



# **Morphological Depiction of Seeds of Landraces of Rice (*Oryza sativa* L.)**

**Gadge Sushant Sundarrao<sup>a</sup> and Bidhan Roy<sup>a\*</sup>**

<sup>a</sup> *Department of Seed Science and Technology, Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar 736165, West Bengal, India.*

## **Authors' contributions**

*This work was carried out in collaboration between both authors. Author BR did the conceptualization of the study. Author BR performed methodology, execution of the work and wrote original draft of the manuscript. Author GSS performed methodology, field experiment, data collection and analysis, investigation, wrote and reviewed the manuscript. Both authors read and approved the final manuscript.*

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## **ABSTRACT**

The landraces of rice play an important role as donor in breeding of varieties for desirable traits. One hundred twenty-one Farmers' Varieties (FVs) of rice collected from West Bengal, Assam and Manipur had used to characterize the physical parameters of seeds. Based on the kernel length and L/B ratio, most of the FVs were found to be long bold (31 FVs) and short bold (47 FVs). Out of the remaining 43 FVs, 27 were long slender, 03 were short slender and 11 were medium slender. Rice seeds were also classified based on test weight. Most of the FVs were medium-heavy (50 FVs) and heavy (27 FVs). The yield of the FVs varied from 0.91 t/ha to 5.19 t/ha. Jadudhan (5.19 t/ha) was found to be the maximum seed-yielding genotype followed by Jaldhyapa-1 (4.92 t/ha), Jagratikartik (4.69 t/ha), Jamainaru (4.68 t/ha), Kerala Sundari (4.58 t/ha), Satiya (4.44 t/ha), Dubari Komal (4.32 t/ha), Jugal (4.08 t/ha), Boichi (4.06 t/ha), Patanai (4.06 t/ha), UBL-4 (4.05 t/ha) and Khayamdhan (4.01 t/ha). From this collection, donors may be selected for breeding long-grained rice as well as rice with high test weight.

**Keywords:** *Rice; traditional varieties; seed physical characters; seed yield.*

## 1. INTRODUCTION

Farmers' varieties (FVs) of rice are an important reservoir of desirable traits for rice improvement [1,2]. Due to the poor yield potential of FVs, crop diversification, intensive cultivation of a number of crops in a piece of land and extensive cultivation of a few improved varieties of rice in a particular area currently caused reduction in cultivation area and number of the FVs. Non-cultivation lead the extinction of a considerable number of FVs of rice. Consequently, the FVs needs to be characterized to identify the desirable traits to be used as donor for auxiliary crop improvement [3].

India is the home for more than 75,000 FVs of rice [4,5]. Eastern and north-eastern parts of India rich in FVs of rice. About 200 FVs of rice have been collected from West Bengal, Assam

and Manipur. Those FVs are being conserved by cultivating four lines of 5 m length during every *Kharif* season. Some of the collected FVs already has been used as donor for development of high yielding varieties [3]. Considering the importance of the FVs in rice breeding, in this endeavour, the FVs were characterized based on seed physical parameters.

## 2. MATERIALS AND METHODS

### 2.1 Experimental Materials

The experimental material consists of 121 scented and non-scented genotypes collected from West Bengal, Assam and Manipur. Out of those two were Basmati varieties (Pusa Basmati and Pakistan Basmati), one improved variety (Swarna *Sub-1*) and 118 FVs of rice. The list of the FVs have been presented in Table 1.

**Table 1. The experimental material consist of 121 farmers' varieties of rice**

Sl. No.	Farmers' varieties	Sl. No.	Farmers' varieties	Sl. No.	Farmers' varieties	Sl. No.	Farmers' varieties
1.	A-1-1	31.	Deharadhun Gandheswari	61.	Kalonunia	91.	Patanai
2.	Agnisal	32.	Dharamphou	62.	Kalturey	92.	PLUE
3.	Annapurna	33.	Deshi Masori	63.	kanakchur	93.	Radhunipagal
4.	Badshahbhog	34.	Dubari Komal	64.	Kankari Joha	94.	Ramegali
5.	Banik	35.	Dudheswar 1	65.	Kashabinni	95.	Rangokomal
6.	Baroonsal	36.	Dudheswar 2	66.	Kashiyabinni	96.	Sadabhat Kalo
7.	Bashkathi	37.	Gandamundi	67.	Kataribhog	97.	Sada mala
8.	Pusa Basmati 1121	38.	Geetanjali	68.	Kauka	98.	Sadanunia
9.	BDO Nagara	39.	Gobindobhog	69.	Kauka Sel	99.	Sagarsugandhi
10.	Betho	40.	Harinikajoli	70.	Kerala Sundari	100.	<i>Salathiya Bora</i>
11.	Binni	41.	Indrasail	71.	Kharadhan	101.	Satiya
12.	Binnidhan	42.	Jadudhan	72.	Khayamghan	102.	Sitalkuchi
13.	Birali	43.	Jagratikantik	73.	Komal	103.	Sitalkuchi-6
14.	Birohi	44.	Jaldhyapa 1	74.	Kukurjali	104.	Songa Bora
15.	Bodhiya Tura	45.	Jaldhyapa-2	75.	Lagedhan-1	105.	Swarna <i>Sub-1</i>
16.	Boichi	46.	Jaldhyapa-3	76.	Lagedhan-2	106.	Talmunfar
17.	Bora	47.	Jalnary Bunni	77.	Lal Bashabhog	107.	Tarapakhari
18.	Baiganmaucha	48.	Jamainaru	78.	Lalbhuna	108.	Thuri
19.	Balam	49.	Jasawa	79.	Laldhyapa	109.	Tulaipunji
20.	Chakhao Soireiton	50.	JP-120	80.	Lal Mala	110.	Tulaipunji-AD
21.	Chakhao Sampak	51.	Jhara	81.	Magursal	111.	Tulshibhog
22.	Chakhao Sel 1	52.	Jugal	82.	Malshira	112.	UBL-15
23.	Chakhao Sel 2	53.	Kagey	83.	Marisal (r)	113.	UBL-16-1
24.	Chakhao Sel 3	54.	Kagey Black	84.	Marisal (W)	114.	UBL-18
25.	Chakhao Sel 4	55.	Kakri	85.	Morichsal	115.	UBL-3
26.	Chakhao Angangbi	56.	Kalawati	86.	Nilachal	116.	UBL-4
27.	Chamatkar	57.	Kaliaphulo	87.	Pahariboichi	117.	UN-1
28.	Chamarmani	58.	Kalo Aush	88.	Pakistani Basmati	118.	UN-4
29.	Chapka Chakhao	59.	Kalo boichi	89.	Panikuthi Shyamlal	119.	UN-9
30.	Deshi	60.	Kalodhyapa	90.	Phoolpakhari	120.	UN 12
						121.	Upendra

## 2.2 Methods

The experiment was conducted during *Kharif*, 2020 and *Kharif*, 2021 at University Research Farm, Pundibari, Cooch Behar, West Bengal, India situated at 26°19' N latitude, 99°23' E longitude and at a height of 43 MSL. Twenty eight days seedlings were transplanted in the main field following randomized block design in two replications. Plot size was 5 m × 1 m with two replication. Row-to-row distance was 30 cm and hill-to-hill distance was 20 cm. Standard cultural practice was followed to maintain good crop stand. Five plants from inner rows were selected to collect the seeds and recording observation on physical characters of seeds. Digital Varner's Calliper was used to measure the grain and kernel length and breadth. Plot yield were converted to t/ha.

## 2.3 Statistical Analysis

Randomized block design (RBD) was laid out for the experiment. The data were subjected to standard statistical methods of analysis of variance (ANOVA) using AgRes Statistical Software, (c) 1994 Pascal Intl Software Solutions, Version 3.01 and significant differences were compared by LSD at  $p=0.05$ . The analysis of data was used to interpret the results and draw conclusions.

## 3. RESULTS AND DISCUSSION

### 3.1 Analysis of Variance

Statistical analysis showed significant variation among the Farmers' Varieties of rice for seed length, seed breadth, kernel length, kernel breadth, test weight and yield (Table 2). Kernel shape also had variation among the FVs and FVs possessed all kind of shapes (extra-long slender, long slender, short slender, long bold, medium slender and short bold, Table 3). Noteworthy variation was also observed in FVs in

terms of qualitative characters [1,6,7,8], such as panicle shape (compact, loose, erect), awning (awnless, short to long awned), husk colour, (straw, golden, golden brown, purple black), grain shape (long slender, short slender, medium slender, long bold and short bold), lodging (susceptible and tolerant) and aroma (non-aromatic, strong aromatic, mild aromatic).

### 3.2 Seed Length (mm)

Seed length varied from 4.16 mm to 12.29 mm with a mean of 8.21 mm (Table 2). Pusa Basmati 1121 showed longest seed followed by Pakistani Basmati (11.74 mm), JP-120 (11.03 mm), Khayamdhan (10.86 mm), Dharamphou (10.86 mm) and Binni (10.44 mm). Badshabhog had shortest seed length (4.16 mm).

### 3.3 Seed Breadth (mm)

Breadth of seeds of FVs extended from 1.82 mm to 3.30 mm with a mean of 2.60 mm (Table 3). Maximum seed breadth was observed for Jugal (3.30 mm) trailed by Kalawati (3.27 mm), Lagedhan-2 (3.23 mm), Jaldhyapa-1 (3.22 mm), Gandamundi (3.21 mm), UN-4 (3.21 mm), UBL-15 (3.20 mm), Baroonsal (3.18 mm), Bora (3.14 mm), Rangokomal (3.11 mm), Sadabhat Khalo (3.10 mm), Lagedhan-1 (3.10 mm), Laldhyapa (3.08 mm), Morichsal (3.04 mm), Deshi (3.01 mm), Jagratikartik (3.01 mm), Jamainaru (3.01 mm) and UN 12 (3.01 mm). Minimum seed breadth was noted for Chamatkar (1.82 mm).

### 3.4 Kernel Length (mm)

Kernel length is important to decide the consumers' demand and market value of milled rice. Urban population desires the slender (extra-long slender, long slender and medium slender) milled rice.

The Kernel length varied from 3.99 mm to 9.09 mm with a mean of 6.09 mm (Table 4). Pusa Basmati 1121 had maximum kernel length

**Table 2. Analysis of variance of quantitative characters of 121 farmers' varieties of rice**

Characters	Mean sum of square		
	Replication	Treatment	Error
d. f.	1	120	120
Seed breadth	0.0022	0.2614**	0.0169
Seed length	0.0083	2.3919**	0.0700
Kernel breadth	0.0002	0.1998**	0.0080
Kernel breadth	0.0017	1.3788**	0.0526
Kernel L/B ratio	0.00003	0.6939**	0.0219
Test weight	0.0203	37.1744**	0.1131
Yield	3.5426	1.8792**	0.0825

\*\* denote significance  $P = 0.01$ ; d. f.: Degrees of freedom

(9.06 mm). Other FVs possessed longer kernel length were Pakistani Basmati (9.09 mm), Khayamdhan (7.88 mm), JP-120 (7.90 mm), Deharadhun Gandheswari (7.31 mm), Komal (7.23 mm), Sadanunia (7.51 mm), Chakhao Sel-4 (7.22 mm), Sagarsugandhi (7.28 mm), UN-1 (7.15 mm), Patanai (7.13 mm), Chakhao Sel-3 (7.01 mm), Kanakchur (7.01 mm), Salathiya Bora (7.03 mm) and Dharamphou (7.12 mm). Minimum kernel length was observed for Birali (4.16 mm) followed by UBL-3 (4.08 mm), Badshahbhog (3.99 mm), Kankari Joha (4.57 mm), Pankuthi Shyamlal (4.48 mm), Agnisal (4.50 mm), Jagratikartik (4.48 mm), Gobindobhog (4.57 mm) and Radhunipagal (5.03 mm).

Similar study was also conducted by Kaur et al. [9] for Basmati varieties of rice. Usually, the Basmati rice have longer kernel with narrow kernel bread leading long slender or extra-long slender kernel.

### 3.5 Kernel Breadth (mm)

Kernel breadth is also an important trait of rice grain to determine the slenderness of milled rice leading to providing a desirable length/breadth ratio.

The kernel breadth fluctuated between 1.66 mm and 3.00 mm with an average of 2.27 mm (Table 4). Minimum kernel breadth was recorded for Sada Nunia (1.66 mm). Other FVs having low values for kernel breadth were Deharadhun Gandheswari (1.67 mm), Chamatkar (1.68 mm), A-1-1 (1.78 mm), Kataribhog (1.79 mm), Basmati-1121 (1.79 mm), Chapka Chakhao (1.79 mm), Tulaipunji (1.80 mm), Sagarsugandhi (1.83 mm), Jalnary Bunni (1.85 mm), Kankari Joha (1.85 mm), Phoolpakhari (1.88 mm), Tulshibhog (1.89 mm), Kagey (1.89 mm), Kalturey (1.90 mm), Komal (1.93 mm), Patanai (1.93 mm), UBL-3 (1.93 mm), Tulaipunji-AD (1.93 mm), Magursal (1.94 mm), Kashiyabinni (1.94 mm), Geetanjali (1.96 mm), Annapurna (1.96 mm), Gobindobhog (1.96 mm), Kukurjali (1.96 mm), Talmunfar (1.98 mm), Radhunipagal (1.98 mm) and Agnisal (1.98 mm).

Wider kernel breadth leads bold milled rice shape. The FVs those had > 2.50 mm kernel breadth were Lal Mala (2.50 mm), UBL-15 (2.50 mm), Dudheswar 2 (2.51 mm), Chakhao Angangbi (2.51 mm), Kalo Boichi (2.51 mm), Betho (2.56 mm), Ramegali (2.56 mm), Boichi (2.57 mm), Kharadhan (2.57 mm), Kalawati (2.60 mm), UBL-16-1 (2.61 mm), Jadudhan (2.62 mm),

Jagratikartik (2.63 mm), Jamainaru (2.64 mm), Laldhyapa (2.64 mm), Morichsal (2.65 mm), Kaliaphulo (2.65 mm), Dubari Komal (2.66 mm), Jugal (2.69 mm), Baroonsal (2.73 mm), Bora (2.74 mm), Marisal (W) (2.75 mm), Lagedhan-2 (2.78 mm), Gandamundi (2.82 mm), Jasawa (2.83 mm), Deshi (2.83 mm), Kalodhyapa (2.89 mm), Lagedhan-1 (2.91 mm), Rangokomal (2.93 mm), UN-4 (2.93 mm) and Jaldhyapa-1 (3.00 mm).

### 3.6 Kernel Length/Breadth Ratio

Length/Breadth ratio of rice kernel is an essential parameter for classification of shape of the milled rice. It varied across the FVs from 1.71 to 5.05 with a grand mean of 2.74 (Table 4). Slender kernel possessed high length/breadth ratio. Maximum L/B ratio was observed for Pusa Basmati 1121 (5.05). The FVs had L/B ratio > 3.00 were Sadanunia (4.53), Pakistani Basmati (4.52), Deharadhun Gandheswari (4.39), Sagarsugandhi (3.98), Patanai (3.76), Komal (3.76), Dharamphou (3.58), JP-120 (3.57), Chapka Chakhao (3.48), Marisal (r) (3.45), Chakhao Sel 4 (3.41), Chakhao Sel 3 (3.38), Binni (3.34), Khayamdhan (3.34), Kagey (3.32), Annapurna (3.28), *Salathiya Bora* (3.28), A-1-1 (3.24), Chakhao Sampak (3.23), Kanakchur (3.22), Phoolpakhari (3.22), Kataribhog (3.21), UN-1 (3.18), Tulaipunji (3.17), Chamatkar (3.17), Nilachal (3.16), Deshi Masori (3.16), Songa Bora (3.15), Magurshal (3.15), Kashiyabinni (3.15), Kalturey (3.15), Tulaipunji-AD (3.14), Geetanjali (3.08), Kerala Sundari (3.08), Jalnary Bunni (3.05) and UBL-18 (3.01).

Minimum L/B ratio (1.71) was observed for Jhgrikartic. Other FVs had low values for L/B ratio were Jasawa (1.99), Jaldhyapa 1 (1.97), Deshi (1.95), UN-4 (1.88), Badshahbhog (1.85), Birali (1.85), Lagedhan-1 (1.83) and Jagratikartik (1.71). Low range of L/B ratio indication of bold rice grain/kernel. Similar study was performed by Divya Prasanna Kumari et al. [10], Roy [11] and Roy et al. [12].

### 3.7 Grain Types

Classification of the grain size and shape is not uniform across the country [13]. The grain classification in India is being followed according to the Ramaiha Committee, thus the grain types has been classified as outlined by Ramaiha Committee [14] and presented in Table 5. Twenty seven FVs were found to have long slender grain, three were short slender, 11 were medium slender 31 were long bold, 47 were short bold and two were extra-long slender.

Table 3. Seed length of 121 farmers' varieties of rice

Farmers' varieties	Seed length (mm)	Seed breadth (mm)	Farmers' varieties	Seed length (mm)	Seed breadth (mm)	Farmers' varieties	Seed length (mm)	Seed breadth (mm)
A-1-1	8.18	2.01	Indrasail	8.26	2.57	Magurshal	8.47	2.26
Agnisal	6.35	2.19	Jadudhan	8.05	2.81	Malshira	7.90	2.43
Annapurna	9.29	2.96	Jagratikartik	6.45	3.01	Marisal (r)	8.00	2.92
Badshahbhog	4.16	2.28	Jaldhyapa 1	8.24	3.22	Marisal (W)	8.05	3.06
Banik	7.95	2.90	Jaldhyapa-2	7.48	2.85	Morichsal	8.36	3.04
Baroonsal	8.57	3.18	Jaldhyapa-3	8.40	2.93	Nilachal	8.96	2.26
Bashkathi	8.02	2.73	Jalnary Bunni	7.80	2.17	Pahariboichi	8.20	2.40
Pusa Basmati 1121	12.29	2.18	Jamainaru	8.18	3.01	Pakistani Basmati	11.74	2.39
BDO nagara	8.51	2.28	Jasawa	8.02	2.96	<i>Pankuthi Shyamalal</i>	5.93	2.27
Betho	8.40	2.83	JP-120	11.03	2.42	Phoolpakhari	7.85	2.19
Binni	10.44	2.54	Jhara	7.92	2.76	Patanai	8.07	2.51
Binnidhan	8.73	2.59	Jugal	8.12	3.30	PLUE	8.43	2.86
Birali	5.69	2.49	kagey	8.11	2.08	Radhunipagal	6.17	2.29
Birohi	8.14	2.37	Kagey Black	7.50	2.56	Ramegali	8.79	2.90
Bodhiya Tura	7.41	2.42	Kakri	8.06	2.76	Rangokomal	8.30	3.11
Boichi	7.15	2.90	Kalawati	8.13	3.27	Sadabhat Khalo	8.99	3.10
Bora	8.01	3.14	Kaliaphulo	8.73	2.96	Sada mala	8.05	2.28
Baiganmaucha	9.01	2.67	Kalo aush	8.07	2.55	Sadanunia	9.60	2.08
Balam	7.55	2.61	Kalo boichi	8.58	2.86	Sagarsugandhi	8.01	2.15
Chakhao Poireiton	9.07	2.64	kalodhyapa	8.05	3.05	Salathiya Bora	9.42	2.40
Chakhao Sampak	9.11	2.46	Kalonunia	7.34	2.28	Satiya	8.18	2.49
Chakhao Sel 1	8.97	2.46	Kalturey	8.36	2.17	Sitalkuchi	8.07	2.74
Chakhao Sel 2	8.91	2.77	kanakchur	7.94	2.95	Sitalkuchi-6	8.52	2.91
Chakhao Sel 3	8.83	2.55	Kankari joha	5.55	2.30	Songa Bora	8.17	2.29
Chakhao Sel 4	8.68	2.50	Kasha binni	7.68	2.49	Swarna <i>Sub-1</i>	8.41	2.65
Chakhao Angangbi	8.35	2.81	Kashiya binni	8.58	2.20	Talmunfar	7.27	2.13
Chamatkar	7.38	1.82	Kataribhog	8.12	1.94	Tarapakhari	8.78	2.57
Chamarmani	7.78	2.21	Kauka	8.54	2.51	Thuri	8.21	2.63
Chapka Chakhao	8.63	2.10	Kauka sel	7.44	2.31	Tulaipunji	8.07	1.94
Deshi	7.51	3.01	Kerala Sundari	7.73	2.65	Tulaipunji-AD	8.58	2.10

Farmers' varieties	Seed length (mm)	Seed breadth (mm)	Farmers' varieties	Seed length (mm)	Seed breadth (mm)	Farmers' varieties	Seed length (mm)	Seed breadth (mm)
Deharadhun gandheswari	9.23	1.99	Kharadhan	8.67	2.84	Tulshibhog	7.26	2.10
Dharamphou	10.86	2.21	Khayamdhan	10.86	2.71	UBL-15	8.06	3.20
Deshi Masori	8.27	2.34	Komal	8.06	2.45	UBL-16-1	7.77	2.87
Dubari Komal	8.48	2.98	Kukurjali	8.34	2.19	UBL-18	9.55	2.50
Dudheswar 1	8.12	2.83	Lagedhan-1	7.26	3.10	UBL-3	5.79	2.13
Dudheswar 2	8.12	2.86	Lagedhan-2	8.00	3.23	UBL-4	7.48	2.43
Gandamundi	8.36	3.21	<i>Lal Bashabhog</i>	7.12	2.30	UN-1	9.61	2.46
Geetanjali	8.11	2.41	Lalbhuna	8.10	2.41	UN-4	7.76	3.21
Gobindobhog	6.01	2.20	Laldhyapa	8.25	3.08	UN-9	8.83	2.95
Harinikajoli	8.39	2.81	Lal Mala	8.18	2.78	UN 12	8.02	3.01
						Upendra	9.09	3.06
						<b>Range</b>	4.16-12.29	1.82-3.30
						<b>Mean</b>	8.21	2.60
						<b>C.D. (5%)</b>	0.524	0.454
						<b>C.D. (1%)</b>	0.692	0.600
						<b>CV (%)</b>	3.23	5.02

Table 4. Kernel length of 121 farmers' varieties of rice

Farmers' varieties	Kernel length (mm)	Kernel breadth (mm)	L/B ratio	Grain type	Farmers' varieties	Kernel length (mm)	Kernel breadth (mm)	L/B ratio	Grain type
A-1-1	5.76	1.78	3.24	SS	Kalo Nunia	5.53	2.06	2.68	SB
Agnisal	4.50	1.98	2.27	SB	Kalturey	5.96	1.90	3.15	LB
Annapurna	6.44	1.96	3.28	LS	kanakchur	7.01	2.18	3.22	LB
Badshahbhog	3.99	2.16	1.85	SB	Kankari Joha	4.57	1.85	2.47	SB
Banik	6.73	2.30	2.93	LB	Kashabinni	5.35	2.26	2.37	SB
Baroonsal	6.25	2.73	2.29	LB	Kashiya binni	6.11	1.94	3.15	LB
Bashkathi	6.17	2.07	2.98	LB	Kataribhog	5.74	1.79	3.21	MS
Pusa Basmati 1121	9.06	1.79	5.05	ELS	Kauka	6.09	2.15	2.84	LB
BDO Nagara	6.06	2.14	2.84	LB	Kauka Sel	5.56	2.18	2.56	MS
Betho	5.97	2.56	2.33	SB	Kerala Sundari	6.62	2.15	3.08	LS
Binni	7.25	2.18	3.34	LS	Kharadhan	6.33	2.57	2.46	LB
Binnidhan	6.11	2.43	2.51	LB	Khayamdhan	7.83	2.35	3.34	LS
Birali	4.16	2.26	1.85	SB	Komal	7.23	1.93	3.76	LS
Birohi	5.89	2.11	2.79	MS	Kukurjali	5.65	1.96	2.88	MS
Bodhiya Tura	5.96	2.26	2.64	MS	Lagedhan-1	5.30	2.91	1.83	SB
Boichi	5.79	2.57	2.26	SB	Lagedhan-2	6.07	2.78	2.19	LB
Bora	5.83	2.74	2.13	SB	Lal Bashabhog	5.38	2.05	2.64	SB
Baiganmaucha	6.41	2.40	2.68	LB	Lalbhuna	5.74	2.19	2.63	SB
Balam	5.42	2.32	2.38	SB	Laldhyapa	5.83	2.64	2.21	SB
Chakhao Poireiton	6.40	2.15	2.97	LB	Lal Mala	6.29	2.50	2.52	LB
Chakhao Sampak	7.15	2.21	3.23	LS	Magursal	6.10	1.94	3.15	LS
Chakhao Sel 1	6.20	2.10	2.96	LB	Malshira	5.78	2.19	2.64	MS
Chakhao Sel 2	6.81	2.36	2.89	LB	Marisal (r)	7.77	2.25	3.45	LS
Chakhao Sel 3	7.01	2.07	3.38	LS	Marisal (W)	5.94	2.75	2.16	SB
Chakhao Sel 4	7.22	2.12	3.41	LS	Morichsal	5.93	2.65	2.24	SB
Chakhao Angangbi	5.78	2.51	2.31	SB	Nilachal	6.40	2.03	3.16	LS
Chamatkar	5.33	1.68	3.17	SS	Pahariboichi	6.18	2.27	2.73	LB
Chamarmani	5.67	2.08	2.73	MS	Pakistani Basmati	9.09	2.01	4.52	ELS

Farmers' varieties	Kernel length (mm)	Kernel breadth (mm)	L/B ratio	Grain type	Farmers' varieties	Kernel length (mm)	Kernel breadth (mm)	L/B ratio	Grain type
Chapka Chakhao	6.23	1.79	3.48	LS	Panikuthi Shyamlal	4.50	2.17	2.08	SB
Deshi	5.53	2.83	1.95	SB	Phoolpakhari	6.04	1.88	3.22	LS
Deharadhun Gandheswari	7.31	1.67	4.39	LS	Patanai	7.24	1.93	3.76	LS
Dharamphou	7.20	2.01	3.58	LS	PLUE	6.52	2.43	2.68	LB
Deshi Masori	6.49	2.06	3.16	LS	Radhunipagal	5.03	1.98	2.55	SB
Dubari Komal	6.29	2.66	2.36	LB	Ramegali	6.32	2.56	2.47	LB
Dudheswar 1	5.73	2.43	2.37	SB	Rangkokomal	5.99	2.93	2.05	SB
Dudheswar 2	5.72	2.51	2.28	SB	Sadabhat Kalo	6.59	2.47	2.67	LB
Gandamundi	6.34	2.82	2.25	LB	Sadamala	5.85	2.06	2.85	SB
Geetanjali	6.02	1.96	3.08	LS	Sadanunia	7.51	1.66	4.53	LS
Gobindobhog	4.57	1.96	2.33	SB	Sagarsugandhi	7.28	1.83	3.98	LS
Harinikajoli	6.14	2.40	2.56	MS	Salathiya Bora	7.03	2.14	3.28	LS
Indrasail	5.83	2.27	2.58	SB	Satiya	5.71	2.36	2.42	SB
Jadudhan	5.68	2.62	2.17	SB	Sitalkuchi	6.12	2.46	2.49	LB
Jagratikartik	4.48	2.63	1.71	SB	Sitalkuchi-6	6.03	2.45	2.47	LB
Jaldhyapa 1	5.90	3.00	1.97	SB	Songa Bora	6.43	2.04	3.15	LS
Jaldhyapa-2	5.60	2.42	2.32	SB	Swarna Sub-1	6.27	2.43	2.59	MS
Jaldhyapa-3	5.87	2.38	2.47	SB	Talmunfar	5.69	1.98	2.88	SB
Jalnary Bunni	5.64	1.85	3.05	SS	Tarapakhari	6.22	2.25	2.76	MS
Jamainaru	5.76	2.64	2.18	SB	Thuri	5.85	2.43	2.42	SB
Jasawa	5.62	2.83	1.99	SB	Tulaipunji	5.70	1.80	3.17	MS
JP-120	7.90	2.21	3.57	LS	Tulaipunji-AD	6.06	1.93	3.14	LS
Jhara	5.56	2.36	2.35	SB	Tulshibhog	5.40	1.89	2.86	SB
Jugal	5.98	2.69	2.23	SB	UBL-15	5.53	2.50	2.22	SB
Kagey	6.28	1.89	3.32	LS	UBL-16-1	5.83	2.61	2.24	SB
Kagey Black	5.23	2.26	2.31	SB	UBL-18	6.78	2.25	3.01	LS
Kakri	6.05	2.49	2.43	LB	UBL-3	4.08	1.93	2.12	SB
Kalawati	5.69	2.60	2.19	SB	UBL-4	5.38	2.02	2.67	SB
Kaliaphulo	6.55	2.65	2.48	LB	UN-1	7.15	2.25	3.18	LS



Farmers' varieties	Kernel length (mm)	Kernel breadth (mm)	L/B ratio	Grain type	Farmers' varieties	Kernel length (mm)	Kernel breadth (mm)	L/B ratio	Grain type
Kalo Aush	5.52	2.42	2.28	SB	UN-4	5.49	2.93	1.88	SB
Kaloboichi	6.25	2.51	2.49	LB	UN-9	6.52	2.38	2.74	LB
Kalodhyapa	6.26	2.89	2.17	LB	UN 12	6.57	2.41	2.73	LB
					Upendra	6.33	2.38	2.66	LB
					<b>Range</b>	3.99-9.09	1.66-3.00	1.71-5.05	-
					<b>Mean</b>	6.09	2.27	2.74	-
					<b>C.D. (5%)</b>	0.454	0.178	0.293	-
					<b>C.D. (1%)</b>	0.600	0.235	0.388	-
					<b>CV (%)</b>	3.77	3.96	5.41	-

Most of the FVs were classified as short bold and long bold categories. The genotypes showed extra-long slender kernels were Basmati. Those two varieties were considered in this experiment as reference varieties for extra-long slender kernel. Most of the urban Indian consumers prefer extra-long and long slender rice and those two groups facet 'premium quality' [15]. Medium slender and short slender fall under 'good/medium quality'. Finally, long bold and short bold 'low quality' in urban India. However, long bold and short bold rice have good demand in rural India.

Grain size depends on length of grains and its maximum width, whereas, the shape depends on length/breadth ratio [16].

### 3.8 Seed Test Weight (g)

Seed test weight varied from 11.24 g to 30.06 g with a mean of 21.11 g (Table 6). The test weight of rice grain more than 20 g is desirable [17]. Seventy seven FVs showed test weight more than 20 g. The FVs which showed > 20 g/1000 seeds were Dubari Komal (30.06 g), Jaldhyapa-2 (29.27 g), Deshi (28.63 g), Rango Komal (28.54 g), Boichi (28.09 g), Baroonshal (27.58 g), Khayamdhan (27.36 g), Laldhyapa (27.18 g), Jaldhyapa-3 (26.46 g), Kharadhan (26.37 g), PLUE (26.36 g), Rameegali (26.34 g), Gandamundi (25.97 g), *Salathiya Bora* (25.81 g), Lagedhan-2 (25.64 g), Bora (25.61 g), Kalawati (25.55 g), Lagedhan-1 (25.52 g), Sadabhat Kalo (25.51 g), Kaloboichi (25.51 g), *SWARNA SUB-1* (25.51 g), UBL-16-1 (25.48 g), Binnidhan (25.38 g), Chakhao Poireiton (25.33 g), Jasawa (25.32 g) and Jhara (25.30 g).

In the present investigation the minimum test weight was observed for Lal Badshabhog (11.24 g) followed by Chamatkar (11.52 g), Jalnary Bunni (12.06 g), Agnisal (12.12 g), Tulaipunji-AD (12.56 g), Birali (13.00 g), UBL-3 (13.10 g), Tulshibhog (13.58 g), Gobindobhog (13.61 g) and ulaipunji (13.76 g). The test weight of newly developed rice varieties are comparatively low, because most of the newly bred rice varieties are slender types (long slender, medium slender or extra-long slender). Study of Divya Prasanna Kumari [10] on test weight showed a range of 14.03 g to 24.07 g.

Wide range of variation in test weight was observed in FVs. This variation could be due to different in place of origin and genetic make-up of the genotypes [18,19].

### 3.9 Classification of FVs of Rice based on Test Weight

Detail of classification of rice seeds based on test weight was presented in Table 7. The seed of 27 FVs were found to be heavy, 50 were medium, 31 were light and 13 were very light based on test weight. Kwarteng et al. [17] stated that rice varieties showing 1000-grain weight more than 20 g are desirable to increase grain/seed yield.

### 3.10 Seed Yield (t/ha)

Eventually assessment of the yield potentiality of individual genotype is the main objective of seed or crop production. The seed yield varied from 0.91 t/ha to 5.19 t/ha with a mean of 2.49 t/ha (Table 6). The national average yield of rice during 2021 was 2.71 t/ha (<https://www.statista.com/statistics/764299/india-yield-of-rice/>; 19.08.2022) and West Bengal average productivity during 2021 was 2.98 t/ha (<https://www.ceicdata.com/en/india/yield-of-foodgrains-in-major-states-rice/agricultural-yield-foodgrains-rice-west-bengal>; 19.08.2021).

Maximum yield was recorded for Jadudhan (5.19 t/ha) followed by Jaldhyapa 1 (4.92 t/ha), Jagratikartik (4.69 t/ha), Jamainaru (4.68 t/ha), Kerala Sundari (4.58 t/ha), Satiya (4.44 t/ha), Dubari Komal (4.32 t/ha), Jugal (4.08 t/ha), Boichi (4.06 t/ha), Patanai (4.06 t/ha), UBL-4 (4.05 t/ha) and Khayamdhan (4.01 t/ha).

Poorest yield was recorded for Dehradun Gandheswari (0.91 t/ha). Other FVs showed poor yield were Bodhiya Tura (1.02 t/ha), Geetanjali (1.05 t/ha), Harinikajoli (1.06 t/ha), Lagedhan-2 (1.07 t/ha), Dharamphou (1.09 t/ha), Marisal (W) (1.15 t/ha), *Lal Bashabhog* (1.20 t/ha), Lalbhuna (1.20 t/ha), Chakhao Sel 2 (1.22 t/ha), Chamarmani (1.25 t/ha), Jasawa (1.26 t/ha), Chakhao Poireiton (1.28 t/ha), Talmunfar (1.37 t/ha), Birali (1.37 t/ha), Kashiabinni (1.42 t/ha), Chakhao Sel 3 (1.46 t/ha), Tarapakhari (1.47 t/ha) and Agnisal (1.48 t/ha).

Yield and quality characters depends on the genetic potential, prevailing weather parameters and cultural practices [18]. The yield of traditional cultivars of rice influenced by seasonal variation and also the time of sowing and transplanting [20]. The possible initiation of flowering time in response to seasonal change mainly determines the yield potential [21] and a positive correlation was found between grain yield and flowering time Gao et al. [22].

**Table 5. Classification of milled rice shape according to the suggestion by Ramaiha Committee [14]**

Sl. No.	Classes	Farmers' varieties	Number of FVs
1.	Long slender	Annapurna, Binni, Chakhao Sampak, Chakhao Sel 3, Chakhao Sel 4, Chapka Chakhao, Deharadhun Gandheswari, Dharamphou, Deshi Masori, Geetanjali, JP-120, Kagey, Kerala Sundari, Khayamdhan, Komal, Magurshal, Marisal (r), Nilachal, Phoolpakhari, Patanai, Sadanunia, Sagarsugandhi, Salathiya Bora, Songa Bora, Tulaipunji-AD, UBL-18, UN-1	27
2.	Short slender	A-1-1, Chamatkar, Jalnary Bunni	03
3.	Medium slender	Birohi, Bodhiyatura, Chamarmani, Harinikajoli, Kataribhog, Kauka Sel, Kukurjali, Malshira, Swarna <i>Sub-1</i> , Tarapakhari, Tulaipunji	11
4.	Long bold	Banik, Baroonshal, Bashkathi, BDO Nagara, Binnidhan, Baiganmaucha, Chakhao Poireiton, Chakhao Sel 1, Chakhao Sel 2, Dubari Somal, Gandamundi, Kakri, Kaliaphulo, Kaloboichi, Kalodhyapa, Kalturey, Kanakchur, Kashiya inni, Kauka, Kharadhan, Lagedhan-2, Lal Mala, Pahariboichi, PLUE, Rameegali, Sadabhat Kalo, Sitalkuchi, Sitalkuchi-6, UN-9, UN 12, Upendra	31
5.	Short bold	Agnisal, Badshahbhog, Betho, Birali, Boichi, Bora, Balam, Chakhao Angangbi, Deshi, Dudheswar 1, Dudheswar 2, Gobindobhog, Indrasail, Jadudhan, Jagratikartik, Jaldhyapa-1, Jaldhyapa-2, Jaldhyapa-3, Jamainaru, Jasawa, Jhara, Jugal, Kagey Black, Kalawati, Kalo aush, Kalo Nunia, Kankani Joha, Kashabinni, Lagedhan-1, Lal Bashabhog, Lalbhuna, Laldhyapa, Marisal (W), Morichsal, Pankuthi Shyamlal, Radhunipagal, Rangokomal, Sada Mala, Satiya, Talmunfar, Thuri, Tulshibhog UBL-15, UBL-16-1, UBL-3, UBL-4, UN-4	47
6.	Extra-long slender	Basmati-1121, Pakistani Basmati	2

**Table 6. Seed test weight and seed yield of 121 farmers' varieties of rice**

Farmers' varieties	Test weight (g)	Yield (t/ha)	Farmers' varieties	Test weight (g)	Yield (t/ha)	Farmers' varieties	Test weight (g)	Yield (t/ha)
A-1-1	24.06	1.69	Indrasail	21.43	1.86	Magursal	24.19	2.40
Agnisal	12.12	1.48	Jadudhan	22.30	5.19	Malshira	21.65	1.88
Annapurna	21.63	2.60	Jagratikartik	17.65	4.69	Marisal (r)	19.27	1.56
Badshahbhog	14.49	3.29	Jaldhyapa 1	25.20	4.92	Marisal (W)	18.38	1.15
Banik	18.49	2.25	Jaldhyapa-2	29.27	1.54	Morichsal	22.28	2.04
Baroonsal	27.58	2.99	Jaldhyapa-3	26.46	2.25	Nilachal	24.00	3.79
Bashkathi	20.08	3.52	Jalnary Bunni	12.06	3.01	Pahari boichi	15.23	3.07
Pusa Basmati-1121	17.98	1.68	Jamainaru	20.64	4.68	Pakistani Basmati	21.24	2.02
BDO Nagara	20.78	2.86	Jasawa	25.32	1.26	Pankuthi Shyamlal	22.48	1.97
Betho	19.37	2.39	JP-120	23.52	3.67	Phoolpakhari	15.39	3.46
Binni	20.36	1.82	Jhara	25.30	1.96	Patanai	21.51	4.06
Binnidhan	25.38	2.42	Jugal	24.22	4.08	PLUE	26.36	2.22
Birali	13.00	1.37	kagey	19.23	2.19	Radhunipagal	15.42	2.89
Birohi	19.45	3.20	Kagey Black	19.66	2.65	Ramegali	26.34	2.22
Bodhiya Tura	20.72	1.02	Kakri	16.24	1.93	Rangokomal	28.54	2.92
Boichi	28.09	4.06	Kalawati	25.55	3.53	Sadabhat Kalo	25.51	2.84
Bora	25.61	2.30	Kaliaphulo	16.71	3.49	Sada mala	19.37	2.19
Baiganmaucha	16.07	2.50	Kalo aush	18.36	1.77	Sadanunia	16.52	3.67
Balam	21.21	2.91	Kalo boichi	25.51	1.57	Sagarsugandhi	16.28	1.89
Chakhao Poireiton	25.33	1.28	kalodhyapa	24.35	3.25	Salathiya Bora	25.81	2.82
Chakhao Sampak	20.50	3.87	Kalonunia	17.60	2.17	Satiya	21.51	4.44
Chakhao Sel 1	17.57	1.59	Kalturey	14.14	1.73	Sitalkuchi	23.31	2.95
Chakhao Sel 2	18.47	1.22	kanakchur	21.68	1.96	Sitalkuchi-6	22.49	3.01
Chakhao Sel 3	24.46	1.46	Kankari joha	14.35	2.76	Songa Bora	21.39	2.65
Chakhao Sel 4	23.35	2.13	Kasha binni	22.72	1.42	Swarna Sub-1	25.51	2.07
Chakhao Angangbi	23.79	2.33	Kashiya binni	18.52	3.09	Talmunfar	16.24	1.37
Chamatkar	11.52	1.65	Kataribhog	17.52	1.59	Tarapakhari	17.14	1.47
Chamarmani	19.42	1.25	Kauka	24.18	2.82	Thuri	21.63	2.70
Chapka Chakhao	23.92	2.52	Kauka Sel	23.31	3.50	Tulaipunji	13.76	2.75
Deshi	28.63	1.82	Kerala Sundari	20.21	4.58	Tulaipunji-AD	12.56	2.30
Deharadhun gandheswari	22.81	0.91	Kharadhan	26.37	2.68	Tulshibhog	13.58	1.61

Farmers' varieties	Test weight (g)	Yield (t/ha)	Farmers' varieties	Test weight (g)	Yield (t/ha)	Farmers' varieties	Test weight (g)	Yield (t/ha)
Dharamphou	22.93	1.09	Khayamdhan	27.36	4.01	UBL-15	24.12	2.05
Deshi masori	24.06	1.58	Komal	23.72	2.26	UBL-16-1	25.48	2.37
Dubari Komal	30.06	4.32	Kukurjali	19.29	1.51	UBL-18	18.31	2.96
Dudheswar 1	21.12	2.16	Lagedhan-1	25.52	3.30	UBL-3	13.10	2.43
Dudheswar 2	20.41	2.37	Lagedhan-2	25.64	1.07	UBL-4	19.43	4.05
Gandamundi	25.97	2.85	Lal Badshabhog	11.24	1.20	UN-1	22.45	2.27
Geetanjali	23.43	1.05	Lalbhuna	21.38	1.20	UN-4	22.51	2.53
Gobindobhog	13.61	2.87	Laldhyapa	27.18	3.75	UN-9	19.67	3.17
Harinikajoli	21.58	1.06	Lal Mala	21.49	3.01	UN 12	20.41	2.88
						Upendra	22.46	1.62
						<b>Range</b>	11.24-30.06	0.91-5.19
						<b>Mean</b>	21.11	2.49
						<b>C.D. (5%)</b>	0.666	0.568
						<b>C.D. (1%)</b>	0.880	0.752
						<b>CV (%)</b>	1.59	11.53

**Table 7. Classification of 121 farmers' varieties of rice based on test weight**

Sl. No	Class	Test weight (g)	Name of the FVs	No. of the FVs
1.	Very light	≤ 15.0 g	Badshahbhog, Kankari Joha, Kulturey, Tulaipunji, Gobindobhog, Tulshibhog, UBL-3, Biral, Tulaipunji-AD, Agnisal, Jalnary Bunni, Chamatkar, <i>Lal Bashabhog</i>	13
2.	Light	15.0 - 20.0 g	UN-9, Kagey Black, Birohi, UBL-4, Chamarmani, Betho, Sadamala, Kukurjali, Marisal (r), Kagey, Kashiya Binni, Banik, Chakhao Sel 2, Marisal (W), Kalo Aush, UBL-18, Pusa Basmati 1121, Jagratikartik, Kalo Nunia, Chakhao Sel 1, Kataribhog, Tarapakhari, Kaliaphulo, Sadanunia, Sagarsugandhi, Kakri, Talmunfar, Baiganmaucha, Radhunipagal, Phoolpakhari, Pahariboichi	31
3.	Medium heavy	≥ 20.0 g and < 25 g	Chakhao Sel 3, Kalodhyapa, Jugal, Magurshal, Kauka, UBL-15, A-1-1, Deshi masori, Nilachal, Chapka Chakhao, Chakhao Angangbi, Komal, JP-120, Geetanjali, Chakhao Sel 4, Kauka Sel, Sitalkuchi, Dharamphou, Deharadhun Gandheswari, Kashiabinni, UN-4, Sitalkuchi-6, Panikuthi Shyamlal, Upendra , UN-1, Jadudhan, Morichsal , Kanakchur, Malshira, Annapurna, Thuri, Harinikajoli, Satiya, Patanai, Lal Mala, Indrasail, Songa Bora, Lalbhuna, Pakistani Basmati, Balam, Dudheswar 1, BDO nagara, Bodhiya tura, Jamainaru, Chakhao Sampak, Dudheswar 2, UN 12, Binni, Kerala Sundari, Bashkathi	50
4.	Heavy	≥ 25.0 g	Dubari Komal, Jaldhyapa-2, Deshi, Rango Komal, Boichi, Baroonshal, Khayamdhan, Laldhyapa, Jaldhyapa-3, Kharadhan, PLUE, Ramegali, Gandamundi, <i>Salathiya Bora</i> , Lagedhan-2, Bora, Kalawati, Lagedhan-1, Sadabhat Khalo, Kaloboichi, Swarna <i>Sub-1</i> , UBL-16-1, Binnidhan, Chakhao Poireiton, Jasawa, Jhara, Jaldhyapa 1	27

#### 4. CONCLUSION

The seed/grain yield of Farmers' Varieties of rice is comparatively low, however, they possessed some special or desirable traits that can be used for breeding to improve the crop. In the present investigation, 121 FVs of rice were subjected to analysis of seed physical parameters along with yield. The parameters considered were seed length, seed breadth, kernel length, kernel breadth, L/B ratio, kernel shape, test weight and seed yield. The result revealed that maximum number of FVs were long bold and short bold. Twenty seven were found to have long slender grain, three were short slender, 11 were medium slender 31 were long bold, 47 were short bold and two were extra-long slender. The yield ranged from 0.91 t/ha to 5.19 t/ha. Maximum yield was recorded for Jadudhan (5.19 t/ha) followed by Jaldhyapa 1 (4.92 t/ha), Jagratikartik (4.69 t/ha), Jamainaru (4.68 t/ha), Kerala Sundari (4.58 t/ha), Satiya (4.44 t/ha), Dubari Komal (4.32 t/ha), Jugal (4.08 t/ha), Boichi (4.06 t/ha), Patanai (4.06 t/ha), UBL-4 (4.05 t/ha) and Khayamdhan (4.01 t/ha). This piece of study revealed that few FVs of rice may be used as donor to breed long slender grains, high test weight as well as higher yield. As these genotypes wider genetic make-up as compare to recent high yielding genotypes of rice, the scope of getting more number of desirable segregants in the segregating generations is high.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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