The idea

Each year, farmers lose millions of dollars to weather, crop disease, pests and poor field management. To understand nutrient availability and environmental variability, consistent and accurate monitoring of crops are essential across all growth stages. Current methods of crop damage monitoring are manually intensive, time consuming, broad sample based and prone to error. This leads to poor crop management advisory and practices that lead to economic losses and deteriorate environment. Data resources in precision agriculture are expanding with increased use of powerful unmanned aerial vehicles that are becoming less expensive and versatile (Rudd et al., 2017).

We propose using a real-time probe attached to a drone to provide farmers with an accurate picture of the field and crop conditions, including in-field insect, disease, deficiency stress with specific classification of cause, and degree of damage.

This real-time assessment system, includes a UAV, a precision agriculture drone (eBee, SenseFly, Switzerland) that is enabled with multi-band sensor probe. The probe consists of a multispectral camera for agriculture purpose using 4 spectral cameras and 4 spectral sensors in visible and near infra-red region (Parrot SEQUOIA, Sequoia, France). The drone and probe device will be used for real-time, on-site data acquisition of crops, plants and field conditions. The acquired data can be collected and processed within a system that includes hardware sensors, artificial intelligence software, and associated support equipment for imaging and sampling biotic and abiotic damages. Predictive analytics, alerts, actions, processes, pattern matching and event processing will be performed by dynamic orchestration of meta-data insights using either Hadoop, Hive or Phoenix big data storage.

We would like to approach through Ensemble model: This is a predictive analytic model that combines several other models to create an overall score to determine crop damage score. This model delivers increased predictive power by combining the desirable characteristics of several different algorithms into a single package, while ground truth data will be used to validate the results. The system can be operated as a handheld device and/or portions thereof may be mounted to a host platform, such as an autonomous vehicle, manned vehicle, or stationary installation in the field. There are reports of aerial multispectral imaging in assessing damages of field crops like potato (Zhou et al., 2016). Precision and timely decisions can be impacted with accurate data on plant damages in large farm pockets.

There is potential in using this technology to enable decision support in (i) provide a way to radically lower operational costs by implementing autonomous scouting compared to current labor intensive scouting efforts for plant damage assessments (ii) facilitates reducing financial costs, support environmental stewardship, and enable compliance with present and future regulations related to controlled chemicals; (iii) have a positive impact on the farmer's productivity, and crop protection management, thereby extending the farmer's competitive advantages (iv) improve food safety, quality, and sustainability from authoritative field data on accurate crop conditions, pest and diseases that impact food/nutritional security. (v) facilitate better soil management practices based on accurate vegetation uptake of crop protection and fertility products; (vi) enable improved water optimization based on improved zone management to highlight water deficiency, especially for irrigation plots and; (vii); reduce emission of greenhouse gases from scouts driving to sites for analysis;

This project intends to demonstrate a prototype system and compare results from imaging with the manual scouting effort. Our hypothesis is that autonomous crop scouting will reduce field diagnostic time and cost by over 20x the time and adoption such approach will outpace traditional agriculture practices, especially in emerging markets like India.

How will you pilot it?

ICRISAT will pilot the above idea through Aegis Consulting Services, the technological partner to scout UAV and probe device and development of App for output demonstration. We seek participation from ICRISATs local partners like the state agricultural university in the state of Andhra Pradesh and pilot the study in the experimental stations at Regional Agricultural Research Stations in Tirupati/ Guntur. We expect to carry a scouting operation if there is any natural calamity like cyclones, flooding or hail damages during the project cycle in the state of Andhra Pradesh. We will complete scouting trials within 6 months and ICRISAT will provide coordination and on the ground support for data collection, pilot location selection and participant engagement for this project.

Specific output data: A web based and mobile App for generating reports will be developed in this project both on android platform

1) Identify and quantify plant damages and infestations in defined crops (2) using hand probe and ground-truth method in greenhouse and field environment.
2) Prepare geo-referenced maps of infestation rates of each field and develop threshold map for each field for the collaborating farmers.
3) Correlate the accuracy of assessing the plant damage levels between the autonomous probe and ground-truth data.

The outputs are expected to be understood by all stake holders including farmers, state agricultural department officers, agri input supply chains, private insurers etc… The outputs of this project will directly provide evidence for the state and private insurers for underwriting risks in crop insurance. The **outcome** of this project will directly help us to quantify plant damages on a real time. This will enable efficiency in plant protection management systems and penetrate quality crop insurance products in countries like India and those in Africa.

If successful, the next steps will be to scale up to an entire district or states in either Asia or Africa. There is potential to customize the requirements to all CGIAR partners and we want to pursue sponsors and also look at commercialization with target weather and crop insurance providers in private sectors in India/ Asia/ Africa.

Budget:

An initial funding of USD 100,000 would cover the implementation costs of this project. ICRISAT will use 50% of the funds for project management including scientific team time, ground data collection, analysis, report writing and travel. The rest of the funds (50%) will be shared with partner Aegis consulting for scouting the drone, probe, software modelling, data generation, integration, rule engines, analytics and exclusive App development.

References:

1. Rudd, J.D., Roberson, G.T. and Classen, J.J., 2017. Application of satellite, unmanned aircraft system, and ground-based sensor data for precision agriculture: a review. In 2017 ASABE Annual International Meeting (p. 1). American Society of Agricultural and Biological Engineers.
2. Zhou, J., Pavek, M.J., Shelton, S.C., Holden, Z.J. and Sankaran, S., 2016. Aerial multispectral imaging for crop hail damage assessment in potato. Computers and Electronics in Agriculture, 127, pp.406-412.

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Non CGIAR Partner:

ICRISATs technological partner, Aegis Consulting Services is a software development company with rich experience in developing and deploying products and projects in Agriculture domain for State governments in India.

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