A UAV-Based Multispectral and RGB Dataset for Multi-Stage Paddy Crop Monitoring in Indian Agricultural Fields

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***Abstract*—We present a large-scale unmanned aerial vehicle (UAV)-based RGB and multispectral image dataset collected over paddy fields in the Vijayawada region, Andhra Pradesh, India, covering nursery to harvesting stages. We used a 20-megapixel RGB camera and a 5-megapixel four-band multispectral camera capturing red, green, red-edge, and near-infrared bands. Standardised operating procedure (SOP) and checklists were developed to ensure repeatable data acquisition. Our dataset comprises of 42,430 raw images (415 GB) captured over 5 acres with 1 cm/pixel ground sampling distance (GSD) with associated metadata such as GPS coordinates, flight altitude, and environmental conditions. Captured images were validated using Pix4D Fields to generate orthomosaic maps and vegetation index maps, such as normalised difference vegetation index (NDVI) and normalised difference red-edge (NDRE) index. Our dataset is one of the few datasets that provide high-resolution images with rich metadata that cover all growth stages of Indian paddy crops. The dataset is available on IEEE DataPort with DOI, . It can support studies on targeted spraying, disease analysis, and yield estimation.**

***Index Terms*—UAV, multispectral imaging, RGB, standard operating procedure, paddy crop, orthomosaic, and NDVI.**

I. Introduction

In the recent years, unmanned aerial vehicles (UAV) based imaging is shown to be promising to perform systematic observation, measurement, and assessment of crop conditions and field parameters. They immensely support precision farming and helps in increasing the yield [1]. The development of compact and advanced multispectral cameras that capture data at various discrete wavelengths across the electromagnetic spectrum, has significantly expanded the scope and reliability of aerial crop imaging [2]. The images captured by the UAV, enable detailed assessment of crop health, growth patterns, field variability. Besides, they also help in the early detection of stress factors such as nutrient deficiencies, water scarcity, pest infestations, as well as discriminating between healthy and unhealthy vegetation, and also bare soil [3]–[5]. Vegetation indices, such as the normalized difference vegetation index (NDVI), which is calculated using the reflectance value of red and near-infrared (NIR) bands, are widely used to quantify vegetation vigor and overall canopy condition. The normalized difference red edge (NDRE), derived from the reflectance value of red-edge (RE) and NIR bands, is more sensitive to subtle chlorophyll variations and early-stage vegetation stress. Unlike satellite imagery, UAVs provide greater temporal flexibility, they can capture data based on need to match crop growth cycles and respond to sudden changes. This combination of precision, adaptability, and timely data acquisition makes UAV based crop health monitoring an effective and reliable solution for enhanced crop monitoring practices. Furthermore, UAV imagery provides a higher ground sampling distance (GSD), which is defined as the distance between the centers of two adjacent pixels on the ground, representing the real area covered by each pixel in the image. UAVs can capture images with a GSD of the order of centimeters compared to the satellites images whose GSD is of the order of meters.

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A. RGB and Multispectral Imaging Datasets

UAV-Based Datasets: The existing UAV based datasets for agricultural applications are as follows: In [6], a dataset of approximately 38,377 images was collected over a 10-day interval across 27 hectares in Eastern Kazakhstan for wheat, barley, and soybean crops, covering five key growth stages. In [7], a dataset of 416 images was collected over 0.06 hectares in Sri Lanka for paddy during vegetative, reproductive, and ripening stages. A total of 7,638 images of Theobroma cacao plantations was acquired in the Central-West region of Côte d'Ivoire, covering 30 hectares during the growth stage [8]. A multispectral UAV dataset of spring-sown pea and chickpea with 275 images was collected in [9]. In [10], multispectral images were collected over paddy fields in the Ruzizi Plain, Democratic Republic of the Congo, focusing on active tillering and panicle initiation stages. United States Department of Agriculture - Agricultural Research Service (USDA-ARS) [11], provides a paddy dataset of six spectral bands that cover emergence to boot stages across 224 and 152 plots in 2021 and 2022, respectively. A paddy dataset that cn be used to assess the crop condition through vegetation indices and spectral reflectance of the region Jitra, Kedah, Malaysia is provided in [12]. For maize fields, a multispectral and multitemporal UAV dataset was collected in [13]. It provides dense annotations for multiple weed species across growth stages and supports segmentation and weed-mapping tasks. A paddy dataset for varieties INPARI-32, INPARI-33, and INPARI-43 were collected over a 90-meter-wide field in Indonesia at three growth stages after planting in [14]. In [15]–[17] collected only RGB UAV datasets for olive orchards, palm trees, and soybean crops, respectively. These datasets are summarized in Table I.

Satellite Based Datasets: Several satellite-based agricultural datasets have been reported in the literature. A Sentinel-2 based dataset for winter wheat monitoring was presented in [5], covering 11.43 hectares in Northern Germany. In [18], a dataset combining Sentinel-2 and UAV imagery was collected over 17 hectares of vineyard fields in Italy. RapidEye satellite imagery was used in [19] to monitor maize cultivation across 677 km^2 in Machakos County, Kenya. The EuroSAT dataset [23] consists of approximately 27,000 Sentinel-2 multispectral image patches spanning 13 spectral bands and covering 10 land-use and land-cover classes across Europe.

Most existing publicly available crop-monitoring datasets remain limited in their ability to support comprehensive and reproducible analysis, particularly for paddy cultivation under Indian agro-climatic conditions. Specifically, these datasets often lack complete crop growth cycle coverage, paddy-specific standardized operating procedure documentation, access to raw RGB and multispectral imagery, and associated environmental metadata. Such limitations constrain longitudinal analysis, reproducibility, and region-specific modeling, thereby motivating the development of a comprehensive and well-documented UAV dataset focused on paddy crop monitoring.

B. Our Contributions

- We provide an SOP and flight checklists for the data acquisition methodology to ensure reproducibility and can be adapted to other UAV platforms.
- We present RGB and four-band (red, green, RE, NIR) multispectral image dataset of 5-acre paddy field for Indian agro-climatic conditions following the developed SOP and checklists. our dataset covers the complete growth cycle of the paddy crop and addresses the significant gap in the publicly available agricultural UAV datasets. During capture, we ensured that 30–32 GNSS satellites were connected for reliable positional accuracy.
- We provide 42,430 raw images (414 GB), covering all growth stages of the paddy crop. Our RGB images have a resolution of 20 -MP (5280 × 3956 pixels) and multispectral images have a resolution of 5 -MP (2592 × 1944 pixels) with 1 cm/pixel GSD.
- Along with the dataset we also provide operational and environmental metadata, including captured location based on Global Navigation Satellite System (GNSS) coordinates, acquisition date and time, illumination conditions, solar elevation and azimuth angles, weather parameters such as temperature, humidity, and wind speed, camera intrinsic and extrinsic parameters, flight altitude, image overlap, GSD, and sensor calibration details.
- We validated the captured data through preprocessing steps such as geometric alignment, band and radiometric calibrations. We also georeferenced orthomosaic maps and vegetation indices (NDVI and NDRE).
- Our dataset enables a wide range of precision agriculture applications including targeted spraying, early pest and crop stress detection, disease analysis, crop classification, growth-stage monitoring, biomass and yield estimation, and temporal change analysis across growth stages.
  Our dataset is publicly released via IEEE DataPort with a persistent DOI,

C. Uniqueness of Our Dataset

- Our dataset includes both RGB and multispectral images unlike datasets in [15]–[17], which provide only RGB images, and datasets in [6], [7], [9], [11], [14], which provides only multispectral images.
- Our dataset covers all six stages: nursery, vegetative, booting, flowering, mature, and harvest. This is different from the other datasets that cover fewer stages as shown in the Table I.
- Our dataset offers higher spatial resolution, i.e., 1 cm/pixel GSD, compared to the existing datasets as shown in Table IV, and allows accurate crop monitoring. It also provides rich operational and environmental metadata.
- Our dataset provides SOP based paddy data for Indian agro-climatic conditions, addressing the gap of very limited datasets for India paddy crops. Existing datasets for Indian crops either lack UAV images [20] or multi-spectral data [22]. Our dataset provides high-resolution UAV based RGB and multispectral images with rich metadata across all six paddy growth stages, making it one of the unique datasets for Indian paddy crops.

D. Outline

Section II describes the SOP and checklists developed for UAV-based RGB and multispectral data acquisition. Section III presents a detailed data description, including the acquisition site, data volume, nomenclature, and data organization. Section IV discusses the data quality and validation procedures using Pix4D software and highlights the potential use cases and applications of the proposed dataset. Section V concludes the paper.

II. SOP AND CHECKLISTS

We developed SOP and checklists to ensure reprehensibility and can be adapted to other UAV platforms and sensing systems. Using the developed SOP and checklists, we created a multispectral and RGB based UAV imaging dataset using a four 5 megapixel multispectral camera including Red, Green, RE, and NIR bands and an 20 megapixel RGB camera with image resolution of 2592 × 1944 pixels for multispectral images and 5280 × 3956 pixels for RGB images of different fields covering around 5 acres, where field 1 covers 3 acres and field 2 covers 2 acres. The dataset includes paddy crop varieties MTU 13/18 and MTU 10/61 cultivated during the Kharif Season and spans six different stages of the crop.

The nursery stage (1–30 days after plantation (DAP)) involves the planting of the seedlings with initial root and leaf growth. In the vegetative stage (30–75 DAP), rapid leaf development and canopy formation occur, and side shoots emerge, boosting the crop's yield potential. The booting stage

TABLE I
COMPARISON OF EXISTING DATASETS WITH OUR DATASET

Source	Location	Crop	Area (acres)	Stages of Crop
[5]	Northern Germany	Winter wheat	28.24	—
[6]	East Kazakhstan	Wheat, soybean, barley	66.72	Emergence, tillering, heading, milky ripe and waxy ripe.
[7]	Sri Lanka	BG300 (Paddy)	0.148	Vegetative, reproductive and ripening.
[8]	Côte d'Ivoire	Cocoa trees	74.12	Growing stage
[10]	Ruzizi Plain, DRC	Paddy	—	Active tillering and panicle initiation.
[11]	US	Paddy	—	Emergence to boot stage
[12]	Jitra, Kedah, Malaysia	Paddy	—	—
[14]	Indonesia	Paddy (INPARI-32, 33, 43)	90 m width	Vegetative and booting.
[18]	Italy	Vineyards	42.01	—
[19]	Machakos, Kenya	Maize	167319	Stem elongation and flowering.
[20]	Tamil Nadu, India	Multi-crop	898	Sowing, transplanting, tillering, and harvesting.
[21]	India	Paddy	—	Weed, seedling, tillering, booting, flowering, and ripening.
[22]	New Delhi India	Basmati paddy (seed-varieties)	—	Seed-level variety imaging (no field growth stages).
Our dataset	India	Paddy (MTU 13/18, 10/61)	5	Nursery, vegetative, booting, flowering, mature, and harvesting.

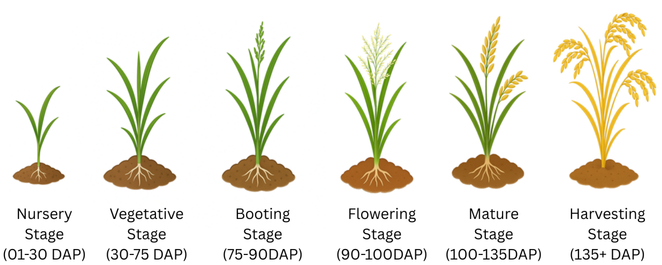

Fig. 1. Different stages of Paddy Crop

(75–90 DAP) marks the formation of panicle inside the top leaf sheath. The flowering stage (90–100 DAP) is when panicles emerge and pollination takes place, which is crucial for grain development. In the mature stage (100–135 DAP), grain filling reaches completion and the plant begins to lose green color. Finally, in the harvest stage (post-135 DAP), the crop reaches full maturity and harvesting can begin. Figure 1 describes different stages of the paddy crop.

A step-by-step SOP was developed to ensure consistent, accurate, and reliable data collection. It outlines essential aspects such as airspace classification, climatic checks, mission planning, and optimal capture time in a day. This SOP also standardizes UAV configurations, flight checklists, and data management, providing a structured framework for reliable and high-quality outcomes. The overall checklist was separated into three parts: pre-flight, in-flight, and post-flight checklists. For ease of understanding we created data description, field weekly status reports and images. This formulated SOP is followed every time for the data capture to generate an accurate dataset and avoid inconsistencies. Our SOP has eight steps, which we explain in detail below.

1) Step 1: Check the Airspace Zones: Firstly, before every flight, check the official airspace map provided by your country's aviation authority to identify the zone to which the area belongs and the corresponding flight regulations. This ensures operational safety and compliance with aviation regulations. For UAV operations, majorly classified into three zones: i) Red zone, which is no fly region, ii) Yellow zone, where controlled flights are allowed with prior permission, and iii) Green zone, where no permission is required to fly but within the permitted altitude limit.

2) Step 2: Check Weather Data: UAV data should be captured only under favorable weather conditions, avoiding rain, dense cloud cover that reduces image clarity, and intense sunlight that can cause overexposure. Wind speed should be below 5 m/s to ensure flight stability, and the UAV's operational limits must be verified under the prevailing conditions. Global tools such as Windy can be used for wind forecasts, AccuWeather or Meteoblue for weather information, and SunCalc for assessing sun position and illumination angles.

3) Step 3: Select Optimal Flight Timing: Plan UAV flights during balanced daylight, when the sun is at a moderate angle. Always adjust flight timing based on local daylight patterns and seasonal variations to capture consistent, high-quality imagery. Avoid flying at midday, intense sunlight can cause glare, harsh shadows, and sensor overexposure. Choose times with stable temperatures and calm winds to prevent battery overheating and ensure flight stability.

4) Step 4: Perform Pre-Flight Checks: Before each UAV mission for data collection, pre-flight preparation is essential to ensure both flight safety and the quality of captured data. Below are the basic considerations,

- Check battery status: Drone battery should be above 95% with spares for the mission, and the controller battery should be above 40% to ensure consistent communication between the drone and the controller.
- Conduct physical inspection: All components, including propellers, motors, and gimbal, must be inspected before the flight, and any damage should be fixed prior to the mission.
- Ensure clean takeoff and landing area: Use a flat, clear landing pad for takeoff and landing to avoid dust, dirt, or debris interfering with the sensors or propellers.

- Use a high-speed SD card: Insert a high-capacity, high-speed SD card with sufficient free space, as multispectral imaging generates large data volumes.
- Calibrate with reflectance panels: Place the panels under uniform lighting and capture reference images before and after the flight to ensure accurate radiometric calibration.

5) Step 5: Plan the Mission: Plan the mission carefully to ensure accurate data capture and safe UAV operation. Follow these key steps:

- Inspect field for obstacles: Identify trees, power lines, and buildings, and plan the flight path to avoid them.
- Set altitude and flight speed: Adjust altitude and speed according to drone capability and mission requirements. Avoid flying too fast to prevent motion blur and too slow to maintain efficiency.
- Adjust GSD: Configure flight altitude to achieve the required image resolution. For crop stress detection, a general GSD of 1–3 cm per pixel is recommended.
- Confirm stable GPS lock: Ensure strong GPS connectivity before takeoff for accurate geotagging and navigation.
- Set image overlap: Use 80% forward overlap and 70% side overlap to provide redundancy for precise orthomosaic stitching.
- Configure camera angle: Position the camera at 90° (nadir) with de-warping turned off to minimize geometric distortions.

6) Step 6: Flight Monitoring and Control: The operator must continuously monitor battery levels, GPS signal, wind conditions, camera triggering, obstacl-avoidance, and communication stability throughout the flight. Maintain a clear visual line of sight with the UAV at all times, in compliance with aviation safety regulations. Immediately respond to any warnings, errors, deviations to ensure safe operation.

7) Step-7 : Conduct Post-Flight Inspection: In the post-flight stage firstly, Inspect the drone for any damage or issues immediately after landing and should record the battery levels of both drone and controller which will help as reference for next flights. Save all mission log files for future planning, troubleshooting, and documenting flight activities. Transfer all captured data to secure storage to prevent loss and ensure it is ready for processing.

8) Step 8: Process and Analyze Data: Process the raw aerial imagery to generate detailed orthomosaics. Calculate vegetation indices such as NDVI and NDRE to assess crop health. Use the processed data for advanced analysis to identify crop stress and make informed management decisions.

A. Our Procedure

Our UAV field data collection procedure follows

1) Step 1: Check Airspace Zones: Before each flight, the Digital Sky Airspace Map provided by the Directorate General of Civil Aviation (DGCA), the civil aviation authority of India, was consulted to identify the airspace classification of the survey fields. All sites were verified to comply with DGCA regulations and were located within the green zone as shown in Figure 2.

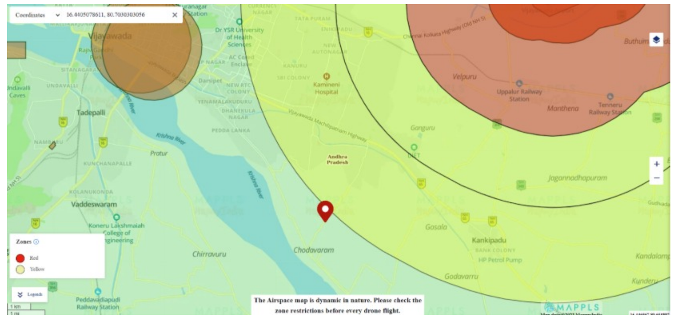

Fig. 2. Airspace Map of our field Chodavaram, Vijayawada, Andhra Pradesh in green zone

(a) Anemometer (b) Digital LUX meter

Fig. 3. Measurement Instruments

2) Step 2: Check Weather Conditions: Climatic observations were recorded during each flight mission to ensure accurate environmental context for the captured imagery. Parameters such as temperature, relative humidity, cloud cover, sun elevation and azimuth angles were obtained using the Drone Buddy app, refer Table II. Wind speed was measured using a handheld anemometer shown in Figure 3a oriented in the direction of the wind, while light intensity was recorded by placing a Lux meter shown in Figure 3b on a flat surface in the field. These measurements helped account for weather and lighting variations, enhancing the accuracy of orthomosaic generation and vegetation index analyses like NDVI and NDRE.

3) Step 3: Optimal Flight Timing: Flights were scheduled based on local daylight availability and ambient temperature conditions. Data acquisition was conducted during early morning or late afternoon hours in Vijayawada, Andhra Pradesh, India, as documented by the *Captured Time* column in Tables V and VI. This scheduling ensured stable flight conditions and consistent image quality across both fields.

4) Step 4: Operational Workflow and Flight Execution: To ensure safe operations and high-quality data acquisition, we followed a structured workflow covering all flight stages pre-flight, mission planning, in-flight monitoring, and post-

TABLE II
FLIGHT MISSIONS WEATHER DATA

Date	Crop Stage	Max (°C)	Min (°C)	Wind (m/s)	Humidity (%)	Cloud Cover	Sun Elev. (°)	Sun Azim. (°)	Light (LUX)	
									F1	F2
15/07/2025	Nursery	36	27	6.9	41	Clear sky	16.3	288.1	–	–
19/07/2025	Nursery	35	25	2.0	74	Sunny	75.3	110.2	–	–
16/08/2025	Vegetative	35	25	4.1	74	Partly cloudy	49.1	257.2	149	152
06/09/2025	Vegetative	34	26	1.8	66	Sunny	19.6	90.3	345	345
27/09/2025	Booting	32	24	3.3	88	Partly cloudy	43.3	227.1	376	405
04/10/2025	Booting	36	28	2.8	83	Clear sky	29.5	250.3	430	258
11/10/2025	Flowering	29	26	3.0	85	Partly cloudy	51.7	148.9	380	440
21/10/2025	Flowering	32	26	3.5	80	Clear sky	25.2	245.9	470	400
08/11/2025	Mature	33	22	2.6	75	Partly cloudy	8.8	253.5	360	420
15/11/2025	Mature	30	19	2.6	75	Clear sky	14.9	240.2	458	380

TABLE III
CROP CALENDAR AND AGRICULTURAL ACTIVITIES FOR THE STUDY FIELD (5 ACRES)

Stage	Date	Activities
Nursery stage	June 25	Seed sowed
	July 12	Seedlings transplanted
	July 16	Herbicide sprayed
Vegetative stage	Aug 02	Urea and DAP applied
	Aug 20	Weeds removed manually
	Sept 05	NPK fertilizer applied
Booting stage	Sept 15	Manual weeding done
	Sept 28	Fungicide sprayed
Flowering stage	Oct 10	Pest monitored
Mature stage	Oct 25	Crop matured
Harvesting stage	Nov 29	Crop harvested

TABLE IV
COMPARISON OF FLIGHT OPERATION PARAMETERS IN UAV-BASED STUDIES

Reference	Horiz. Speed (m/s)	Alt. (m)	Front Overlap (%)	Side Overlap (%)	GSD (cm/px)	Camera Mode
[6]	5	57	60	75	3	Still image
[7]	1.5	30	80	70	–	3 s interval
[8]	7	80	80	70	4.2–4.6	–
[10]	1	15	–	–	1.25	–
[11]	–	120	75	75	–	–
[14]	6	75	80	80	8.2	Fast mode
[18]	2	120	80	80	8	–
Our parameters	3.5	22	80	70	1	Distance interval

flight inspection. At each stage, we used the checklists provided below, which were developed based on standard procedures and field-tested parameters. During pre-flight and mission planning, we verified all components using this checklist and configured key flight parameters such as GSD-1 cm, image overlap 80% forward, 70% side, and camera angle 90° based on experimental requirements. During flight, the in-flight checklist helped us monitor drone performance, GPS signal, battery levels, and safety parameters in real time. After each mission, we performed a complete post-flight inspection using the post-flight checklist to assess drone condition, save mission logs, and secure captured data. This systematic approach ensured both the safety of the drone and the accuracy and reliability of the collected data. We monitored and tabulated the activities taken place in fields such that no event is missed during the data collection provided in Table III. We also reviewed several research papers and prepared a comparison table, as summarized in Table IV.

5) Step 5: Data Processing and Analysis: Raw images shown in Figure 4 were stitched together into orthomosaics. Vegetation indices such as NDVI and NDRE were calculated to assess crop health as shown in Figure 6. The processed data was analyzed to identify crop stress and guide management decisions.

B. Standard Checklist

We prepared a standardized drone flight checklist and followed it for every flight during data capture, conducted in a standardized manner to ensure safety, consistency, and high-quality outcomes.

1) Pre-Flight Checklist: Prior to each drone mission, a comprehensive pre-flight checklist was followed to ensure operational safety, optimal flight conditions, and high-quality data capture. This included verification of drone and controller battery levels, environmental conditions, flight parameters, and structural integrity, as summarized in Table VII.

2) During-Flight Checklist: During flight, continuous monitoring of satellite connectivity, battery status, wind conditions, and camera operation was maintained to ensure accurate and uninterrupted data acquisition. Table VIII summarizes the key parameters observed throughout each flight.

3) Post-Flight Checklist: After landing, a post-flight checklist was performed to confirm the drone's condition, verify data integrity, and ensure proper storage of equipment and images. Table IX presents the parameters and checks completed after each flight mission.

III. DATA DESCRIPTION

In this study, the UAV data were captured at the Chodavaram, Vijayawada, Krishna District, Andhra Pradesh in India at coordinates [16° 26' 25.8295" N, 80° 42' 10.9091" E]. The survey covered 5 acres with a total of 414 GB of imagery, consisting of 8,486 RGB images and 33,944 multispectral images, making 42,430 images in total. Each dataset included associated metadata such as GPS coordinates, altitude, and time of acquisition.

TABLE V
CAPTURED DETAILS OF FIELD 1

Date	Captured Time	Folder Name	No.of RGB Images	No.of Multi-spectral Images	Total No. of Images	Storage (GB)
15 Jul 2025	17:16	F1_01_2025_07_15_1716_Nursery_Stage	58	232	290	2.61
19 Jul 2196	10:51	F1_02_2025_07_19_1051_Nursery_Stage	549	2196	2745	24.9
16 Aug 2025	16:09	F1_03_2025_08_16_1609_Vegetative_Stage	549	2196	2745	27.1
06 Sept 2025	07:07	F1_04_2025_09_06_0707_Vegetative_Stage	549	2196	2745	27.5
27 Sept 2025	14:50	F1_05_2025_09_27_1450_Booting_Stage	549	2196	2745	27.1
04 Oct 2025	15:50	F1_06_2025_10_04_1550_Booting_Stage	549	2196	2745	27.4
11 Oct 2025	10:48	F1_07_2025_10_11_1048_Flowering_Stage	549	2196	2745	27
21 Oct 2025	16:00	F1_08_2025_10_21_1600_Flowering_Stage	549	2196	2745	27.2
08 Nov 2025	17:00	F1_09_2025_11_08_1700_Mature_Stage	550	2200	2750	26.6
15 Nov 2025	16:58	F1_10_2025_11_15_1658_Mature_Stage	549	2196	2745	26.5
Total			5000	20000	25000	244

TABLE VI
CAPTURED DETAILS OF FIELD 2

Date	Captured Time	Folder Name	No. of RGB Images	No. of Multispectral Images	Total No. of Images	Storage (GB)
15 July 2025	17:16	F2_01_2025_07_15_1716_Nursery_Stage	30	120	150	1.32
19 July 2025	09:37	F2_02_2025_07_19_0937_Nursery_Stage	384	1536	1920	16.8
16 Aug 2025	16:39	F2_03_2025_08_16_1639_Vegetative_Stage	384	1536	1920	18.8
06 Sept 2025	06:44	F2_04_2025_09_06_0644_Vegetative_Stage	384	1536	1920	19.1
27 Sept 2025	14:26	F2_05_2025_09_27_1426_Booting_Stage	384	1536	1920	19
04 Oct 2025	16:23	F2_06_2025_10_04_1623_Booting_Stage	384	1536	1920	19.3
11 Oct 2025	10:25	F2_07_2025_10_11_1025_Flowering_Stage	384	1536	1920	19
21 Oct 2025	16:46	F2_08_2025_10_21_1646_Flowering_Stage	384	1536	1920	19
08 Nov 2025	16:38	F2_09_2025_11_08_1638_Mature_Stage	384	1536	1920	18.8
15 Nov 2025	16:37	F2_10_2025_11_15_1637_Mature_Stage	384	1536	1920	18.8
Total			3486	13944	17430	170

A. Nomenclature

1) Folder Structure: The dataset follows a systematic file naming convention for clarity and easy retrieval. We created structured folders to organize the captured images. A primary folder named DATASET contain subfolders for each surveyed field.

Primary subfolder structure: FieldXXX_Acre

- XXX is the field number,
- Acre is the field area in acres.

Example: Field001_3Acres.

Within each field folder, data is further subdivided into date-time folders structured as:
FX_XX_YYYY_MM_DD_HHMM_Stage

- FX corresponds to the field number where F1 for Field001 and F2 for Field002,
- XX represents the serial number of that particular field,
- YYYY_MM_DD represents the captured year, month, and date,
- HHMM indicates the hour and minute,
- Stage describes the crop growth stage during data collection.

Examples:

- F1_01_2025_07_15_1716_Nursery_Stage - data is first survey of Field001 captured on July 15, 2025 at 17:16 during the Nursery Stage.
- F2_03_2025_08_16_1639_Vegetative_Stage - data is third survey of Field002 captured on August 9, 2025 at 17:02 during the Vegetative Stage.

2) Image Structure: RGB Images Format: YYYYMMDDHHMMSS_ImageNumber_D.JPG

- YYYYMMDDHHMMSS: Year, month, date, hour, minute, and second of capture,
- ImageNumber: Sequential image number,
- D: Indicates downward-facing RGB image.

Example: 20250809173606_0001_D.JPG

This file corresponds to the first RGB image captured on August 9, 2025, at 17:36:06.

Multispectral Images Format:
YYYYMMDDHHMMSS_ImageNumber_Band.TIF

- YYYYMMDDHHMMSS: Year, month, day, hour, minute, and second of capture,
- ImageNumber: Sequential image number,
- Band: Spectral band designation:
  - Green — MS_G
  - Red — MS_R

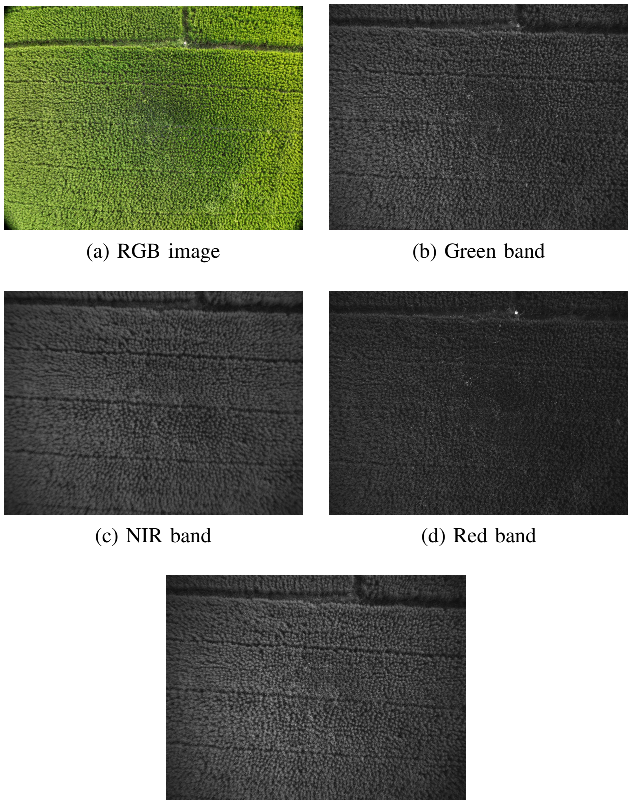

Fig. 4. RGB and multispectral images: (a) RGB, (b) Green, (c) NIR, (d) Red, (e) RE.

  - Red Edge — MS_RE
  - Near Infrared — MS_NIR

Example: 20250809173606_0001_MS_NIR.TIF

This is the first NIR band image captured on August 9, 2025, at 17:36:06.

B. Data Organization

We created structured folders to manage the captured images. A primary folder named Dataset contains subfolders for each surveyed field. Each field folder is named using the format FieldXXX_Size.

Each field folder is further organized into four subfolders based on the capture dates and time:
FX_XX_YYYY_MM_DD_HHMM_Stage as shown in Figure 5.

Within each dated subfolder, there are three components: system files, RGB images (.JPG format), and multispectral images (.TIF format) comprising Green, Red, NIR, and RE bands. This hierarchical structure ensures clear separation of datasets by field and date, while also simplifying retrieval and analysis. The details of captured images and storage for each field are summarized in Table V and Table VI. The current release corresponds to dataset version v1.0, with future updates planned based on additional field campaigns.

TABLE VII
DRONE FLIGHT PRE-FLIGHT CHECKLIST

Parameter	Value/Threshold	Status	Remarks
Zone	Red / Green / Yellow		
Obstacles	Trees, Buildings, Other (Y/N)		
Drone Battery	$\geq$ 95%		
Remote Controller Battery	$\geq$ 40%		
Wind Speed	5–7 m/s (11–15 mph)		
Satellites Connected	$\geq$ 16 (up to 32)		
Altitude	30 m		
Flight Speed	1.5 m/s (3.35 mph)		
Shutter Speed	—		
De-warping	OFF		
Launch Pad Available	Yes / No		
Reflectance Panel Used	Yes / No		
Forward Overlap	80%		
Side Overlap	70%		
Camera Mode	—		
Camera Orientation	90° (Nadir)		
GSD (Ground Sampling Distance)	—		
Propeller Inspection	No damage, secure		
Motor Free Spin Test	Spins freely		
Structural Integrity Check	No cracks/damage		
Temperature (Min/Max)	—		
Humidity	—		
Sun Elevation Angle	—		
Sun Azimuth Angle	—		
Sowing Rate (kg/acre)	—		

TABLE VIII
DRONE DURING-FLIGHT CHECKLIST

Parameter	Expected Condition	Status	Remarks
Satellite signal	Stable, no drops or losses		
Battery level monitoring	Sufficient until landing		
Flight Path Followed	As planned		
Wind conditions	Acceptable $<$ 7 m/s		
Camera trigger	Working, consistent captures		
Live feed	Stable and visible		
Communication with drone	No interruptions		
Avoiding obstacles	Manual override when required		

IV. DATA QUALITY AND VALIDATION

Data quality and validation were ensured through systematic checks during image acquisition and processing. Radiometric consistency was maintained by capturing imagery under comparable illumination conditions and applying sensor-based calibration within the photogrammetry workflow. Adequate forward and side image overlap was verified to ensure reliable feature matching and stable orthomosaic reconstruction. Embedded GPS metadata were examined to maintain positional consistency across images, and the generated orthomosaics were evaluated for spatial continuity and

TABLE IX
DRONE POST-FLIGHT CHECKLIST

Parameter	Description	Status	Remarks
Drone battery level	Record %		
Remote battery level	Record %		
Propeller re-check	No damage		
Motor function	No unusual sound		
Structural check	Frame intact		
Data downloaded	Yes / No		
Image quality check	Blurriness / Sharp		
Control response check	Pitch/Roll/Yaw functional		
Log saved	Flight data saved		
Reflectance panel collected	Yes / No		

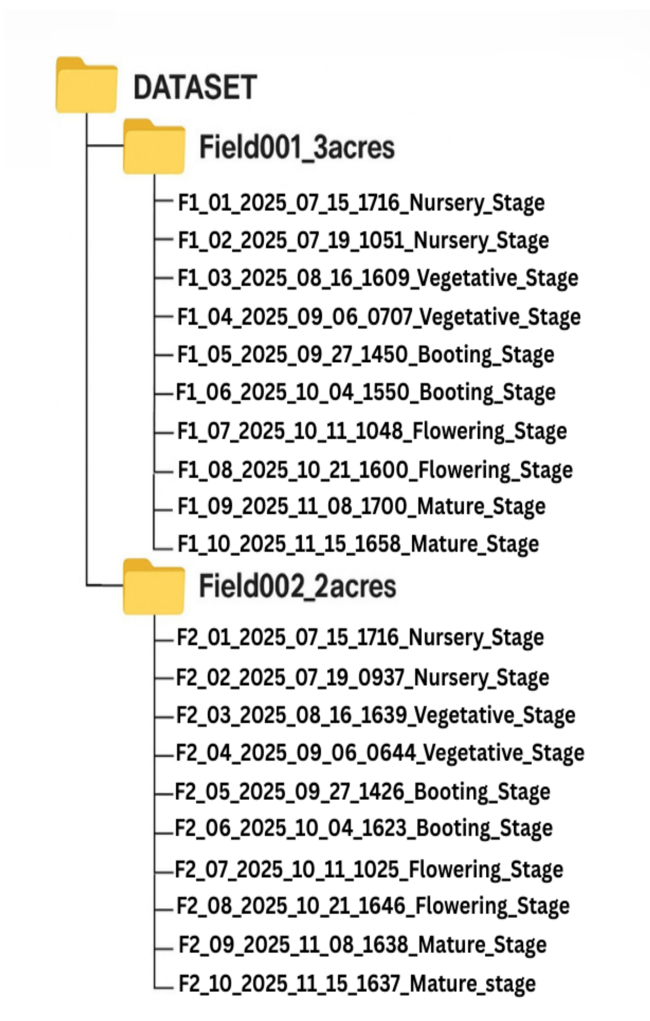

Fig. 5. Folder Structure

alignment accuracy, with visual inspection used to identify and minimize residual stitching or alignment errors. Temporal consistency was preserved by organizing the dataset according to predefined paddy growth stages and maintaining uniform acquisition protocols across all flight campaigns.

1) Pix4D Software: Pix4D Fields version 2.19, operated under a valid license, was used to process the aerial imagery collected during the experiment. The software was employed to generate high-resolution orthomosaic maps and vegetation index layers, including NDVI and NDRE, as illustrated in Figure 6. The processing workflow involved georeferencing individual images, stitching them into seamless orthomosaics, and computing vegetation indices to assess crop health and spatial variations in plant vigor and stress. From the dataset, one folder from Field 1 (3 acres) named F1_03_2025_08_16_1609 containing 2,196 multispectral images, and another folder from Field 2 (2 acres) named F2_03_2025_08_16_1639 containing 1,920 multispectral images were processed using Pix4D Fields. Two separate orthomosaics were generated, and the NDVI layers were applied to classify crop health. The resulting outputs, including orthomosaic, NDVI, and NDRE maps for both Field 1 and Field 2, are shown in the Figure 6.

A. Use Cases of the Dataset

- Our work facilitates the SOP and checklists for drone-based agricultural monitoring.
- Supports UAV mission planning and optimization, including flight parameters, image overlap, acquisition timing, and high-resolution imagery at 1 cm/pixel GSD for precise vegetation index assessment.
- Offers insights for agricultural policy and extension services, supporting data-driven decision-making and sustainable crop management.
- Our dataset can transfer learning, allowing models trained on other crops or regions to be adapted to tropical Indian paddy fields.
- Provides a large-scale, publicly available UAV dataset covering RGB and multispectral imagery across all paddy growth stages, enabling comprehensive research and analysis.
- Precision crop monitoring and management: High-resolution RGB and multispectral imagery, combined with NDVI and NDRE layers, can support targeted spraying, early pest and stress detection, weed and disease analysis, and accurate crop classification.
- Temporal analysis and modeling: Complete coverage from nursery to harvest supports growth-stage monitoring, biomass estimation, yield prediction, and temporal change assessment, facilitating advanced crop modeling and predictive analytics.

V. CONCLUSION

Precision agriculture faces challenges in effectively monitoring crops throughout their full growth cycle, as variability in growth stages and environmental conditions can affect yield. To address this, we developed a large-scale UAV-based RGB and multispectral dataset over 5 acres with high-resolution imagery at 1 cm/pixel GSD, covering the complete

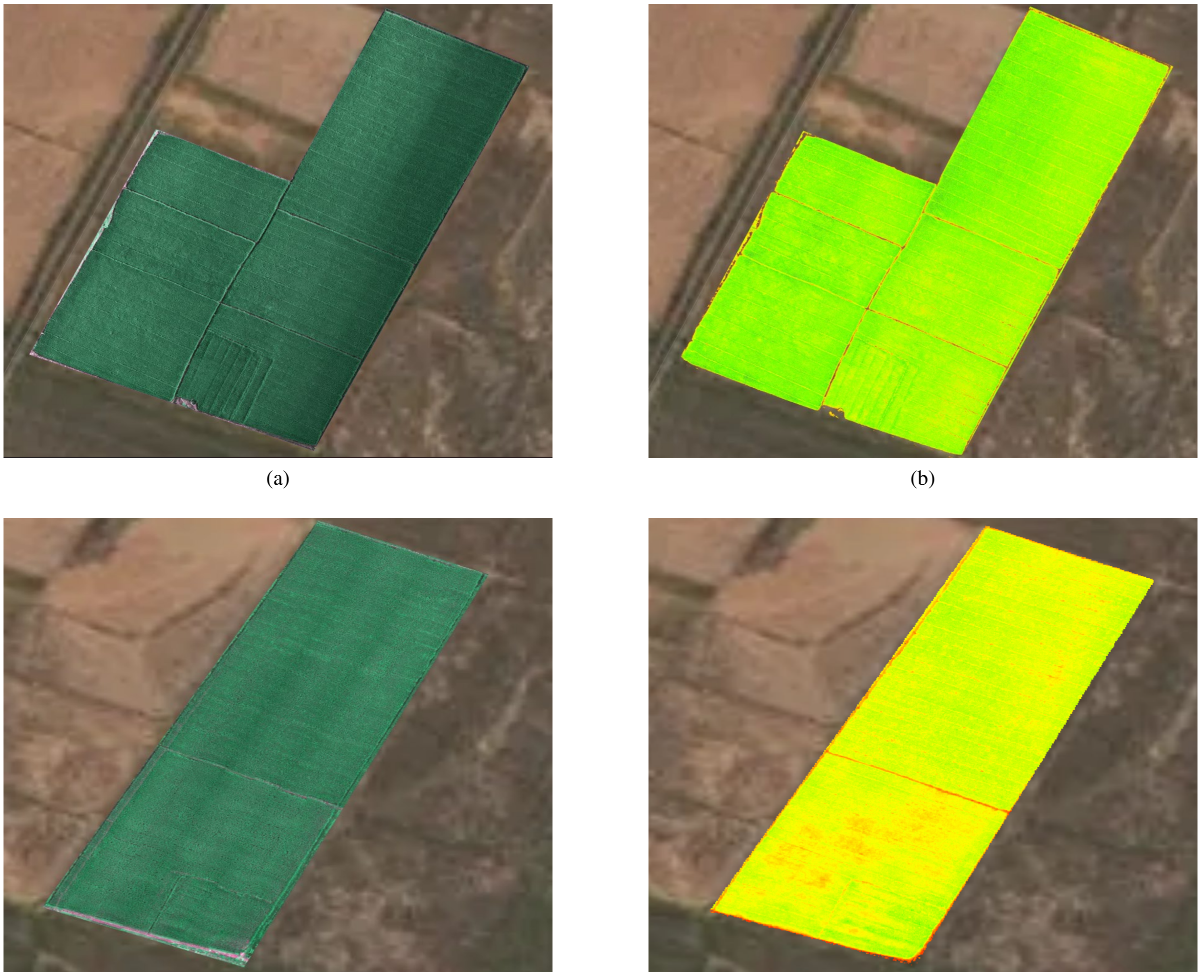

Fig. 6. Visualization of orthomosaic and NDVI outputs: (a) Field001 – 3 Acres Orthomosaic, (b) Field001 – 3 Acres NDVI, (c) Field002 – 2 Acres Orthomosaic, (d) Field002 – 2 Acres NDRE.

paddy growth cycle from nursery to harvest stages. This dataset can support accurate monitoring, stress detection, and growth-stage analysis. By following a standardized operating procedure for UAV flights and image processing, we ensured consistent, high-quality data acquisition and reliable metadata collection. This work fills a critical gap in publicly available datasets for paddy crops and supports precision agriculture applications such as yield optimization, crop classification, vegetation index analysis, and machine learning–based predictive modeling. The dataset serves as a valuable resource for researchers and practitioners aiming to enhance crop monitoring practices and improve decision-making in paddy cultivation.

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