International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(6): 1693-1700

Received: 04-09-2019
Accepted: 06-10-2019

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# Genetic variability of agro-morphological traits in traditional varieties of rice (*Oryza sativa* L.) from Madhya Pradesh, India

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**Abstract**
An extensive collective of 261 farmers' variety from tribal areas of Madhya Pradesh was done by the researches of Jawaharlal Nehru Krishi Vishwa Vidyalaya to generate breeding material and broaden the gene pool of advanced genotypes. Varieties namely Biranjphool, Patharilal Teduha, Khurdy, Buddhu Dhan, Lalita Dhan, Khurdy, Batrolal, Ramesh Dhan, Bhuri Saiyri, Dhaniya Dhan, Dhanshingh Dhan, Kali Dhan, Sairi Chhote, Safed Dhan, Dihula Sidhi and Ishwarya Dhan were identified for earliness. Lalu Dhan, Rambhog, Nawari, Kali Dhan, Dhan Langa, Biranjiphod Janki, Dhan4, Chapti Gurmatiya, Banpur Dhan and Dihula Yagya are potential varieties for short stem length. Hulling and milling percentage was fairly good in farmers' variety ranging from 72.09% (Dhan2) to 84.76% (Bhataphool) and 54% (Chhota Sathiya) to 78.65% (Asamkoti). But recovery of head rice was as poor as 27.35% (Rakeda Chhota).

**Keywords:** Rice farmers' variety, landraces, genetic variability, Madhya Pradesh, genetic variability

## Introduction
Rice is the most significant human sustenance crop on the planet which directly feeds nearly half of world's population – more than 3 billion people, over a more extended time than has any other crop. In India itself a wide varieties of rice cultivars, landraces and numerous lesser known traditional varieties have been under development through natural and forced selection since ages by tribal farmers [1]. India was once a home of 75,000 plus cultivars/landraces of rice [2, 3, 4]. At present 80% of India's rice acreage is occupied by high yielding superior varieties and only 20% consist of traditional cultivars. In the past, farmers would select and spare a proportion of seed of their crops at each harvest to sow and cultivate in the next growing season, selecting the seed from the plants that performed best in their local environment and sometimes selecting different types characterized by desirable traits (e.g., different ripening times, particular tastes and winter-hardiness etc.). These cycles of selection were often repeated over many years on the same farm, and resulted in crops that were genetically heterogeneous but comparatively homogeneous and stable for specific trait(s) for which they have been evolved by the farmers/communities due to repeated exposure to both natural and human selective pressures. These crops are known as 'landraces', but are sometimes also referred to as 'farmers' variety', or 'local', 'primitive' or 'traditional' varieties [5].

The modern high yielding varieties (HYVs) differs from its wild progenitor in large arrays of morphological and physiological traits and is a source of traits and genetic diversity for agriculture. HYVs have wider adaptability in contrast, farmers' varieties are generally niche-specific. But since they have been developed in a specific geographical condition and has survived decades of climate change, they seemed to have develop resistance to abiotic and biotic stresses therefore performs better in the area of its evolution. Plant breeding has benefited from landraces, to develop more nutritious plant varieties, as well as varieties tolerant to biotic and abiotic stresses [6].

## Material and Method
From tribal rice ecosystem of Madhya Pradesh, 261 farmers' variety was collected and grown in the university Seed Breeding Farm, college of agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, situated at $26^0192'$ N latitude, $99^0232'$ E longitude.

The experiments were conducted in a Randomized Block Design (RBD) with three replications. Nineteen days aged seedlings were transplanted in the main field on 6th July of *Kharif* 2017 where as in *Kharif* 2108, twenty one days old seedlings were transplanted on 6th July. The standard cultural practices were followed during the crop season to obtain good crop stand in the main field. Each entry was sown in a plot comprising of four rows having three meter length at spacing of 20 cm between rows and 15 cm between plants.

The traits studied were Days to 50% flowering (days), Days to maturity (days), Tillers per plant, Effective tillers per plant, Plant height (cm), Stem thickness (mm), Flag leaf length (cm), Flag leaf breadth (cm), Penultimate leaf length (cm), Penultimate leaf breadth (cm), Panicle length (cm), Panicle weight (g), Spikelet per panicle, Fertile spikelet per panicle, Spikelet fertility percentage, Spikelet density, 1000 grain weight (g), Grain length (mm), Grain breadth (mm), Grain length breadth ratio, Decorticated grain length (mm), Decorticated grain breadth (mm), Length breadth ratio of decorticated grain, Hulling percentage, Milling percentage, Head rice recovery percentage, Biological yield per plant, Panicle index, Harvest index and Grain yield per plant (g). All the standard protocol according to Indian Institute of Rice Research, Hyderabad, India (formerly, Directorate of Rice Research) was followed for estimating the grain quality parameters [7].

**Result and discussion**

The existence of genetic variability is essential for effective selection as well as for wider adaptability. In present investigation, the estimates of genetic variability parameters *viz*., mean, range, variance in phenotype and genotype, phenotypic and genotypic coefficient of variance, heritability and genetic advance is been highlighted (Table 2).

**Days to 50% flowering:** It was found that the farmers practiced selection for very early (<71 days) to early (71-90 days) flowering varieties, as 80% of the varieties fall under this category. Lalita Dhan, Buddhu Dhan, Ishwarya Dhan, Rushman Dhan, Ramesh Dhan, Dihula Sidhi and Biranjphool are top very early flowering varieties. Varieties which showed late (110-130 days) flowering time are Bhataphool, Sheri Karhi, Rajbhog, Lawangchoor, Kardhana, Nawari, Bhataphool, Bhejri, Rakera, Rambhog Jagdish, Kalajeera, Dubraj and Haathi.

**Days to maturity:** Farmers varieties were categorized into very early (<100 days), early (101-120 days), medium (121-140 days), late (121-140 days) and very late (>160 days) types. While none of the farmers' varieties matures in more than 151 days, maximum (73%) varieties fall under the category of very early and early types. This proves that farmers preferably select varieties which could be harvested as early as 3 to 4 months. Farmers varieties which could be harvested in two and a half months are Biranjphool, Patharilal, Khurdy, Buddhu Dhan, Lalita Dhan, Khurdy, Batrolal, Ramesh Dhan, Bhuri Saiyri, Dhaniya Dhan, Dhanshingh Dhan, Kali Dhan, Sairi Chhote, Safed Dhan, Dihula Sidhi and Ishwarya Dhan. Late maturing varieties are Dubraj, Rajbhog, Vishnubhog, Lawangchoor, Bhataphool, Kala Jeerashankar, Kali Kammo, Asamkoti, Kalajeera, Bhataphool, Rakera, Kardhana, Rambhog, Tulsi Amrit, Sheri Karhi and Jamun Surki.

**Tillers per plant and productive tillers per plant:** Average tillers per plant were recorded for farmers' variety is 10.80. Nawari Narwad and Karhani Juri reported highest number of tillers per plant (25 tillers each), followed by Dihula Yagya (21 tillers), Kardhana (21 tillers), Basmatiya (20 tillers) and Dihula Sidhi (20 tillers). Similar study on chathisghar landraces reported an average tillets of 6.61 [8]. Number of productive tillers per plant is another yield attributing trait [9]. Farmers' varieties produced few productive tillers per plant as 79% of the varieties recorded less than 11 panicles per plant. Only 2 varieties showed more than 20 productive tillers per plant which are Karhani Juri and Nawari Narwad.

**Stem length (excluding panicle) and Stem thickness:** It exhibited sensible measure of variation with range values of 51.25-169.74 cm. The average stem length obtained was 110.50 cm which fell under medium category, while 60% of the varieties fall under short to medium category. Lalu Dhan, Rambhog, Nawari, Kali Dhan, Dhan Langa, Biranjiphod Janki, Dhan4, Chapti Gurmatiya, Banpur Dhan and Dihula Yagya were top ten varieties with very short stature. Similar study conducted at Directorate of Rice Research Farm, ICRISAT on 70 landraces reported maximum genotypes with very short stem length [10]. Short stature varieties benefits from non logging attitude therefore reduce substantial yield losses. 190 varieties out of 261 farmers varieties i.e. 73% had medium stem thickness. Average stem thickness was 4.7 mm and ranges from 2.52 mm to 8.16 mm. Thickest stem was recorded for Dhaniya Dhan (8.16 mm).

**Leaf length and width:** Length of flag leaf from the farmers' varieties ranges from 20.83-67.80 cm and the mean value, 41.29 cm was exhibited by this trait. Most of the varieties (66%) had medium length (30-45 cm). One variety *i.e.* Sukraphool (0.89 cm) showed narrow flag leaf. While 86% of the varieties showed medium flag leaf width ranging from 1-2 cm. Rest of the varieties had broad leaf width. Penultimate leaf length ranges from 26-89.06 cm with the mean value of 52.32 cm. 83% of the varieties was recorded to have longer (>45 cm) leaf length. It had a mean value of 1.43 cm and range value of 0.81-2.02 cm.

**Panicle length of main axis:** Farmers made selection for varieties which showed longer panicle length that's why 45% of the study material falls under this category. Variation ranged from 17.59-39.09 cm and the mean was 26.69 cm. Longest panicle length was recorded for Dihula Yagya (39.09 cm), Bhataphool (35.17 cm) and Kalajeera (35.13 cm). Panicle length is one of the contributing traits for high yield, but several other traits like number of fertile spikelet per panicle, number of productive tillers per panicle, panicle weight and grain characteristics contributes to the grain yield.

**Panicle weight per plant:** The weight of the panicles ranges from 7.25 g – 60.03 g with an average of 24.92 g. Panicles of the variety Basmatiya had maximum weight i.e. 60.03 g followed by Peeli Luchai (53.19 g), Belaodhachakdour (49.11 g), Hansa Kanak (47.40 g), Luchai (46.46 g), Haru Dhan (46.07 g), Pandu (45.87 g), Dhaur Dhan (45.32 g), Sultho (44.97 g) and Dhan Khamera (44.16 g).

**Spikelet per panicle and fertile spikelet per panicle:** Another important yield attributing trait is number of spikelet born on a single panicle. Variation found for this trait ranges from 43.95-446.03 with the mean of 176.54. Lalajeera

(446.03), Bhataphool (386.42), Vishnubhog (385.05), Bakram Paraswada (361.76), Dhan4 (346.93), Jamun Surki (345.96), Sonal Mongaon (345.37), Krishnabhog (344.10) and PeeliLuchai1 (337.03) are top varieties having maximum number of spikelet per panicle. A study consisting of few landraces of Madhya Pradesh has reported 298 grain per panicle for PeeliLuchai1 which is in accordance with the present findings [11]. Fertile spikelet develops into grain therefore it's an important trait. Lalajeera (446.03, 384.04) and Bhataphool (386.42, 324.11) had highest number of spikelet per panicle as well as fertile spikelet per panicle.

**Spikelet fertility percentage and spikelet density:** Spikelet fertility percentage was more than 95% for Lohandi, Lal Lohandi, Pandu and Muhbeli. Spikelet density (number of grains per centimeter on the panicle) was recorded maximum for Lalajeera, Peeli Luchai and Sonal Mongaon. Spikelet density affects the grain yield as it an important character in seed setting rate [12].

**1000 grain weight:** The weight of 1000 fully developed grains, which is one of the most important yield attributing traits, showed wide variation among accessions *viz.*, very low (11%), low (51%), Medium (38%), high weight (24%) and, very high (7%). Test weight of cultivars ranged from 10.21 g (Chhindikappoor) to 39.73 g (Ganga nunga) with a mean weight of 19.84 g.

**Seed characteristics:** In the material studied, more than 94% of the varieties falls in short to medium group in terms of grain length, whereas 92% of the varieties had grain width ranging from medium to very broad type. Maximum grain length (11.42 mm) was recorded for Khada while minimum kernel length (5.42 mm) was Krishnabhog. Maximum grain breadth (4.80 mm) was recorded for Junwaniamar Dhan while minimum grain breadth (2.2 mm) was recorded for BadalPhool. Such high variability in seed characteristics of rice landraces from West Bengal has been reported with similar results [13, 14].

**Hulling, milling and head rice recovery percentage**

Minimum hulling percentage was recorded for Dhan2 (72.09%) followed by Jurandikavli (72.1%), hathwa (72.81%) and Hariya Pouni (72.9%) where as maximum hulling percentage was recorded for Jhular (87.2%) and Bhataphool (84.76%). In case of milling percentage, minimum milling percentage was noted for Chhota Sathiya (54%), Akloni (59.86%), Hariya Pouni (61.44%), Dhan 2 (62.09%) while maximum in Lal Lohandi (80.99%), Urai Boota (79.62%) and Asamkoti (78.65%). The maximum head rice recovery was observed in Lal Lohandi (76.83%) followed by ChatsafedLuchai (75.22%) and Badai Luchai (75.09%) while minimum in PeeliLuchai1 (25.64%), BagariRagu (26.97%) and Rakeda Chhota (27.35%). Study on grain quality characteristics of traditional rice varieties in Sri Lanka showed similar range of hulling and milling percentage [15].

**Biological yield per plant and Harvest index:** Biological yield per plant was highest for Chhinoor (Lohara), 124.52g and lowest for Barra Dhan (20.83g). Maximum harvest index was recorded for Banko (68.97) and minimum for Haathi (13.01).

**Grain yield per plant:** It also exhibited high range (4.57-59.29 g) with a mean of 21.51 g. Top ten farmers variety having high grain yield per plant are Basmatiya (59.29 g), PeeliLuchai1 (48.08 g), Belaodhachakdour (44.84 g), HansaKanak (43.20 g), Luchai2 (42.74 g), DhaurDhan (40.82 g), Sultho (40.29 g), HaruDhan (40.28 g), Pandu (39.45 g) and LuchaiDhan (39.25 g).

**Genetic Variability Parameters**

**Genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV):** Results in Table 2 exhibited wide range of variation for different traits. The maximum genotypic and phenotypic variations were obtained for total number of spikelet per plant (5217.23 and 5308.68 respectively) followed by number of fertile spikelet per plant (3931.67 and 3988.16), plant height (483.51 and 501.55) and days to maturity (454.08 and 454.70). The high magnitude of genotypic coefficient of variation reveals the high genetic variability present in the material studied. The highest value (>20%) of PCV and GCV was recorded in decreasing order of magnitude for number of fertile spikelet per plant > spikelet density > total number of spikelet per plant > grain yield per plant > numbers of effective tillers per plant > biological yield per plant > panicle weight > days to 50% flowering > harvest index > 1000 grain weight > days to maturity. Phenotypic coefficient of variation (PCV) was higher in magnitude than genotypic coefficient of variation (GCV). This indicates the apparent variation is not only due to genotypes but also due to the influence of environment but in the present study the different between PCV and GCV is very less hence there is negligible influence of extraneous factors and therefore, selection for such traits on the basis of phenotype only could also be rewarding [16, 17].

**Broad sense heritability and genetic advance**

Heritability estimates coupled with genetic advance are normally more helpful in predicting the gain under selection. Heritability ($h^2$) estimates were interpreted as low (<30%), medium (31% - 70%) and high (>70%) and genetic advance as percent of mean as high (>20%), moderate (10-20%) and low (<10%) [18]. Characters namely Days to maturity (99.9, 42.77), days to 50% flowering (99.9, 54.24), panicle weight per plant (99.8, 72.87), 1000 grain weight (99.7, 48.59), head rice recovery (99.6, 36.3), grain yield per plant (99.5, 80.09), panicle length (99.5, 27.98), biological yield per plant (99.3, 77.14), number of fertile spikelet per panicle per plant (98.6, 88.60), spikelet density (98.3,85.71), total number of spikelet per panicle (98.30, 83.55), number of tillers per plant (98.20, 63.50), number of effective tillers per plant (98.20, 63.50), plant height (96.40, 39.44), harvest index (95.80, 52.10), grain length (94.0, 24.27), decorticated grain length (90.50, 27.77), spikelet fertility percentage (89.40, 26.43), stem thickness (87.50, 31.73), penultimate leaf length (82.40, 34.41), kernel length breadth ratio (76.10, 35.11), grain length breadth ratio (74.70, 28.73), flag leaf length (74.70, 32.63), grain breadth (73.60, 24.47) and decorticated grain breadth (73.20, 28.12) exhibited high heritability coupled with high genetic advance. It clearly indicates that most likely the heritability is due to additive gene effects and selection may be effective.

Medium heritability with high genetic advance was seen for flag leaf width (58.80, 20.76) whereas high heritability with moderate genetic advance was found for panicle index (92.70, 17.28). Moderated heritability and genetic advance was found for penultimate leaf breadth (51.60, 17.60) and milling percentage (97.30, 10.21). Only hulling percentage reported to have high heritability with low genetic advance, 91.70 and 5.11 respectively. Results of PCV, GCV and heritability are consistent with the findings of landraces released by GBPUA&T, Uttarakhand [19].

**Table 1:** Categorization of Madhya Pradesh farmers' variety on the bases of kernel shape

| Kernel shape | Kernel length (mm) | Length/ breadth ratio | Farmers varieties | Number of farmers varieties |
|---|---|---|---|---|
| Short Bold | < 6.0 | < 2.5 | Lalita Dhan, Lal Dhan1, Dhan3, Khurdy, Haruhan, Tedumari, Dhaniya Dhan, Karhani, Bhuri Saiyri, Safed Luchai, Chhinoor (Lohara), Assan Chuni, Jeera Shankar, Padma, Bhata Makdi, Chhinoor, Badshabhog, Lalajeera, Chhindi Kapoor, Jeeraphool, Sukdas, Dhan Langa, Chintaman Dhan, Safed Batero Dhan, Adharlal Dhan, Assam Koti, Desi Sarla, Gundali Ram, Luchai Dhan, Barra Dhan, Dihula Sidhi, Hansraj Teduha, Biranjphool1, Layachi Tejbahadur, Chinmauri, Jalhore Uday, Longa Aditya, KarmayaIndra, Bhata Phool2, Lohdi Kailash, Mangar (Raimun), Dubraj Teduha, Hathwa, Vishnu Bhog1, Vishnu Bhog2, Lohadi Katharra, Sonkharchi Shiv, Dihula Yagya, Ishwarya, Lal Dhan, Lal Dhan Bhatlai, Dhan Dongariya, Shera Kher, Nawari Narwad, Sulbariya Dhan, Dulari Dhan, Sukhlal Dhan, Uresa, Pusa Khurri, Vishnubhog3, Jamun Surki, Tulsi Amrit, Krishnabhog, Asamkoti, Jhular, Bhataphool3, Karanphool, Akloni, Kushiyari, Banko, Sheri Karhi, Dihula Safed, Biranjiphod Janki, Kala Jeerashankar, Rajbhog, Bhataphool, Bhejri, Rakera, Nawari3 | 79 |
| Medium Slender | < 6.0 | 2.5-3.0 | Dhan4, Lalu Dhan, Thhari Devi, Sonal Mongaon, Tharri, Rambhog Jagdish, Dubraj, | 7 |
| Long Slender | > 6.0 | > 3.0 | Basmatiya, Sitha Chandana, Harad Gundi, Lakhoa, Ganga nunga, Mamok Dhan, Batrodhan, Patharilal Teduha, Basmati Shiv, Set Bhaidanu, Lakhoa Dhan, Badal Phool | 12 |
| Long Bold | > 6.0 | < 3.0 | Batrolal, Kamlesh Dhan, Shriram Dhan, Ramesh Dhan, Dhanshingh Dhan, Govind Dhan, Badli Dhan, Varpani Dhan, Nihal Dhan, Buddhu Dhan, Chamchnadra Dhan, Kishori Dhan, Dhan1, Niwari1, Oraikant, Lal Dhan2, Lal Dhan3, Kali Saraiya, Rai Boot, Chhoti Luchai1, Ladai Pooch, Badali Dhan, Karman, Nawari2, Lohandi1, Rakeda Chhota, Rakeda Bada, Dhaur Dhan, Galari, Badai Luchai, Badi Pardeshi, Kisan Dhan, Benam Dhan, Lohi Khairwar, Lal Saraiya, Peeli Luchai1, Safed Badi, Chhipda, Monya Kali, Pandu, Tulsi Das, Luchai1, Haathi, Raibua, Bhadachinga, Bahurupi, Muhbeli, Safed Dhan1, Kali Dhan, Sakaloo, Chhota Sathiya, Junwaniamar Dhan, Urai Boota, Dharam, Dhan Khamera, Rebuta, Nungi, Bhadela, Luchai2, Bade Nunga, Chhoti Nunga, Sukdas, Dhanna Dhan, Mahesh Dhan, Dangu Dhan, Kardhana1, Kardhana2, Hridhan Brij, Kardhana3, Safed Dhan2, Safed Dhan3, Jal Dhan, Kardhana4, Sukhdas Dhan, Rushman Dhan, Kardhana5, Nagkeshar, Kewlari, Madhudheta, Gundali, Peeli Luchai2, Kakehari, Peeli Luchai3, Sultho, Chatsafed Luchai, Bagboot, Choti Luchai, Haru Dhan, Kudveriya, Sarsari Dhan, Kardhana6, Kardhana7, Sitri, Barrachhatridhan, Sairi Chhote, Barbhai Chapra, Karhani Juri, Bhejaripushp, Hansa Kanak, Gurmatiya1, Karan Phool, Badaliyogya, Retua, Lachai Lila, Nadawal Prem, Bagari Krishna, Kanak Nand, Bagari Naresh, Belaodhachakdour, Banke Raghuveer, Bagari Ragu, Bhaidanu, Banpur Dhan, Makrand Mahagaon, Bahurupichijgaon, Kalimoonch Pouni, Jurandi Kavli, Badlapurparaswada, Bakram Paraswada, Hariya Pouni, Sushma Khandapar, Raghunath Sammapur, Sukhdas Chapra, Kala Antarbel Dhan, Laali Anant, Omkar Lakoli, Kuriya Dhan, Nanha Luchai, Navari, Kakera, Jahri, Kathi, Garud Luchai, Urai Boota, Galgaliya, Lohandi2, Chhindikappoor, Lal Lohandi, Patharchatti, Gurmatiya2, Ranikajal, Rabuta, Chapti Gurmatiya, Sathiya, Dhaur, Karhani, Karanphool, Bharri Dhan, Kariya Dhan, Karhani, Lawangchoor, Kali Kammo, Sukraphool, Kalajeera, Barhi, Kardhana8, Jhular Dhan, Safed Saraiya | 159 |
| Extra Long Slender | > 7.5 | > 3.0 | Dhan2, Kanak Chhota, Khada, Veerbhan, | 4 |
| Total | | | | 261 |

**Table 2:** Genetic parameters of 30 yield and quality traits of 261 farmers' variety of rice

| | Minimum | Maximum | Mean | Phenotypic variance | Genotypic variance | PCV | GCV | Heritability | Genetic advance |
|---|---|---|---|---|---|---|---|---|---|
| Days to 50% Flowering | 44.75 | 120.33 | 73.00 | 370.28 | 369.89 | 26.36 | 26.35 | 99.90 | 54.24 |
| Days to Maturity | 65.55 | 150.53 | 102.57 | 454.70 | 454.08 | 20.79 | 20.78 | 99.90 | 42.77 |
| Number of tillers per plant | 5.73 | 25.69 | 10.80 | 11.48 | 11.28 | 31.39 | 31.10 | 98.20 | 63.50 |
| Number of effective tillers per plant | 3.51 | 23.46 | 9.01 | 11.87 | 11.45 | 38.26 | 37.58 | 96.50 | 76.04 |
| Plant height (cm) | 51.25 | 169.74 | 105.50 | 501.55 | 483.51 | 19.86 | 19.50 | 96.40 | 39.44 |
| Stem diameter (mm) | 2.52 | 8.16 | 4.70 | 0.68 | 0.60 | 17.60 | 16.47 | 87.50 | 31.73 |
| Flag leaf length (cm) | 20.83 | 67.80 | 41.29 | 76.65 | 57.27 | 21.20 | 18.33 | 74.70 | 32.63 |
| Flag leaf breadth (cm) | 0.89 | 2.48 | 1.71 | 0.09 | 0.05 | 17.13 | 13.14 | 58.80 | 20.76 |
| Penultimate leaf length (cm) | 26.00 | 89.06 | 52.32 | 112.34 | 92.61 | 20.26 | 18.40 | 82.40 | 34.41 |
| Penultimate leaf breadth (cm) | 0.81 | 2.02 | 1.43 | 0.06 | 0.03 | 16.56 | 11.89 | 51.60 | 17.60 |
| Panicle length (cm) | 17.59 | 39.09 | 26.69 | 13.26 | 13.20 | 13.64 | 13.61 | 99.50 | 27.98 |
| Panicle weight (cm) | 7.52 | 60.03 | 24.98 | 78.33 | 78.21 | 35.43 | 35.40 | 99.80 | 72.87 |
| Number of spikelet per panicle | 43.95 | 446.03 | 176.54 | 5308.68 | 5217.23 | 41.27 | 40.91 | 98.30 | 83.55 |
| Number of fertile spikelet per panicle | 14.78 | 384.04 | 144.75 | 3988.16 | 3931.67 | 43.63 | 43.32 | 98.60 | 88.60 |
| Spikelet fertility (%) | 33.79 | 98.71 | 81.97 | 138.51 | 123.79 | 14.36 | 13.57 | 89.40 | 26.43 |
| Spikelet density | 2.09 | 18.38 | 6.68 | 8.00 | 7.86 | 42.34 | 41.97 | 98.30 | 85.71 |
| 1000 Grain Weight (g) | 10.21 | 39.73 | 22.36 | 27.97 | 27.89 | 23.65 | 23.62 | 99.70 | 48.59 |
| Grain length (mm) | 5.46 | 11.42 | 8.27 | 1.07 | 1.01 | 12.54 | 12.16 | 94.00 | 24.27 |
| Grain width (mm) | 2.20 | 4.80 | 3.50 | 0.28 | 0.20 | 16.15 | 13.85 | 73.60 | 24.47 |
| Grain length breadth ratio | 1.32 | 4.85 | 2.60 | 0.24 | 0.18 | 18.68 | 16.14 | 74.70 | 28.73 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Decorticated grain length (mm) | 2.47 | 9.31 | 6.17 | 0.85 | 0.77 | 14.90 | 14.18 | 90.50 | 27.77 |
| Decorticated grain width (mm) | 1.52 | 3.76 | 2.64 | 0.27 | 0.19 | 18.66 | 15.96 | 73.20 | 28.12 |
| Decorticated grain length breadth ratio | 0.43 | 4.43 | 2.31 | 0.27 | 0.20 | 22.38 | 19.53 | 76.10 | 35.11 |
| Hulling percentage (%) | 72.09 | 87.20 | 79.66 | 4.63 | 4.25 | 2.70 | 2.59 | 91.70 | 5.11 |
| Milling percentage (%) | 54.00 | 80.99 | 70.85 | 13.02 | 12.67 | 5.09 | 5.02 | 97.30 | 10.21 |
| Head rice recovery (%) | 25.64 | 76.83 | 58.50 | 107.00 | 106.62 | 17.68 | 17.65 | 99.60 | 36.30 |
| Biological yield per plant (g) | 20.83 | 124.52 | 54.84 | 427.67 | 424.65 | 37.71 | 37.58 | 99.30 | 77.14 |
| Panicle index | 60.73 | 104.14 | 85.34 | 59.62 | 55.27 | 9.05 | 8.71 | 92.70 | 17.28 |
| Harvest index | 13.01 | 68.97 | 40.51 | 114.42 | 109.58 | 26.41 | 25.84 | 95.80 | 52.10 |
| Grain yield per plant (g) | 4.57 | 59.29 | 21.51 | 70.58 | 70.26 | 39.06 | 38.97 | 99.50 | 80.09 |

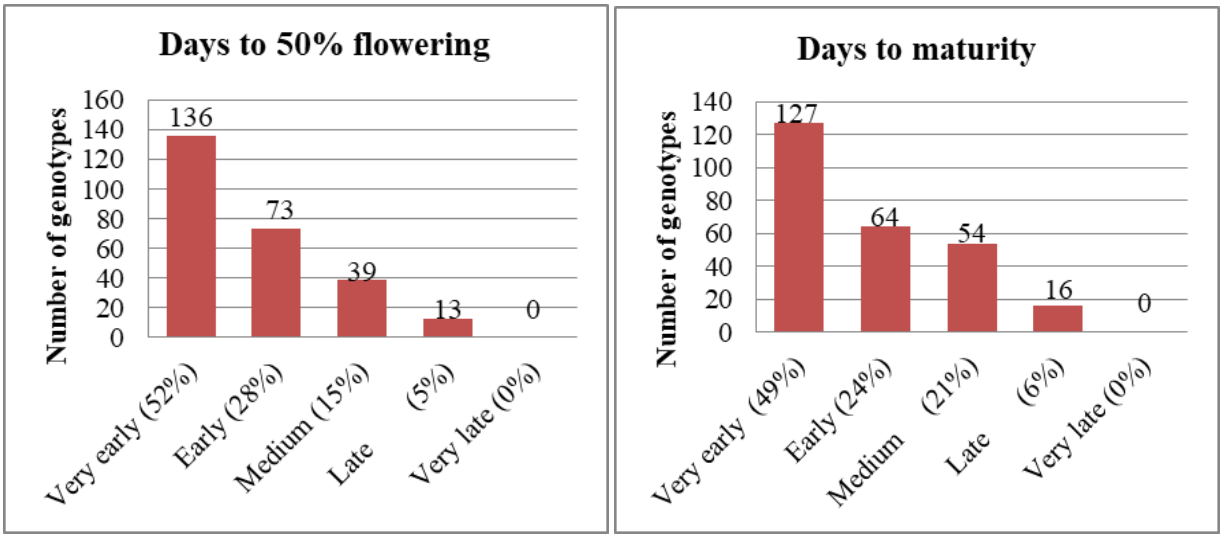
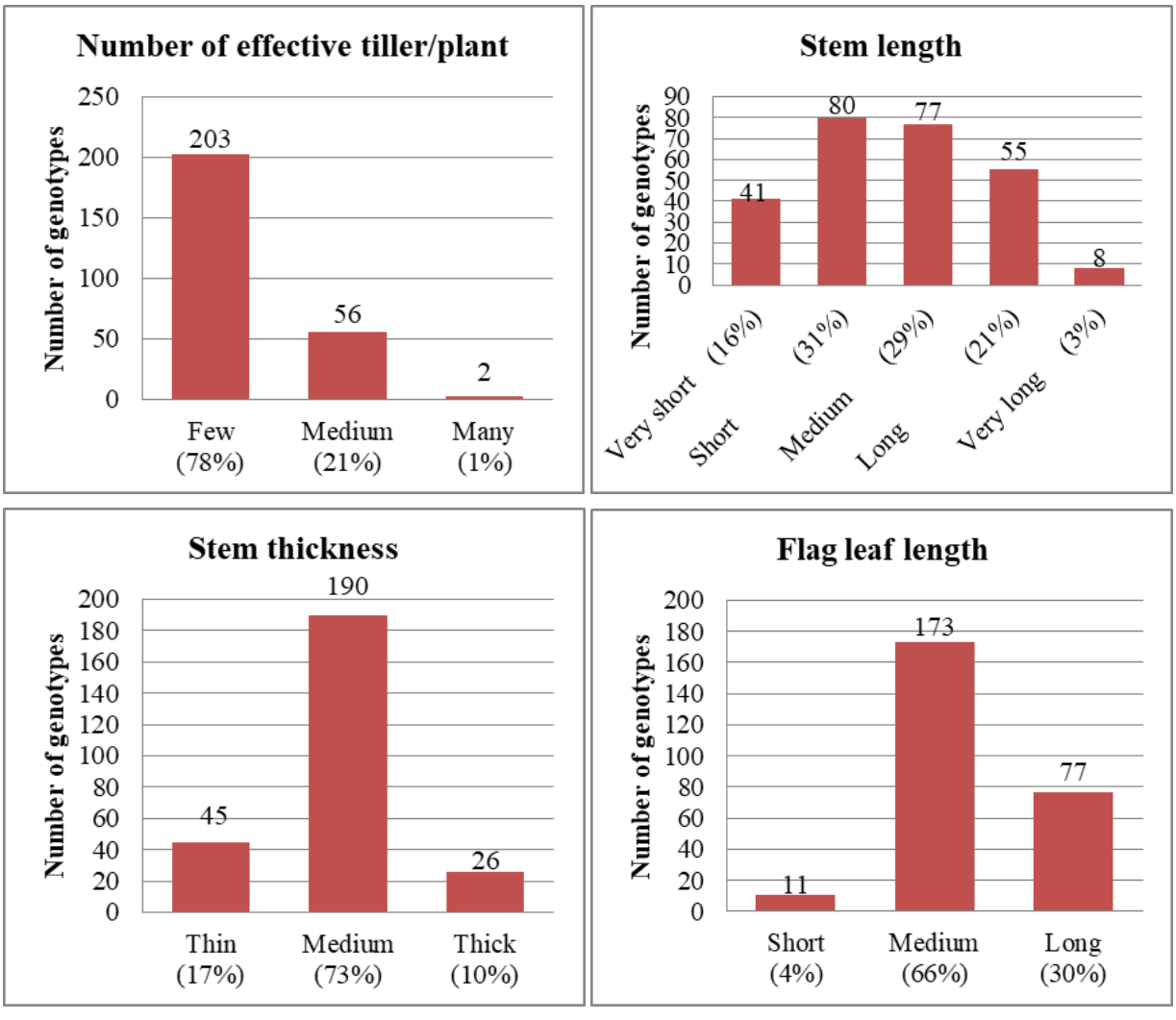



**Fig 1(a):** Histogram showing frequency distribution pattern of quantitative traits



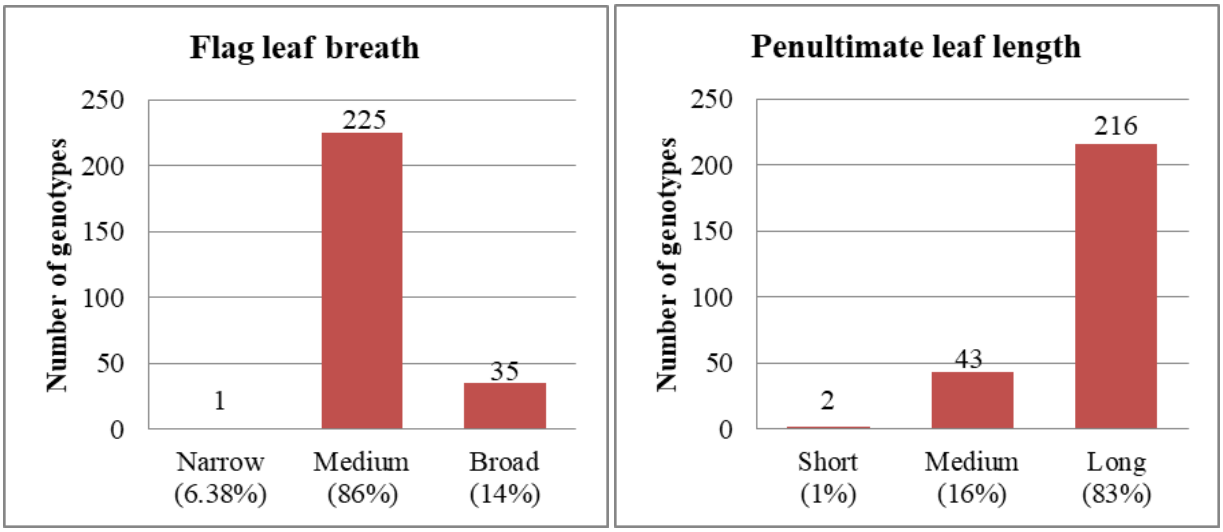
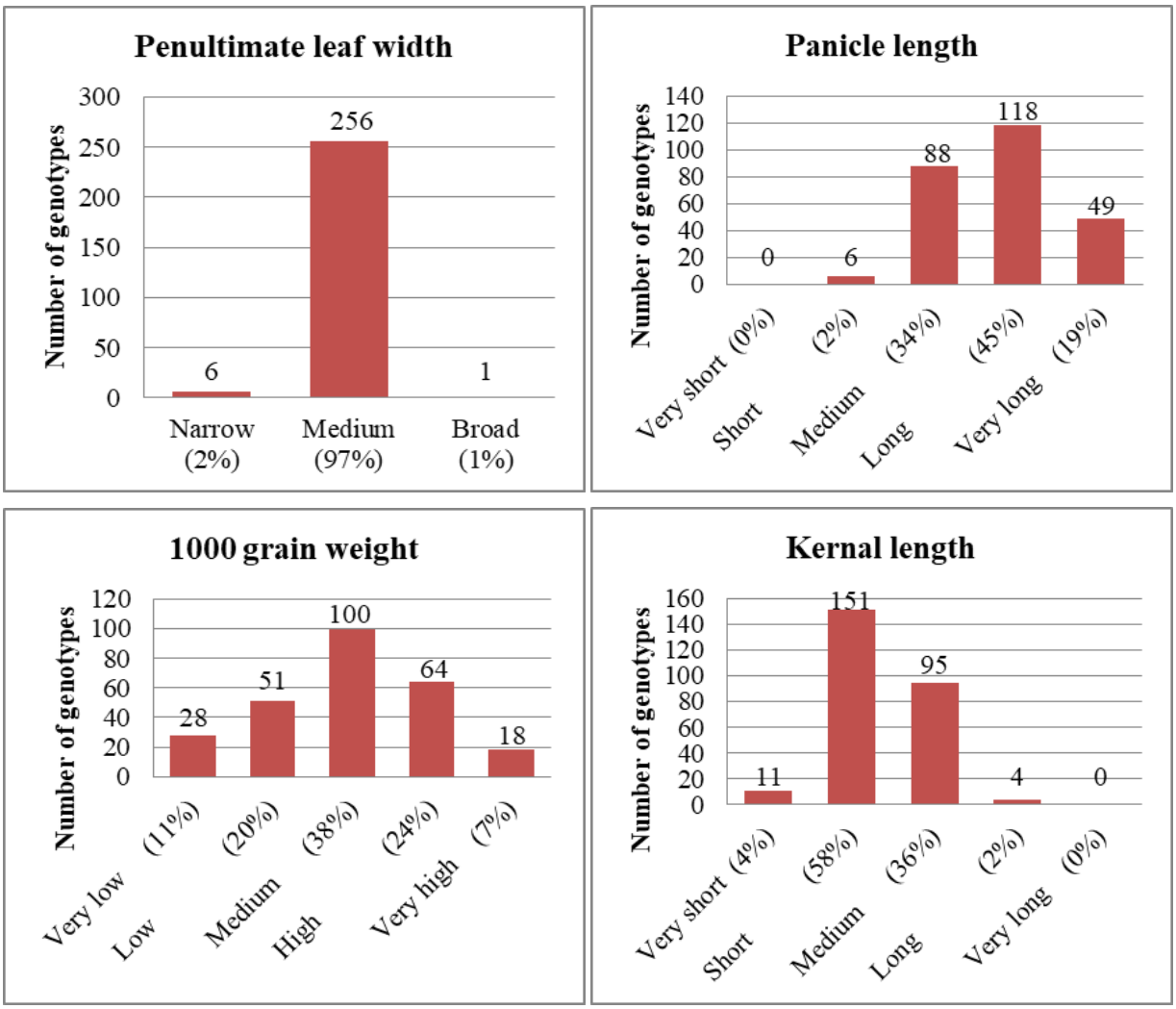



**Fig 1(b):** Histogram showing frequency distribution pattern of quantitative traits



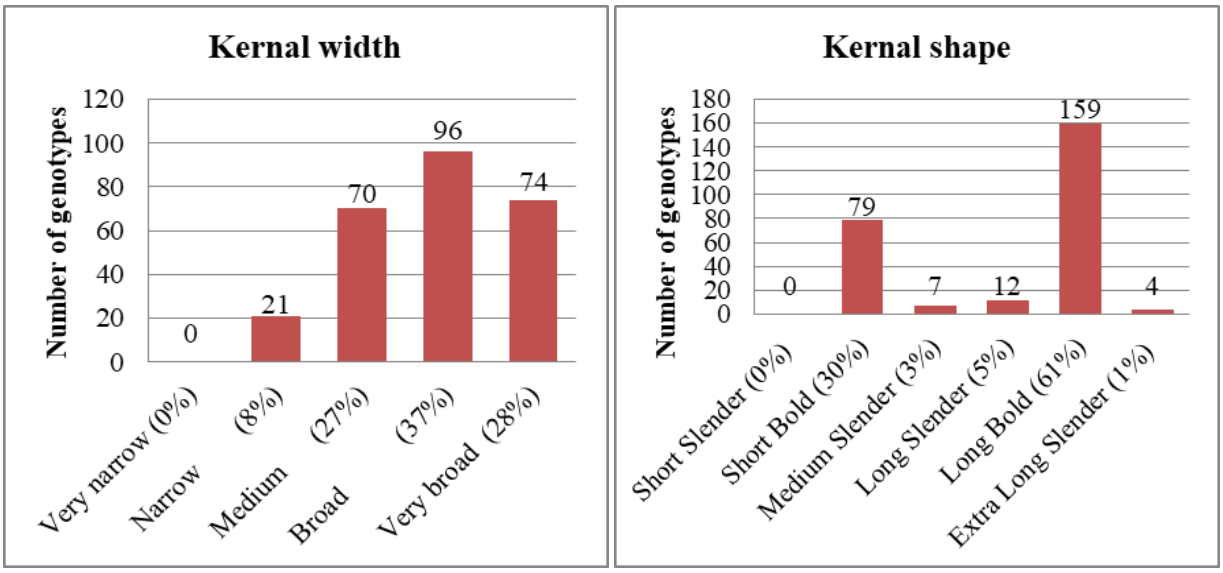



**Fig 1(c):** Histogram showing frequency distribution pattern of quantitative traits

## Conclusion

Tribal farmers of Madhya Pradesh harbors a tremendous asset of rice cultivars that are lesser known at the market front however holds key to introduce variability to the high yielding uniform cultivars, dominating the market. An effort was made to collect 261 farmers' variety and study quantitative variability present among them. Wide genetic variation was presented among these varieties which may be utilized for the selection of the parents for the plant breeding and production of new improved variety. It was conclusive that tribal farmers have done selection towards earliness and there varieties namely Biranjphool, Patharilal Teduha, Khurdy, Buddhu Dhan, Lalita Dhan, Khurdy, Batrolal, Ramesh Dhan, Bhuri Saiyri, Dhaniya Dhan, Dhanshingh Dhan, Kali Dhan, Sairi Chhote, Safed Dhan, Dihula Sidhi and Ishwarya Dhan could be harvested in less than 3 months. In general lodging tolerant varieties have short plant height, preventing substantial yield loss. Tribal farmers also realized the importance of short stature plant and developed varieties like Lalu Dhan, Rambhog, Nawari, Kali Dhan, Dhan Langa, Biranjiphod Janki, Dhan4, Chapti Gurmatiya, Banpur Dhan and Dihula Yagya which are very short types having stem length ranging between 51-91 cm. From this study it could also be concluded that one of the reasons for low yield in farmers varieties is few productive tillers, here majority of the varieties have less than 11 tillers per plant. Hulling and milling percentage was fairly good in farmers' variety ranging from 72.09% (Dhan2) to 84.76% (Bhataphool) and 54% (Chhota Sathiya) to 78.65% (Asamkoti). But the process of milling produced more broken rice in case of farmers' variety therefore recovery of head rice was as poor as 27.35% (Rakeda Chhota). Tribal's have preference for long bold rice grain for consumption since 61% of the studied material had long bold kernal type. Though PCV is more than GCV the difference is very minor for all the studied traits hence showed less influence of environment which is good for further selection of these traits. The present investigation provided the breeding materials to the rice breeders for exploitation of farmers' variety in future breeding programme.

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