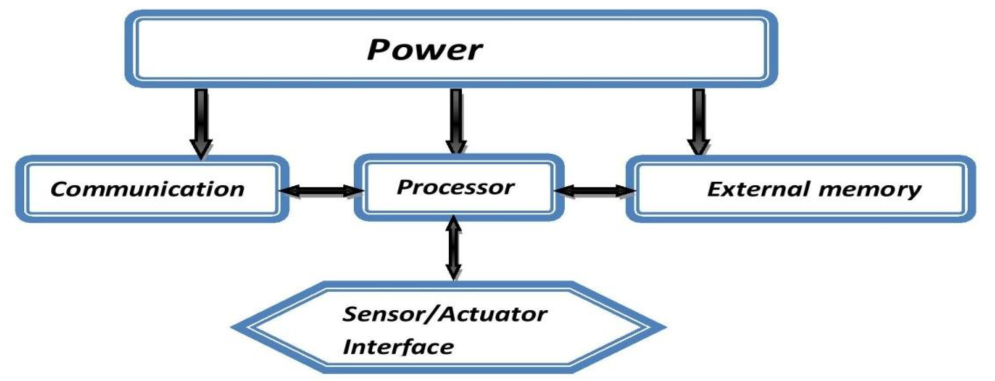

Figure1: Design of wireless sensor node

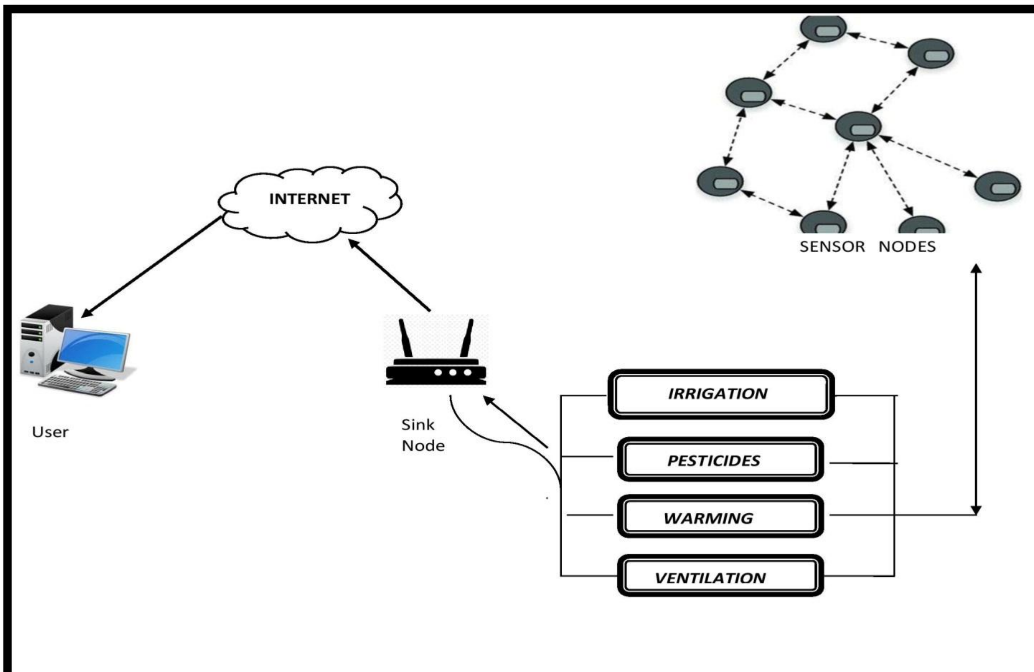

Figure2 : Schematic view of working mechanism of computer application in agriculture

(Aqeel-ur-Rehman et al, 2011)

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Conclusion

Agriculture is a diverse sector in which the scope of use of different computer applications and advanced technologies like wireless sensor technology has become essential day by day. This is because the global production of food crops needed to be increased in order to meet the demands of over increasing population. Computer applications can contribute significantly to this cause in a sustainable manner without deterioration of environmental quality. They will also help in the vertical expansion of food production in the coming future. Therefore, developing countries like India needed to revolutionize the agriculture sector by using computer applications in order to meet the food production demands of a growing population. Government and private sector should be encouraged to invest more in this sector to explore the new possibilities of higher production with the help of technologies.

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