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# ROLE OF ARTIFICIAL INTELLIGENCE IN INSECT PEST MANAGEMENT

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In order to ensure nutrition demand of the growing world population, food production needs to be increased from year to year, but the world's arable areas are limited. The field of agriculture faces many challenges such as disease and pest infestation, improper soil treatment, inadequate drainage and irrigation, and many more. These leads to severe crop loss along with environmental hazards due to excessive use of chemicals. To cope with these challenges, a continuous and sustainable increase in productivity in all agricultural production areas is needed, while water, energy, pesticides and fertilizers, etc. should be used diligently and efficiently. Several researches have been conducted to address these issues. The field of artificial intelligence with its rigorous learning capabilities have become a key technique for solving different agriculture related problems. Systems are being developed to assist the agricultural experts for better solutions throughout the world. Artificial Intelligence (AI) is one of the key areas of research in computer science. With its rapid technological advancement and vast area of application, AI is becoming pervasive very rapidly because of its robust applicability in the problems particularly that cannot be solved well by humans as well as traditional computing structures. In IPM, expert staff constitutes the essential element. The expert plays a role in system design, monitoring ecological factors, and decision-making mechanisms. For sustainable pest management, it is possible to perform the routine processes such as monitoring biological and environmental components and choosing the appropriate time and method through artificial intelligence. Such an area of extreme importance is agriculture where about 30.7% of the world population is directly engaged on 2781 million hectares of agricultural land. Such a venture is not so smooth running, it faces several challenges from sowing to harvest. The major issues are pest and disease infestation, inadequate application of chemicals, improper drainage and irrigation, weed control, yield prediction, etc.

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The main concept of AI in agriculture is its flexibility, high performance, accuracy, and cost-effectiveness. The introduction of AI to agriculture will be enabled by other technological advances, including big data analytics, robotics, the internet of things, the availability of cheap sensors and cameras, drone technology, and even wide-scale internet coverage on geographically dispersed fields. By analyzing soil management data sources such as temperature, weather, soil analysis, moisture, and historic crop performance, AI systems will be able to provide predictive insights into which crop to plant in a given year and when the optimal dates to sow and harvest are in a specific area, thus improving crop yields and decrease the use of water, fertilizers, and pesticides. Via the application of AI technologies the impact on natural ecosystems can be reduced, and worker safety may increase, which in turn will keep food prices down and ensure that the food production will keep pace with the increasing population. The idea of using AI technique in crop management was first proposed in 1985 by McKinion and Lemmon in their paper "Expert Systems for Agriculture". The application of computers in agriculture was first reported in 1983. Different approaches have been suggested to solve the existing problems in the agriculture starting from the database to decision support systems. Out of these solutions, systems that apply AI have been found to be the most excellent performers as far as the accuracy and robustness are concerned. Agriculture is a dynamic domain where situations cannot be generalized to suggest a common solution. AI techniques have enabled us to capture the intricate details of each situation and provide a solution that is best fit for that particular problem. Gradually very complex problems are being solved with the development of various AI techniques. Three major AI techniques; Expert Systems, Artificial Neural Networks and Fuzzy systems are considered as the focused areas.

- Expert systems are an artificial intelligence application that uses a knowledge base of human expertise for problem solving.
- In a neural network expert system, the knowledge is encoded in the weight, and the artificial neural network generates inference rules.
- Fuzzy logic is used in Natural language processing and various intensive applications in Artificial Intelligence. It is extensively used in modern control systems such as

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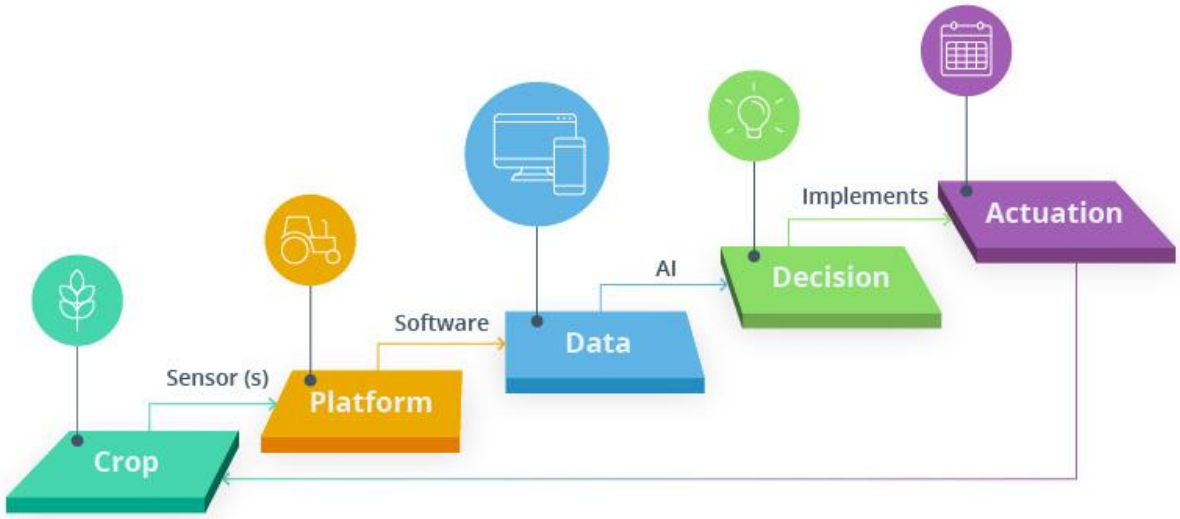
expert systems. Fuzzy Logic mimics how a person would make decisions, only much faster. Thus, you can use it with Neural Networks.

## The role of AI in the agriculture information management cycle




Insect pest infestation is one of the most alarming problems in agriculture that leads to heavy economic losses. Over decades researchers have tried to mitigate this menace by development of computerized systems that could identify the active pests and suggest control measures. Many rule based expert systems were proposed which includes Pasqual and Mansfield, SMARTSOY of Batchelor et al., CORAC of Mozny et al., The knowledge involved in agricultural management is most of the times imperfect, vague and imprecise hence the rule base expert system may lead to uncertainty. To capture this uncertainty, several Fuzzy logic based expert systems were proposed including IPEST by Hayo et al., An objected oriented approach to frame a rule base was taken by Ghosh et al., in developing TEAPEST, an expert system for pest management in tea. Here also a phase by phase identification and consultation process have been adopted. Later this system was redesigned by Samanta and Ghosh by employing a multi-layered back propagation neural network and

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then reformulated by Banerjee et al., by using radial basis function model to achieve higher classification rates.

## Advantages

## AI enables better decision-making

Predictive analytics can be a real game-changer. Farmers can collect and process significantly more data and do it faster with AI than they would otherwise. Analyzing market demand, forecasting prices, and determining the optimal time for sowing and harvesting are key challenges farmers can solve with AI.

### AI brings cost savings

AI can provide farmers with real-time insights from their fields, allowing them to identify areas that need irrigation, fertilization, or pesticide treatment. The result is reduced use of pesticides, better harvest quality, higher profits, and significant cost savings.

### AI addresses labour shortages

Agricultural work is hard, and labor shortages in this industry are nothing new. Farmers can solve this problem with the help of automation. Driverless tractors, smart irrigation and fertilizing systems, smart spraying, vertical farming software, and AI-based robots for harvesting are some examples of how farmers can get the work done without having to hire more people. Compared with any human farm worker, AI-driven tools are faster, harder, and more accurate.

**Plantix**

**Plantix** is a mobile crop advisory app for farmers, extension workers and gardeners. Plantix was developed by PEAT GmbH, a Berlin-based AI startup. The app claims to diagnose pest damages, plant diseases and nutrient deficiencies affecting crops and offers corresponding treatment measures. Users can participate in the online community where they find scientists, farmers and plant experts to discuss plant health issues. Farmers can access local weather, get

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good agricultural advice throughout the season and receive disease alerts once a disease is spreading in their surrounding.

## CURTAILING CHALLENGES OF AI IN PEST MANAGEMENT

Expert systems are tools for agricultural management since they can provide site-specific, integrated, and interpreted advices. However, the development of expert systems for agriculture is fairly recent, and the use of these systems in commercial agriculture is rare to date. Although AI has made some remarkable improvement in the agricultural sector, it still has a below the average impact on the agricultural activities when compared to its potentials and impacts in other sectors. More still need to be done to improve agricultural activities using AI as there are many limitations to its implementation.

1) **Response Time and Accuracy**: A major attribute of an intelligent or expert system is its ability to execute tasks accurately in very short time. Most of the systems fall short either in response time or accuracy, or even both. A system delay affects a user's selection of task strategy. Strategy selection is hypothesized to be based on a cost function combining two factors: (1) the effort required to synchronize input system availability, and (2) the accuracy level afforded. People seeking to minimize effort and maximize accuracy, choose among three strategies: automatic performance, pacing, and monitoring.

**2) Large Data Required:** The strength of an intelligent agent is also measured on the volume of input data. A real-time AI system needs to monitor an immense volume of data. The system must filter out much of the incoming data. However, it must remain responsive to important or unexpected events. An in-depth knowledge of the task of the system is required from a field expert and only very relevant data should be used improving the system's speed and accuracy. The development of an agricultural expert system requires the combined efforts of specialists from many fields of agriculture, and must be developed with the cooperation of the growers who will use them.

**3)Method of Implementation:** The beauty of any expert system lies on its execution methodology. Since it uses big data, the method of looking-up and training should be properly defined for speed and accuracy.

**4) Expensive method:** Most AI systems are internet-based which in turn reduces or restricts their usage, particularly in remote or rural areas. The government can support farmers by

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designing a web service enabling device with lower tariff to uniquely work with the AI


systems for farmers. Also, a form of "how to use" orientation (training and re-training) will really help farmers adapt to the use of AI on the farm.

**5) Flexibility**: Flexibility is a strong attribute of any sound AI system. It is perceived that much progress has been made in applying AI techniques to particular isolated tasks, but the important theme at the leading edge of the AI-based robotics technology seems to be the interfacing of the subsystems into an integrated environment. This requires flexibility of the subsystems themselves. It should also have expansive capabilities to accommodate more user data from the field expert.

**THE FUTURE OF AI IN AGRICULTURE**

Global population is expected to reach more than nine billions by 2050 which will require an increase in agricultural production by 70% in order to fulfil the demand. Only about 10% of this increased production may come from unused lands and the rest should be fulfilled by current production intensification. In this context, the use of latest technological solutions to make farming more efficient remains one great necessity. Present strategies to intensify agricultural production require high energy inputs and market demands high quality food. Robotics and autonomous systems (RAS) are set to transform global industries. These technologies will have great impact on large sectors of the economy with relatively low productivity such as agro-food (food production from the farm to the retail shelf).

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