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Remote Sensing-Based Pre-Harvest Acreage Assessment of Summer Paddy and Maize in Darrang and Nagaon Districts, Assam: A Pilot Study

Dr. Kalyanjit Sarmah[1], Ranjit Sarma[2], and PLN Raju[3]

[1]Project Scientist, Assam State Space Application Centre (ASSAC), Guwahati, Assam, India
[2]Senior Scientific Officer, Assam State Space Application Centre (ASSAC), Guwahati, Assam, India
[3]Director, Assam State Space Application Centre (ASSAC), Guwahati, Assam, India

Correspondence should be addressed to Dr. Kalyanjit Sarmah; kalyanjitsarmah2@gmail.com

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ABSTRACT- The spatial distribution of crops is influenced by Climatic conditions, Soil characteristics, Topography, Traditional practices, and Market availability. However, globalization, technological advancements, and improved infrastructure have facilitated the introduction of non-traditional crops in various regions. This study aims to estimate the pre-harvest acreage of Boro rice and Summer maize in Darrang and Nagaon districts using Remote sensing techniques. The study highlights the changing cropping pattern in Darrang district, where summer maize is increasingly replacing traditional Boro rice cultivation due to its Shorter duration, Lower water requirements, and Higher profitability. Sentinel-2A satellite imagery and hybrid classification methods were used to assess acreage, with ground truth validation conducted through field surveys. The findings indicate a significant expansion of maize cultivation in Darrang and a discrepancy between remote sensing and government estimates. The study underscores the necessity of real-time crop monitoring using modern geospatial technologies.

KEYWORDS- Remote Sensing, Pre harvest Acreage, Boro Rice, Summer Maize & Cropping Pattern

I. INTRODUCTION

The spatial distribution of crops is determined by various environmental and socio-economic factors, including climate, soil characteristics, topography, traditional practices, and market availability [3]. However, globalization, technological advancements, and improved transport and communication systems have facilitated the introduction of non-traditional crops in new regions[5].

Boro rice cultivation in Assam is traditionally concentrated in low-lying areas of the Lower Brahmaputra Valley, North Bank Plain Zone, and Central Brahmaputra Valley. It contributes approximately 20% of total rice production in the state[1]. Traditionally, maize was grown as a non-commercial crop in different districts of Assam. However, in recent years, maize has emerged as a profitable commercial crop in districts such as Darrang, Nagaon, Morigaon, Dima Hasao, and Karbi Anglong [4]. Due to its short duration (90–100 days), low water requirements, and high profitability compared to Boro rice, summer maize cultivation has expanded into traditional Boro rice-growing areas of Darrang district [2]. This study was undertaken to analyze this shift in cropping patterns using remote sensing techniques.

II. STUDY AREA

The study focuses on **Nagaon and Darrang districts**, located centrally in the **Brahmaputra Valley** of Assam. **Nagaon district** falls within the **Central Brahmaputra Valley Zone**, while **Darrang district** is part of the **North Bank Plain Zone**. Agriculture forms the backbone of the economy in both districts, with a significant portion of the population engaged in farming.

Both districts experience flood-prone conditions, primarily due to their proximity to the Brahmaputra River and its tributaries. The soils in the region range from old alluvial to new alluvial**,** with textures varying from sandy to clayey**,** particularly in low-lying areas. The soil is predominantly acidic**,** with medium to high organic carbon content and low to medium levels of phosphorus and potash, which influence crop productivity. The average elevation of both districts varies between 48 to 58 meters above mean sea level**.**

Agricultural practices in Nagaon and Darrang are characterized by small landholdings, largely operated by family labor, including both men and women. The average farm size is 0.95 hectares in Darrang and 0.99 hectares in Nagaon, reflecting the fragmented landholding pattern typical of Assam. The dominance of smallholder agriculture poses challenges related to mechanization, irrigation, and commercial-scale production. However, recent trends indicate a shift towards high-value and commercial crops like maize due to its short growth cycle, low water requirement, and high market demand**.** Figure 1 highlights the location of Darrang & Nagaon District.

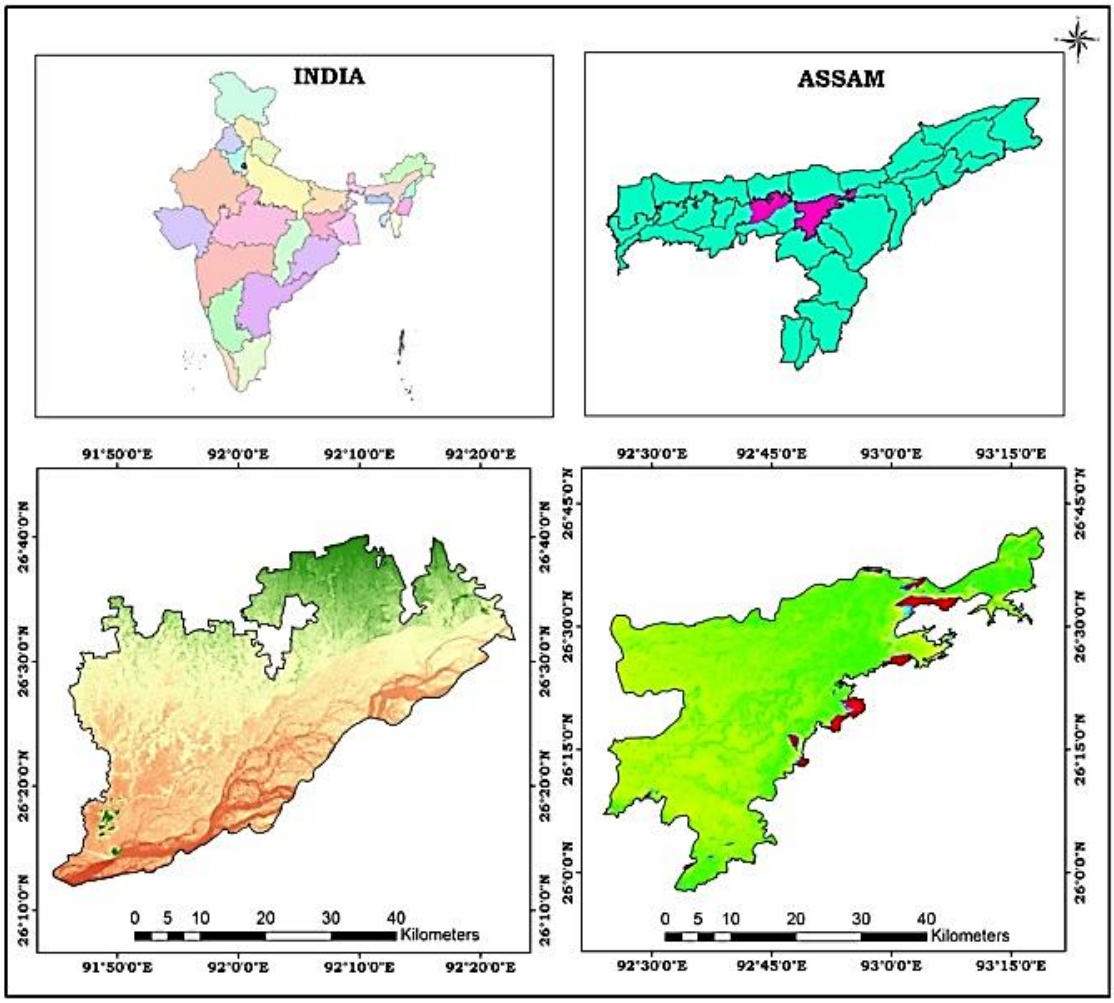

Figure 1: Location map of the Study Area

III. OBJECTIVES OF THE STUDY

- Pre-harvest Acreage estimation of Boro rice in Darrang and Nagaon districts using Remote sensing-based techniques.
- Pre-harvest acreage estimation of Summer Maize in Darrang district.
- Comparative study of the expansion of Summer Maize in traditional Boro rice-growing areas in Darrang district.
- Establishing the feasibility of Remote sensing techniques for acreage estimation of Boro rice and Maize crops in Assam.

IV. DATABASE & METHODOLOGY

A. Satellite Data

The present study utilizes Sentinel-2A imagery, acquired on **17th February 2022**, to identify and map Boro rice and Maize cultivation areas. With a **spatial resolution of 10 meters** and **13 spectral bands** covering the **Visible, Near-Infrared (NIR), and Shortwave Infrared (SWIR)** regions. The dataset is well-suited for crop classification. The **temporal resolution of 10 days** ensures frequent observations, aiding in tracking crop phonology and seasonal variations. The **290 km swath** provides extensive regional coverage, making it efficient for large-scale agricultural assessment. Table 1 shows the Satellite dataset used in this particular study and its full specifications.

Table 1: Showing the Dataset Used in the study

Satellite/Sensor	Specification	Date of Acquisition
Sentinel-2A	Spatial resolution: 10 m; Spectral Bands: 13 (Visible, NIR, SWIR); Temp3oral resolution: 10 days; Swath: 290 km	17th February 2022

B. Other Ancillary Data

Crop statistics are obtained from the Department of Economics & Statistics (DES) and are used for comparative analysis, allowing for a better understanding of trends and variations in agricultural production. The district boundary data is sourced from ASSAC (Assam State Space Application Centre), which aids in the identification and delineation of the study area. Field information is gathered through a questionnaire and a GPS-based survey, ensuring verification and authentication of collected data. Together, these datasets contribute to a comprehensive and reliable research framework. In Table 2 a brief description on the different types of Ancillaries used this particular study has been presented.

Table 2: Showing the different Ancillary dataset used for the study

Data	Source	Purpose of Utilization
Crop Statistics	Department of Economics & Statistics	Comparative study
District Boundary	ASSAC	Identification of the study area
Field Information	Questionnaire & GPS-based survey	Verification & Authentication

V. METHODOLOGY

- Sentinel-2A optical remote sensing data was used for acreage estimation.
- Data was collected during the peak vegetative phase of maize and early growing stage of Boro rice.
- A hybrid classification approach (combination of unsupervised and supervised classification) was used.
- Ground truth data was collected from 19 sites in Darrang and 35 sites in Nagaon.
- ERDAS Imagine 2016 software was used for image analysis.
- A detailed study was conducted in Darrang district to analyze maize expansion in traditional Boro rice-growing areas.
- A questionnaire-based survey was conducted in Darrang to understand the reasons for maize expansion.
- Only Boro rice acreage estimation was carried out in Nagaon to establish the feasibility of remote sensing techniques.

VI. ACCURACY ASSESSMENT USING ERDAS IMAGINE

To evaluate the classification accuracy, the *Erdas Imagine Accuracy Assessment Tool* was used after the completion of the image classification process. A set of Randomly selected ground-truth points were compared with the classified output, generating an Error matrix and key accuracy metrics such as:

A. Overall Accuracy (%): Measures the proportion of correctly classified pixels.

B. Producer's Accuracy (%): Represents the likelihood that an actual class is classified correctly.

C. User's Accuracy (%): Indicates the reliability of a specific class in the classification.

D. Kappa Coefficient (κ): Quantifies classification agreement beyond random chance.

The accuracy assessment results validated the reliability of Sentinel-2A data for mapping Boro rice and maize cultivation areas, demonstrating high precision in distinguishing crop types.

VII. RESULTS

Remote sensing analysis revealed that maize acreage in Darrang district is significantly higher than the government estimates. The field survey confirmed that maize cultivation is replacing Boro rice due to higher profitability, shorter growing duration, and lower risks. In Nagaon, Boro rice acreage estimated using remote sensing was significantly lower than the DES estimates, possibly due to discrepancies in reference data. In Table 3 the detail results of Crop Acreage pattern for Boro Rice and Maize crop in Darrang and Nagaon District of Assam has been highlighted.

Table 3: Showing the results different Crop Acreage pattern for Boro Rice and Maize crop in Darrang and Nagaon District of Assam

District	*Maize RS Acreage (ha) 2021-22*	*DES Acreage (ha) (2019-20)*	*DES Acreage (ha) (2020-21)*	*Boro Rice RS Acreage (ha) 2021-22*	*DES Acreage (ha) (2019-20)*	*DES Acreage (ha) (2020-21)*	*Deviation (%)*
Darrang	11,672.7	7,680	8,080	7,598.14	16,915	16,749+	+32.49 (Maize), -54.85 (Boro Rice)
Nagaon	Not Done	Not Done	NA	22,572.35	40,603	32,830	-62.66 (Boro Rice)

A. Crop Acreage Pattern of Boro Rice and Maize in Darrang and Nagaon Districts

The remote sensing analysis of crop acreage in Darrang and Nagaon districts reveals significant shifts in land use. In Darrang district, the remote sensing-based estimate of maize acreage in 2021-22 was 11,672.7 ha, significantly higher than the DES estimates of 7,680 ha (2019-20) and 8,080 ha (2020-21). This increase highlights the growing popularity of maize, primarily due to its higher profitability, shorter duration, and lower water requirements compared to Boro rice. Meanwhile, the Boro rice acreage in Darrang district has declined to 7,598.14 ha, which is significantly lower than the DES estimates of 16,915 ha (2019-20) and 16,749 ha (2020-21), indicating a shift towards maize cultivation in traditional rice-growing areas.

In Nagaon district, remote sensing estimated the Boro rice acreage at 22,572.35 ha in 2021-22, whereas DES reported 40,603 ha in 2019-20 and 32,830 ha in 2020-21. This discrepancy suggests that traditional estimation methods may overestimate the crop acreage. The sharp decline in Boro rice cultivation, with a deviation of -62.66%, indicates potential factors such as changing farmer preferences, climatic challenges, and economic viability

influencing crop choices. Figure 2 shows the detail distribution pattern of Maize crop cultivation areas in Darrang district.

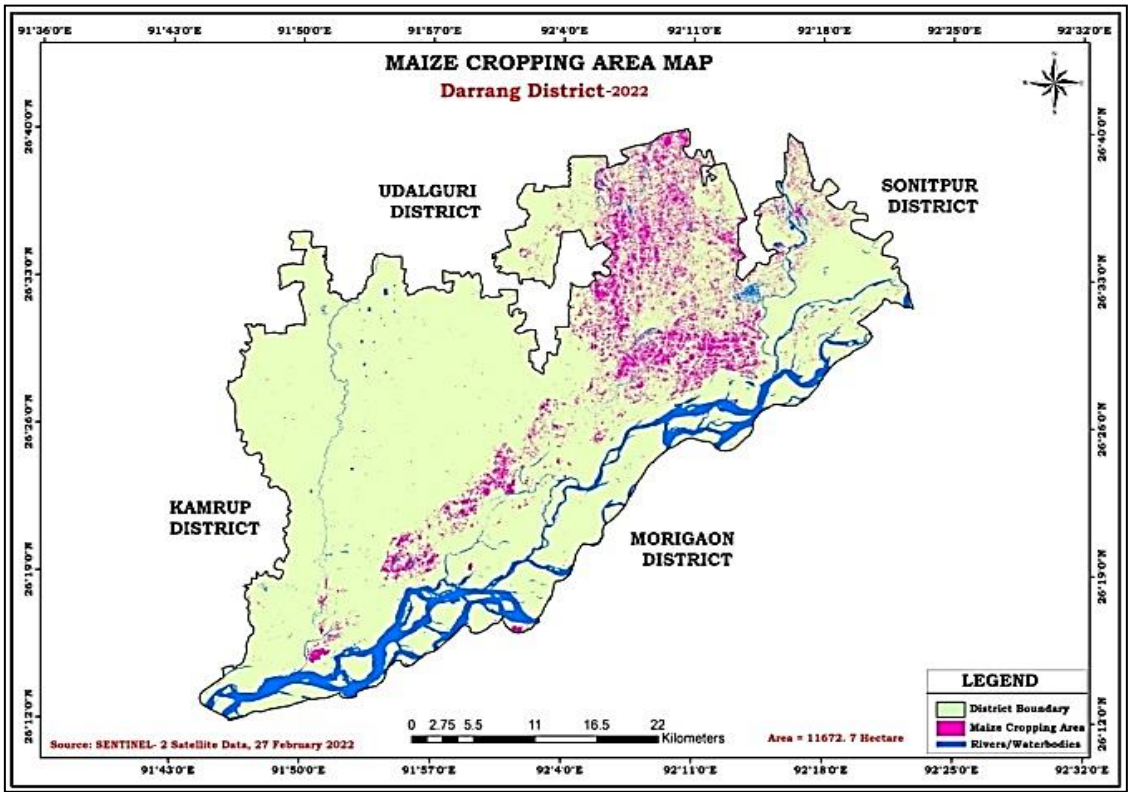

Figure 2: Maize Cropping areas in Darrang District

The distribution scenario of Boro rice cultivation pattern in Darrang and Nagaon districts has been reflected in Figure 3 and Figure 4.

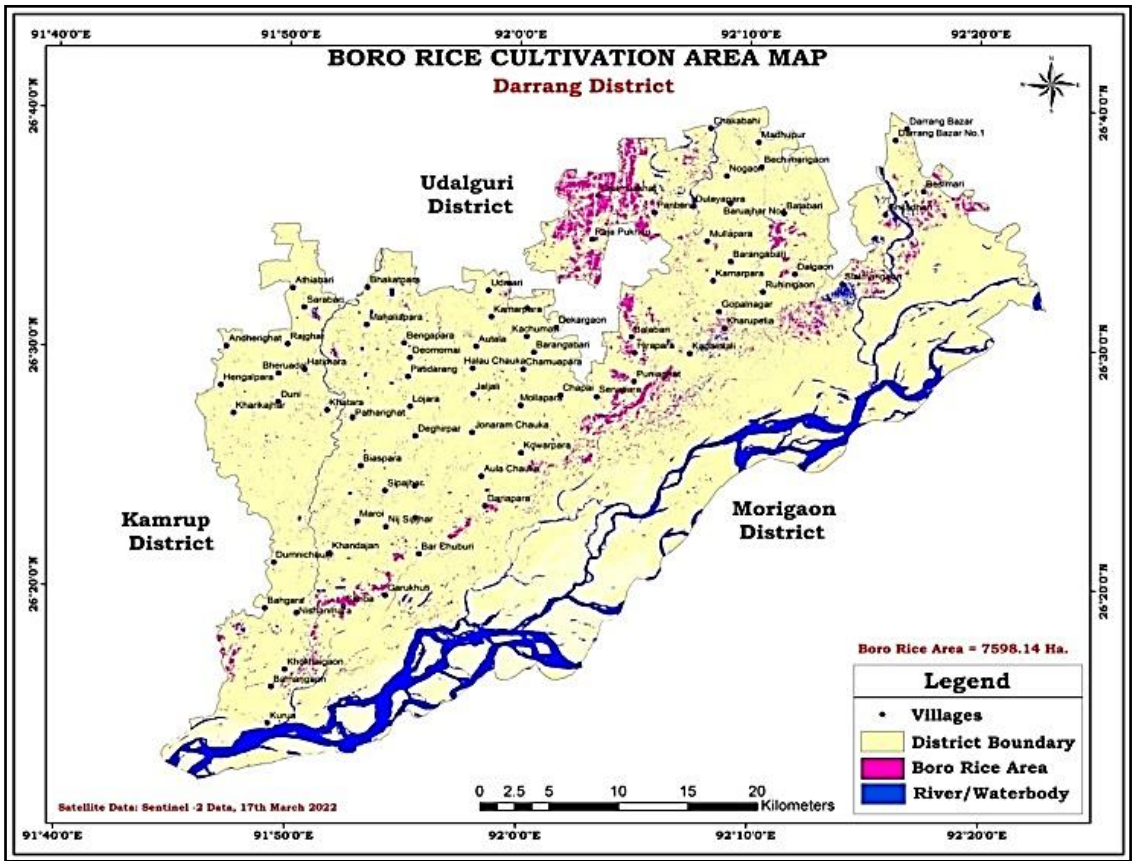

Figure 3: Boro Rice Cultivation Sites in Darrang District

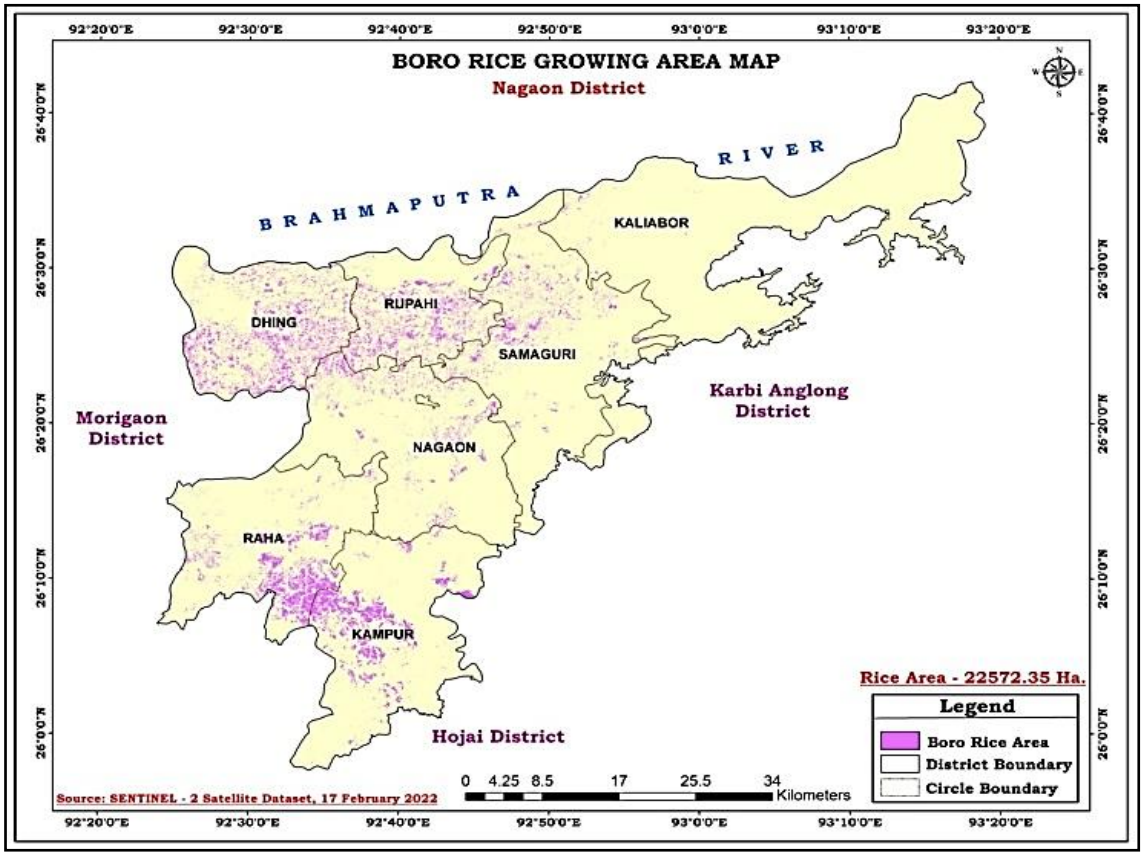

Figure 4: Boro Rice Cultivation Sites in Nagaon District

VIII. CONCLUSION

Maize cultivation has witnessed significant growth in Darrang district, emerging as a vital commercial crop. However, government records do not accurately capture this shift, leading to an underestimation of its economic impact. Currently, the entire maize produce is sold to other states through middlemen, preventing local industries from utilizing this resource for value addition and economic growth within Assam. This lack of data-driven insights hinders Policy making and Agricultural planning. Implementing real-time crop monitoring using remote sensing and GIS can bridge this gap by providing accurate and up-to-date databases on commercial crops. Such an approach would not only ensure better resource management but also open avenues for local Agro-based industries, ultimately boosting the rural economy and strengthening Assam's agricultural sector.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

ACKNOWLEDGMENT

We sincerely thank the officials of the Department of Agriculture, Darrang and Nagaon Districts, Government of Assam, for their invaluable support in completing our study. Their guidance, timely assistance, and resource facilitation were crucial to achieving our research objectives. We appreciate their dedication to agricultural development and look forward to future collaboration.

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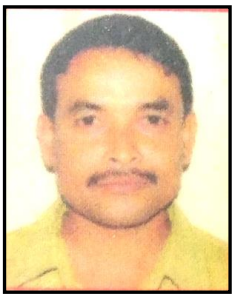
ABOUT THE AUTHORS

Dr. Kalyanjit Sarmah is a Geospatial Specialist with over 16 years of extensive experience in GIS and Remote Sensing applications. He holds a Ph.D. in Environmental Sciences, where he utilized geospatial technology for research. Currently, he is associated with ASSAC as a Senior Project Scientist, contributing to GIS-based research and project development.



Mr. Ranjit Sarma, Senior Scientific Officer at ASSAC, has over 20 years of experience in applying Remote Sensing technology in the agricultural sector. His expertise lies in crop acreage estimation, yield prediction, and crop damage assessment in Assam. Through his extensive research and studies, he has significantly contributed to agricultural monitoring and decision-making in the region.

Mr. PLN Raju, a former scientist at ISRO, is a distinguished expert in geospatial sciences with extensive experience in remote sensing, GIS, and space applications. He has contributed significantly to satellite-based research and geospatial technology development. Currently serving as the Director of the Assam State Space Application Centre (ASSAC), he plays a pivotal role in advancing geospatial research, remote sensing applications, and spatial data infrastructure in Assam.