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RESEARCH ARTICLE

On-farm Conservation of Rainfed Rice Landrace Diversity in Chhattisgarh, India

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India is considered as one of the centers of origin and diversity for Asian rice, where a large number of landraces are still under cultivation. Though, there has been continuous loss of genetic diversity but concerns have been addressed with increased pace in recent years. Keeping this in mind, the present study was aimed to collect, conserve (ex-situ) and identify the determinants of on-farm landrace diversity in the rainfed ecosystem of Chhattisgarh. The landrace diversity of rainfed rice and knowledge about their socio-economic and cultural importance among the local farming communities of six districts of Chhattisgarh was documented during this study. The farmers are presently maintaining various drought tolerant rice landraces on on-farm (in-situ) through rainfed cropping system. Hence, considering the significance of genetic resources of rice particularly for drought tolerance under changing climate locally adapted cultivars of rice growing in rainfed conditions were collected during *kharif* 2015. Based on the morphological and quantitative characters as observed in farmer's field, 48 diverse samples of rice landraces were assembled along with associated indigenous traditional knowledge. Based on quantitative characters, landraces were grouped into two major clusters each of which further grouped into two sub-clusters keeping in view the similarity in traits. Besides agro-morphological characters, various observations pertaining to agro-ecological habitats, traditional processing methods, socio-economic and cultural development, diversity available, factors responsible for erosion/replacement of diversity, visual values and specialized food quality etc. have been discussed.

Key Words: Diversity, Genetic resources, Indigenous traditional knowledge, Nomenclature, Rainfed rice landraces

Introduction

Rice (*Oryza sativa* L.) is one of the major staple food crops. Asia is the largest producer of rice contributing around 91% of total world rice production, while India contributes about 26% (Verma, 2017). India is the center of origin of Indica rice (*O. sativa*), wherein Odisha and adjoining parts of Chhattisgarh are considered the cradle of rice (Chauhan *et al.*, 2000). It is cultivated in about 45% rainfed area of the world, of which, 41% area alone falls in South and South East Asia (Maclean *et al.*, 2002; Pandey and Bhandari, 2008). Rainfed rice growing areas are considered as highly prone to drought, high temperature and submergence because of uneven rainfall distribution and topography. Most of the landraces and farmers varieties are evolved in rainfed areas and still being maintained by poor and marginal farmers. In India, most of the traditional landraces of rice have been collected from such environments (Chauhan *et al.*, 2000; Shukla *et al.*, 1996; Sarawagi and Rastogi, 2000).

Among different stresses, drought is the major constraint which can reduce rice yield in rainfed areas (approximately over 23 million ha) of South and Southeast Asia (Huke and Huke, 1997). According to Chauhan *et al.* (2000) about 74% cropped area under rainfed ecosystems is occupied by high yielding varieties (HYV) and that could be even higher in irrigated ecosystems.

In Chhattisgarh, rice is mainly grown in rainfed ecosystem that covers about 74% cropped area under central plain, 97% under Bastar plateau and 95% under northern hill zones. The central plains of Chhattisgarh are known as rice bowl of central India (Patel and Srivastava, 2015). In Eastern India, problem of drought is comparatively severe because more than 10 million ha of drought-prone fields have been noticed with 40% yield loss mainly in Jharkhand, Odisha and Chhattisgarh. According to Richharia (1979), significant variation in climate, topography, soil and hydrology coupled with

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varying cultural heritage have resulted into evolution of high genetic diversity in rice germplasm in Chhattisgarh. So far, limited success could be achieved in development of draught tolerant rice as compared to other traits. According to Haque *et al.* (2013), several donors are available but use of unstable donors with high drought tolerance particularly at the reproductive stage of the crop is very crucial to get optimum yield under drought conditions. Hence, considering the impact of climate change and associated factors, identification of suitable genotype for use in improvement of rice for drought tolerance is need of the hour.

Materials and Methods

Study Area

To conduct the present study, an exploration was undertaken in six districts (Rajnandgaon, Balod, Raigarh, Kanker, Naryanpur and Kondagaon) of Chhattisgarh for collection of rainfed rice germplasm during October-November, 2015. The study area lies between 17º46'N to 24º5'N latitude and 80º15'E to 84º20'E longitude with an altitudinal range between 313 to 660 m asl. The study area is bounded by Madhya Pradesh in northwest, Maharashtra in southwest, Telangana in south, Odisha in east and Jharkhand in northeast (Fig. 1).

Various tribal communities (Lodhi, Marar, Thanwar, Suri, Markam, Vattee, Mandvi, Netam, Bhaskar, Uike, Anchla, Kaloo, Vaddey, Muria, Sarda, Gonds and Rathia) reside in the remote localities of study area. Due to undulating topography and backwardness of the area, rainfed agriculture is the major livelihood source for them. Old and experienced farmers were contacted to record the information about the traditional rice landraces grown in the past and their status at present in the area. Coordinates (longitude & latitude) of collection sites were recorded using Global Positioning System (GPS). Important characters of landraces and other related information were recorded using standard formats/ unstructured questionnaire. For sampling of germplasm, random/bulk population method was adopted (Marshall and Brown, 1975; Hawkes, 1976, 1980) while passport data book was used to record information on each accession. Data on eight quantitative and qualitative traits were recorded on-site (Table 1). Test weight of 100 grains was recorded in gr; awn length, kernel length and breadth in mm; while length/breadth ratio was also calculated. Various qualitative traits including tolerance/ resistance to biotic and abiotic stresses were also recorded. For recording the kernel colour, The Royal Horticultural Society (RHS) colour chart was used (Royal Horticultural Society, 2001). The seed coat characters were recorded as per descriptors developed by ICAR-National Bureau of Plant Genetic Resources (Bansal *et al.*, 2006). Data was analyzed using statistical software (MINITAB version 17.0: minitab.com). Cluster analysis of landraces was done keeping in view the similarity in quantitative traits (grain weight, grain length, grain breadth and grain l/b ratio). A matrix of similarity was generated based on the simple Euclidean distance across all accessions of different landraces, which was used in a hierarchical clustering technique of Ward's Minimum variance method (Ward, 1963; Kaufman and Rousseeuw, 1990).

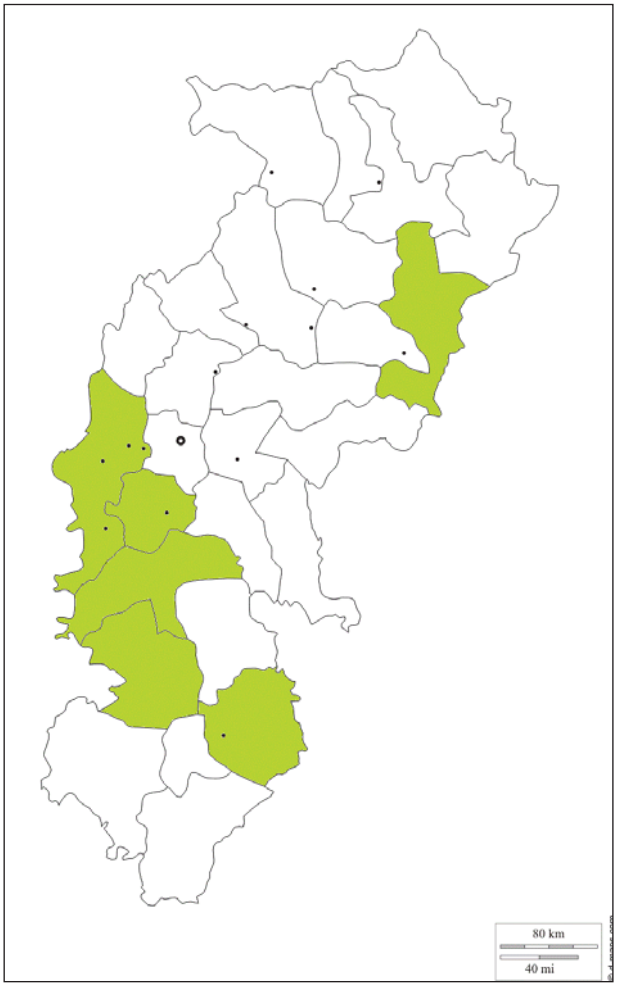

Fig 1. Rice germplasm collected from Raigad (1), Rajnandgoan (2), Balod (3), Kanker (4), Narayanpur (5) and Kondagoan (6) districts of Chhattisgarh.

Table 1. Characteristics of rice landraces collected from Chhattisgarh

S. No.	IC / Collection Nos.	Traditional landraces	Source*	Frequency#	100 grain wt. (g)	Grain length (mm)	Grain breadth (mm)	Grain colour	Kernel colour	Important characteristics and traditional uses
1	IC617726	Ampo dhan	TY	R	2.65	5.0	1.1	Light yellow	White	Grain medium sized, plant height 70-75 cm, drought tolerant, non-shattering and early type
2	IC 622694	Paras mani	FS	R	1.93	3.5	1.2	Yellowish	White	Grain fine, small, sweet in taste, plant height 70-75 cm and yield-12-15 q / acre.
3	RSR/SKY-4	Deshi sapri	FS	R	2.30	5.2	1.1	Yellowish	White	Medium sized grain, plant height 135-150 cm and yield-10-12 q / acre.
4	RSR/SKY-5	Dabaar dhan	FS	R	2.33	3.8	1.0	Reddish brown	Red	Grain bold, awned, plant height 70-75 cm, yield -10 - 12 q / acre. Rice is used for general debilities and diabetes.
5	IC 617727	Lal dhan	TY	R	1.87	4.3	1.0	Brown	White	Grain fine, husk hardy, plant height 70-80 cm and require little irrigation at the time of sowing.
6	IC-623311	Shri dhan	TY	R	2.41	3.0	1.0	Straw	White	Scented, plant height 105-120 cm and yield-10-12 q / acre, tolerant to insect pests. Rice is used for general debility and also offered to local deities during worship.
7	IC-623312	Sathia	FS	R	2.52	3.7	2.0	Blackish	Reddish	Drought tolerant, matures in 60-70 days, grain bold, awned. Grains are supposed to be highly nutritive hence cooked mainly on the occasion of Dushera Puja.
8	IC 617728	Dabaar dhan	FS	R	2.80	4.0	1.3	Reddish brown	Red	Grain awned, tolerant to insect/ disease and drought, plant height 90-100 cm and yield 10 -15 q / acre.
9	IC 622695	Jandra dhan	FS	R	2.19	4.7	1.2	Yellowish	Red	Grain medium sized, extra early, drought tolerant, plant height 65-75 cm.
10	IC 617729	Dabaar dhan	FS	R	2.70	4.2	2.0	Black	Red	Grain awned, plant height up to 90 cm. Rice water is used as medicine in general weaknesses.
11	IC 617730	Turia dhan	FS	R	1.59	4.2	1.1	Straw	White	Scented type with very fine grain, awned. very early, tall, plant height up to 75 cm.
12	IC 622696	Bayo dhan	FS	R	1.84	4.5	1.1	Brownish yellow	Red	Grain fine, small, awned, plant height up to 75 cm. Cooked rice is used for general weaknesses.
13	IC 617731	Turia dhan	TY	R	1.70	4.3	1.7	Golden yellow	White	Grain very fine, scented, panicle in cluster, drought tolerant, plant height up to 120 cm. Grains sweet in taste, used in general weaknesses.
14	IC 622697	Kolia punchhi	TY	R	1.12	4.0	1.0	Reddish brown	White	Grain scented, panicle is like ear head of foxtail-millet, plant height up to 90cm, drought tolerant. Cooked grains are sweet.
15	IC 622698	Dokra munchha	FF	R	1.96	3.7	1.0	Light yellow	White	Awn slight curved like bent body of old age man having moustaches, grain small, bold, plant height 110-120 cm, very early, drought tolerant, matures in September.

Contd.

S. No.	IC / Collection Nos.	Traditional landraces	Source*	Frequency#	100 grain wt. (g)	Grain length (mm)	Grain breadth (mm)	Grain colour	Kernel colour	Important characteristics and traditional uses
16	IC-623313	Dabaar dhan	TY	R	2.63	4.5	2.3	Brownish black	Red	Grain bold, awned, plant height 70-80 cm, yield-10-12 q / acre, drought tolerant. Rice is used for general weaknesses and diabetes.
17	IC 622699	Dabaar dhan	FF	R	2.47	4.0	1.3	Brownish black	Red	Grain bold, awnless, plant height 75-90 cm, yield - 12-14 q / acre, drought tolerant. Rice is used for general weaknesses and diabetes.
18	IC 617732	Para dhan	TY	R	2.79	4.2	1.3	Light yellow	Red	Grain small, awned, plant height 60-70 cm, early, matures during September, highly drought tolerant.
19	IC 617733	Kalapara	FS	R	2.42	3.5	1.0	Black	White	Very early type; matures in August (60-75 days), plant height 70 cm, highly drought tolerant. Kernel white but after cooking its colour is changed to red; sweet and best for Chapati making and for preparation of local beverage.
20	IC-623314	Koliya punchha	FS	R	2.27	6.1	1.2	Dark brown	White	Grain fine and scented, panicle resembles with tail of Fox, plant height 90-105 cm, drought tolerant and matures during October.
21	RSR/SKY-28	Lalichudi	FS	R	1.75	4.2	1.0	Light brown	Reddish	Grain fine, scented. It requires little irrigation at the time of sowing.
22	IC 622700	Bans bhida	FS	R	1.27	4.1	1.0	Light yellow	White	It has high number of tillers like bamboo, grain fine, small, plant height 60-70 cm, drought tolerant, early type and yield 10-12 q/acre. This has been cultivated for the past 100 years.
23	IC 622701	Luchai	TY	R	1.56	4.1	1.0	Light yellow	Red	Grain fine, small, awnless, plant height 60-70 cm, drought tolerant and yields 10 q/acre. Tasty and the kernel increases in size when cooked.
24	IC 622702	Dhan	TY	R	1.68	5.0	1.2	Light yellow	White	Grain fine, medium, plant height up to 60 cm and drought tolerant.
25	IC 622703	Kalinga	FS	R	1.89	5.0	1.3	Light yellow	White	Fine grained, plant height up to 60 cm and drought tolerant.
26	IC 617734	Chuhka dhan	FS	R	1.33	3.1	1.1	Brown with yellow patches	White	Fine grain & scented, plant height 90 cm, number of tillers high, drought tolerant and yields 10- 15 q/acre. Rice good in taste, preferred in feast during Pujas and also has good market price.
27	IC-623315	Dumar phool	TY	R	1.64	3.5	1.0	Brown	White	Panicle is compact like fig (Gular), grain fine, small, scented, plant height 75-90 cm, drought tolerant, non shattering type and yield 12-15 q/acre.
28	IC 617735	Chirai nakhi	TY	R	1.22	4.0	0.9	Light brown	Red	Grain very fine like beak of sparrow, small, scented, awned, plant height 90 cm, yield 12-14 q/acre, drought tolerant and very good taste.

Contd.

S. No.	IC / Collection Nos.	Traditional landraces	Source*	Frequency#	100 grain wt. (g)	Grain length (mm)	Grain breadth (mm)	Grain colour	Kernel colour	Important characteristics and traditional uses
29	RSR/SKY-37	Gada khunta	FS	R	3.03	4.1	1.5	Light Yellow	White	Plant is strong like wooden/iron rod used to hold the animals. Grain bold. Plant height. 160 - 180 cm, drought tolerant, late maturing with strong stems and yields 12-15 q / acre.
30	IC 622704	Dhania	FF	R	2.38	4.0	1.2	Brown	White	Grain bold , stem strong, long panicle and plant height 100 -120 cm.
31	IC 617736	Sathia	FS	R	2.16	4.0	1.1	Light Yellow	Red	Very early, matures in 60 days in August, tall up to 105 cm and highly drought tolerant.
32	RSR/SKY-40	Barangi	FS	R	2.57	4.5	1.5	Light Yellow	White	Grain bold, matures in 100 days, tall up to 80 cm and sweet.
33	RSR/SKY-41	Gurmutia	FS	R	2.38	4.0	1.1	Golden	White	Grain bold, plant height 90 cm, stem and leaf colour blackish green, stem strong, late in maturity (140 days), drought tolerant, yield 15 q / acre and cultivated in compact soils.
34	IC 617737	Bhata sapri	TY	R	2.25	5.3	1.1	Golden	White	Grain medium sized, very dwarf, 45 - 50 cm in height, stem strong, drought tolerant and matures in 60-70 days. Cooked rice is used in general weaknesses.
35	IC 617738	Culture	FS	R	1.83	4.0	1.0	Light yellow	White	Grain fine, plant tall up to 90 cm, stem strong, drought tolerant and matures in 60 - 70 days.
36	IC 617739	Bhata sapri	FS	O	2.10	4.8	1.2	Light yellow	White	Grain medium sized, plant very dwarf, 45 - 60 cm in height, stem strong, mature in 60 -70 days, drought tolerant and good taste.
37	IC 617740	Bhurshi	FS	R	1.63	3.5	1.3	Whitish yellow	Red	Grain small, awned, plant height 60 -75 cm, matures in 70-80 days and drought tolerant. Cooked rice water taste like milk and is preferred for food.
38	IC 622705	Khut bodi	FF	R	2.55	4.2	1.1	Brown with yellow spots	White	Grain small, awned, plant tall up to 75 cm, matures in mid October, grown in rainfed condition and drought tolerant.
39	IC 617741	Barangi	FF	O	3.03	4.5	1.8	Mottled yellow	White	Grain small, rounded, plant height up to 90 cm, brown spots on leaves and stem strong. This landrace gives better yield under zero inputs and highly drought tolerant.
40	IC 622706	Barangi	FF	O	2.68	5.0	1.5	Mottled	White	Grain small, round in shape, plant height up to 90 cm, stem strong and with brown spots on leaves. It gives better yield under zero input and highly drought tolerant.
41	IC 622707	Ashan churi	FS	R	2. 13	5.1	1.0	Dark yellow	White	Grain fine, plant height 90 to 100 cm and drought tolerant.
42	IC 622708	Mandria	FS	R	2.54	4.2	1.8	Golden	White	Grain bold, plant height 90 cm and drought tolerant.
43	IC 622709	Haldi ghanthi	FS	R	2.50	4.4	1.2	Yellowish brown	White	Grain very fine, plant height up to 90 cm and drought tolerant.

Contd.

S. No.	IC / Collection Nos.	Traditional landraces	Source*	Frequency#	100 grain wt. (g)	Grain length (mm)	Grain breadth (mm)	Grain colour	Kernel colour	Important characteristics and traditional uses
44	IC 617742	Kolia dhan	TY	R	2.40	3.5	1.0	Black	Blackish	Grain medium sized, plant height up to 70 - 80 cm, drought tolerant and matures in 90 -100 days.
45	RSR/SKY-57	Bhata sona	TY	R	1.54	4.2	1.0	Black	White	Grain small, very fine, plant height up to 60 cm, matures in 90 -105 days, highly drought tolerant and good taste
46	IC 617743	Anjan dhan	TY	O	2.56	3.5	1.0	Yellowish brown	White	Grain bold, medium sized, plant height up to 60 cm, matures in 90 -105 days and sweet.
47	IC 617744	Culture	TY	O	2.27	6.1	1.5	Light yellowish brown	White	Grain very fine, plant height up to 60 cm and matures in 70 - 80 days. Rice quality is good and very tasty. It is being cultivated since over 70 years.
48	IC 622710	Dabaar dhan	TY	R	2.54	4.0	1.3	Black	Blackish	Grain medium sized, bold, awned, tall up to 60-70 cm and matures during September. Rice is very good in taste and rice water is sweet.

*FF: Farmers field, FS: Farm store, TY: Threshing yard, #R: Rare, O: Occasional

Results and Discussion

During the survey, a total of 48 diverse landraces were collected from 18 villages of six districts of Chhattisgarh. It was observed that the old age (70-80 years) farmers were very much fond of memorizing the local names of most of the landraces grown in the area. The folk nomenclature of local landraces was done by observing their important characters, distinctiveness as well as continuous experimentation with them in their original habitat (Lando and Mark, 1994). The names of landraces were slightly different in some of the villages because of change of dialect of tribal communities. The farmers often assign name to the local landraces based on certain characteristics. Naming of landrace is quite scientific as it possesses certain traits which generally reflect in its name; hence a landrace could be identified easily, if a particular name is assigned to it. Appearance of seed and kernel, crop plants, taste, maturity, plant size, growing conditions are major factors which form the basis of naming a landrace. In Chhattisgarh, the nomenclature of traditional landraces/cultivars was also done on the basis of their use/characteristics (Table 1 and 2).

Literature indicates that over 20,000 rice cultivars/ landraces including some of the landraces viz., Bans bhira, Bhata sapri, Asan chudi, Chirai nakhi, Dhania, Dabar dhan, Gurmatia, Lal dhan, Lochai and Satia have been maintained by traditional farmers in Chhattisgarh (Singh, 2013). According to Pandravada *et al.* (2004), Barangi chudi, Bhatta dhan and Chudi dhan are commonly cultivated landraces of this region. The commonly grown landraces collected from Chhattisgarh were Desi-sapri, Dabaar dhan, Lal dhan, Shri dhan, Sathia, Turia dhan, Bayo dhan, Kolia dhan, Lali chaudi dhan, Kalinga, Chuhka dhan, Dumar phool, Gadha khunta, Barangi, Gurmatia dhan, Bhata sapri, Khutbodi, Ashan churi, Haldi ghanthi and Bhata sona. The landraces containing similar names at different localities have also showed variation in morphological traits. Similar observations have also been reported by Ahmed *et al.* (2016). In Chhattisgarh, the landraces are grown through direct seed sowing method for better yield. Majority of landraces are grown by the poor and marginal farmers under stress prone rainfed land locally known as dand/ bhata/tand/tikra (upland sites).

Variability in Traits

Rice landraces showed high variability with respect to quantitative and qualitative traits and adaptability to local environments. Significant variability was mainly observed for plant height, days to maturity, seed colour, seed-size and shape and awn length (Table 1 and Fig. 2). Variability observed in quantitative traits viz., grain weight, grain length, grain breadth and grain l/b ratio was also analysed. Maximum grain length (6.1 mm) was recorded in Kolia punchha and Culture while minimum (3.0 mm) in Sridhan. Similarly, maximum grain breadth (2.3 mm) was recorded in Dabaar dhan and minimum (0.9 mm) in Chirai nakhi. Rice landraces

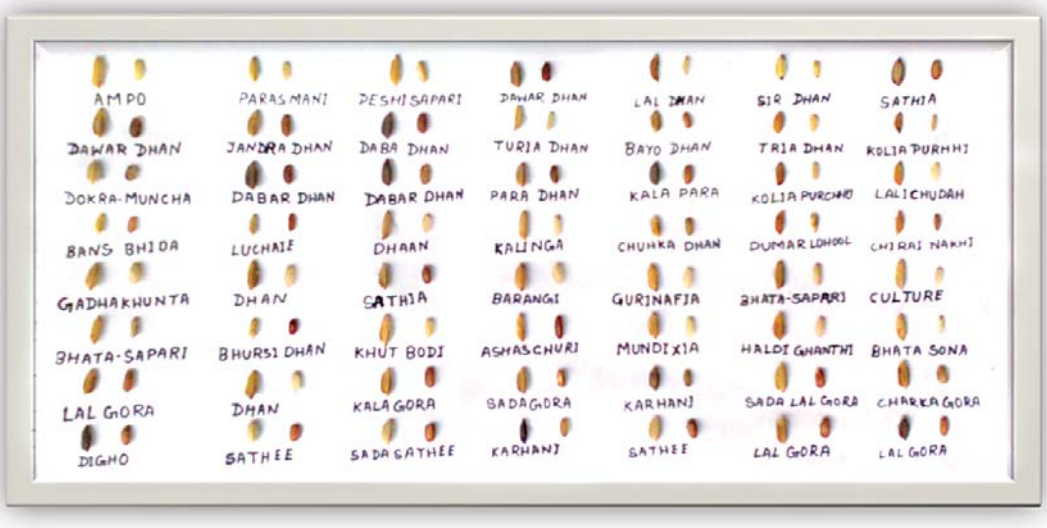

Fig 2. Grain and kernel variability in rice landraces

Table 2. Folk nomenclature and traits associated with rice landraces

Landraces	Meaning of landraces	Associated traits
Dokra mucha	Awn similar to mustaches of an old age man (Dokra-old man; mucha-mustaches)	Awn
Turia dhan	Sharp awn (Turia-sharp awn)	
Kolia punchha	Black coloured awns like tail of animal (Kolia-black; punchha-tail)	
Bans bhida	Dense tillers like many bamboo stems arising from single rootstock (bans-bamboo; bhida-dense/more)	Tiller
Dumar phool	Containing many panicles like fig contains many flowers inside fruit (Dumar-fig; phool-flowers)	Panicle
Chirai nakhi	Grain sharp as like bird's claw of toe (Chirari-bird; nakhi-claw)	Grain shape
Sathia	Matures in 60 days (Sathi-60 days)	Maturity
Gurmati	Suitable to grow in compact soils like jaggery (Gur- jaggery; mati-soil)	Soil type
Haldi ganthi	Husk colour is yellow like turmeric (Haldi-turmeric; ganthi-rhizome)	Grain husk colour
Lal dhan	Kernel colour is red (Lal- red; dhan-rice)	
Dabaar Dhan	Rice used as medicine (Daba/Dabaar) for stomach troubles.	Medicinal rice
Gada khunta	Stem strong as wooden pole embedded as a peg in soil (Gada-embedded; khunta-peg)	Lodging resistant
Bhata sona and Bhata sapri	Easily survive/grow in gravel soil and can withstand in draught conditions and gave better yield (Bhata-gravel soil and Sona-like gold)	Draught resistant
Kala para and Para dhan	Teeds arranged from the other side of Kala river (Kala-river or stream; para- other side of river)	Seed procurement source
Chuhka dhan	Rice supposed to be pious for offering in feast during worship (Chukha-pious; dhan-rice)	Religious importance

showed considerable variability for quantitative traits as indicated by coefficients of variation (CV). Among the traits studied, the highest variability (CV %) was observed for grain breadth (25.13 mm) followed by 100 grain weight (22.54 g) and ratio of grain length and breadth (21.83 mm) (Table 3).

Traits-specific Landraces

The unique traits and general characteristics recorded in 48 landraces are presented in Table 1. Among these, six landraces (Chiral nakhi, Chuhka dhan, Dumar phool, Lali chudi, Shri dhan and Turia dhan) were recorded as scented with fine grains; four landraces (Bhata sapri, Dabaar dhan, Shri dhan, Turia dhan and Bayo dhan) are considered good for general weaknesses and diabetes by Gonds; two landraces (Ampo dhan and Dumar phool) were identified as non-shattering types; Barangi is considered as one of the best landrace because of its highest grain yield under highly drought conditions; Dabaar dhan is cultivated mainly in the upland areas due to its early maturity, sweet taste and medicinal properties. Some of the promising collections identified for various other traits were IC622697, IC617741 and RSR/SKY-37 for 100 grain weight; IC-623311, IC-623314 and IC617744 for long grain and IC617735 and IC-623313 for grain breadth.

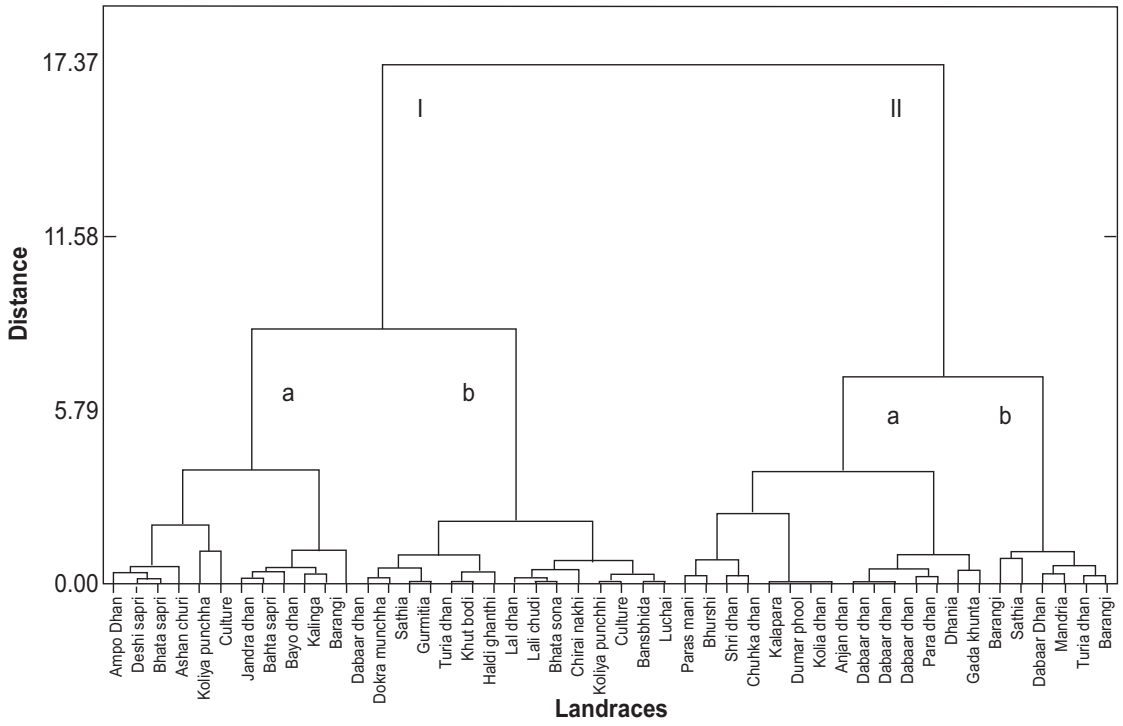

Fig 3. Clusters based on grain characteristics of landraces

Grouping of Landraces

To understand the association ship between the landraces, three quantitative traits (100 grain weight, grain length and grain breadth) were analyzed for grouping the similar genotypes into clusters and accordingly five clusters in 100 grain weight and four each in grain length and breadth were made. The maximum grain length (5.0 mm) in Barangi and grain breadth (2.3 mm) in Dabaar dhan had shown the close association with high 100 grain weight (Table 1). Results of similarity matrix based on Euclidean distance and hierarchical clustering technique are depicted in Fig. 3. The analysis has grouped all the 48 landraces in to two major clusters, consisting 27 landraces in cluster-I and 21 landraces in cluster-II. While cluster-I was further sub-divided into two sub-clusters (Ia and Ib), based on similarity in quantitative characters (grain weight, grain length and breadth, and l/b ratio). Sub-cluster (a) contains Ampo dhan, Deshi sapri, Bhata sona, Ashan churi, Koli punchha, Culture, Jandra, Bhata sapri, Bayo dhan, Dhan, Kalinga and Barangi while sub-cluster (b) contains Dabaar dhan, Dokra munchha, Sathia, Gurmatia, Turia dhan, Khutbodi, Haldi ganthi, Lal dhan, Lalichudi, Bhata sona,Chirai nakhi, Kolia punchhi, Culture and Luchai. Cluster-II was also further sub-divided into two sub-cluster (IIa and IIb). The landraces (Parasmani, Bhurshi dhan, Shri dhan, Chuhka dhan, Kalapara, Dumar phool, Kolia dhan, Anjan dhan, Dabaar dhan, Para dhan, Dhania dhan, Gada khunta and Barangi belong to sub-cluster IIa and Sathia, Dabaar dhan, Mandria, Turia dhan and Barangi to sub-cluster (IIb) (Fig. 3).

Table 3. Quantitative analysis of grain characters in rice landraces collected from Chhattisgarh

Variables	Minimum	Maximum	Mean	SE	CV
100 grain wt. (g)	1.12	3.03	2.16	0.07	22.54
Grain length (mm)	3.00	6.10	4.25	0.09	15.45
Grain breadth (mm)	0.90	2.30	1.24	0.04	25.13
l/b ratio	1.85	5.10	3.57	0.11	21.83

Determinants of On-farm Diversity

Poor economic conditions, remoteness and backwardness are the major reasons which force the poor and marginal farmers for cultivation of landraces under rainfed conditions. In addition, lack of irrigation and marketing facilities, difficulties in access to seed companies and adoption of new technologies are some other factors which are also equally responsible to compel the farmers for cultivating traditional crop diversity in these areas. Despite of all these factors, poor and marginal farmers play a major role in on-farm conservation of landrace

diversity and in providing ecosystem services to the society, which is very much essential for adaptation of crops against climate change. Moreover, the marginal farmers are not capable to continue on-farm conservation of crop diversity and also cannot sustain their livelihood for longer period with presently grown landraces. The society should also not expect maintenance of crop diversity by them for longer period at the cost of short-term gains. If society values resilient agriculture and sustainable food systems, a fruitful intervention to support the poor and marginal farmers particularly in tribal areas and sustenance of on-farm crop diversity needs to be thought off. During the last five years, several projects in support of on-farm conservation in India have also been executed by ICAR and other organizations. According to Gowdy *et al.* (2009); De Boef *et al.* (2013) and use of local crops and varieties (landraces and underutilized traditional crops) to sustain the food security of marginal farmers is very urgent in order to provide a wider range of options for livelihood diversification and economic growth, thereby promoting resilience and enhancing farmers' capacity to adopt against climate change.

The landraces collected from study area are grown traditionally from ancient time by the tribes of Chhattisgarh, indicates that on-farm conserved landrace diversity holds a special position in the livelihood and traditional culture of people of the study area. Xu *et al.* (2012) have also opined that the patterns of variation in on-farm varieties are directly associated with traditional culture and custom of different ethnic groups. His findings confirm the role of on-farm conservation in management of plant genetic resources, as it provides baseline information for betterment of on-farm conservation and sustained utilization of plant genetic resources.

Unfortunately for many reasons, the genetic diversity in rice landraces and other crops is eroding fast in different parts of the world. This fact has also been supported by Chauhan *et al.* (2000) and Hammer and Teklu (2008) by citing high genetic erosion in rice landraces due to replacement of traditional varieties through introduction of HYV. Hence, efforts should be made to provide irrigation facilities and seeds of important landraces with early maturity to the farmers in order to mining the shortage of food in the region and to upgrade socio-economic conditions. Landraces which are being grown under rainfed conditions should also be conserved *ex-situ* for utilizing in crop improvement against drought faced by the farmers in different parts of the country. Genetic diversity in folk varieties offers the basis for evolution of cultivated crops while distinctiveness expressed by various cultivars provides opportunity to adapt them in different environmental conditions. In South Asia, more than 100,000 folk varieties of the Indica group of rice are grown under rainfed conditions where they co-evolved with crop pathogens, insect pests and their predators (Richharia and Govindasamy, 1990; Morishima and Oka, 1995).

Conclusions

Landraces are still being conserved on-farm by ethnic communities and marginal/poor farmers in various parts of the country because these are most suitable for diverse agro-ecological conditions, deeply associated with cultural diversity and are capable to fulfill cultural and food requirements of the people. At present because of weakening of cultural traditions, declining of economic viability due to low yield, changing climate, the enthusiasm of farming/tribal communities to conserve traditional landraces on-farm for maintaining varietal richness is gradually decreasing. These facts necessitate efforts for collection and conservation of crop genetic resources from the areas where still primitive landraces/ cultivars are grown by rural/poor/marginal farming communities (Ishikawa *et al.*, 2002). It is a well known fact that the landraces which possess the desired characteristics such as drought tolerance, early maturity, stickiness, medicinal properties, aroma, kernel colour, etc. can become important resources for breeding and broadening the genetic base of rice. Thus, collecting such trait-specific germplasm would help in strengthening the food security effort in changing climatic condition and also to exploit their potential for biotic and abiotic stresses, yield and other quality traits. From the present study, it can be concluded that the landrace diversity in the study area is quite high. The most motivating factors for landraces diversification in the area are land heterogeneity, risk considerations and weekly market participation. Hence, to promote sustainable on-farm conservation of crop genetic resources and traditional cultural practices of ethnic communities in the study area, incentives to the farmers need to be provided.

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