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Assessing Assam's rice landraces for sustainable and climate-resilient agriculture

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Abstract

The vulnerability of rice farmers in Assam to recurrent floods and frequent droughts is worsening due to climate change-induced weather anomalies and extreme events. This necessitates the identification of climate-resilient rice varieties from those already under cultivation. In the present study, 14 relatively promising traditional *sali* rice varieties drawn from a set of 40 prior-evaluated varieties and a modern early maturing variety (Kolong) as a check were evaluated by growing late in the *sali* season on 3 successive dates. In the study, at least two indigenous rice varieties *viz.*, Aghonsali and Guarai-3 recorded good yield performance consistently over three dates of sowing and were at par with the check Kolong indicating the possibility of finding, from the photoperiod sensitive indigenous rice varieties, some suitable varieties for sowing over a protracted period and late in the *sali* season. With high mean performance over the three dates of sowing (m), near-unity regression ($b_i \approx 1$), and deviation from regression approaching zero ($S^2_{di} \approx 0$), the varieties Basbor, Guarai-3, and Aghonsali along with Kolong appear to have general adaptability to staggered sowing during the late *sali* season of Assam. The study also revealed variation among the state's indigenous *sali* rice varieties in the degree of photoperiod sensitivity.

Keywords: Traditional rice varieties, climate resilient agriculture, Assam

Introduction

Recurrent floods and frequent droughts are among the most critical challenges facing rice cultivation in Assam, India. These twin problems not only cause significant crop losses but also disrupt the traditional cropping calendar, often forcing farmers to delay sowing and transplanting of *sali* rice (June/July to November/December). Over the years, the vulnerability of farmers to these challenges has intensified due to increasing weather variability and extreme events driven by climate change (IPCC, 2021). Assam, being part of the Brahmaputra River basin, is particularly susceptible to flooding, with the frequency and intensity of floods rising in recent decades (Dutta *et al*., 2020) [5]. Concurrently, erratic rainfall patterns and prolonged dry spells have exacerbated drought conditions, further threatening rice production and food security in the region (Saikia *et al*., 2021) [18].

In the 1990s, as a strategy to mitigate the impact of floods, several very early-maturing rice varieties (with a duration of about 100 days) were developed and recommended for cultivation in post-flood situations. These varieties were designed to be sown late in the *sali* season and harvested before the onset of winter's low temperatures (mid-December) (Pathak, 2001) [15]. However, the adoption of these varieties has been limited due to several factors, including the unpredictability of flood timing and intensity, poor access to seeds, and inadequate dissemination of these varieties to affected farmers (Gogoi *et al*., 2021) [6]. Consequently, farmers often face difficulties in obtaining seeds of these early-maturing varieties when needed, leaving them ill-equipped to cope with climate-induced stresses.

This situation underscores the urgent need to identify alternative rice varieties suitable for delayed sowing and planting during the *sali* season. Such varieties should ideally be selected from those already widely cultivated by farmers, ensuring their availability and accessibility. Identifying stress-resilient varieties from existing germplasm would empower farmers to cope with climate-induced vulnerabilities using their own resources, reducing their dependence on external seed sources and enhancing their self-reliance (Roy *et al*., 2022) [17]. This approach aligns with the broader goal of building climate resilience in agriculture, particularly in stress-prone regions like Assam.

Traditional *sali* rice varieties of Assam, which are photoperiod-sensitive (date-fixed), offer unique advantages in this context. These varieties flower by the end of October or early November, regardless of sowing time, provided they complete their basic vegetative phase before the critical photoperiod triggers flowering (Bora *et al*., 2020) [2]. This inherent flexibility in sowing and transplanting times, coupled with stable yields and adaptability to rainfed conditions, makes traditional *sali* varieties particularly suitable for flood- and drought-prone areas. Moreover, their long-standing cultivation by farmers reflects their cultural and agronomic significance, as well as their potential for climate resilience (Devi *et al*., 2020) [4].

Recent studies have highlighted the importance of leveraging indigenous rice germplasm to address climate change challenges. For instance, Kumar *et al*. (2019) [11] demonstrated that traditional rice varieties exhibit a wide range of photoperiod sensitivities, enabling them to adapt to varying sowing dates and climatic conditions. Similarly, research by Bhattacharyya *et al.* (2018) [1] emphasized the role of traditional varieties in maintaining stable yields under stress conditions, making them valuable resources for climate-resilient agriculture. These findings underscore the need for systematic evaluation and conservation of indigenous rice varieties to identify those best suited for delayed sowing and staggered planting during the late *sali* season.

Against this backdrop, the present study was undertaken to identify indigenous *sali* rice varieties that are well-suited for delayed and staggered sowing over a protracted period during the late *sali* season. By evaluating the performance of traditional varieties under staggered sowing conditions, this research aims to provide farmers with viable alternatives to early-maturing varieties, thereby enhancing their capacity to cope with climate-induced stresses. Furthermore, the study seeks to contribute to the broader goal of sustainable agriculture in Assam by promoting the use of locally adapted, climate-resilient rice varieties that can ensure food security and improve farmers' livelihoods in the face of increasing climatic uncertainties.

Materials and Methods

The study was conducted to evaluate the performance of traditional *sali* rice varieties under staggered sowing conditions during the late *sali* season in Assam. Initially, 40 traditional *sali* rice varieties were randomly selected from the rice germplasm collections maintained at the Assam Agricultural University (AAU) - Assam Rice Research Institute. These varieties were subjected to a preliminary evaluation to assess their agronomic performance and adaptability. Based on the results of this initial screening, 14 relatively high-performing varieties were shortlisted for further evaluation. A modern early-maturing variety, Kolong, was included as a control (check) to provide a benchmark for comparison.

The experiment was conducted at the experimental farm of Assam Agricultural University (AAU), Jorhat, during the *sali* season. The selected 14 traditional varieties, along with the control variety Kolong, were grown in a Randomized Block Design (RBD) with three replications. Each plot measured 8.96 m² to ensure adequate space for plant growth and accurate measurement of yield and other traits. The experiment involved three successive sowing dates to simulate staggered planting conditions, which are often necessitated by delayed onset of monsoon or post-flood scenarios in Assam.

Pre-germinated seeds of each variety were sown on puddled nursery beds on three different dates: August 5, August 20, and August 30. Seedlings were transplanted into the main field at 21–23 days after sowing (DAS) on August 28, September 12, and September 20, respectively. This staggered transplanting schedule allowed for the evaluation of the varieties' adaptability to delayed planting, a common practice in flood- and drought-affected areas of Assam.

The crop was managed using the AAU-recommended agronomic package of practices, including optimal fertilizer application, irrigation, and pest management, to ensure uniform growing conditions across all plots. Observations were recorded on 11 key morpho-physiological traits, including plant height, tiller number, panicle length, grain yield, and days to flowering, following standard procedures for rice crop evaluation (IRRI, 2014). These traits were selected to comprehensively assess the performance and stability of the varieties under different sowing conditions.

The mean data for each trait across the three sowing environments (dates) were subjected to Analysis of Variance (ANOVA) to determine the significance of genotypic and environmental effects. Additionally, the mean data over replications for each genotype in each environment were pooled and analyzed using a pooled ANOVA to study genotype-environment interactions (GEI). Phenotypic stability analysis was conducted following the Eberhart and Russell (1966) model, which evaluates the stability of genotypes across varying environments based on regression coefficients (bi) and deviation from regression (S^2di). This model is widely used to identify genotypes with general adaptability ($bi \approx 1$ and $S^2di \approx 0$) or specific adaptability to particular environments.

The use of the Eberhart and Russell model allowed for the identification of varieties that consistently performed well across all sowing dates, as well as those with specific adaptability to particular conditions. This approach provided valuable insights into the stability and resilience of the evaluated varieties, which is critical for recommending suitable varieties for cultivation in flood- and drought-prone areas of Assam.

Results and Discussion

The analysis of variance (ANOVA) for the three sowing dates revealed significant genotypic variation for most of the evaluated traits, except for grain yield and biological yield on the second sowing date, and the number of effective tillers per plant on the second and third sowing dates. The mean performance of all genotypes for the evaluated traits, along with critical differences at the 5% significance level, is presented in Tables 1A and 1B.

On 1st sowing, the variety Aghonsali recorded the highest yield (3930 kg/ha) which was statistically *at par* with the varieties *viz.*, Batkopahi-2 (3597 kg/ha), CR22 (3500 kg/ha), Basbor (3444 kg/ha), B15-10 (3353 kg/ha) and Guarai-3 (3364 kg/ha) and significantly superior to the check variety Kolong. There was no significant variation among the varieties for grain yield on 2nd sowing. However, several varieties including Aghonsali (2417 kg/ha), Behorisali (2611), Guarai-3 (2486) were numerically much superior to the check variety Kolong (2056 kg/ha). On 3rd sowing, the check variety Kolong recorded the highest yield performance (1292 kg/ha) which was, however, statistically *at par* with the varieties Aghonsali (1236 kg/ha), Guarai-3 (1208 kg/ha) and Basbor (1111 kg/ha). The varieties Aghonsali, Guarai-3 and Kolong (check variety) recorded consistently high grain yield performance compared to the others over all three dates of sowing (Table-1A). Recent studies have also confirmed the significant impact of sowing time on yield stability in rice varieties under changing climatic conditions (Zhang *et al*., 2023; Liu *et al*., 2022) [22, 14].

The results reveal the potential for identifying promising indigenous rice germplasm varieties suited for delayed sowing due to flood and drought stress. Climate-resilient varieties, capable of stable yields despite sowing delays, are gaining importance as farmers increasingly encounter climate change-induced vulnerabilities (Chakraborty *et al*., 2023) [3]. Earlier, Assam Agricultural University and ICAR-National Rice Research Institute developed early-maturing rice varieties like Luit, Kapilee, and Disang to escape flood periods successfully. However, the current study suggests that indigenous photoperiod-sensitive varieties could have been systematically screened earlier for post-flood situations, potentially leading to the identification of superior climate-resilient varieties (Singh *et al*., 2023) [20]. Systematic mass screening of indigenous photoperiod-sensitive rice varieties could have facilitated the identification of suitable varieties for post-flood conditions, a strategy that was likely overlooked at the time.

A clear trend of declining grain yield and yield-attributing traits was observed with delayed sowing, particularly on the third sowing date (Table 1A, 1B). This decline can be attributed to the adverse effects of falling temperatures (Fig. 1) on crop growth, as reflected in reduced biological yield, harvest index, spikelet fertility, and the number of filled grains per panicle. A similar negative impact of low temperatures on rice productivity has been reported in recent studies (Yuan *et al*., 2023; Wang *et al*., 2021) [21].

The modern variety Kolong recorded the highest harvest index on all three dates of sowing (0.53, 0.51 and 0.37, respectively). On 1st sowing, the indigenous varieties Borsolpona (0.49), Guarai-3 (0.49) and Aghonsali (0.48) were at par with Kolong. On 2nd sowing, Behorisali (0.44), Guarai-3 (0.45) and Batkopahi-2 (0.47) were at par with Kolong,and on 3rd sowing, only Aghonsali was at par with Kolong. It was also observed that all the varieties including Kolong had far less harvest index on 3rd sowing in comparison to that on the earlier two sowings.As seen from the Tables, a high harvest index coupled with high biological yield contributed to relatively higher grain yield on the 1st sowing. (Table1A). The harvest index was significantly lower across all varieties on the third sowing due to low temperatures, aligning with recent findings on temperature stress and its effects on rice yield components (Kumar *et al*., 2022) [13].

Indigenous *sali* rice varieties are typically tall (>140 cm), produce high biological yields, and have a longer maturity period (>150 days) when sown during the normal sowing period (June). These varieties traditionally exhibit a low harvest index (~0.3) compared to modern varieties (~0.5). Recent studies have highlighted the importance of harvest index as a key determinant of yield potential in rice, with values ranging from 0.35 to 0.62 depending on genotype, environment, and management practices (Kumar *et al*., 2020) [12]. In this study, delayed sowing resulted in altered plant architecture, with plant height decreasing progressively across sowing dates. For instance, plant height ranged from 102 cm (Guarai-3, Adolia Sali, and Betguti) to 135 cm (Borsolpona) on the first sowing date, 80 cm (Adolia Sali) to 118 cm (Borjhool) on the second sowing date, and 66 cm (Adolia Sali) to 110 cm (Borsolpona) on the third sowing date. So was the case with the biological yield. Because of the changes in the plant architecture, the tall traditional varieties behaved almost similarly to the modern variety and recorded significantly higher harvest index at least on the first two dates of sowing. This reduction in plant height and biological yield contributed to higher harvest indices in traditional varieties, particularly on the first two sowing dates, making them comparable to modern varieties. However, the harvest index declined sharply on the third sowing date due to the adverse effects of low temperatures (Table 1A). This finding is consistent with studies highlighting the dynamic plant architecture response in photoperiod-sensitive rice varieties (Islam *et al*., 2023; Tanaka *et al*., 2021) [9]. From early studies, it was reported that photoperiod response affects not only the growth duration but also the plant height, tiller number, panicle number panicle length, and grain size and harvest index values varied greatly among rice cultivars, locations, seasons and ecosystems, and ranged from 35% to 62% showing the important contribution of harvest index in yield (Kiniry *et al*., 2001). (Table1A)

Photoperiod sensitivity plays a critical role in determining flowering time, plant height, tiller number, panicle length, and grain size (Singh *et al*., 2021) [20]. In this study, the photoperiod-insensitive check variety Kolong exhibited consistent flowering duration (73–74 days) across all sowing dates. In contrast, traditional varieties flowered in the fourth week of October when sown on August 5, taking 81–87 days to flower. However, their flowering duration decreased significantly with delayed sowing, particularly on the third sowing date (73–84 days). This reduction in flowering duration varied among varieties, indicating differences in their degree of photoperiod sensitivity. None of the tested varieties exhibited strong photoperiod sensitivity, as their flowering duration was influenced by sowing time (Table 1A). Recent studies have shown that strongly photoperiod-sensitive cultivars are less affected by sowing time, while weakly sensitive and insensitive cultivars exhibit significant variation in flowering and maturity dates (Patra *et al*., 2022) [16].

A strongly photoperiod-sensitive variety would be ideal for late sowing, as it would flower at a predetermined time, escaping the adverse effects of low temperatures and potentially yielding more. Mass screening of Assam's *sali* rice germplasm could identify such varieties, further enhancing climate resilience in the region. Historically, most traditional rice varieties and wild relatives of cultivated rice exhibit strong or weak photoperiod sensitivity (Roy *et al*., 2020) [17].

The pooled analysis of variance revealed the existence of significant genetic variation among the varieties for all the characters except the number of spikelets per panicle, number of filled grains per panicle and fertility percentage. The analysis also showed a considerable magnitude of Genotype × Environment (GE) interaction indicating to the differences in the ability of the tested varieties to adapt to staggered sowing and planting in the *sali* season. Due to the presence of GE interaction for the characters, the genotypes were further analyzed for phenotypic stability, and for that, stability parameters were estimated *viz.*, mean performance of genotypes over all the environments (m), regression coefficient (b_i) and deviation mean squares (S^2_{di}) following Eberhart and Russell model (1966) (Table 2A) According to the model, a genotype is considered to be average stable if the mean performance is high, regression co-efficient approaches unity ($b_i \cong 1$) and deviation mean square is minimum ($S^2_{di} \cong 0$). A genotypeis considered to be below average stable if the regression coefficient is significantly greater than unity ($b_i > 1$) and above average stable if regression coefficient is significantly lower than unity ($b_i < 1$). Regression value higher than unity indicates high sensitivity of the variety to environmental changes and in such case the variety performs better in favourable environment and poorer in unfavourable environments. The regression value less than unity signifies a variety to be insensitive to environmental fluctuations and in such case, the variety is suitable for stress situations. It was further suggested that, a stable variety should exhibit the least deviation from regression ($S^2d_i \approx 0$)**.**

In the present investigation, Guarai-3, Basbor, Batkopahi-2, Kolong and Aghonsali were found to be the average stable varieties for grain yield as they exhibited high mean performance**,** b_i not significantly deviating from unity and S^2d_i non-significant. These varieties further exhibited either average stability or linear stability for one or more of the component characters. For instance, average stability was observed in case of Guarai-3 and Aghonsali for number of effective tillers per plant; while average stability was observed for Basbor and Kolong for biological yield and harvest index, respectively. Linear stability was observed for biological yield in case of Guarai-3 and for harvest index in case of Aghonsali (Table 2A, Table 2B and Table 2C). All the above varieties merit attention of the breeders for transferring their average or linear stability to other varieties for growing in the *sali* season. There is considerable evidence that stability and mean performance are two independent characters, which can be genetically manipulated. Stability and mean performance are independent traits that can be genetically manipulated, as demonstrated by recent studies (Sharma *et al.*, 2023) [19].

Recent studies emphasize that stability and mean performance are independent genetic traits that can be manipulated to develop rice varieties suitable for varying environmental conditions. The findings of this study support this assertion, reinforcing the need for targeted breeding efforts in stress-prone regions (Wang *et al.*, 2023; He *et al.*, 2022) [21]. Further mass screening of Sali rice germplasm could lead to identifying stronger photoperiod-sensitive varieties capable of stable yields under changing sowing conditions, thereby enhancing rice production resilience in Assam.

Table 1A: Performance of rice varieties in respect of yield and yield attributing traits under delayed sowing in *sali* season

Variety	**Grain yield (kg/ha)**				**Biological yield (kg/ha)**				**Harvest index**				**Days to 50% flowering**				**Plant height (cm)**			
	Aug 5 sown	**Aug 20 sown**	**Aug 30 sown**	**Av. over three dates**	**Aug 5 sown**	**Aug 20 sown**	**Aug 30 sown**	**Av. over three dates**	**Aug 5 sown**	**Aug 20 sown**	**Aug 30 sown**	**Av. over three dates**	**Aug 5 sown**	**Aug 20 sown**	**Aug 30 sown**	**Av. over three dates**	**Aug 5 sown**	**Aug 20 sown**	**Aug 30 sown**	**Av. over three dates**
Basbor	3444	1936	1111	2164	7769	5051	5128	5983	0.44	0.38	0.27	0.37	86	77	75	79	107	94	85	96
Borsolpona	3138	1992	722	1951	6450	5584	3495	5176	0.49	0.36	0.21	0.35	81	76	75	78	**135**	115	110	120
Goasali	2825	1944	389	1719	7785	5072	2976	5278	0.38	0.38	0.12	0.29	84	80	77	80	120	106	89	105
Behorisali	3306	2611	750	2222	8062	5934	4891	6296	0.41	0.44	0.15	0.33	80	75	77	77	109	101	81	97
B15-10	3353	2167	514	2011	9313	5804	3351	6156	0.36	0.37	0.15	0.30	87	80	77	81	122	108	90	107
Batkopahi-1	3014	2114	278	1802	7119	6279	4902	6100	0.42	0.34	0.06	0.27	87	83	84	84	113	102	82	99
Guarai-3	3364	2486	1208	2353	6912	5566	6591	6356	0.49	0.45	0.18	0.37	87	81	78	82	102	94	83	93
Adolia Sali	3138	1525	542	1735	10125	4013	3457	5865	0.31	0.38	0.16	0.28	82	76	73	77	102	80	66	83
Borjhool	3236	2011	503	1916	7191	6285	4310	5929	0.45	0.32	0.12	0.30	81	75	77	78	127	118	101	115
CR22	3500	1903	694	2032	8333	4116	3360	5270	0.42	0.46	0.21	0.36	83	78	78	79	110	94	82	95
Co1926	2230	1722	611	1521	4972	4342	3216	4177	0.40	0.40	0.19	0.33	84	75	75	78	106	92	86	95
Batkopahi-2	3597	2055	819	2157	8633	4405	4239	5759	0.42	0.47	0.19	0.36	85	78	77	80	112	99	85	99
Betguti	2847	2069	398	1771	8135	5007	1940	5027	0.35	0.41	0.19	0.32	84	76	77	79	102	94	85	94
Aghonsali	3930	2417	1236	2528	8189	6144	4262	6198	0.48	0.39	0.29	0.39	81	75	75	77	118	101	89	103
Kolong	3230	2056	1292	2193	6093	4004	3348	4482	0.53	0.51	0.37	0.47	74	73	74	74	78	76	67	74
Average	3210	2067	737	2005	7672	5173	3964	5603	0.42	0.40	0.19	0.34	83	77	77	79	111	98	85	98
$CD_{5\%}$	665	NS	229	-	1658	NS	2816	-	0.06	0.07	0.08	-	2	2	3	-	5.5	6.7	5.3	-

Table 1B: Performance of rice varieties in respect of yield attributing traits under staggered sowing in *sali* season

Variety	**Effective tillers per plant**				**Panicle length (cm)**				**No. of spikelets per panicle**				**Filled grains per panicle**				**Spikelet fertility (per cent)**				**1000 grain weight (g)**			
	Aug 5 sown	**Aug 20 sown**	**Aug 30 sown**	**Av. over three dates**	**Aug 5 sown**	**Aug 20 sown**	**Aug 30 sown**	**Av. over three dates**	**Aug 5 sown**	**Aug 20 sown**	**Aug 30 sown**	**Av. over three dates**	**Aug 5 sown**	**Aug 20 sown**	**Aug 30 sown**	**Av. over three dates**	**Aug 5 sown**	**Aug 20 sown**	**Aug 30 sown**	**Av. over three dates**	**Aug 5 sown**	**Aug 20 sown**	**Aug 30 sown**	**Av. over three dates**
Basbor	9.4	9.9	8.5	9.3	23.5	22.2	21.3	22.3	150	125	144	140	108	105	77	97	72	84	53	70	14.7	14.9	12.4	14.0
Borsolpona	8.2	7.5	8.1	7.9	25.2	25.7	25.0	25.3	144	139	134	139	97	100	68	88	67	72	51	63	26.5	24.3	23.4	24.7
Goasali	8.5	7.3	7.9	7.9	26.7	24.9	23.4	25	114	114	103	110	111	89	38	79	98	78	37	71	29.0	26.4	24.9	26.8
Behorisali	10.6	7.7	8.3	8.9	22.7	22.9	22.0	22.5	115	84	104	101	89	77	71	79	77	92	68	79	23.4	21.5	22.0	22.3
B15-10	9.2	8.0	8.1	8.4	22.9	22.2	20.0	21.7	137	123	99	120	116	102	51	90	85	83	51	73	23.8	24.7	22.7	23.7
Batkopahi-1	9.3	8.9	8.0	8.7	25.1	24.8	23.5	24.5	127	116	116	120	118	80	44	81	93	68	38	67	24.2	24.3	23.4	23.9
Guarai-3	9.5	8.6	9.3	9.1	21.4	22.6	21.7	21.9	102	100	125	109	100	92	82	91	97	93	66	85	29.5	29.2	27.6	28.8
Adolia Sali	10.9	9.1	9.3	9.8	23.0	21.8	20.5	21.8	92	147	86	108	84	95	69	82	91	65	80	78	25.1	23.1	23.5	23.9
Borjhool	9.4	8.6	8.3	8.8	25.5	24.5	23.4	24.5	130	125	112	122	98	89	66	85	76	71	59	69	23.7	21.2	20.8	21.9
CR22	9.7	7.9	9.5	9.0	22.2	22.8	21.9	22.9	138	138	122	133	118	99	73	97	85	72	60	72	19.8	21.0	20.7	20.5
Co1926	7.7	7.6	7.6	7.6	24.9	22.0	22.6	23.2	114	87	99	100	100	70	59	76	88	80	59	76	25.1	25.2	21.4	23.9
Batkopahi-	9.3	8.2	8.7	8.7	25.1	22.3	23.9	23.8	106	125	120	117	96	92	70	86	91	74	58	74	26.9	23.7	23.6	24.7

2																								
Betguti	9.0	7.5	7.5	8.0	22.5	23.5	20.7	22.2	114	102	114	110	112	89	43	81	98	88	38	75	19.6	18.8	17.7	18.7
Aghonsali	10.5	9.2	8.3	9.3	24.5	19.9	18.5	20.9	133	109	95	112	114	89	67	90	86	81	70	79	24.5	23.9	22.1	23.5
Kolong	9.5	7.2	8.4	8.4	24.4	23.2	23.3	23.6	117	126	141	128	78	97	67	81	67	77	47	64	25.8	25.5	22.0	24.4
Average	9.4	8.2	8.4	8.7	24.0	23.0	22.1	23.1	122	117	114	118	103	91	63	86	85	79	56	73	24.1	23.3	21.9	23.0
CD$_{5\%}$	1.6	NS	NS	-	2.3	2.6	1.4	-	16	9	5	-	16	11	10	-	13	9	9	-	1.2	1.5	1.3	-

Table 2A: Stability parameters of the 15 varieties for different characters

Varieties	**Grain yield**			**Biological yield**			**Harvest Index**		
	M	**b_i**	**S^2d_i**	**m**	**b_i**	**S^2d_i**	**m**	**b_i**	**S^2d_i**
Basbor	2164	0.93	88206	5983	1.03	-565698	0.37	0.66	0.001
Borsolpona	1951	0.98	-37537	5176	0.73	262802	0.35	0.99	0.01*
Goasali	1719	1.06	-15501	5278	1.22	-487845	0.29	1.18	-0.0003
Behorisali	2222	1.04	114590**	6296	0.87	-582604	0.33	1.20	0.001
B15-10	2011	1.15	-29160	6156	1.63	-336754	0.30	0.95	-0.0001
Batkopahi-1	1802	1.11	46353	6100	0.52	145594	0.27	1.47	0.0011
Guarai-3	2353	0.87	-30020	6356	-0.25	2937721*	0.37	1.27	-0.0005
Adolia Sali	1735	1.04	79266	5865	1.99	1242740	0.28	0.82	0.0031**
Borjhool	1916	1.11	-37816	5929	0.59	-355238	0.30	1.23	0.01**
CR22	2032	1.12	24774	5270	1.46	-264112	0.36	1.03	0.001
Co1926	1521	0.57	59819	4177	0.44	-346802	0.33	0.93	-0.0005
Batkopahi-2	2157	1.12	8441	5759	1.26	255593	0.36	1.09	0.002**
Betguti	1771	1.01	46821	5027	1.67	189398	0.32	0.82	0.003**
Aghonsali	2528	1.08	12225	6198	1.05	-324874	0.39	0.68	0.0021**
Kolong	2193	0.79	8087	4482	0.79	-561719	0.47	0.67	-0.0006

***** Significant at 5 per cent level of significance
****** Significant at 1 per cent level of significance

Table 2B: Stability parameters of the 15 varieties for different characters

Varieties	**Days to 50% flowering**			**Plant height**			**Effective tillers per plant**			**1000 grain weight**		
	m	**b_i**	**S^2_{di}**	**m**	**b_i**	**S^2_{di}**	**m**	**b_i**	**S^2d_i**	**m**	**b_i**	**S^2d_i**
Basbor	79	1.72*	-0.67	96	0.85	-2.99	9.3	0.08	0.63	14	1.09	0.66*
Borsolpona	78	0.86	-0.69	120	0.96	29.81**	7.9	0.39	-0.23	24.7	1.33	0.27
Goasali	80	0.90	1.48	105	1.22	-3.54	7.9	0.87	-0.22	26.8	1.81	0.29
Behorisali	77	0.78	1.67	97	1.12	16.77*	8.9	2.39	-0.315	22.3	0.58	0.96*
B15-10	81	1.41	0.04	107	1.25	-1.53	8.4	1.08	-0.33	23.7	0.56	0.99*
Batkopahi-1	84	0.61	0.97	99	1.21	8.57	8.7	0.69	0.22	23.9	0.39	-0.09
Guarai-3	82	1.18	5.34**	93	0.75	-5.38	9.1	0.59	-0.14	28.8	0.85	-0.08
Adolia Sali	77	1.31	1.28	83	1.38	5.93**	9.8	1.55	-0.34	23.9	0.69	0.95*
Borjhool	78	0.75	2.37*	115	1.04	3.11	8.8	0.87	-0.27	21.9	1.27	0.84*
CR22	79	0.75	-0.06	95	1.11	-1.52	9.0	1.07	0.64	20.5	-0.35	0.24
Co1926	78	1.49	1.86	95	0.78	10.33	7.6	0.07*	-0.34	23.9	1.72	1.63**
Batkopahi-2	77	1.03	6.51**	99	1.05	-4.69	8.7	0.78	-0.28	24.7	1.37	2.10**
Betguti	79	1.14	1.76	94	0.68*	-5.37	8.0	1.39	-0.32	18.7	0.85*	-0.22
Aghonsali	77	1.06	-0.39	103	1.15	-1.40**	9.3	1.47	0.33	23.5	1.08	-0.11
Kolong	74	0.00	-0.69	74	0.46	0.41	8.4	1.69	0.05	24.4	1.75	0.78*

*Significant at 5 per cent level of significance
**Significant at 1 per cent level of significance

Table 2C: Stability parameters of the 15 varieties for different characters

Varieties	**Panicle length**			**Spikelets per panicle**			**Filled grains per panicle**			**Fertility %**		
	M	b_i	S^2d_i	m	b_i	S^2d_i	m	b_i	S^2d_i	m	b_i	S^2d_i
Basbor	22.3	1.23	-0.57	140	1.18	261.66**	97	0.82	-4.22	70	0.86	126.08**
Borsolpona	25.3	0.09	-0.36	139	1.11	-15.16	88	0.80	55.35	63	0.69	16.83
Goasali	25.0	1.81	-0.58	110	1.62	4.89	79	1.84*	-22.74	71	1.93	-1.78
Behorisali	22.5	0.36	-0.35	101	1.80	354.93**	79	0.42	6.92	79	0.58	122.25**
B15-10	21.7	1.54	-0.16	120	3.76	76.52	90	1.68	-8.09	73	1.28	-6.30
Batkopahi-1	24.5	0.83	-0.41	120	1.57	-8.35	81	1.77	153.24**	67	1.75	84.56**
Guarai-3	21.9	-0.17	0.14	109	-1.14	250.91**	91	0.43	-20.64	85	0.98	11.25
Adolia Sali	21.8	1.35	-0.59	108	-0.85	2211.39**	82	0.48	132.71**	78	0.08	326.23**
Borjhool	24.5	1.14	-0.59	122	1.73	15.16	85	0.82*	-23.39	69	0.59	-13.37
CR22	22.9	0.13	-0.15	133	1.46	57.70*	97	1.09	-7.14	72	0.79	28.27
Co1926	23.2	1.28	1.35	100	2.37	195.57**	76	0.92	193.04**	76	0.94	-14.08
Batkopahi-2	23.8	0.65	2.55*	117	-1.80	37.70	86	0.68	-13.61	74	1.01	52.83*
Betguti	22.2	0.94	1.82*	110	0.65	90.08*	81	1.71	-20.58	75	2.09	-10.18
Aghonsali	20.9	3.26	1.10	112	3.98	-13.75	90	1.12	58.92	79	0.55	-11.87

Kolong	23.6	0.58	-0.32	128	-2.44	20.43	81	0.43	290.96**	64	0.88	97.22**

*Significant at 5 per cent level of significance

**Significant at 1 per cent level of significance

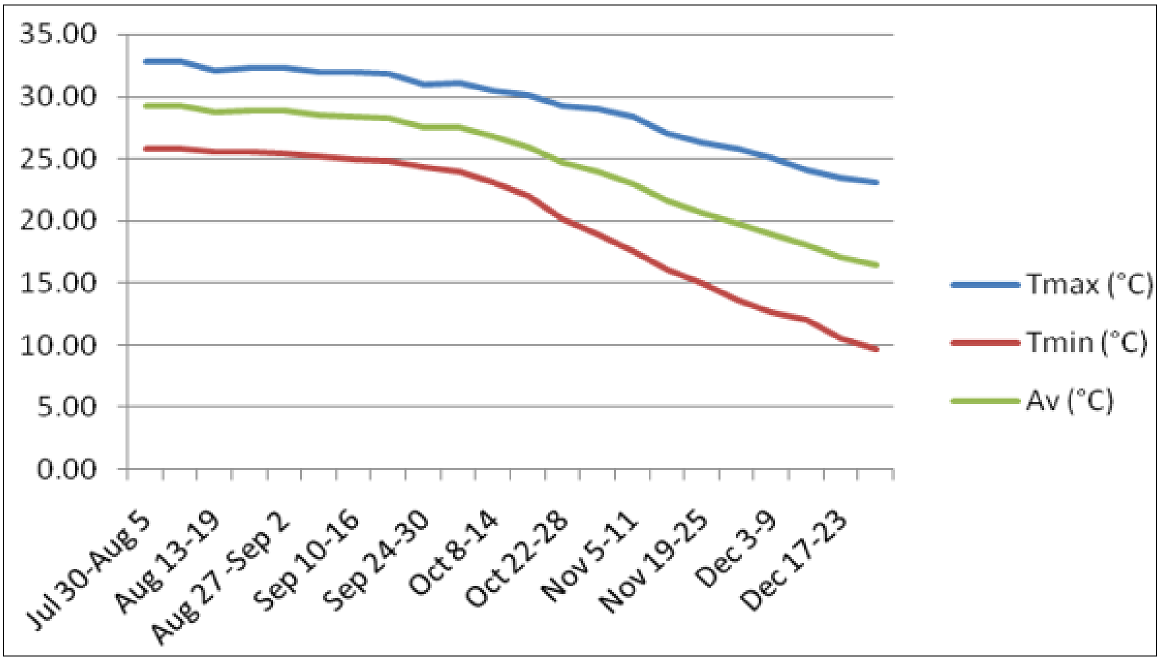

Fig 1: Normal weekly temperature during August to December at Jorhat

Conclusion

The present study highlights the significant potential of selecting promising traditional rice varieties from Assam's indigenous germplasm to help *sali* rice farmers in rainfed, stress-prone regions cope with climate change-induced stresses such as floods and droughts. At least two indigenous *sali* rice varieties, Aghonsali and Guarai-3, along with the modern check variety Kolong, demonstrated consistently high grain yield performance across all three sowing dates during the late *sali* season. These varieties exhibited remarkable adaptability to staggered sowing, making them suitable for cultivation in flood- and drought-affected areas of Assam and other parts of Eastern India.

Farmers in stress-prone environments have, over generations, cultivated specific rice varieties to mitigate the challenges posed by floods and droughts. Their traditional knowledge and experience, coupled with the rich diversity of indigenous germplasm, provide a valuable resource for developing climate-resilient rice varieties. It is imperative for breeders to integrate this farmer wisdom and germplasm into modern breeding programs to identify or develop varieties tailored to flood- and drought-prone conditions. Such an approach not only enhances the relevance of breeding efforts but also ensures the preservation and utilization of valuable genetic resources.

The study also revealed variations in the degree of photoperiod sensitivity among the tested traditional varieties, with none exhibiting strong photoperiod sensitivity. This finding underscores the need for further exploration of Assam's rice germplasm to identify strongly photoperiod-sensitive varieties, which could offer greater resilience to climatic uncertainties by flowering at predetermined times and escaping adverse environmental conditions. Additionally, the observed reduction in plant height and biological yield with delayed sowing, particularly under low-temperature conditions, highlights the importance of selecting varieties with stable yield traits across varying sowing dates.

The identification of Aghonsali, Guarai-3, and Kolong as stable and high-yielding varieties under staggered sowing conditions provides a strong foundation for promoting these varieties in stress-prone areas. Their consistent performance, coupled with their adaptability to late sowing, makes them ideal candidates for climate-resilient rice cultivation. Furthermore, the study emphasizes the importance of phenotypic stability analysis, as demonstrated by the Eberhart and Russell (1966) model, in identifying genotypes with general adaptability to diverse environmental conditions.

In conclusion, this study underscores the critical role of traditional rice germplasm in addressing the challenges posed by climate change. By leveraging the genetic diversity and adaptability of indigenous varieties, it is possible to develop sustainable rice cultivation strategies that enhance food security and improve the livelihoods of farmers in flood- and drought-prone regions. Future research should focus on large-scale screening of Assam's rice germplasm to identify additional varieties with strong photoperiod sensitivity and other desirable traits, thereby further strengthening the resilience of rice farming systems in the face of climate change. The findings from this study reinforce the importance of conserving and utilizing traditional rice varieties, not only for climate adaptation but also for maintaining agrobiodiversity and food security in the face of increasing climate uncertainties.

References

1. Bhattacharyya P, Nayak AK, Mohanty S. Climate change impacts on rice production and strategies for adaptation in Northeast India. Agric Syst. 2018;159:1-12.
2. Bora SS, Sarma RN, Baruah AR. Traditional rice varieties of Assam: A potential resource for sustainable agriculture. J Crop Improv. 2020;34(2):145-60.
3. Chakraborty P, *et al*. Climate-resilient rice: Breeding strategies for yield stability under variable environments. Theor Appl Genet. 2023;136:1205-20.
4. Devi MT, Singh PK, Das A. Drought and submergence tolerance in traditional rice varieties of Northeast India.

Crop Sci. 2020;60(3):1234-45.

5. Dutta R, Das P, Sarma KP. Flood risk assessment in the Brahmaputra River basin: Implications for rice cultivation in Assam. Nat Hazards. 2020;103(2):1235-54.
6. Gogoi N, Baruah KK, Gupta PK. Indigenous rice varieties of Assam: Potential for climate-resilient agriculture. Sustainability. 2021;13(4):2105.
7. He Y, *et al*. Genotypic variation and phenotypic plasticity in rice under different sowing dates. Agric Syst. 2022;198:103364.
8. IPCC. Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press; 2021.
9. Islam MS, *et al*. Photoperiod response and agronomic performance of rice under staggered sowing. Crop Sci. 2023;63:215-30.
10. Kiniry JR, McCauley G, Xie Y, Arnold JG. Rice parameters describing crop performance of four rice cultivars. Agron J. 2001;93:1354-61.
11. Kumar A, Singh S, Singh PK. Photoperiod sensitivity in traditional rice varieties: Implications for climate adaptation. Field Crops Res. 2019;231:1-10.
12. Kumar A, Singh S, Singh PK. Harvest index and yield stability in rice: Implications for climate-resilient breeding. Field Crops Res. 2020;249:107-15.
13. Kumar R, *et al*. Impact of temperature fluctuations on rice yield: A multi-location analysis. J Agron Crop Sci. 2022;208:177-89.
14. Liu X, *et al*. Assessing the influence of sowing time on rice productivity and climate resilience. Nat Plants. 2022;8:752-65.
15. Pathak K. Development of early-maturing rice varieties for flood-prone areas of Assam. Indian J Agric Sci. 2001;71(5):321-5.
16. Patra BC, Roy S, Gogoi B. Photoperiod sensitivity and its role in rice adaptation to changing climates. J Agron Crop Sci. 2022;208(3):245-56.
17. Roy S, Gogoi B, Saikia K. Traditional rice varieties of Assam: A treasure trove for climate-resilient agriculture. Genet Resour Crop Evol. 2022;69(1):45-60.
18. Saikia P, Bhattacharyya KG, Bora T. Climate change and its impact on rice production in Assam: A review. J Environ Manag. 2021;280:111694.
19. Sharma P, Singh R, Kumar S. Genotype × environment interaction and stability analysis in rice: A review. Crop Breed Appl Biotechnol. 2023;23(1):1-12.
20. Singh PK, Devi MT, Das A. Photoperiod sensitivity in rice: Genetic and physiological mechanisms. Plant Physiol Rep. 2021;26(2):123-35.
21. Wang Y, *et al*. Low-temperature stress and its effects on rice development. Plant Physiol Biochem. 2021;167:300-12.
22. Zhang H, *et al*. Genetic insights into rice adaptation to late-season sowing. Front Plant Sci. 2023;14:1048201.