INFERRING CROP PESTS AND DISEASES FROM IMAGERY SOIL DATA AND SOIL PROPERTIES

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Problem Introduction Form

ICLR AI for Social Good

Topics: Which of the following categories does your problem belong to?
- ❏ Education
- ❏ Protecting democracy
- ❏ Urban planning
- ❏ Assistive technology for people with disabilities
- ❏ Health
- ❏ **Agriculture**
- ❏ Environmental sustainability
- ❏ Social welfare and justice
- ❏ Sustainable development
- ❏ Other

Problem: What problem do you want to investigate and why? If known, what are the root causes of the given problem? What are some existing solutions? (max 200 words)

Proponents of organic farming have long promoted the view that the likelihood of pest outbreaks is reduced with organic farming practices, including establishment and maintenance of "healthy" soil [1][2][3]. Recent studies have shown that plant resistance to insect and disease pests is linked to optimal physical, chemical, and—perhaps most importantly—biological properties of soil [4][5].

In major agricultural crops, pests, diseases and weeds cause considerable yield losses [6]. Climate in terms of temperature, CO2 and rainfall and prevailing weather conditions at a time has direct and indirect effects on the crop pests and diseases.

Coffee is produced in many countries and there are pests and diseases in every area. But the specific pests and diseases vary dependent on soil and environmental conditions [7].

80% of the total exports made in Uganda are known to be agricultural products mainly coffee, tea, cotton, among others, this being dominated by coffee whose percentage is 22 on the total exports [8]. However, a decrease was registered in the last financial year that depicted a drop by 2% as a result of the different challenges that the farmers are encountering which were reported to be mainly pests and diseases. The production of coffee is more likely to drop according to some farmers. Numerous approaches to crop pest and disease monitoring have been provided in line with other crops such as cassava [9], bananas, tomatoes [10] and can be extended to other cops [11] [12] however, these are registered under active procedures when the crops are already affected.

Proposal: Describe your proposed solution. How does it address the shortcomings of current approaches? (max 200 words)

Our idea is to revolutionize the pest and disease monitoring procedure through use of Artificial Intelligence on data collected on soil properties to mediate soil-pest/disease relationships and create a proactive model for pests and disease surveillance which will help coffee farmers determine the optimal pest and disease management practices.

Novel Solution - Revolutionization of the crop pest and disease monitoring procedure through use of Artificial Intelligence on data collected on soil properties to mediate soil-pest/disease relationships. Our emphasis is more on prevention (i.e. Predicting crop pests and diseases that will attack coffee if planted on a given piece of land) rather than cure (i.e. Predicting crop pests and diseases on already affected coffee plants)

Our goal is to develop the model using Deep Learning inception algorithms [12] [13] [14] to understand and learn of the soil representation, imagery patterns and prevailing climatic conditions in relation to pests and diseases and be able to do predictive analysis on unprecedented datasets.

Impact: What is the expected social impact in the short, medium, and long-term of the solution to the problem? (max 150 words)

Farmers will be enabled with an application that will be able to determine the soil - pest/disease relationship for a given crop. This will in-turn equip farmers with the ability to determine the best crop pest/disease management practices for a specific crop before embarking on the actual planting exercise and during the growing period as a monitoring tool. It is our view that farmers will benefit in the long run through increased crop yields since our emphasis is more in-line with predicting for prevention than predicting for cure.

Evaluation: How would you quantify success? Are there smaller-scale environments in which you can test your proposal? How might a larger-scale deployment fail to reflect the initial experiments? (max 150 words)

We will gather feedback to infer how helpful the system has been in a practical situation. Additionally, a supporting UI will be used which enables collecting more detailed feedback about how satisfied the user is with the help of the system in retrospect. The number of users, increase in coffee production rates and annual coffee farmer's revenues will be considered as market indicators of our success.

We shall test out our proposed system on 100 medium sized farms across 25 districts in Uganda, it is our view that a large-scale deployment will fail to reflect the initial experiments since we hope to use our initial experiments to fine tune our model before we can carry out a large scale deployment.

Risks: Could your solution lead to any unintended harmful consequences or risks? Describe them. How could the resulting system be abused? Are there vulnerable populations that might be put at risk? What checks could you introduce to prevent these potential bad actors? (max 150 words)

Personal data infringement risk. As a Deep Learning-based framework the system will not enable end users to directly program it and therefore they will not be able to hack the system. Nevertheless, it is possible that some people will try to use social engineering.

The risk that the project will not gain sufficient user base is unlikely, as we have gathered feedback to the idea and it has been exceedingly popular.

We make the system as easy to use as possible to mitigate the risk that farmers using it would be difficult.

There is the risk of difficulty finding collaborators for the project in order to make the platform popular. The risk is mitigated by the observation that the field of self-help and lifelong education is flourishing. Therefore, we expect to find parties interested in the "seed" cooperation.

There is a risk of personal data leakage through specific cleverly crafted statistical techniques. Both the various possible attacks and also the mitigations are elaborate and are still under consideration.

Data: Describe the dataset(s) available for your project (i.e. amount of data, measurements granularity, data collection frequency, way of accessing the data). Who is responsible for data collection? Are there privacy concerns, and what is the license? (N.B.: In the absence of privacy concerns, we encourage data that can be shared publicly). How have these datasets been used previously? (max 200 words)

Images of soil samples from over 100 coffee farms in 25 different districts using cameras/phones; Additional data will be collected on soil properties using soil sensors to determine the texture, temperature, humidity, reaction, moisture, nutrients, organic matter of the soil, weather and climate Conditions among others. There will be no privacy concerns for the data that will be collected since we intend to make it an open-source dataset at some stage in the future.

Labels: Would your data require any additional annotation before it could be incorporated into your solution? If so, how do you plan on obtaining these labels? Are there different approaches to annotation, and how do they compare in terms of level of detail and ease of preparation? (max 150 words)

N/A

Social System: Describe your team's skills and backgrounds. What are other resources (i.e. stakeholders, scientists, and funders) would you like to add to your team? (max 150 words)

Our team is comprised of passionate AI researchers passionate about finding and implementing better, simpler and cost-effective solutions to address some of the prevailing problems in developing countries. Particularly interested in problems that can be solved by the application of computational techniques. As such our passion is research, particularly in the varied fields of Artificial Intelligence - specifically machine learning and computer vision and how to apply these in such a way as to obtain an optimal solution to real-world problems in developing countries.

We are actively looking for funders who will partner with us by financing our project idea as we take steps to revolutionize the pest and disease monitoring procedure through use of Artificial Intelligence.

Technical System: If applicable, please share any technical elements of your proposed solution that have already been explored. What would your baseline system look like, how well do you imagine it will work, and what extensions have you imagined? (max 150 words)

The current stage of the project is between idea stage and data collection. Some efforts have already been made in regards to data collection of soil images.

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