

Body of Knowledge (BOK)

Increasing Productivity and Business Model of Agriculture Drone

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The Rapidly Changing World of Agriculture

- 
- A large agricultural drone, specifically a quadcopter, is shown from a rear three-quarter perspective. It has four black propellers and landing gear. It is positioned in the middle of a green, cultivated field with rows of crops. In the background, there are trees and a building with a red roof under a clear sky.
- The farming operations of today look quite different than even a few decades ago.
 - New technology has allowed the growers of today to optimize each part of their operations — from field spraying to grow cycles and crop health.
 - A big part of that transformation can be attributed to drones and other types of Unmanned Aerial Vehicles (UAV).
 - With an agriculture drone, farmers get in-depth data analysis and mission planning as well as new tools capable of handling physical work.

Current Challenges with Pesticide Spraying

- Traditional method of pesticide spraying include tractor spraying, manual spraying using container, etc.
- These methods of spraying are laborious, time consuming, and highly inefficient.



- These methods are restricted, for ex: Tractor cannot be used in rice paddy fields, it is very difficult to spray pesticide in sugarcane farm with manual spraying container.

Current Challenges with Pesticide Spraying contd.



Similar problems are faced in sugarcane crop spraying



Person spraying pesticide needs cover properly and there is no protection from snakes and other animals

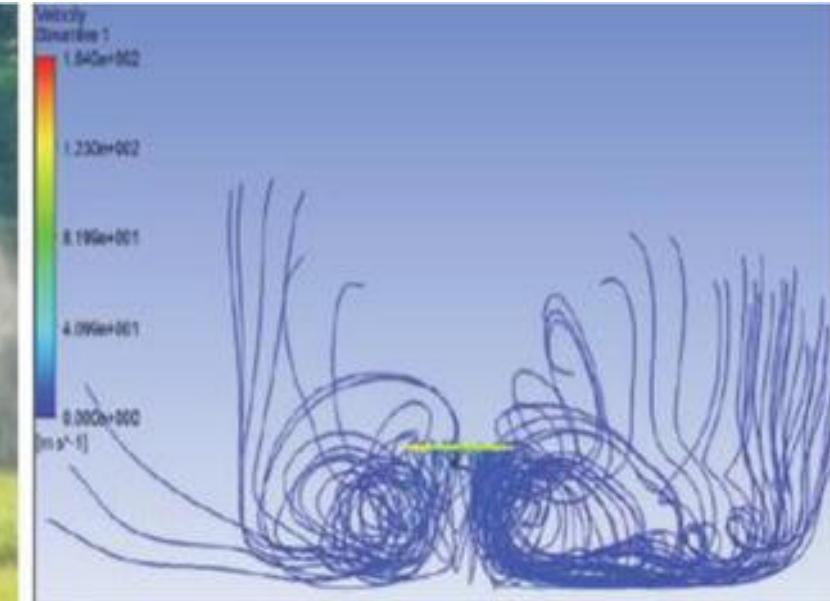
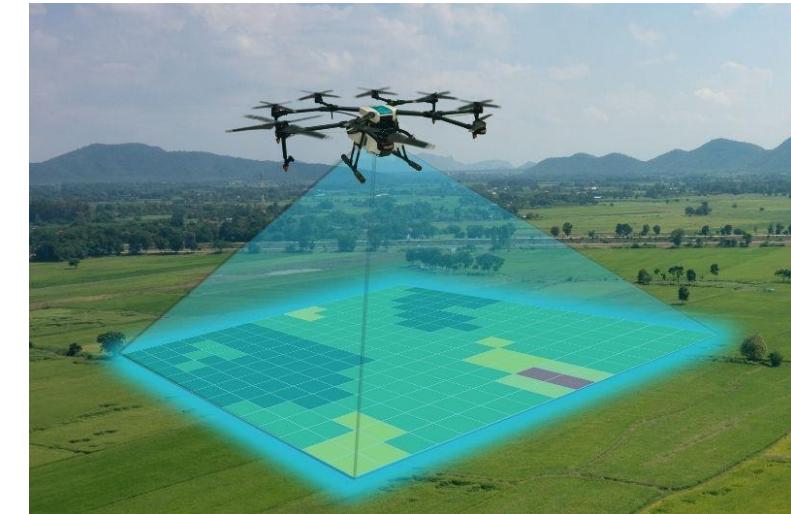
Intercomparison of Traditional Method and Drone Spraying



Basis	Device	Drone	Knapsack Sprayer	Tractor Sprayer	Elevated Spraying Vehicle
Pesticide Utilization Efficiency		85 %	30 %	30 %	30%
Adaptability	Mountain, hilly terrain and paddy field.	Crop, flower and fruit are easily damaged, trampled or dropped by human.	Can't work in mountain and hilly terrain.	Can't work in mountain and hilly terrain.	Can't work in mountain and hilly terrain.
Water Consumption per hectare	Spraying uniformly with low dilution rate and high concentrated liquid pesticide, the water can be saved by 90%	Traditional immersion jet spraying, resulting in waste of water and most pesticides lost into soil along with water	Traditional immersion jet spraying, resulting in waste of water and most pesticides lost into soil along with water	Traditional immersion jet spraying, resulting in waste of water and most pesticides lost into soil along with water	Traditional immersion jet spraying, resulting in waste of water and most pesticides lost into soil along with water
Safety	Away from field during pesticide spraying to avoid the pesticide poisoning.	Pesticide enter human body by mouth, easily lead to pesticide poisoning.	Applying pesticide from close range, easily lead to pesticide poisoning.	Applying pesticide from close range, easily lead to pesticide poisoning.	Applying pesticide from close range, easily lead to pesticide poisoning.

Benefits of using Agriculture Drone

- Greater access to land
- Time saving
- 10x faster data for quick decision-making
- Cost saving as lot of pesticide and water is saved
- Increase in crop yield
- Increase in crop quality
- Safer way to spray crops
- Maintenance free
- Spraying pesticide where it is required
- 99% Accuracy rate data collection



HxD-22 Agriculture Drone

- Agricultural Drones who will become the biggest asset to farming in future will skyrocket the economy of this sector by multi folds and with our HxD-22, we are looking to take part in this upcoming revolution by offering a sustainable and economical solution to most of the crop dusting/spraying needs.
- When you're looking for the best in agricultural technology, you want the drones and payloads of Hexagon Dynamics. Our solutions are designed with the needs of farmers in mind.
- **Technical Specification**
 - Endurance/flight time: 12-15 min
 - Total take off weight: 24 kg
 - Area coverage: 2 acre / flight
 - Wind resistance: 5 m/s
 - Spray span: 4-5 m
 - Operating Altitude: 3-10 m
 - Tank capacity: 10 lit/16 lit/20lit
 - Rechargeable batteries: (LiPo 6S 22.2 V 16000 mAh) x 2
 - IP 55 (Waterproof)



HxD- 22

Critical Components of HXD-22 Drone



- Hardware
 - Fixed Wing Drones
 - Rotary Blade Drones
 - Hybrid Drones
- Software and Services
 - Data Management Software
 - Imaging Software
 - Data Analytics Software
 - Others
- Frames
- Controller Systems
- Propulsion Systems
- Camera Systems
- Navigation Systems
- Batteries, Other Components (Wires, connectors, power systems, carry cases, sprayers, and sprinklers)



Unique Selling Proposition (USP) of HXD-22

- The Ministry of Civil Aviation (MoCA) and Directorate General of Civil Aviation (DGCA) have stringent guidelines of drone flying in India.
- This is a technical topic most of the people in India, are not well aware of such regulations.
- Many companies in India purchase Chinese drones, which do not satisfy these requirement.
- These drones work different radio frequency and hamper surrounding conditions.
- Hexagon Dynamics offer HXD-22 drone which is designed on the basis of these requirement.

Conditions and limitations to Ministry of Agriculture & Farmers Welfare for operating Remotely Piloted Aircraft

1. This exemption to M/o Agriculture & Farmers Welfare from the paragraphs 5.3, 6, 7, 8.4, 9, 11.1 [c, d], 11.2 [a,d], 12.4, 12 .5, 12.18,12.19 and 15.3 of CAR Section 3, Series X, Part I, is subject to exemption from Rule 15A of the Aircraft Rules, 1937 by Ministry of Civil Aviation.
2. The M/o Agriculture & Farmers Welfare shall obtain necessary clearances from (a) Local Administration (b) Ministry of Defence (c) Ministry of Home Affairs (d) Air Defence Clearance from Indian Air Force and (e) Airport Authority of India (AAI) [as applicable] prior to operation of Remotely Piloted Aircraft System (RPAS).
3. The M/o Agriculture & Farmers Welfare only operate the RPAS models specified in the approved Standard Operating procedures (SOPs) reference no. 9119 (PMFBY)ISOP 01 Revision No.O of WRMS, SOP reference no. 9119(PMFBY)ISOP/01 Revision No.O of Agrotech and SOP reference no. 9119(PMFBY) SOP/01 Revision No. O of AMNEX . The operations shall be as per the above the above mentioned SOPs. The RPAS have to be voluntarily disclosed to Government of India and issued with a valid Drone Acknowledgement Number (DAN) and the fleet details are to be maintained by M o Agriculture & Farmers Welfare. Any change/ amendment/ revision in the SOP or model or change in use 'case shall be included in the SOP and submitted to DGCA for approval.
4. M/o Agriculture & Farmers Welfare shall ensure that only trained I experienced bona fide personnel operates the RPAS. Further, Mio Agriculture & Farmers Welfare shall ensure that rerr.ote flight crew are trained through approved FTOs/ RPTOs.
5. M/o Agriculture & Farmers Welfare shall ensure that the RPAS is in working condition as mentioned in the SOP and shall be responsible for any eventualities due to malfunction I disorientation of equipment.
6. M/o Agriculture & Farmers Welfare shall maintain the records of each RPA flight and make such records available to the DGCA on demand.

Pesticide Spray Video



Features

- Obstacle avoidance
- Vertical Take off and landing
- Empty tank warning
- Optional geo fencing
- Intelligent Flight plan (A-B)
- Live streaming of telemetric data
- Multiple nozzle options
- Stable flight at low heights
- **Flight Modes:**



- **Manual Mode** -Fly the Drone with the help of Remote Controller [Transmitter]
- **Autonomous Mode** -Fly the Drone Autonomous without any human Interaction. Connect your mobile to the transmitter. Select the spraying area. Adjust the Spacing Width. Adjust the Spraying Altitude. Adjust the Spraying Speed. Upload and click on start button to start the Operation.

Suitable Crops for Drone Spraying



RICE FARM



GREEN VEGETABLE FARM



WHEAT FARM



TOMATO FARM



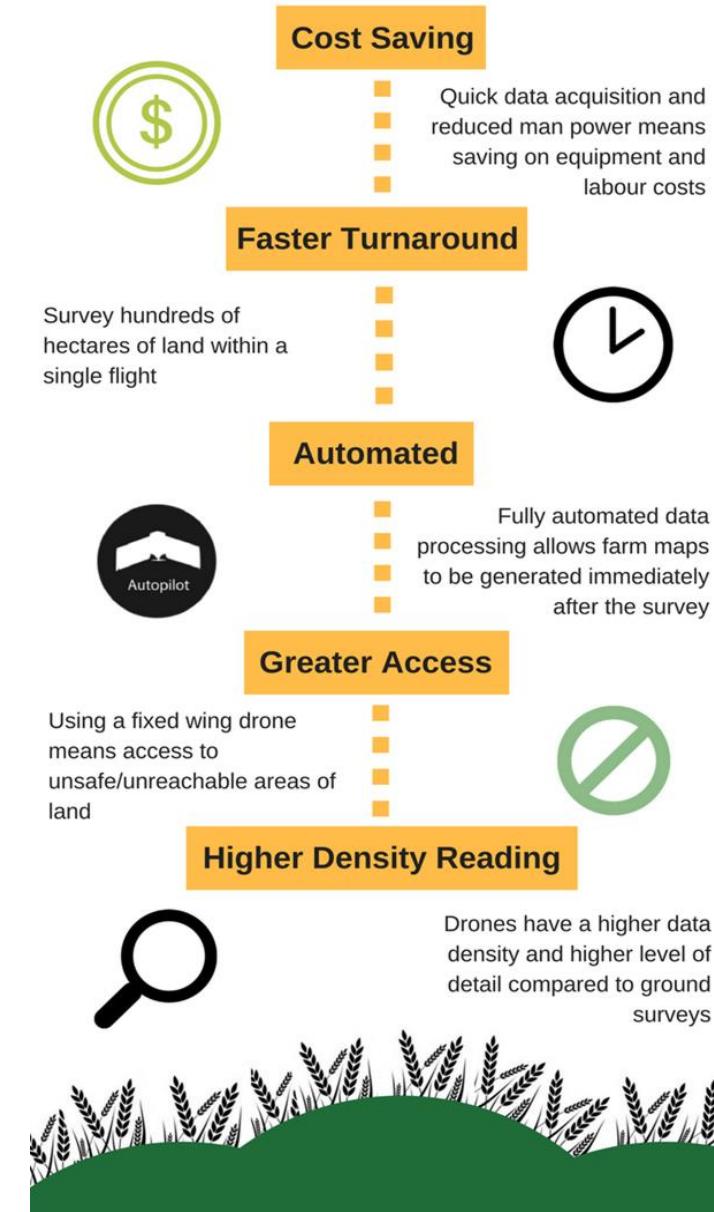
SOYABEAN FARM



COTTON FARM

Business by Spraying Drone

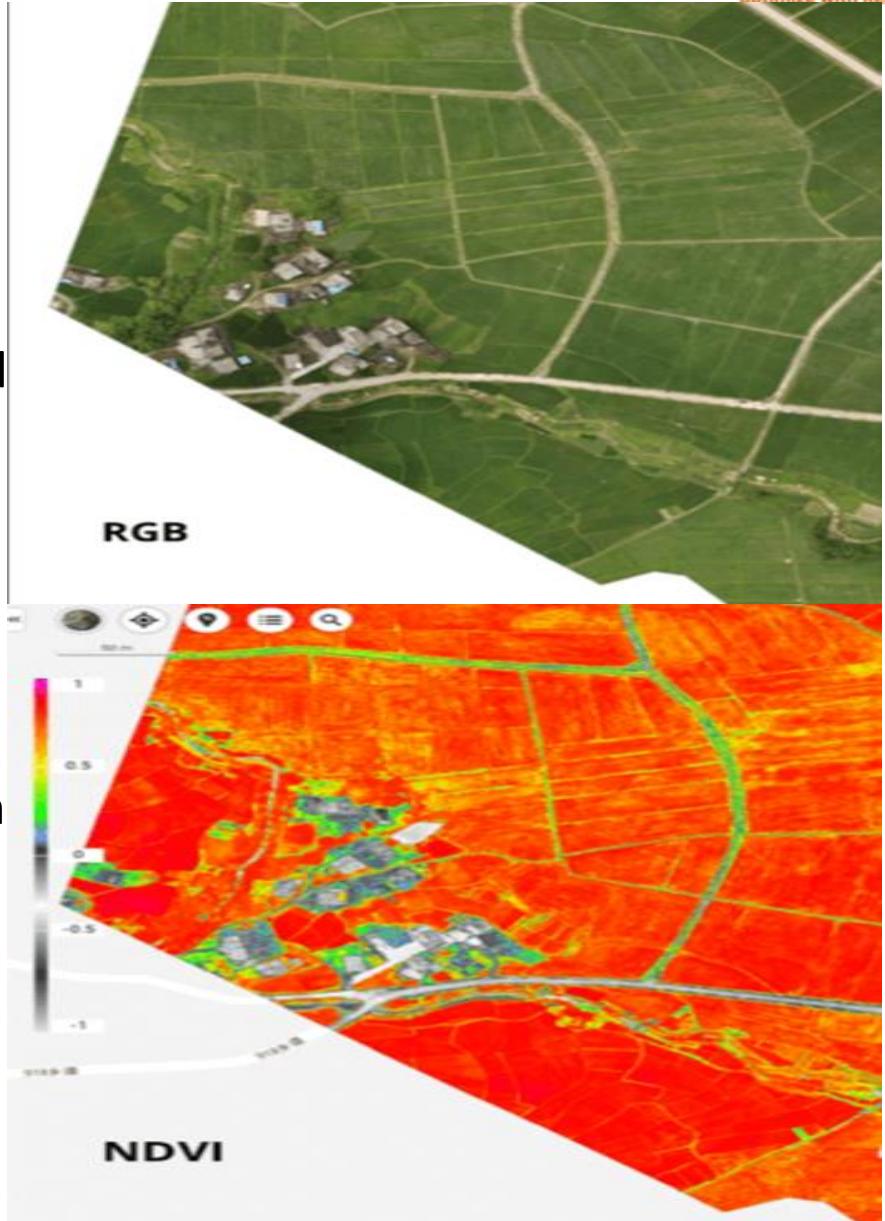
- HXD-22 Pesticide drone uses ultra low volume nozzle which atomizes pesticide, hence reducing the consumption of pesticides and water.
- A tank of 10 lit uses 1 lit of pesticide and 9 lit of water
- Spraying drone can used for business by giving it on rental basis.
- Battery of (16000 mAh) x 2 gives 500 cycles which can cover 500 acres of land.
- Average price of rent is around 1000 Rs/acre
- Capacity of drone is 50 acres/day
- So, revenue of 5 lakhs/month can easily be generated through this business



Using drones to gather Data for Precision Agriculture

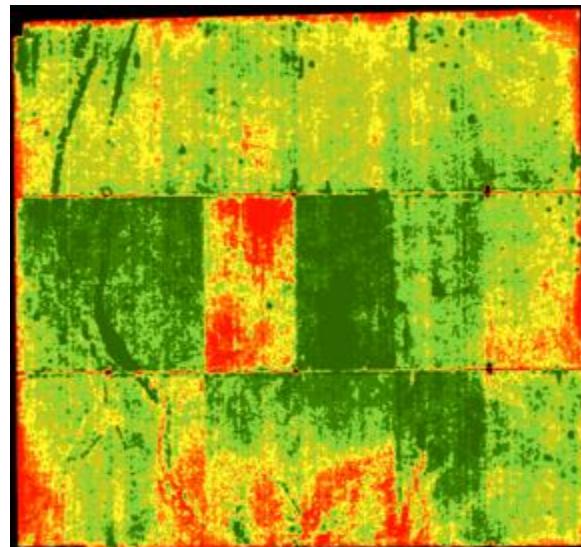
Some Smart Solutions

- Smart spraying and seeding aren't the only ways to increase overall agricultural efficiency, cut costs, or increase yields. Drones can also be used to map out an area and create new insights — taking the guesswork out of much of the growing process.
- **RGB maps:** A birds-eye view but even better, even a basic Red Green Blue (RGB) map can offer fresh information. These maps allow you to see exactly how much land you have to grow on to the [centimetre](#) and assist with crop monitoring over an extended period of time, helping you adjust from season to season.
- **NDVI maps:** Normalized Difference Vegetation Index (NDVI) takes the insights of an RGB map one step further. The map shows the amount of infrared light reflected in an area, which is an indicator of malnourishment and drought. According to Go Intelligence, this kind of data collection can be used to spot problem crops [as much as two weeks before physical signs emerge](#), making it an invaluable tool for farmers trying to accurately predict their yield rate.



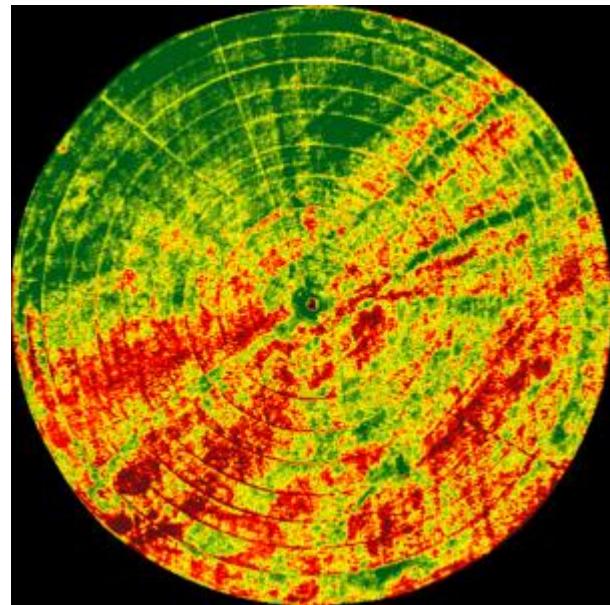
Vegetation Indices

- Indices and band ratios are the most common form of spectral enhancement.
- A Vegetation Index (VI) is a spectral transformation of two or more bands designed to enhance the contribution of vegetation properties and allow reliable spatial and temporal intercomparison of photosynthesis activity.



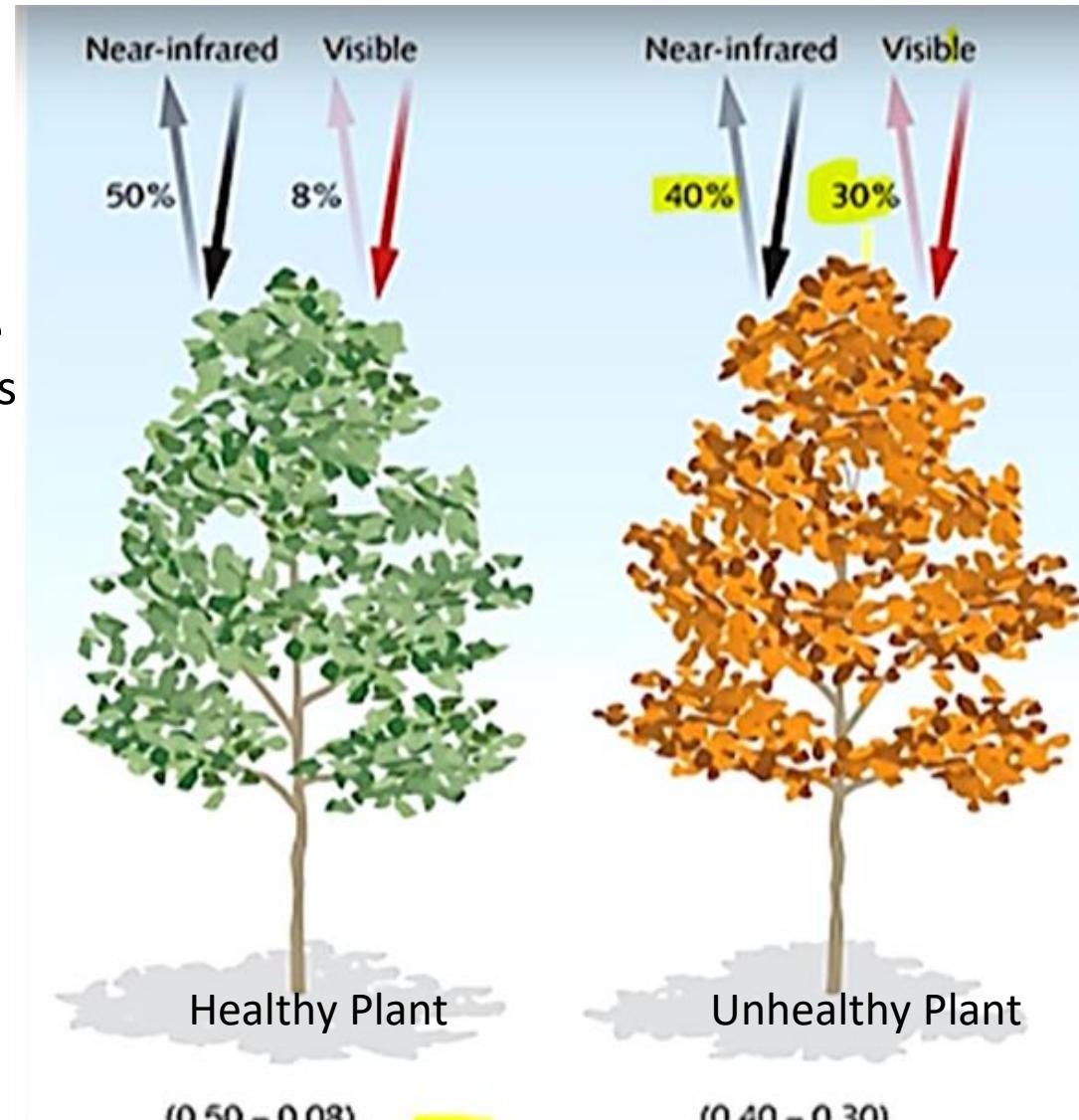
Regulator error

The stressed area in the center of this field was caused by improperly set irrigation regulators.



Nutrient deficiency

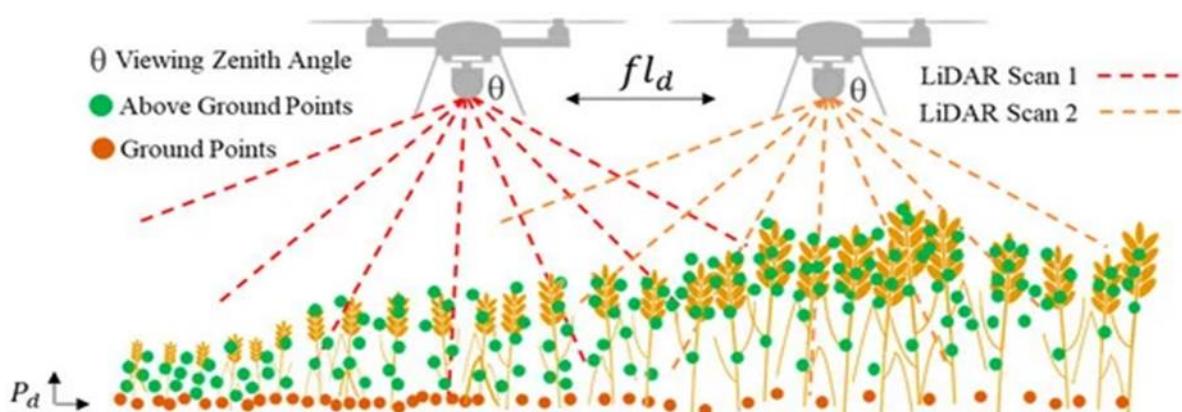
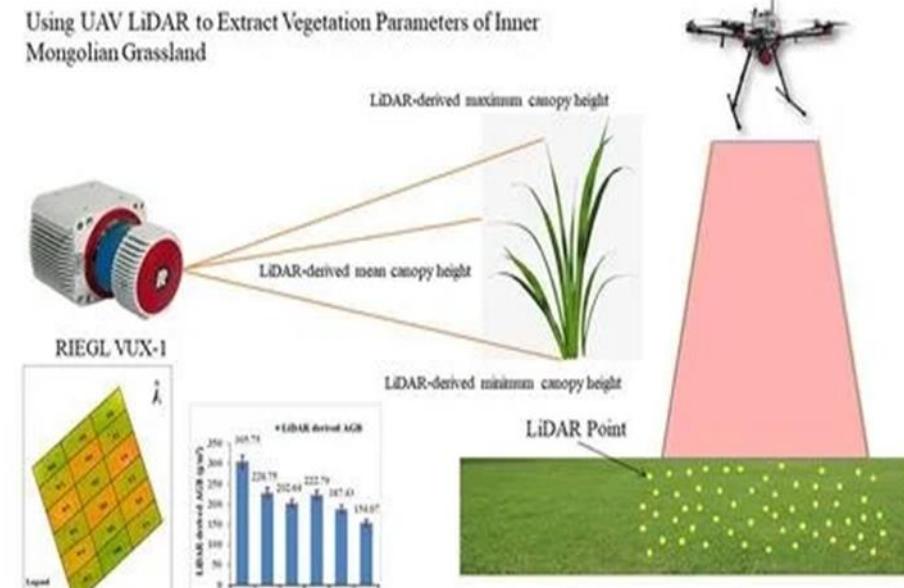
In this field, stressed areas were found to correspond to areas with an inferior soil type.



Smart Farming using Sensors

LiDAR Sensor

- Useful in 3d digital surface modelling stockpile calculation
- Surface variation detection and flood mapping
- Penetrates through vegetation: It can perform height measurement by collecting range of information from plant canopy and from the ground.
- LiDAR technology is instrumental in developing 3D models of farmland and helps come up with accurate maps of the natural resources around that area. With this data, the farmer can then be able to discern the exact terrain of the farm and identify the water catchment area and the flow of erosion.



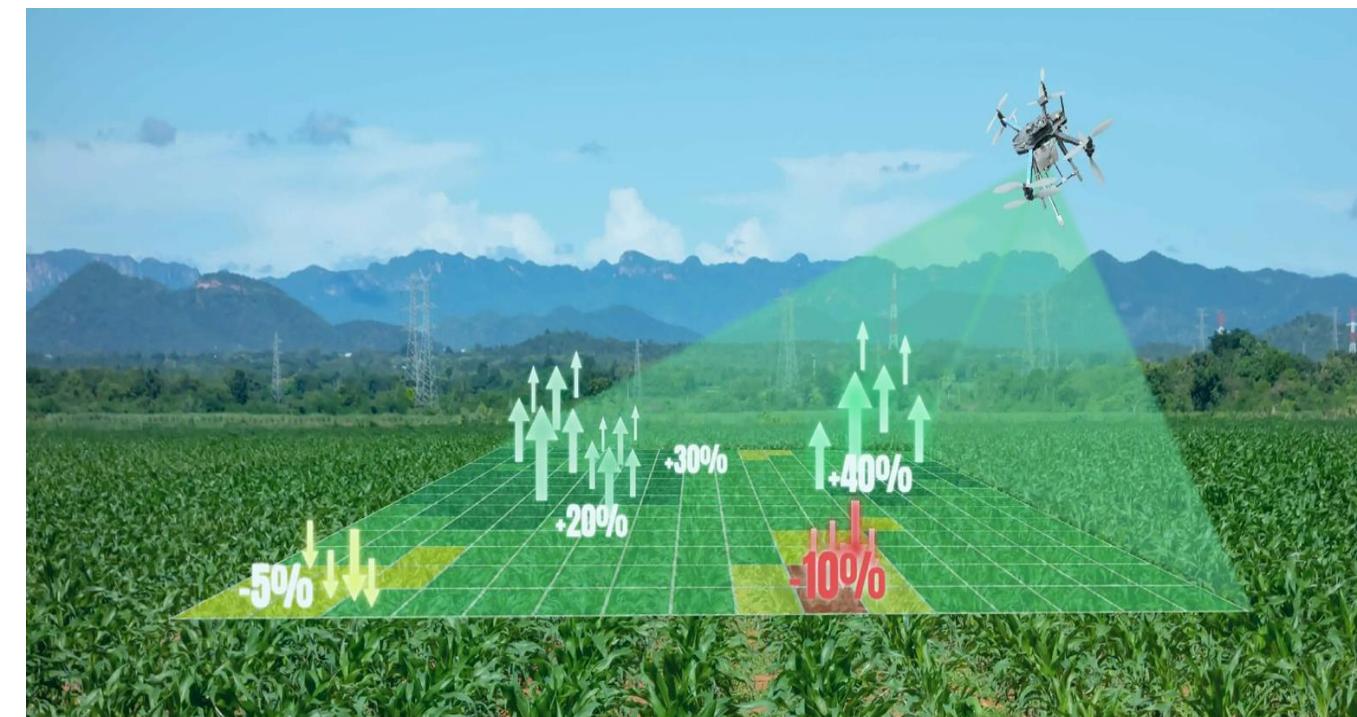
Thermal Sensor

- Heat signature detection
- Health monitoring of crops
- Livestock Detection
- Surveillance and security
- Water temperature detection and water source detection



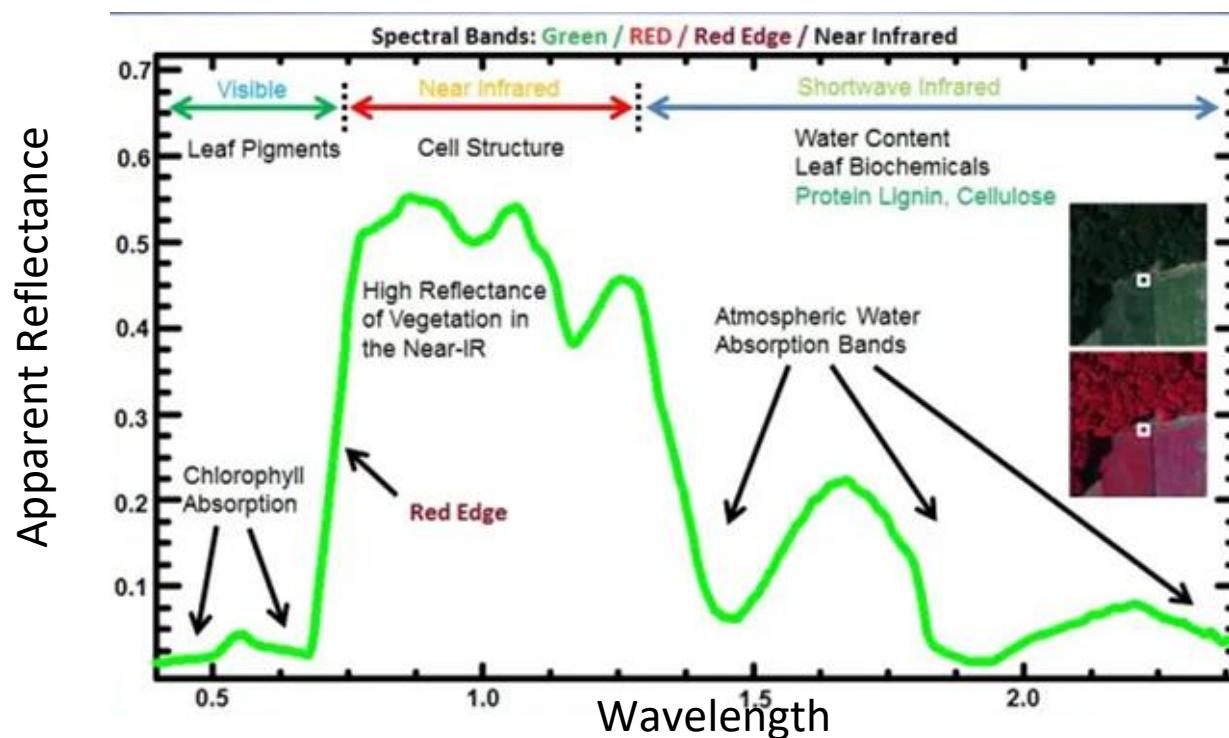
Visual Sensor

- Crop Management
- Irrigation Monitoring
- Crop Damage Assessment
- Field Soil Analysis
- Plant Counting, etc.



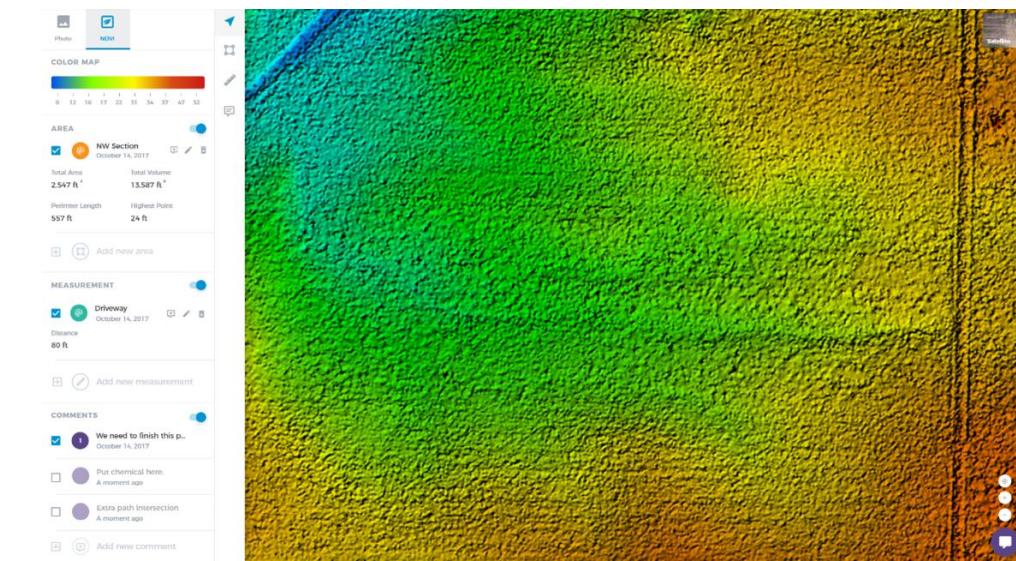
Multispectral Sensor

- By uploading multispectral sensor data into [Data Analytics Agriculture Software](#), our mapping and data analytics platform, you can transform the various bands of multispectral data into indices that indicate vegetation health and stress. Indices require varying amounts of spectral data.
- For example, a basic Normalized Difference Vegetation Index (NDVI) can be applied to basic red-green-blue (RGB) visual imagery captured by a regular camera. However, NDVI has its limitations. To gain a more accurate measure of crop health, you can deploy a multiband multispectral sensor, that includes near-infrared and infrared wavelengths of light, enabling you to run a Normalized Difference Red Edge (NDRE) vegetation index. This is better for mid- and late-season crops, which have greater accumulated levels of chlorophyll and multiple layers of vegetation





Use of Artificial Intelligence (AI) and Machine Learning (ML) in Agriculture

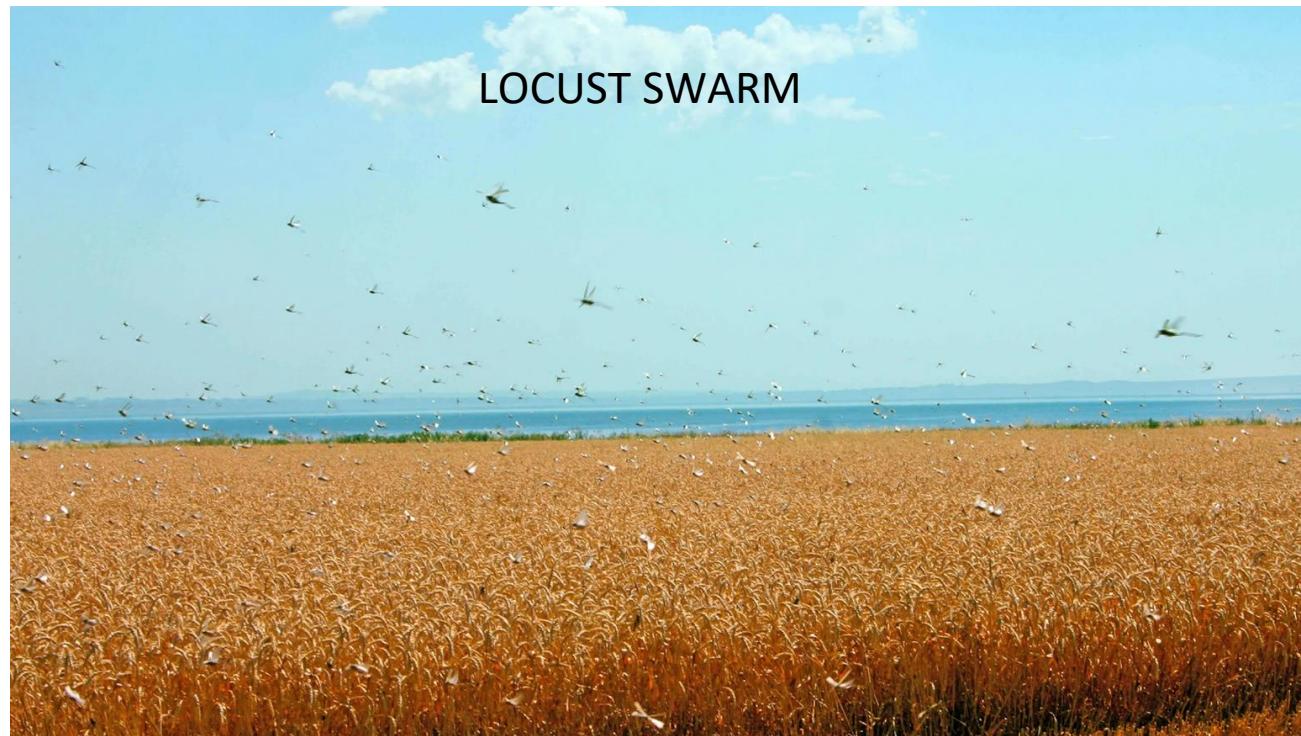
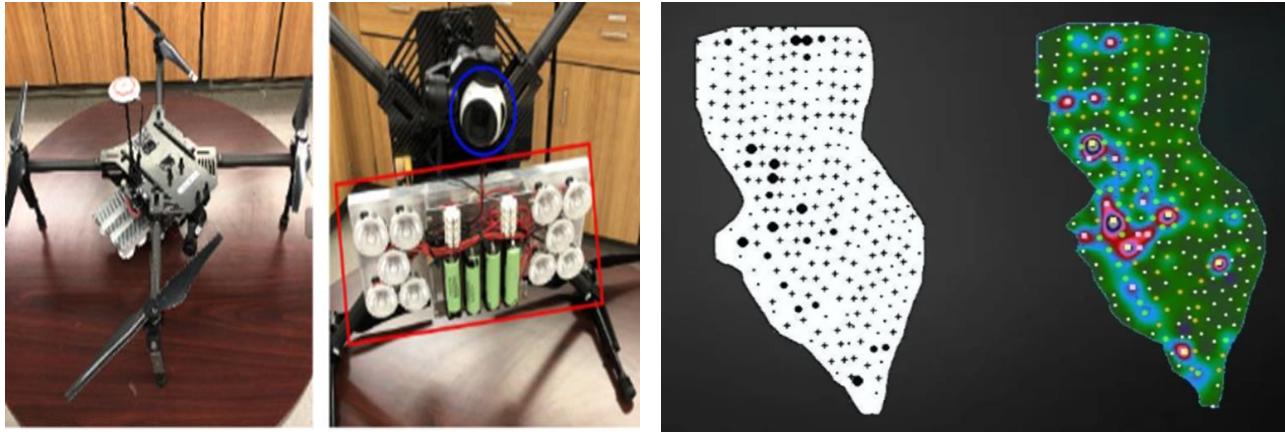


- **Terrain Mapping:**
 - Drones with their inherent capability to survey vast tracts of lands are perfect tools to perform [terrain mapping](#).
 - AI drones that are programmable to perform various tasks including terrain mapping for better management of the agricultural industry.
 - Hexagon Dynamics drones equipped with LiDAR and other sensors are used by farmers to map the terrain across vast swaths of lands as a reconnaissance tool for land preparations.
- **Livestock Monitoring:**
 - The drones in the agriculture industry are also widely used by farmers for effective [livestock management](#). AI-backed programmable drones are perfect tools to automate the monitoring of livestock at the fraction of the cost.
 - These drones can be used to keep track of the livestock, as well as, to identify any injured or missing livestock. It can also be used to identify pastures across vast swaths of lands and can be pre-programmed to continue tracking the livestock across the pasture.
- **Soil and Field Analysis:**
 - Drones are great tools to access insightful data for the quality of the soil at the beginning or end of a crop cycle. [AI drones](#) equipped with LiDAR can be used to create 3D maps of the soil to be able to understand any issues with the quality of the soil including the nutrients or any dead zone.
- **Health assessment:**
 - Lastly, drones are effectively used to monitor crop health. Drones equipped with infrared and thermal sensors are widely used to get real-time imagery for analysis of crop health.
 - Hexagon Dynamics offer customized crop health monitoring software that can be used to instantly assess the chlorophyll content, as well as, estimate soil fertility through crop imagery in the infrared and thermal region of the electromagnetic spectrum.

Future Prospects of Drone Farming

Bug Mapping

- A key aspect to controlling and reducing the effects invasive insect species have on agriculture is to obtain knowledge about the migration patterns of these species.
- However, this approach involves a human researcher manually searching for these insects in large fields and results in very low recapture rates.
- An automated system for detecting released insects using an unmanned aerial vehicle. This system utilizes ultraviolet lighting technology, digital cameras, and lightweight computer vision algorithms to more quickly and accurately detect insects.



Precision Agriculture

- **Precision agriculture (PA)** is a farming management concept based on observing, measuring and responding to inter and intra-field variability in crops. The goal of precision agriculture research is to define a decision support system (DSS) for whole farm management with the goal of optimizing returns on inputs while preserving resources.
- The practice of precision agriculture has been enabled by the advent of GPS and GNSS.



- Precision agriculture also provides farmers with a wealth of information to:
 - Build up a record of their farm
 - Improve decision-making
 - Foster greater traceability
 - Enhance marketing of farm products
 - Improve lease arrangements and relationship with landlords
 - Enhance the inherent quality of farm products (e.g. protein level in bread-flour wheat)

Government to offer 100% subsidy on Agriculture Drone



- The Indian government has announced that it will subsidize the purchase of agricultural drones by up to 100% for certain organizations in the sector, in order to offer training and encourage adoption of the technology.
- It will provide a grant covering 100% of the cost of drones — up to a total cost of ₹1 million (\$13,400) — to agri research and education establishments, including the [Indian Council of Agricultural Research Institutes](#), [Farm Machinery Training & Testing Institutes](#), [Krishi Vigyan Kendra](#) extension centers, and state agricultural universities.

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Farming going hi-tech: Govt to fund drone use in agriculture

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Agri Business

Govt announces subsidy to popularise drone in agriculture

Prabhudutta Mishra | New Delhi, January 2 | Updated On: Jan 22, 2022



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100 per cent grant will be given to Farm Machinery Training and Testing Institutes, ICAR Institutes, Krishi Vigyan Kendras

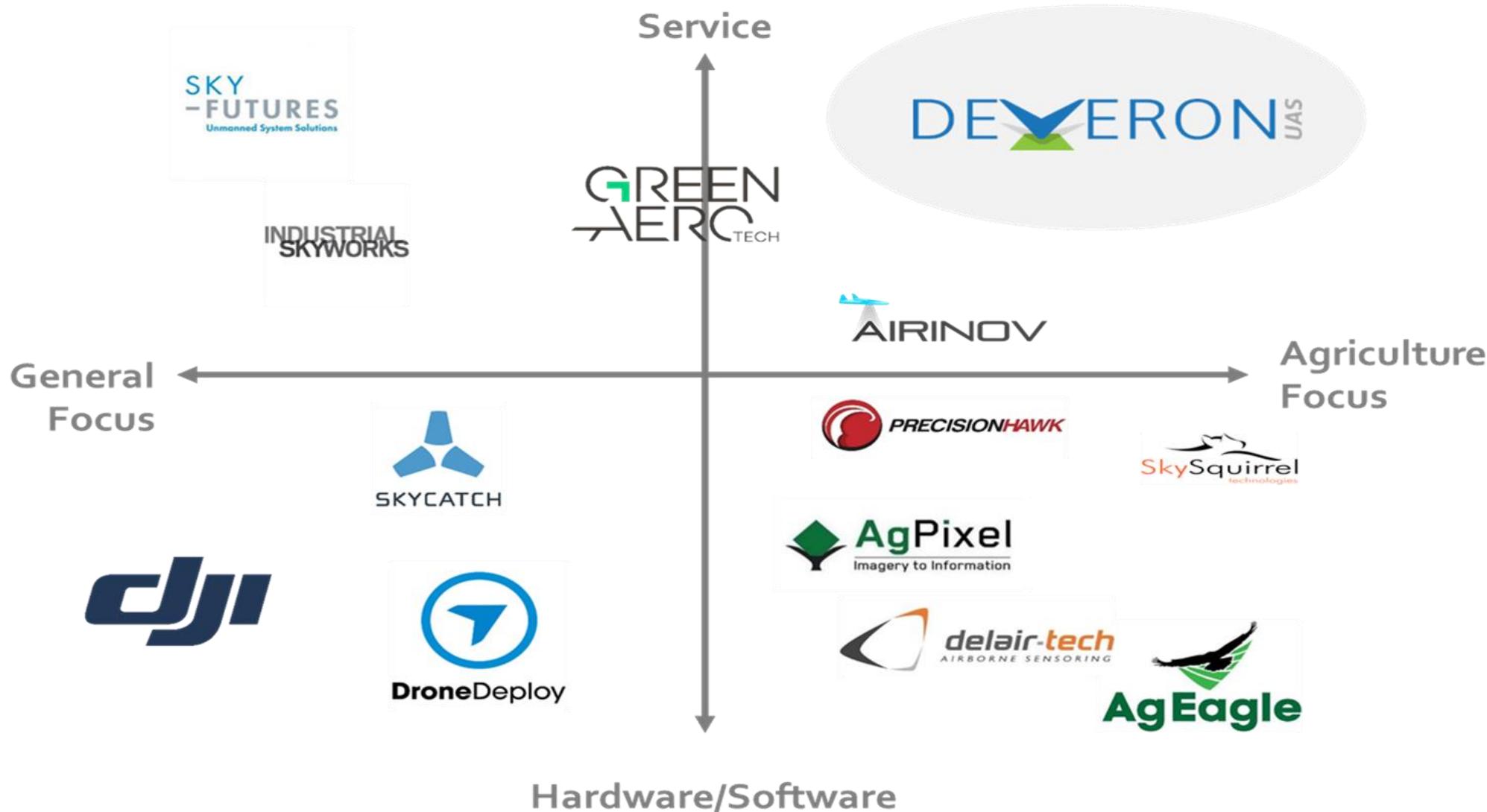
a move aimed at making drones more accessible to the farmers, the Union Agriculture

Government Is Offering 100% Subsidy For Purchase of Drones

Abha Toppo Updated 27 January, 2022 5:17 PM IST



Global Companies in field of Agricultural Drone



DJI



AGRAS T30
Crop Protection



DJI
Mission Planning



Phantom 4 RTK
Field Mapping



P4 Multispectral
Crop Inspection



PRECISIONHAWK



Matrice 200 V2
Field Mapping



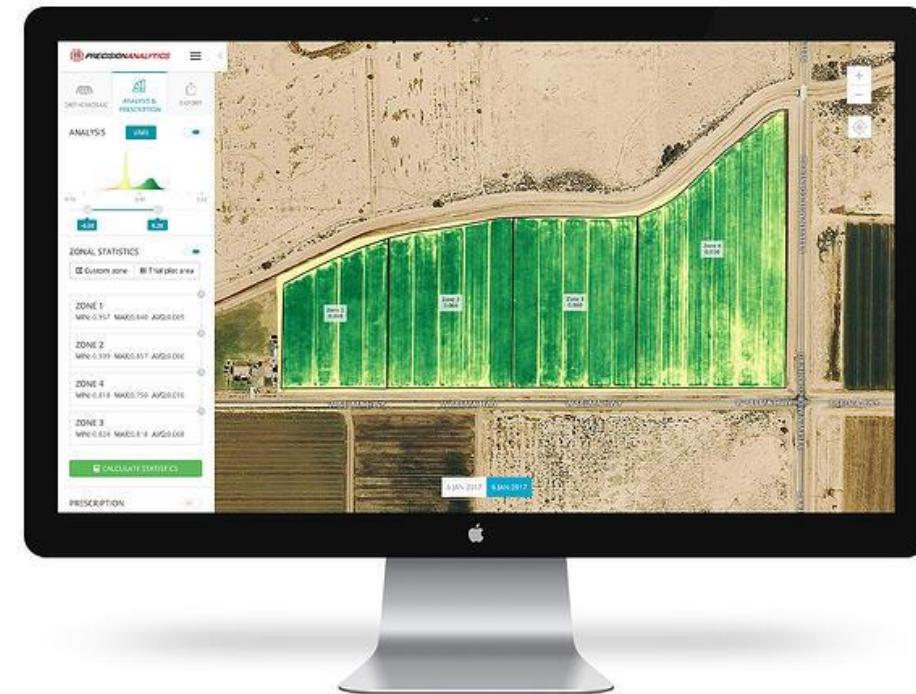
Parrot Sequoia+ multispectral unit features
two sensors, multispectral and sunshine



Mica Sense Altum
multispectral sensor



Mica Sense Red edge MX
flexible multispectral sensor



Precision Analytics Agriculture Software



Indian Companies in field of Agricultural Drone



Daksha Unmanned Systems



DH Micro Quad
Field Mapping



DH – HM
Gasoline powered
Crop Protection



DH Quad
Crop Inspection



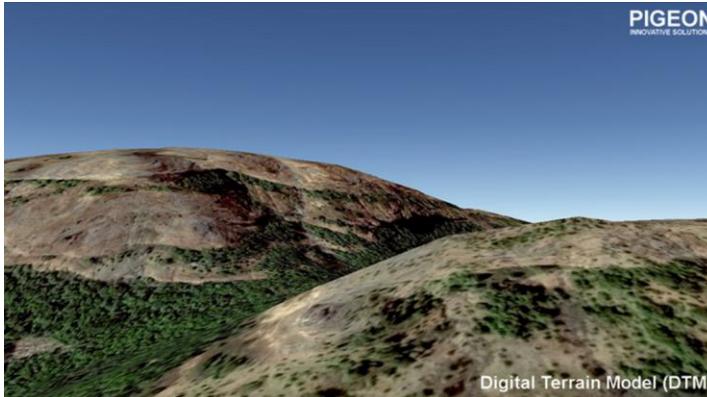
SYENA – Q10
Crop Protection

Sr.No.	Parameter/Feature	Specification
1	Type	Multicopter Quadcopter X
2	Dimensions (Propellers Folded Inwards)	Folded (mm): 625 x 570 x 625 Open (mm): 1025 x 1025 x 710
3	Payload Capacity	10 Litre / 10 Kg (whichever is less)
4	Flight Time	Upto 20 minutes
5	Battery Charging Time	60 minutes
6	Spray Width	3 – 5 metres
7	Flight Mode Options	Manual / Semi-Autonomous / Autonomous
8	Wind Resistance	Level 5 as per Beaufort Scale
9	Flight Speed	Upto 10 m/s (Recommended upto 5 m/s)
10	All Up Weight (with 10 Kg Payload)	25 Kg
11	Frame Material	3 K Carbon Fibre
12	Other Features	<ul style="list-style-type: none"> – GPS and Radar for uniform, efficient & precision spraying – Continuous Operation Data Monitoring

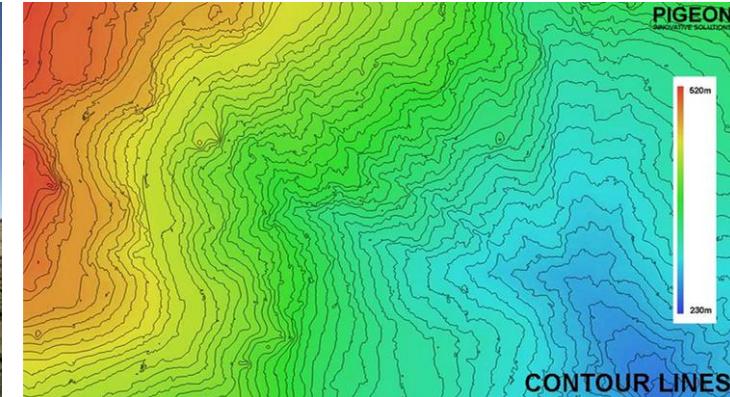
Pigeon Innovative Solutions



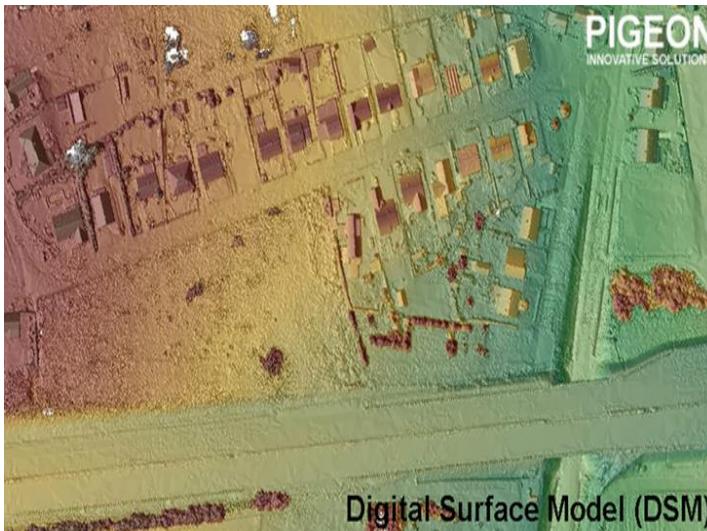
- Company Solutions Include:
 - Contour Maps
 - 3D Volumetric
 - Stockpile Analysis (Shape/ Volume)
 - Distance/Area/Volume Measurements
 - Tree Canopy Identification
 - Corridor Mapping and Indexing
 - Plant Counting
 - Classify management zones based on health
 - Scheduling Seeding/Harvesting
 - Monitoring plant health



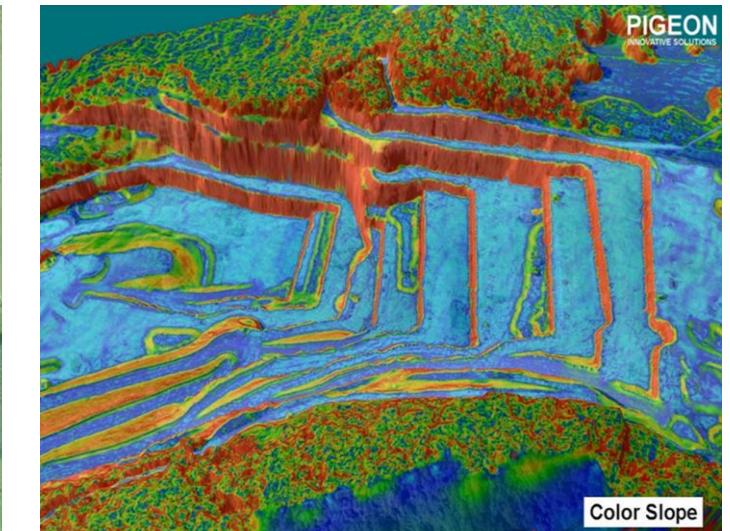
Digital Terrain Model



Contour Lines



Digital Surface Model



Color Slope

End of Presentation