SPARK CHALLENGE 22/23

SPARK

ENTC
Electronic and Telecommunication Engineering

EC

Pathfinders

PestSense

Team Pathfinders

A system to identify insects damaging crops and recommend the insecticide usage accordingly.

Pathfinders

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Pathfinders

Team Details

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Problem Description

PRIMARY AREA OF DEVELOPMENT

- Food production and preservation

SUPPORTING AREAS OF DEVELOPMENT

- Environmental conservation and preservation

PROBLEM STATEMENT

"The excessive and improper usage of insecticides in agriculture adversely affects farming communities, consumers, and the ecosystems by increasing production costs, compromising consumer and farmer health and safety, and giving rise to environmental pollution and ecological imbalances"

PROBLEM

- The misuse of insecticides in agriculture due to the lack of knowledge of farmers and inability to identify pests before crops are damaged.

PROBLEM VALIDATION

- It has been observed that one-third of farmers routinely use insecticides [1] and 40% of farmers use pesticides prior to the appearance of pest symptoms [2].
- It was also stated that 40% of farmers used a certain type of pesticide although it damaged the environment [2].

IMPACTS OF PROBLEM

Water body pollution

- Heavy usage of pesticides has resulted in it leaching into water bodies. Water bodies show higher levels than threshold level (0.005 mg/l) set by national regulations.[1]

- This directly impacts the biodiversity of the lakes and other waterbodies surrounding agricultural settlements, causing death of fish and other organisms in the water bodies.

- The drinking water obtained from the water bodies will contain excessive amounts of heavy metals and other dangerous substances which could cause health issues to humans upon consumption.

Heavy metals in food

- Direct contact with vegetables and grains causes heavy metals to be absorbed by aforementioned food items.[3]

- Additionally, upon consumption of lake fish from affected water bodies, there is an excess of heavy metals consumed.

Human health impacts

- Owing to the above impacts, the intake of harmful chemicals and heavy metals increase in consumers. This affects both the farming community and the general public.

- The indirect exposure to heavy metals in water can be seen with the dramatic rise in kidney related ailments in the North-Western province of the country.

- Additionally the direct exposure to pesticides causes fatal diseases and conditions such as cancers, neuro-behavioural impairment, and immunotoxicity etc. [4]

Reduction of crop yield

- The inability to control pests due to misuse of insecticides causes damage to the crops and significantly hinders the amount of food production.

IMPACTS OF PROBLEM

- **Insecticide resistance**
  - Overuse of pesticides creates selective pressure on insects, leading to the survival and reproduction of insects with natural resistance traits.
  - The natural resistance shown causes the same insecticide to be ineffective.

AFFECTED USERS

- Farmers
- Members of farming communities.
- Consumers from the general public.
- Pest management industry.

IMPACT ON CLIMATE CHANGE

- **Solution to excessive insecticide use reduces greenhouse gas emissions: Adopting alternative pest management strategies in farming, such as integrated pest management or biological control, reduces insecticide use and associated greenhouse gas emissions.**

- **Addressing insecticide overuse promotes soil health and carbon sequestration: By reducing insecticide applications and adopting sustainable farming practices like organic or regenerative agriculture, farmers improve soil health, enhance carbon sequestration, and mitigate climate change.**

- **Sustainable agriculture reduces insecticide use and combats deforestation: Minimizing reliance on insecticides and promoting sustainable farming methods helps prevent deforestation, conserve forests, and preserve their carbon-storing capacity.**

- **Minimizing insecticide usage protects ecosystems and biodiversity: Finding alternatives to excessive insecticide use safeguards beneficial insects, pollination, and non-target organisms, preserving biodiversity and ecological balance.**

Solution Description

KEY FINDINGS

- **As mentioned in the problem description, a majority of farmers overuse and misuse insecticides.**
- **The major reasons can be stated as follows**
  - They expect insecticides to protect the crops 100%.
  - Pressure to get immediate results. So if the result are visible, tendency to repeat it without knowing what step actually gave the result.
  - General instructions are not specific to their field so results are not guaranteed.
  - Have no training and education on chemicals or their usage.
  - Have little to no knowledge on effects of insecticide misuse.
- **The safe levels of insecticides vary on the type of pest, frequency of use and residue limits.**
- **The frequency of use depends on the amount of insects affecting the crops.**
- **The effects on the other insects and wildlife present depend on the chemicals used.**

EXISTING SOLUTION

- **Currently, there is no system available in the market to provide the information on the amount and type of pesticide required. The necessary information must be obtained from an expert in the area and even then, it is conducted on previous statistics and conventions**

PROPOSED SOLUTION

- **A system which observes, analyses and identifies the required type and dosage of the insecticide needed to be used on the crop.**

PROPOSED SOLUTION

- The product is an advanced insect monitoring and management system designed to track and control insect populations effectively.

- At the core of this product are sophisticated traps equipped with advanced sensors. These traps are specifically designed to attract and capture insects of interest. The modular approach allows customization of the container and sensors to meet specific trap requirements, enabling precise monitoring of targeted insect species.

- The system takes into account field size, shape, and other geographical factors to optimize trap placement and maximize efficacy. This strategic positioning of traps ensures accurate and representative capture of insect activity across the entire field or area of interest.

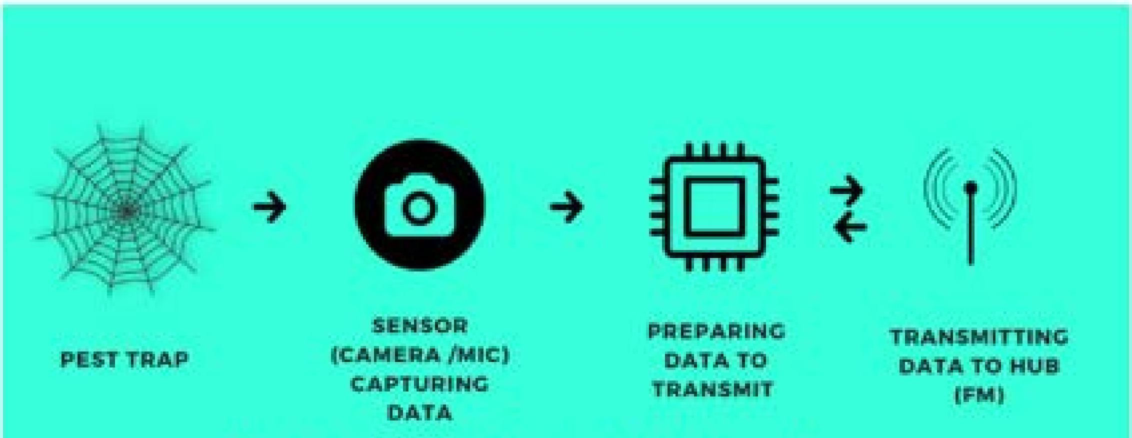
- Captured insects are identified and counted using statistical models, providing precise and reliable population data. (Devices that could be used camera and processing module - IMX477 Cameras , Mic module - MAX4466).
  For example
  1. Aphids, Lepidoptera - Yellow sticky traps and cameras
  2. Fruit Flies - Modified traps with Fresnel lenses and associated wingbeat stereo-recording device
  3. Palm Weevil - Piezoelectric microphone and amplifier
  4. Sucking pests, Whiteflies - Scanned yellow sticky traps

- For insecticide selection, the product uses government or research databases through the internet. The main source being the "Manual on Pesticide Recommendations for 'Food, Plantation, Export Agricultural and Floricultural Crops' in Sri Lanka" [7]. This feature provides access to up-to-date information on the appropriate types and dosages of insecticides.

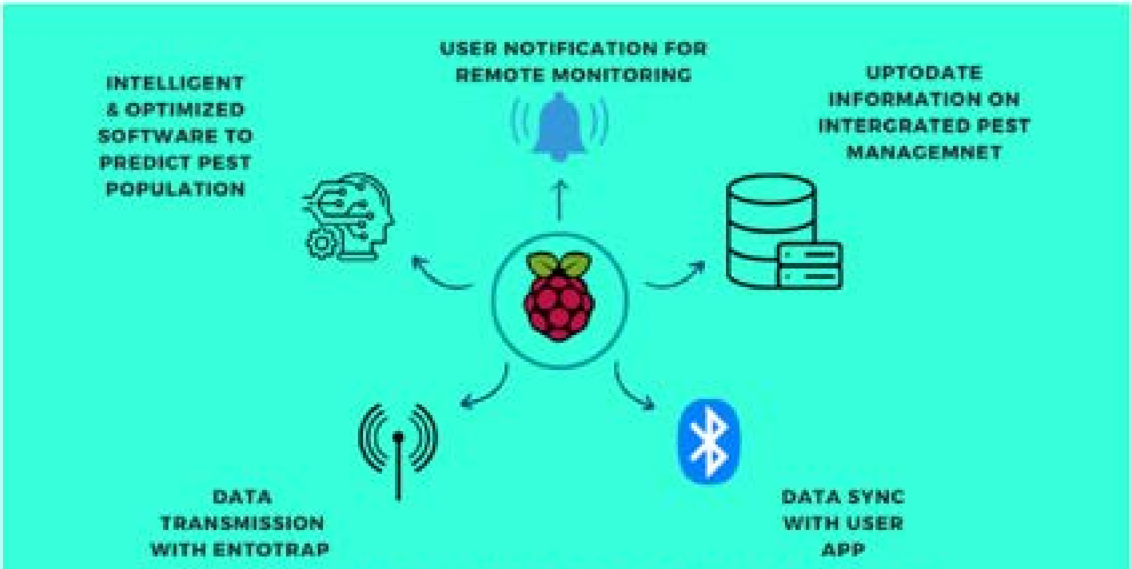
- A radio network, powered by a system onboard a device like a Raspberry Pi, establishes a connection between the traps and a centralized hub. This enables real-time data transfer and facilitates efficient monitoring of multiple traps simultaneously.

- To visualize and analyze the collected data, a user-friendly application accompanies the product. The app provides an intuitive interface that displays processed data in a visually appealing and easily understandable format. Users can access detailed reports, trend analysis, and make informed decisions based on the comprehensive insights provided.

FUNCTIONAL BLOCK DIAGRAMS



Entotrap funtional block diagram



CentralHub funtional block diagram

1. Communication
    a. Sensor communications - radio
        i. Take data from sensors
        ii. Send confirmation to sensors
    b. Comms with internet - GPRS module
        i. Take data from service
        ii. Send user alerts for remote monitoring.
    c. Communications through Bluetooth
        i. Sync dashboard with user app

2. Processing - Raspberry pi
   - Storage
     - Gather data from sensors
     - Get data from user (app) on crop seasons
     - Get data from database (updated by internet) on insect cycle and insecticides
   - Processing
     - Statistical calculations
     - Dosage recommendations.
3. Power
   a. Battery powered / Mains
4. Web service
   a. Communication with central hub
      i. Send the updates to central hub
      ii. Get the user notifications from hub to user app
   b. Communication with user
      i. Direct user notifications from hub to user app

SOLUTION VALIDATION

With the proposed solution, farmers will have a solution that specifically provide what chemical and dosage is required to be applied at what area and the frequency.

1. **Save chemicals cost, labour and time.**
2. **Easy to manage.**
3. **Ease of implementation of "Integrated Pest Management".**
4. **No need for specific training and education, that part is replaced by the system.**
5. **Can constantly update on good practices in using pesticides.**
6. **Reduce use of chemicals - so reduce exposure and resulting health impacts**

Environment impacts

- Recommendations up-to-date on with local and global research findings.
- Delay resistance of insects with responsible use of chemicals

Health effects

- Less chemically contaminated food for users.
- Presence of chemicals in the safe ranges in food.

Water

- Recommended dosages help reduce chemicals to safe levels in the area.
- Reminding farmers on safe practices and informing dangers of misusing.

SUSTAINABILITY

The product aligns with several Sustainable Development Goals due to its focus on sustainable pest management and positive impacts on various aspects of sustainability.

- SDG 2 - Zero Hunger: The product optimizes pest control and minimizes crop damage, which contributes to increasing agricultural productivity and ensuring food security.

- SDG 12 - Responsible Consumption and Production: The product promotes responsible consumption and production by reducing the reliance on excessive insecticide use. It encourages sustainable farming practices and minimizes the environmental impact associated with pest management.

- SDG 13 - Climate Action: By reducing insecticide use and adopting sustainable farming methods, the product contributes to mitigating climate change impacts. It helps preserve soil health, enhances carbon sequestration, and promotes climate resilience in agriculture.

- SDG 15 - Life on Land: The product supports SDG 15 by minimizing the negative impacts of insecticides on biodiversity and ecosystems. It protects beneficial insects, preserves pollination, and maintains ecological balance, contributing to the conservation of biodiversity and the stability of natural habitats.

- SDG 17 - Partnerships for the Goals: The product facilitates collaboration and partnerships among various stakeholders, including farmers, researchers, and regulatory agencies. It connects to databases for insecticide guidance and provides a platform for sharing knowledge and best practices in sustainable pest management.

The product contributes to sustainable development by promoting responsible agricultural practices, reducing environmental harm, preserving biodiversity, and supporting climate resilience.

Social and Environmental Impact Assessment

The solution has positive impacts on both the society and the environment.

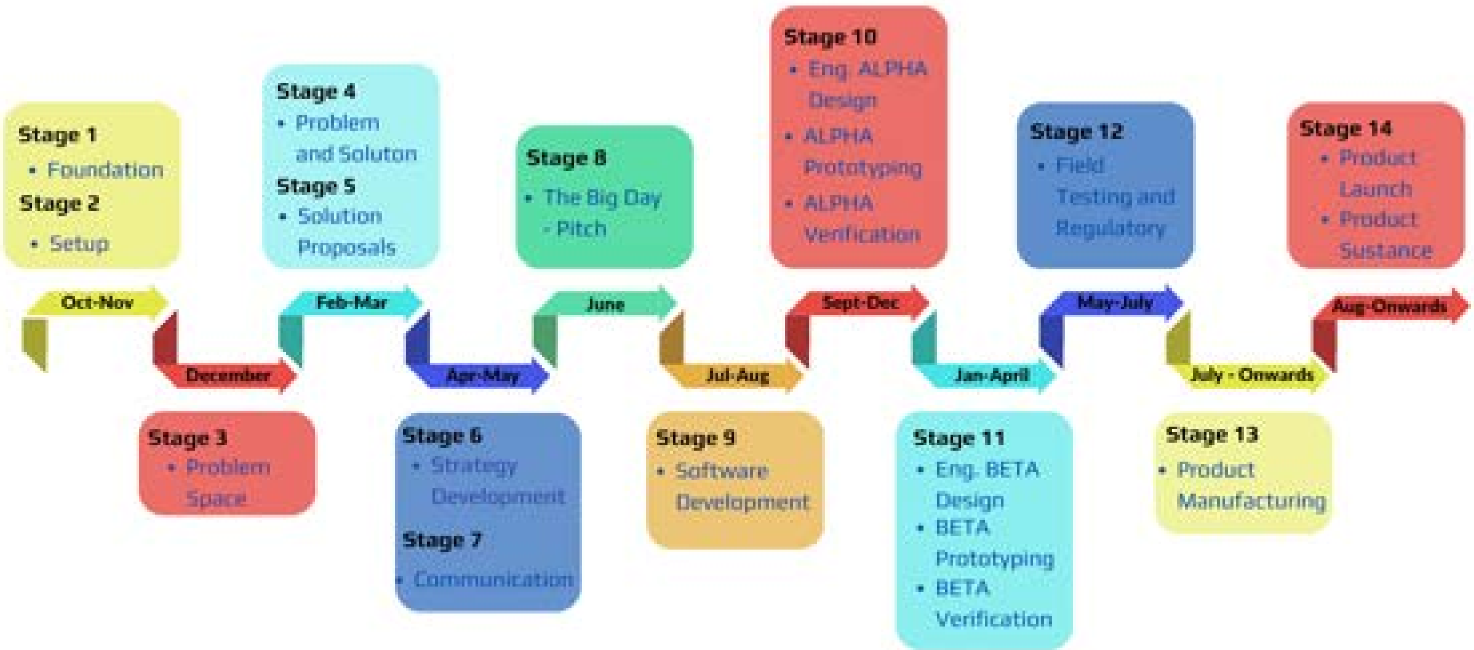
Society (Stakeholders)

1. **Farmers**: The solution benefits farmers by providing them with accurate data on insect populations, enabling informed decision-making in pest management. It helps minimize crop damage, optimize resource allocation, and increase agricultural productivity.
2. **Consumers**: By promoting sustainable pest management practices, the solution contributes to the production of safer and healthier food. Consumers can have confidence in the reduced use of harmful insecticides, resulting in improved food quality and safety.
3. **Local Communities**: The solution benefits local communities by reducing the environmental impact of insecticides. It promotes healthier ecosystems, preserves biodiversity, and maintains the stability of natural habitats, thereby supporting the overall well-being of communities.

Environment

1. **Biodiversity Preservation**: The solution minimizes the negative impact on beneficial insects, pollinators, and other non-target organisms. By reducing the use of insecticides, it helps preserve biodiversity and the ecological balance in agricultural landscapes.
2. **Soil Health and Carbon Sequestration**: Through sustainable pest management practices, the solution promotes soil health, allowing for better nutrient retention and carbon sequestration. This helps combat climate change and supports the overall health of the environment.
3. **Reduced Chemical Exposure**: By minimizing the use of insecticides, the solution decreases chemical exposure in the environment. This has a positive impact on air and water quality, reducing potential harm to ecosystems, wildlife, and human health.

Logistics



<u>**Contribution to Pi-Mora**</u>

Moshintha Isuru (team leader) : Chairperson - Pi mora 2.2
Participant in Pi-Mora 2.1 workshops.

Gishan Kalasinghe : Participant in Pi-Mora 2.1 and 2.2 workshops
Mewan Rathnayaka: Participant in Pi-Mora 2.1 and 2.2 workshops
Senul Samarasekera: Participant in Pi-Mora 2.1 and 2.2 workshops

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[1] M. M. J. G. C. N. Jayasiri, S. Yadav, N. D. K. Dayawansa, C. R. Propper, V. Kumar, and G. R. Singleton, "Spatio-temporal analysis of water quality for pesticides and other agricultural pollutants in Deduru Oya river basin of Sri Lanka," Journal of Cleaner Production, vol. 330, p. 129897, Jan. 2022, doi: https://doi.org/10.1016/j.jclepro.2021.129897.

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Appendix

Meetings conducted with Prof. Dissanayake on progress and improvements

Main Points Discussed in the meetings

- **Two methods of detection can be employed in pest management:**

  1 . One method involves detecting volatile substances released by plants in stress conditions, such as during a pest attack. By measuring the levels of these substances, we can gauge the economic injury caused to the plants. This information can also be used to study population dynamics.

  2. Another method focuses on pest identification through imaging and sound analysis. If feasible, this approach can provide valuable insights by quantifying pest populations using statistical models.

- **To recommend a dosage for pest control, population estimates can be utilized. By determining the pest population, appropriate instructions can be given for the application of pesticides or other solutions.**

- **Adjusting details for pest resistance is crucial. When applying the same chemicals repeatedly, higher dosages can lead to pest resistance. To combat this issue, it is important to change the pesticide with a different mode of action, as there are several modes of action for insecticides (e.g., carbonate).**

Appendix

The concept of economic injury level is used to determine whether the cost of applying a solution, such as chemicals, exceeds the savings achieved through its application.

Farmers may not always follow instructions due to several reasons:

1. They often place trust in sellers who may recommend overdosing as it benefits their business.
2. There is a common belief among farmers that higher dosages are more effective, which can contribute to pesticide resistance.
3. The use of pesticide cocktails, or mixing multiple pesticides together, is another factor that can deter farmers from following instructions.

Educating a selected group of farmers can be an effective approach to address these issues and promote proper pest management practices.

In the realm of pesticides, resistance can occur due to the repeated use of the same chemicals. To counteract this, it is advised to change pesticides with different modes of action as per instructions.

It is worth noting that the utilization of pesticides is a controversial topic. The _____ register office holds all details regarding pesticides.

Currently, the trend in pest management is shifting towards integrated pest management, which combines the use of both chemical and bio pesticides. For instance, in the case of controlling whiteflies on coconut trees, a mixture of garlic and other ingredients can be used as spraying chemicals directly on coconut trees can be challenging.

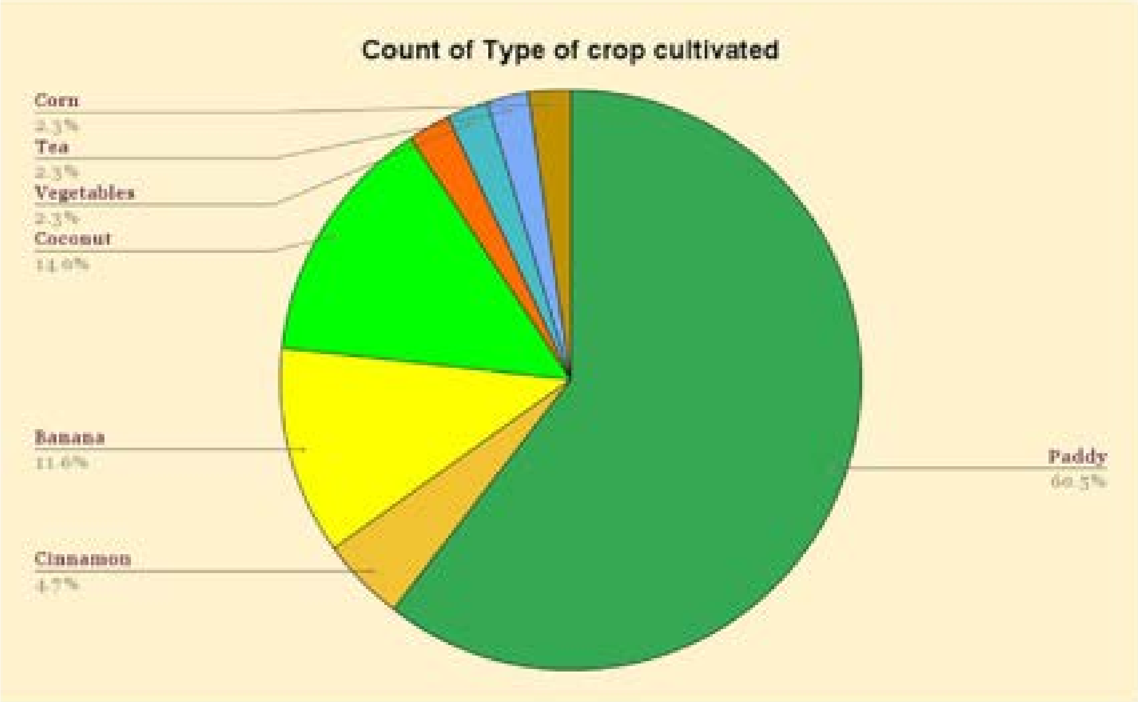
Bio pesticides, though not entirely trusted, offer a more sustainable approach. Chemical pesticides often provide quick results, but there are no Sri Lankan products available at present. Many foreign bio pesticide products are available in the market.

Previously, there was a focus on disease management, but now the emphasis has shifted to pest management.

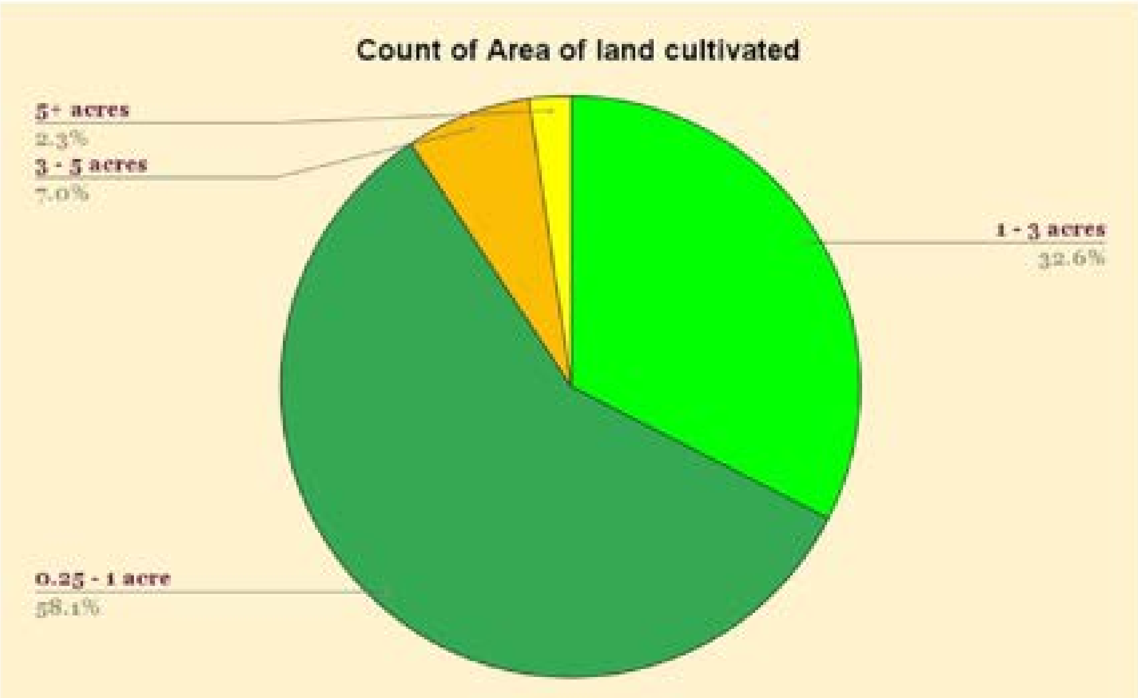
Appendix

Survey results from survey conducted on 184 farmers.

Type of crop cultivated.



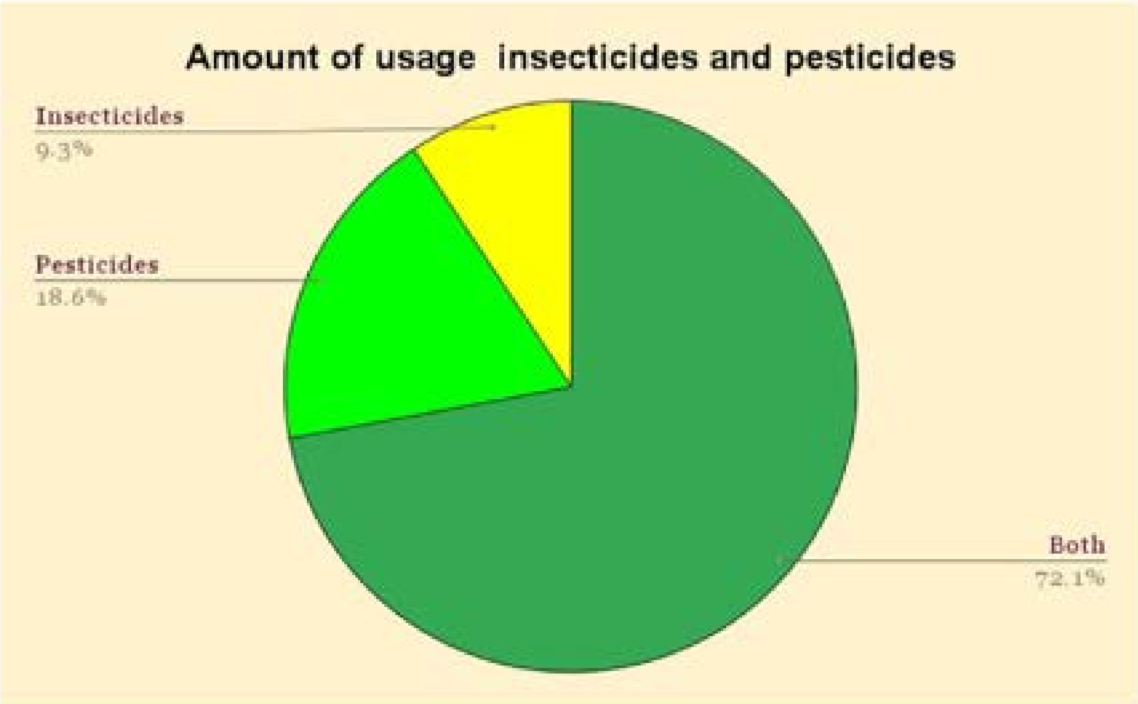
Area of cultivation



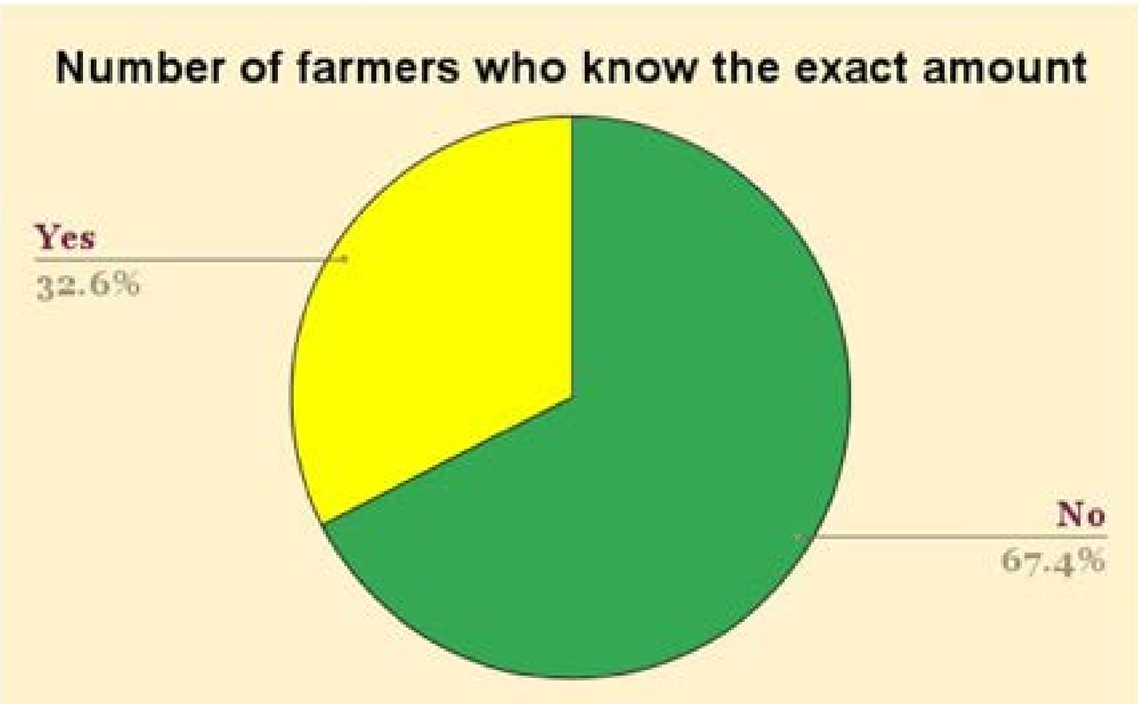
Appendix

Survey results from survey conducted on 184 farmers.

Insecticide or pesticide usage



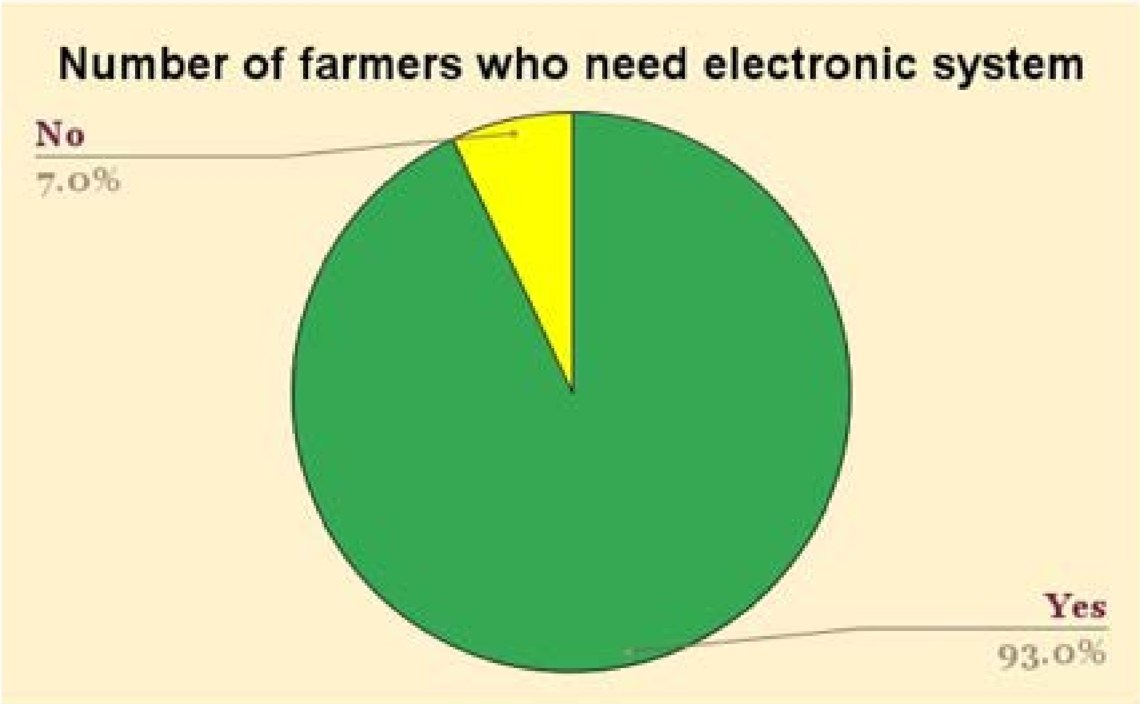
Whether the necessary amount of insecticide is known



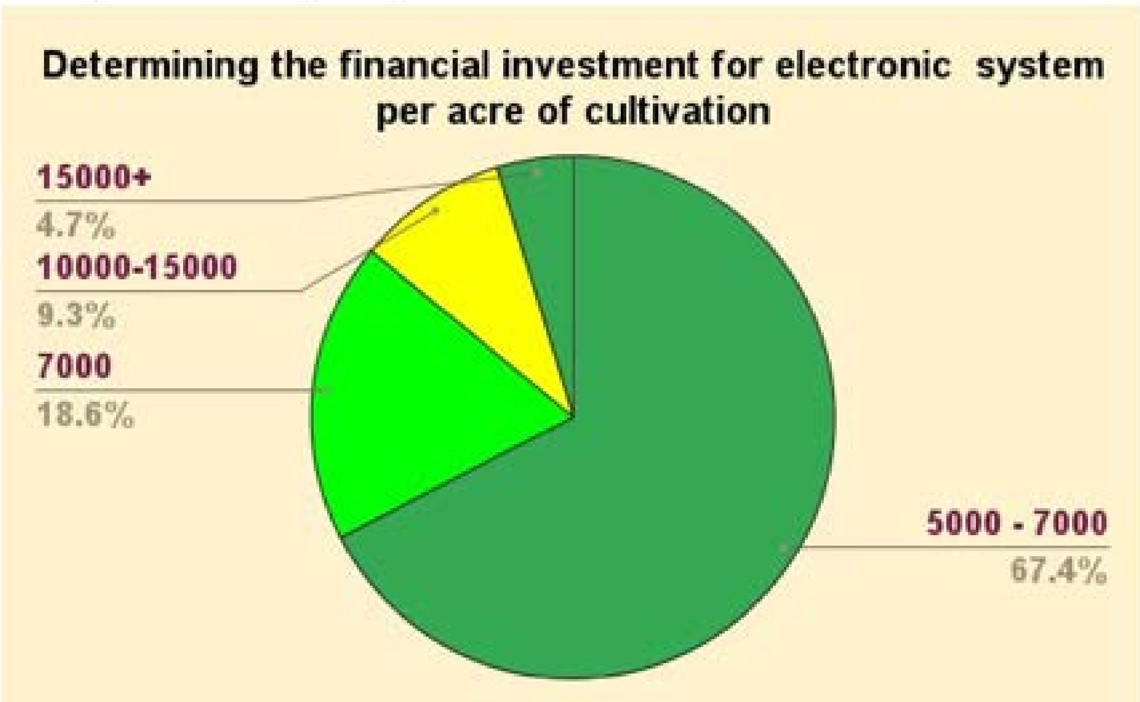
Appendix

Survey results from survey conducted on 184 farmers.

Need of an electronic system to provide amount and chemical type.



Price requirement (LKR)



PestSense

"FOR A SUSTAINABLE AGRIFUTURE"

PATHFINDERS