**1. Title of the Technology: AGRO-X:**

The Intelligent Agricultural System for Non-Lethal Animal Deterrence, Pest Control, and Precision Farming AGRO-X is an integrated solution that uses non-lethal animal deterrents, pest control, IoT-based soil quality monitoring robot, and real-time data analytics for optimized farm management, not only to protect crops against animal invasions but also against pests.

**2. Background of the Project**

Agriculture operations always suffer from damage attributed to the invasion of wildlife on farms and pest infestation. These consequences are massive crop damage and monetary losses for these farmers. In India, agriculture operations on farmlands near villages often suffer from wild animals such as elephants and wild boars, which invade farmlands frequently and destroy up to 55% of the crops. Other than human and animal casualties, such instances highlight the pressing need for solutions that would mitigate these conflicts without hurting wildlife.

Farmlands and crops also suffer immensely through pests and insects that consume crops, multiply diseases, and break the growth cycle. Productivity losses in this area stand at a phenomenal 18–25%. It has been estimated that annually, pests cost India Rs 5000 crore in terms of monetary loss. The war against pests has led to the rampant use of pesticides that have far-reaching environmental implications such as soil and water contamination and loss of biodiversity.

Besides, the practice of farming in the olden times is not accurate as far as soil testing is concerned because of nutrient management and crop yield decline. Roughly 60 percent of Indian farmers lack proper soil testing methods to ensure appropriate use of fertilizers and consequent diminished crop yield. AGRO-X is the answer to these problems by a combination of non-lethal deterrence, pest control, and IoT-enabled precision farming technologies.

AGRO-X makes use of an all-inclusive approach that includes high-beam flickering lights with acoustic frequencies, an IoT-based autonomous robot collecting soil quality data over large fields, and pest control systems to fight agricultural pests. The robot collects soil samples autonomously from different locations every month equipped with a specially designed NPK sensor to sense Nitrogen, Potassium, Phosphorus, pH, temperature, and moisture levels. The collected data is processed in the cloud, analyzed, and updated in a user-friendly interface accessible to farmers. These data are useful in ensuring that farmers make the appropriate decisions relating to crop management, thereby increasing their productivity while saving their resources.

Another technology integrated into the system is pest control, which utilizes ultrasonic frequencies to repel insects and rodents without in any way damaging the crops or impacting the environment. This approach gives the farmer a dependable real-time crop protection capability while at the same time improving the efficiency of farm management, thus impacting overall agricultural output and economic stability at large.

**3. Brief Objective/s of the Project**

**Key objectives of the AGRO-X project:**

* **Wildlife Deterrence:** Since the said system could be a non-lethal one, high-beam flickering lights, and acoustic frequencies against entering farmlands by animals, ensure the safety of crops without harming wildlife.
* **Ultrasonic Pest Control:** Design an ultrasonic pest control system that would prevent insects and rodents that could harm the crop's health. This system would deliver a clean and efficient means of pest management.
* **Precision Soil Monitoring:** Autonomously harvesting soil data from multiple locations in the field using an NPK sensor installed in an IoT-enabled robot with real-time information on available nitrogen, potassium, phosphorus, temperature, moisture, and pH levels that are then uploaded for processing and analysis in the cloud.
* **Automated soil data collection:** the autonomous robot automatically collects and uploads soil data every month, allowing the farmer to have real-time information on which to base decisions about soil health based on elaborate reports produced with cloud-based analysis.
* **Accessible data platform:** farmers can access real-time data on soil quality, pest control, and crop health through a simple web interface to optimize resource utilization and increase crop yield.

Through the merging of these objectives, AGRO-X looks forward to developing an efficient system of sustainable agriculture that will also increase productivity, reduce crop loss by further margins, and enable precision farming.

**4. Methodology Adopted:**

AGRO-X uses a blend of high-end technologies for crop protection and optimal farming practices. Here's how the system works:

* **Wildlife Detection and Deterrence**: The system uses radio frequency (RF) motion sensors and infrared (IR) thermal sensors around the field periphery that can detect intruding animals. After an intruding animal is detected, high beam flicker flood lights are turned on and certain acoustic frequencies like 500-550 Hz for the elephant deter wildlife but do not cause any further damage.
* **Pest Control System**: The system uses ultrasonic pest control devices that operate at frequencies above 20 kHz frequencies to ward off harmful insects and rodents, which might be damaging crops. They are energy efficient and thus friendly to the environment, making them an environmentally sustainable form of pest management for farms.
* **Autonomous Soil Monitoring Robot**: The NPK soil quality sensor is equipped with GPS using the AGRO-X robot, navigating the field autonomously. Results: The soil data are collected once a month from several predefined locations, including nitrogen, potassium, phosphorus, temperature, moisture, and pH. The data is uploaded to the cloud for processing, analysis, and storage.
* **Cloud-based data processing**: Data uploaded by the robot from the soil into the cloud allows complex algorithms to further analyze the data for trends, anomalies, and potential problems with soil health. Reports are generated and distributed to farmers online via a friendly user interface.
* **User-friendly farmer's interface access:** The health of the soil, the activity of the pests, and wildlife deterrents are made available to the farmers in real time utilizing a user-friendly web interface. Such a user-friendly interface would allow the farmer to monitor his or her fields, get alerts, and make decisions based on the analyzed data.

This methodology ensures complete automation in agricultural management with wildlife intrusion pests’ control and precision farming.

**5. How You Contribute to the Project at Different Stages**

My primary involvement in the AGRO-X project was in system design and integration. In this endeavor, I led the deployment of a robot carrying the NPK sensor and also placed this robot under autonomous navigation through farms. My other tasks involved setting up a cloud-based data processing system and developing a graphical interface for the farmers. On the other end, I worked on testing the ultrasonic pest control system and effectively ensured that no mechanism that deters wildlife was deterred in the process.

**6. How to Ensure Future Sustainability of Installed Technology in the Village**

To maintain the sustainability of the AGRO-X system in rural areas, several key actions will be taken:

1. **Local Training**: Farmers and local technicians will receive training on how to operate, troubleshoot, and maintain the AGRO-X system, ensuring the technology can be managed independently by the community.
2. **Affordable Parts and Maintenance**: AGRO-X uses cost-effective components that can be easily replaced or repaired. By partnering with local service providers, we ensure that spare parts and maintenance services are readily available at affordable prices.
3. **Pest Control and Wildlife Deterrence Upkeep**: The pest control system and wildlife deterrents require periodic calibration and testing. Local technicians will be trained to monitor and maintain these systems to ensure they continue to function effectively over time.
4. **Cloud-Based Data Updates**: The cloud system will receive regular software updates to ensure that data collection and analysis continue smoothly. This ensures that the platform remains relevant and adaptable to emerging farming challenges.
5. **Solar Power Integration**: The system’s reliance on solar energy makes it sustainable, even in off-grid areas. Periodic cleaning of solar panels and battery checks will be part of the maintenance routine to ensure uninterrupted power supply.

By focusing on these areas, the AGRO-X system will remain sustainable and accessible to rural communities in the long term.

### 7. Impact of this Work on Learning of Students:

Students involved in the AGRO-X project gain hands-on experience with IoT, robotics, and environmental technologies. They learn to integrate real-world applications of sensor technologies, data processing, and automation, bridging the gap between theoretical knowledge and practical implementation. The project also enhances students’ problem-solving and project management skills, equipping them for future careers in engineering and agriculture.

### 8. ****Impact of this Work on the Learning of the Teacher****

Teachers working on the AGRO-X project enhance their expertise in IoT, robotics, and precision agriculture technologies. They gain valuable insights into the practical deployment of emerging technologies in farming, which they can share with students. The experience also improves their interdisciplinary teaching skills, as they learn to integrate electronics, software, and environmental sciences cohesively.

**9. Role of PI after Compilation of the Project Duration**

After the project’s completion, the Principal Investigator (PI) will oversee the ongoing maintenance of the AGRO-X system. This includes training local operators, ensuring the cloud-based data system continues to function, and refining the pest control and wildlife deterrent technologies. The PI will also gather feedback from farmers to improve the system and adapt it to future needs.

**10. Duration of Monitoring by PI Post Completion of the Project**

The PI will monitor the system for a period of six to twelve months after project completion, ensuring the technology operates as expected. This period will involve troubleshooting technical issues and supporting local operators. Continuous data collection during this time will also be analyzed to optimize the system's performance and ensure long-term sustainability.

  

  