1.

Related work

Research on rice variety classification in Bangladesh spans both technological approaches using image analysis and machine learning, as well as socio-economic studies investigating farmers' adoption of modern rice varieties. The first stream focuses on computational methods for accurately identifying rice varieties, which is crucial for quality control, breeding programs, and market standardization.

Salman Qadri *et al.* (2021) proposed a machine vision-based approach using texture features for rice variety classification. They utilized a custom dataset comprising 10,800 grains from six varieties, captured with a smartphone camera under uncontrolled lighting conditions. Traditional machine learning models, including LMT, MCR, MB, T-J48, and MAS-C, were applied to classify the rice grains. The study reported high accuracy, with the LMT model achieving 97.4%. The approach demonstrated the feasibility of using interpretable ma- chine learning techniques for small datasets and real-world images. However, the method was limited by the small size of the dataset, absence of deep learning techniques, and variability in lighting, which could affect generalization to other datasets or deployment in diverse conditions.

In contrast, Md. Masudul Islam *et al.* (2025) introduced a next-generation deep learning approach, combining Convolutional Neural Networks (CNNs) with Transformer-based attention mechanisms for rice variety classification. This study employed two datasets: a private dataset with 27,000 images across 20 classes and a public dataset with 6,750 images across 5 classes. The deep learn- ing models achieved near-perfect accuracy, with 99.6% on the private dataset and 10% on the public dataset. Compared to traditional machine learning methods, this approach offers greater robustness, scalability, and suitability for real-world deployment. The main limitations include the need for high- performance GPUs for training, limited availability of public datasets, and few external validation studies to confirm generalizability. Collectively, these two studies illustrate the progression from conventional machine learning to deep learning methods in rice variety classification, highlighting improvements in ac- curacy, scalability, and model sophistication.

Beyond computational classification, research has also addressed factors in- fluencing the adoption of modern rice varieties by farmers. Mohammad Samiul Islam *et al.* (2024) conducted a survey of 510 Boro rice farmers in seven Upazi- las of Mymensingh district. They collected detailed socio-economic, farm, and institutional data to understand drivers of adoption. Using a Tobit regression model, supported by descriptive statistics and chi-square analysis, the study identified education, farm size, access to extension services, training, credit, and seed availability as significant positive determinants. The model exhibited a strong fit, with Pseudo $R^2 = 0.8911$, indicating that it explained the major- ity of variance in adoption behavior. However, the study's scope was limited geographically to Mymensingh district, excluded other rice seasons (Aus and Aman), and relied on self-reported data, which may introduce bias.

Taken together, these studies provide a comprehensive view of rice variety research in Bangladesh. On the technological side, advancements in image- based classification—from traditional machine learning to CNN-Transformer models—have enhanced the accuracy and scalability of variety identification. On the socio-economic side, understanding the behavioral and institutional factors influencing farmers' adoption decisions is essential for effective dissemination of modern rice varieties and for designing policies that support sustainable agricultural practices. Future research could integrate these two perspectives, combining accurate automated classification systems with adoption studies to optimize rice production, distribution, and policy interventions in Bangladesh.

Author	Year	Dataset / Study Focus	Total Data	Categories	Model / Method	Overall Accuracy (%)
Jin et al. (ACS Omega)	2022	NIR hyperspectral rice seed dataset	4,500	6 varieties	CNN + PCA	99.4%
Tahsin et al. (PMC11615915)	2024	Bangladeshi rice kernel image dataset (microscopic)	5,040	38 varieties	ResNet-50	98.7%
Rahman et al. (ScienceDirect, S0733521025000268)	2025	UAV/drone-based paddy field images	3200	8 varieties	EfficientNet-B3	97.9%
Ahmed et al. (IET Research	2024	Rice seed visual dataset (Bangladesh)	7,800	12 varieties	Hybrid CNN–SVM	96.8%
Hossain et al. (SSRN 4749601)	2024	Multi-class rice variety dataset	10,000	15 varieties	Custom CNN	97.2%
Biswas et al. (PLOS One)	2023	Rice image dataset variety)	8,200	10 classes	VGG-16	98.5%
Patel et al. (Taylor & Francis)	2021	Indian rice variety recognition using grain morphology	2,500	6 varieties	Random Forest	95.6%
Kabir et al. (ResearchGate	2024	Socio-economic study (non-image)	520 farmers	–	Statistical ML (Logistic Regression)	N/A (behavioral study

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