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CONSERVATION PRACTICES AND ASSESSMENT OF SPATIAL AND TEMPORAL VARIABILITY IN RICE LANDRACES OF BASTAR REGION OF CHHATTISGARH, INDIA

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Rice (*Oryza sativa* L.) is the staple food for more than half of the population in the world. In India, it provides food security and nutrition to more than two-third population and contributes 20-25% in Indian Agriculture. The state of Chhattisgarh is endowed with rich genetic diversity in cultivated and wild relatives of rice. Rice farming is practiced in several agro-ecologies ranging from rainfed upland rice ecosystem, rainfed lowland rice ecosystem, irrigated rice ecosystem and flood-prone rice ecosystem. Extensive field surveys and personal interviews were conducted in Bastar district of Chhattisgarh, India in the months of September to November during 2017 - 2019 and the rice samples were collected. During the field survey, a total of 193 varieties varying in seed characteristics viz. red, dark red, light red and white kernel types were collected. The grain size of the varieties ranges from slender to bold types and the grain length varied from long (8.1 to 11.0 mm), medium (5.0 to 8.0 mm) to small (2.5 to 4.0 mm). Red rice is much liked by the tribal people in the region due to its color and flavor with slow digestibility as it keeps them energetic for a longer time in the field. Out of the total varieties collected from the region, 41 varieties were recorded as red kernel type, 36 in brown rice category and five in light brown types. Regression line found in 2.67 by 2.25 (R^2= 0.211) in seed and kernel color comparison.
Keywords: Conservation methods, Chhattisgarh, diversity, Traditional rice

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INTRODUCTION

Climate change has impacts on species distribution and phenology from polar, terrestrial to tropical and marine ecosystem (PARMESAN and YOHE, 2003; WALTHER *et al.,* 2002) and may be dangerous to many species' extinction in the near future (URBAN, 2015). Many studies have provided evidence that climate change affects biodiversity in several different ways, including phenological shifts (COHEN *et al.,* 2018; PARMESAN and YOHE, 2003), changes in abundance (PARMESAN, 2006; STURM *et al.*, 2001) and evolutionary responses (PARMESAN, 2006; RANK and DAHLHOFF, 2002). Another, widespread, consequence of climate change is a shift in the distribution of species (BARTON *et al.*, 2016; CHEN *et al*., 2011; HICKLING *et al*., 2005; LA SORTE and THOMPSON, 2007; PARMESAN, 2006; PERRY *et al.*, 2005). Shifting climate diverts the farm level traditional rice conservation as it triggers family preserve for providing food security throughout the year with meagre production, mainly distracts them to grow more ~~of~~ number of landraces. In the present scenario, the conservation of landraces requires high cost of cultivation. The supply of rice at nominal charges by government aggravated the problem of loss of traditional varieties; even old mind set of farmers to grow a greater number of land races can tackle the climate resiliency. Although this mind set could not overcome the re-establishment of phenomenon for climate resiliency. A few numbers of land races remained with farmers either in small patches or household level. Otherwise, most of the farmers are interested to choose high yielding improved varieties in the place of traditional landraces, which is now hardly survive in villages. Seed replacement is a primary focussed programme of government while climate change governs a considerable role in reshaping communities; so far, the main cause of biodiversity decline is the direct effect of habitat loss (SALA *et al*., 2000). As climate and land-use changes are expected to interact to shape future species' distribution (JETZ *et al*., 2007; MARSHALL *et al*., 2018), it is imperative to examine how they together contributed to long-term biodiversity changes.

Rice accounts for about 42% of total food grain production and more than 55% of diet in India. It is cultivated below the sea level in the Kuttanad region of Kerala state as well as at an altitude of 2000 meters above the mean sea level in the hilly tracks. Rice diversity consists of landraces, improved cultivars and hybrids, closely related wild relatives adapted to varying agro-ecological conditions, *viz.*, altitude, temperature, rainfall, soil-type etc. and possessing varied agro-morpho-physiological characteristics (RATHNABHARATHI, 2009; SINGH *et al*., 2006; DAS and OUDHIA, 2000). Rice is on the frontline in the fight against world hunger and poverty and is also a symbol of cultural identity and global unity. It shapes religious observances, festivals, customs, cuisine and celebrations and is drawn from an understanding that rice-based systems are essential for food security, poverty alleviation and improved livelihoods (ANONYMOUS, 2000). Rice crop occupies 22.8% of total crop area, which is the largest acreage in the world. Through the introduction of modern high yielding varieties, along with new management practices, the Green Revolution has led to a considerable increase in rice production in India as in other Asian countries. Beginning with the release of the high yielding varieties, traditional landraces were replaced within less than one decade in most of the rice growing regions of the country. The traditional landraces were collected and maintained by the large breeding institutions as *ex-situ* conservation. The rice grain is the most rapidly growing food source in

Asia and has a major influence on human nutrition and food security all over the world. The rice grain enclosed in lemma and palea is generally separated by traditional hulling methods by the small farmers and tribal people. The nutritional value of traditionally hulled rice grains (husked rice) is more than modern method of milling (polished rice). Protein, fats, vitamins and minerals are present in greater quantities in the germ and outer layers than in the starchy endosperm. Removal of the protecting pericarp also facilitates the extraction of soluble substances from the aleurone layer during washing immediately before cooking the grain. Losses on polishing are 29% of the protein, 79% of the fat, 84% of the lime, and 67% iron. Diversity analysis of grain characteristics and micronutrient content in rice landraces of Tripura, India indicated higher mineral content especially of Zn++ and Fe++ in the grains of local landrace germplasm like *Hazar* and *Mai kasam* (B) and may be helpful in mitigating deficiencies in local population and selecting promising lines with enhanced mineral contents for mitigating their deficiencies in human population (DIKSHIT, 2016). The state of Chhattisgarh is considered as the rice bowl of India. Significant variation in climate, topography, soil and hydrology coupled with varying cultural heritage have resulted in evolution of high genetic diversity in rice germplasm in Chhattisgarh RICHHARIA (1979). But the number of rice varieties are quickly replaced by modern varieties resulting in shrinking of the genetic base. Reduced genetic variability necessitates the need to collect and characterize germplasm for agro-morphological traits for use in future breeding programs. But local landraces are still being cultivated by the resource-poor traditional farmers under subsistence farming. These varieties are a great source of variability including tolerance to biotic and abiotic stress and quality traits. Hence, an effort was made to document and conserve the rice biodiversity in the tribal region of Bastar, Chhattisgarh, in light of the rapidly dwindling rice landraces.

MATERIALS AND METHODS

The extensive field trips and personal interviews were carried out in the Bastar district of Chhattisgarh during the *kharif* (wet) season in the months of September to November 2017 - 2019. Semi structured interviews on the land characteristics, agricultural practices, characteristics of the traditional rice varieties, storage system, including utilization and conservation practices were recorded. All the recorded data are based on farmers and tribal communities' long-term experience.

Study design

We selected the sites in order to cover real traditional pockets of the region, each block was treated as identical sites considering the core village viz., remote, monoculture, forest and forest fringe villages for extracting valid information and to draw the present status of traditional rice cultivation. 35 villages of seven blocks of Bastar division were surveyed and, in each village, average of 5 group members' discussion were held. Meanwhile, sampling seeds from standing crop and household were done during the third year, survey. The collected seeds were subjected to grouping based on seed morphology, life span and morphometric characteristics. Further, the recorded data were computerized and processed using statistical methods.

Conservation related study included storage, conservation technique and sustainable method of conservation of traditional rice varieties.

Survey method

Surveyed villages were categorized as city periphery, forest fringe, hilly or *Dongri*, foot of hills, remote villages and plain area, which were demarcated with durational growth period of traditional rice. On the basis of rice cultivation, expected duration were allocated for grouping as 60-80, 80-100, 100-120 and >120 days with each village categories. Hence, city periphery was the area surrounded by rice cultivation in outskirt, forest fringe included just nearer to forest, the rice field adjoined to forest, hilly or *Dongri* were those rice field where steep slope or rolling surface features, foot hills that kind of rice field found just below the *Dongri* or hill, remote villages were purposely considered with less frequency of transportation only which were located more than 45 km away from urban/city/block head quarter.

Climate details of the region

Bastar region has experienced annual rainfall totals of over 1000 mm for the past three decades, but less than 1000 mm in 1997 and 2002. However, in two odd years, 1990 and 2010, there was more rainfall than 2000 mm. The annual pattern of 1400–1500 mm was maintained by the long-term rainfall. Due to the adoption of rainfed agriculture throughout the entire region, quantity and variety have a direct impact on regional agriculture. Pre-monsoon showers were experienced between 1986 and 1996 in April, moving to May in succeeding decades. Although the pattern of rainfall varied greatly from June to October from 1997 to 2007 compared to 1986 to 1996 and 2007 to 2018, and a declining tendency in rainfall was seen from November to December from 1986 to 1996. While the winter rainfall pattern increased from 1907 to 2007 and decreased in the most recent decade (2008–18), Thus, summer showers increased in number in 1986–1996 and 2008–2018, showed variation in the SW monsoon. While other seasons did not differ in terms of amount, the SW monsoon (June–September) exhibited a modest variance in rainfall. Regardless of the decades, the winter monsoon's monthly rainfall decreased from 21.27 mm to 11.25 mm (PRADHAN *et al*., 2018).

Data analyses

The collected data were analysed using XLstat 2003 for assessing basic statistics to know the actual variation in different landforms of Bastar region after completion of survey. The data were categorized in various similar groups keeping class limits. Variance correlation of seed and grain morphology was calculated using XLstat 2003 software.

RESULTS AND DISCUSSION

During the extensive field trips, it was observed that the traditional rice varieties collected from the study area possess generally high morphological variations and some of them are significantly important in the context of socio-economical values. 193 rice landraces collected from the Bastar district showed variations in kernel color, husk color, and grain size. The appearance of the varieties varied as dark red, red, light red and white. Similarly, the grain size of the varieties is long (up to 11 mm), medium (5 to 8 mm) and small (2.5 to 4 mm). The dark red color and long size of the varieties are comparatively more nutritious as per knowledge of farmers (Table 1 and Fig 5). According to the elderly farmers of Bastar, the red rice varieties liked by farmers are more nutritious.

Table 1. Grouping of traditional rice varieties based on duration and seed characteristics

Seed length	*Land races*
> 9 mm length	*Adan Chilpa, Alsaakar, Assam Chudi, Bade Khuji, Bamnichudi, Bans Koriya, Badsahbhog, Barengi, Bhata Safari, Bhatatsapur, Bandichudi, Bidi Safari, Ghotiya, Haldigathi, Hirnbako, Hirvadhan, Indardhoriya, Kawabur, Khutidhan, Kala Mali, Kukdi (R), Kundaphool, Kuradhan, Kurwadhan, Haldijip, Jhumra, Kurmatibhog, Kusumjhopa, Lalbarengi, Lokesari, Luchae, Mitkormel, Mudariya (L), Orandi, Pandariluchae, Pandarisatka, Paradhan, Potekhuji, Ranggadakhuta, Ramlaxman, Rantanchudi, Sargiphool, Sela, Shakhidhan, Sindursengar, Sirdibako, Sofa Kaanan, Sonpuri, Surmatiya, Taangan, Temru Mundi, Tikichudi, Tinkormel.*
< 5 mm length	*Ajam lali, Baardasaal, Bhatagadakhuta, Dhawdaphool, Mundariya (M), Ranikajar.*
Duration	*Land races*
Less than 100 days	*Jondranarki, Mehar, Pandaristka, Paradhaan, Satka, Sedur Singar, Badi, Dongarkabri.*
More than 100 days	*Bhatagadakhuta, Bhatakudae, Bhatakhuji, Dodekarengi, Kakdo, Meharlaldhan, Muthiyadhan.*
More than 140 days	*Badsahbhog, Bhaludubraj, Cheptigurmatiya, Gadakhuta, Karela (R), Karigrass, Karigrass (N), Kundaphool, Sonpuri, Surmatiya (S).*
Seed (kernel) colour	*Land races*
Golden yellow (golden to golden yellow)	*Alsaakar, Amtiminja, Badiyadhan, Bodidhan, Dumarphool, Haldichudi, Haldigathi-F, Keraphool, Khutidhan, Kusawari, Lokati Mundi, Lalbako, Mundariya (M), Ramjeera.*
Red colour	*Badsahbhog, Bamnichudi, Bhatagadakhuta, Bhatakhuji.*
	Land races
Brown (light to dark)	*All remaining fall under this category*
Grain (husk) colour	*Land races*
Red	*Adanga (R), Bamnichudi, Bandigoandi, Bukkuda, Chiradhan, Dhagdadhan, Damkidhan, Dongarkabri, Haldigathi, Hathipanjara, Indardhoriya, Jatiya, Jhumra, Jondranarki, Kawabur, Karela (R), Karigrass, Khutidhan, Kudaedati, Kukdi, Kukdi (R), Lochae, Laxmibhog, Layacha, Lalbako, Mehardhan, Meharlaldhan, Nanichudisapur, Pakhiya (R), Pandarisatka, Paradhan, Pilkormel, Pilkotmel, Potekhuje, Ratanchudi, Satka, Shakhidhan, Taangan, Temrumundi, Tikichudi.*
Brown	*Adanga, Assamchudi, Badsahbhog-Laam, Batiyadhan, Bhatasapur, Abndichudi, Bidisafari, Bodela, Cheptigurmatiya, Dengichudi, Dhaniyadhan, Dhawdaphool, Dubraaj (Local), Elayachi, Gdakhuta-S, Ghotiya, Haldijip, Hansadubraaj (R), Kadamphool, Kahae, Kalamali (S), Loktimochhi, Mejhodhan, Motilur, Milkotmel, Muthiyadhan, Pakhiya (B), Pandariluchae, Ranikajar, Ram Laxman, Sargiphool, Sindursengar, Sirdibako, Sofa Kaanan, Sapurluchae, Tinkormel.*
Light brown	*Dhanukand, Hardigathi-F, Mundariya (L), Tamakoni, Umariyachudi.*

Even they consume due to its properties of slow digestion and also prefer for pregnant lady to fulfill the requirement of iron requirement. They consume starchy water made from red rice varieties, locally known as *Pasia* or *Maad* and it helps to keep them energized and healthy. Even they do not feel thirsty for a long period if they drink *Pasia* while their hard physical work. Tribal people prefer coarse grain rice owing to its slower in digestion which is eaten just after cooking with tomato *Chutney*. The unpolished rice is a healthier food because it provides with rice bran. Rice bran provides mankind greatest nutritional needs VAUGHAN (1994), RABBANI (2008). Rice bran is one of the richest sources of vitamins, minerals and antioxidants. The amylose content of the starch varies according to the type of grain and the long-grain types contains up to 17.5% amylose GRIST (1975). The genetic resources of scented varieties of rice could be tapped and used in the breeding programme which necessitates the on-farm maintenance of landraces. Significant variability was observed in morphological, agronomical and cooking characteristics among the aromatic rice varieties of Odisha (DIKSHIT, 2014).

The survey was conducted in selected villages of Bastar to collect the information related to the names of the rice landraces in the region. More than 25 traditional rice varieties possessing nutritional properties. Some of the landrace's varieties were not under cultivation and having less in restricted areas. Inhabitants of the regions use this traditional rice for the human beings and cattle also (GEPTS, 1993).

Since the shape, size, colour, and other characteristics of rice play a significant role in determining the quality of nutrients present in the kernel, researchers have focused on identifying and gathering valuable genetic resources in the context of new desired varieties that may meet future demand. These rice cultivars demonstrate multi-dimensional approaches for climatic resilience and stress tolerance, while many farmers continue to conserve their resources through barter system. Among the collection, 55 varieties were longer than 9 mm in seed length and 6 were less than 5 mm; in case of long duration landraces (>140 days) were 10 and less than 100 days were 8 in numbers (Table 1). The less than 100 days varieties were found to be climate resilient by ripening early that is why these varieties are still in practice for food security. Red rice is much liked by tribals in the region due to color and flavor with the slow digestibility; 41 varieties were recorded red kernel and 36 in brown color category. Kernels of the landraces were accounted as light brown only in five landraces out of 193 collections of traditional rice. DAS and OUDIA (2000) reported similar results in the medicinal rices of Chhattisgarh. In an evaluation study on 1180 rice genetic resources of Odisha, India DIKSHIT *et al.* (2004) observed high genetic diversity for various agro-morphological, yield contributing and insects and pest resistance traits.

Considering length and width of both seed and grain of different landraces, were categorized by class value and frequency. Maximum number of 183 landraces were found in 6-10 mm seed length category, and only two landraces were between 11 to 15 mm long. Seed width measurement ranged from 2 to 6 mm in 21 landraces and 171 landraces were in the range of 4 to 6 mm width. In case of grain morphology, majority of 128 landraces were bold grain (4-6 mm) followed by 61 landraces in 7-8 mm and long grains (9-12 mm) in 4 landraces. (Table 2). This means a large number of farmers grow coarse type landraces as compared to fine or smooth grain type. The grain and kernel comparison for standard coefficients was 2.67 at 90% confidence interval and regression line in 2.67 by 2.25 (R^2= 0.211). Active and validation were analyzed on standard residuals with 2.25, validation grouping was observed in negative to positive scale, similar trend was followed by active residual in comparison to seed and rice variation which led the prediction for varietal variation. OVESNA *et al*. (2002); DICE (1945); ANONYMOUS (2000).

Table 2. Seed and grain morphological variation in the collected rice germplasm

Feature	Seed		Grain	
	Category class	Frequency	Category class	frequency
Length (mm)	1 to 5	7	4 to 6	128
	6 to 10	183	7 to 8	61
	11 to 15	2	9 to 12	4
Width (mm)	2 to 4	21	0 to 3	174
	4 to 6	171	4 to 6	18

Table 3. Duration of traditional rice varieties

Category class	*Frequency*
70 to 80	3
91 to 110	12
111 to 120	1
120 to 130	18
>130	158

Rice crops of the region varied from 70 to >130 days and was categorized into five groups in which 158 landraces were more than 130 days duration and preferred in lowland (*Gabhar*) followed by 120 to 130 days duration. There were only 12 landraces of 91 to 110 days duration well suited for early cessation of rainfall under climate change mitigation plan for tribes of Chhattisgarh (Table 3). Because of more rainfall (>1400mm), farmers used to prefer long duration varieties for lowland farming. Overall classification of seed, grain and duration showed more variation in case of length and width, the maximum and minimum length of seed was 12.20 and 5.00 mm, respectively with average of 8.60 mm, whereas seed width varied from 1.75 to 6.10 mm as minimum to maximum with average of 3.39 mm. Similar observations were recorded for grain measurement and landraces having longer size grain length was 11.20 mm and width 4.00 mm, maintaining a mean of 7.60 mm *vice-versa* with width ranged from 0.8- 1.50 mm as maximum and minimum size grain (Table 4). Wide range of maturity duration was also observed among landraces like minimum 75 days and maximum 145 days with average of 110 days.

Table 4. Range of variation in seed and grain characteristics of traditional rice landraces

Seed Feature		Max. (mm)	Min. (mm)	Average
Seed	Length	12.20	5.00	8.60
	Width	6.10	1.75	3.93
Grain	Length	11.20	4.00	7.60
	Width	0.8	1.50	1.15

Farming niche includes city periphery, forest fringe, hilly (*Dongri*), foot of hills, remote villages and plain area where more than 60 landraces of 120 days were sown regularly, but due to introduction of improved and hybrid rice varieties in various farming lands negatively affected the number of traditional rices. Hilly (*Dongri*) and remote villages had higher number of landraces in cultivated fields as short duration (60-80 days), whereas 80-100 days maturity was in hilly (35) and remote villages (31), 40 landraces found in forest fringe. Highest priority had been given to 120 days duration landraces in plain area compared to city periphery, foot hills and forest fringe having 74, 70, 64 and 40, respectively (Table 5). The cultivated lands are locally recognized land forms as *Marhaan* (slopy upland unbunded), *Tikra* (Upland occasionally bunded), *Maal* (midland bunded) *Gabhar* (lowland bunded), and *Bahara* (extreme lowland where water continues to flow until the end of January). *Marhaan* (Upland) have wide variability in rice landraces, in which the *Marhaan dhan* is cultivated and *Gabhar* is preferred for long duration rice cultivars, whereas rest of landforms dwells in between these landforms (Figure 1). Among 105 landraces from tribal areas of Santhal Parganas in Jharkhand, India, different landraces suited to different land situations/ecosystems for various economic traits and suggested that on-farm conservation of rice in marginal rainfed cultivation in eastern India plays a very important role in security of food crops DIKSHIT *et al*. (2012). Change in diversity of rice over time (VELLEND *et al*., 2013) influenced the traditional rice especially in combination with information on local climatic and land-use trends. However, most studies reporting decline in diversity were carried out in lowland, intensively managed agricultural systems (BOMMARCO *et al*., 2012; DUPONT *et al*. 2011; PLOQUIN *et al*., 2013), with a relatively natural land cover where subtle effects of land-use and climate change are not masked by the intensification of agricultural practices.*O. rufipogon* is widely distributed in tropical regions and can be found, for example, in swamps, deep and shallow water and paddy ditches (VAUGHAN., 1994). Because this wild species has the ability to outcross with cultivated rice, and hybrids and intermediate plants are found around paddy fields as a result of gene flow between cultivated and wild rices. Cultivated rice is predominantly self-pollinated and has lower outcrossing ability than *O. rufipogon*. According to MESSEGUER *et al.* (2001), the natural cross-pollination rates of *O. sativa* are less than 1%; these data are based on old experimental records of three Asian countries. Recently, the outcrossing rates of rice cultivars were examined with respect to transgene escapes.

Table 5. Distribution of traditional rice in different farming niche

Field. location	Duration (days)			
	60-80	80-100	100-120	>120
City periphery	2	8	20	70
Forest fringe	10	10	40	40
Hilly (*Dongari*)	46	35	15	4
Foot of hills	1	5	30	64
Remote villages	32	31	20	17
Plain area	1	10	15	74

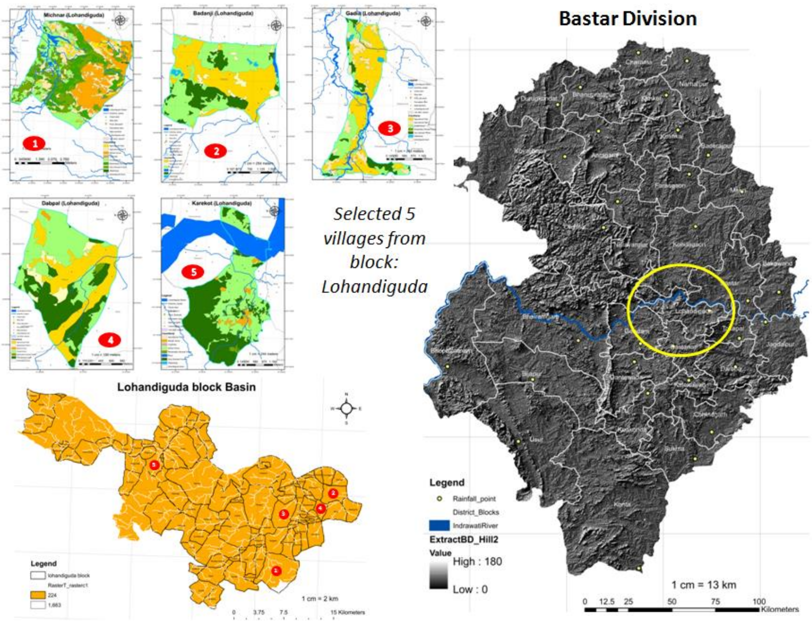


Figure 1. Schematic representation of surveyed area in Bastar division

The rates of gene flow between cultivars were reported to be lower than 0.1% in a normal side-by-side plot design (ENDO *et al.*, 2009, MESSEGUER *et al.*, 2001). According to conservation of landraces, the storage system was more prominent in rural areas as compared to urban or periphery of city where most of farmers use to sell the produce immediately by machine threshing at MSP (Minimum Support Price) set by government that affects much to storage of rice varieties in urban or city areas. In remote villages, farmers hardly get machines, therefore, prefers traditional system of storage (Table 6). In this context, forest fringe, hilly, foot hills and remote villages were found to be more vulnerable to all system of conservation in their houses.

Table 6. Conservation system of traditional rice

Conservation system	City periphery	Forest fringe	Hilly (*Dongari*)	Foot of hills	Remote villages	Plain area
In-situ conservation	3	19	32	23	20	3
Ex-situ conservation	29	10	11	13	8	31
Hanging panicles	1	28	22	19	28	2
Barter system	0	25	18	14	41	1

Land characteristic supports rice farming showing durational diversity in *Marhaan*, *Tikra*, *Maal* and *Gabhar* as per landraces feasibility. Landforms of Bastar depicted how that soil type helps in maturing the rice varieties which is unique due to undulating plain (Fig 6).

Parameters like traditional practice, slope, degradation, moisture, rice duration and sustainability were considered in the study with these characteristics.

Conservation practices

Broadly speaking, conservation practises include maintaining diversity of rice types by sowing them regularly in rice fields each year, preserving them in storage bins/structures, and using a barter system where seeds are traded for goods.

1. Maintenance through sowing of rice varieties: Every year farmers used to grow and maintain genetic purity of particular rice varieties and this is a very common in practise (Fig 2,3 & 4). Field level cultivation of rice was considered in this practice as the main method of seed chain maintenance. Cultivation includes basically regular sowing of these varieties in rice field every year and they use to maintain existence of rice landraces as short-term planning. At the time of flowering, rogue the off type and wild one which are locally known as "*Kapni*" or "*Jhara*" for maintaining genetic purity and reduce the risk of contamination. In this method, tribals obtain pure seed every year. JARVIS *et al*. (2008) reported that considerable genetic diversity continues to be maintained on farm in the form of traditional varieties.

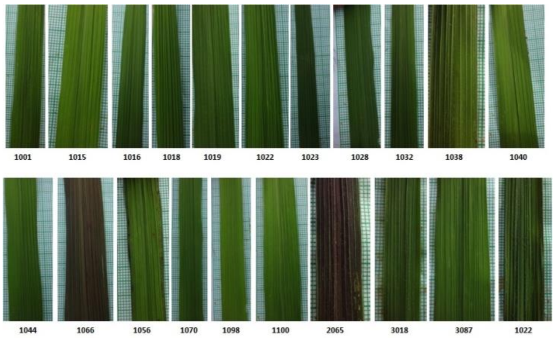


Figure 2. Showing leaf blade variation

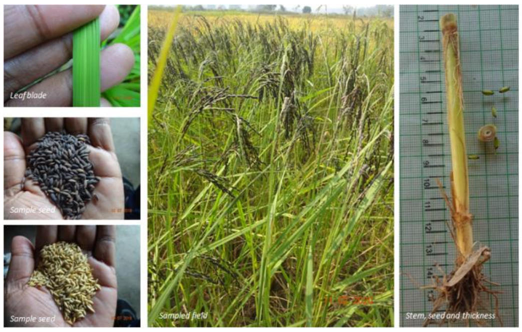
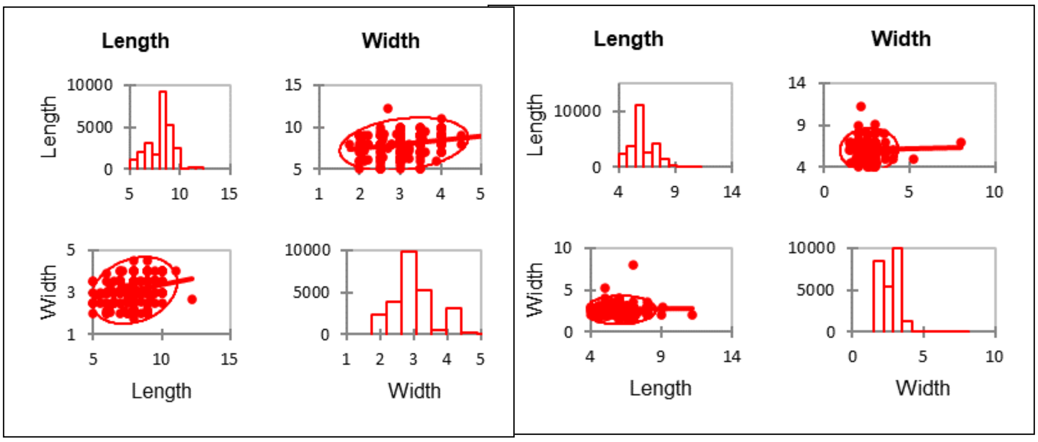


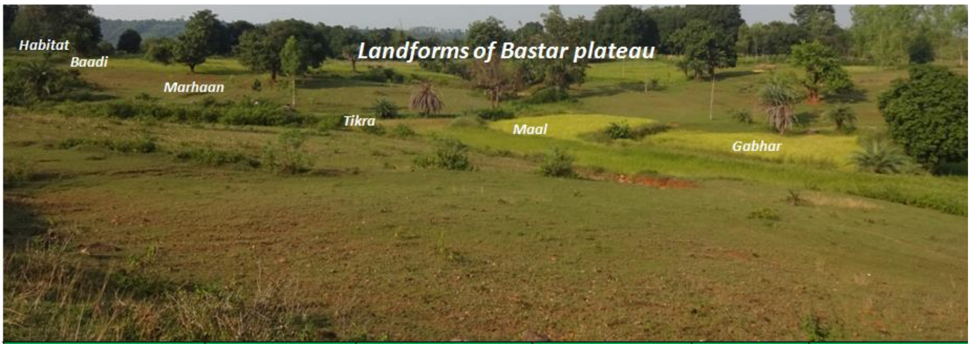
Figure 3. Sampling and observation of rice landraces

Figure 4. Ligule and auricle of rice land races



Seed measurement Grain measurement

Figure 5. Variance correlations of seed and grain morphology



Parameter	*Baadi*	*Marhan*	*Tikra*	*Maal*	*Gabhar*
Traditional practice	Backyard cereals, pulses, oilseeds, vegetables	Extra short duration rice, niger, horsegram, til, urd, mung	Short to medium duration rice	Medium duration rice	Long duration rice
Changed practice	Improved vegetables + fertilizers	Hybrid maize, vegetables + fertilizers	Hybrid & improved rice with fertilizers	Hybrid & improved rice with fertilizers	Hybrid & improved rice with fertilizers
Slope (%)	8-10	5-8	3-5	2-3	1-2
Soil degradation	High	Medium	Less	Less	High siltation
Moisture	Rainy season	Rainy season	Till late rainy season	Till winter	Till March
Rice duration (day)	60-80	70-100	90-110	110-130	>130
Rice sustainability	less	less	Medium	Medium	More

Figure 6. Landforms of Bastar region

2. Storing in storage structures: When the farmer faces the weather vagaries for one or two years then this method is widely used by storing properly in storage structure up to two years. Tribal farmers mostly prefer to keep the harvested paddy in traditional structures like *Kadagi*, *Phutka*,

Gopa and *Gadiya* with lining of paddy straw as moisture resistance layer. In this method, 1–2-year storage can be extended with 90-100% viability. As increase in year of storage loose the viability and sometime store grain pest damage the paddy, therefore they use hard material in outer layer to protect from vertebrates. The quantity available along from family decides the storage manner if huge quantity of paddy is produced that would be stored into "*Phutka, Kadki* and *Gadiya*", whereas less quantity (2-5q) is kept in *Gopa* but it is for a short period (Fig 7).

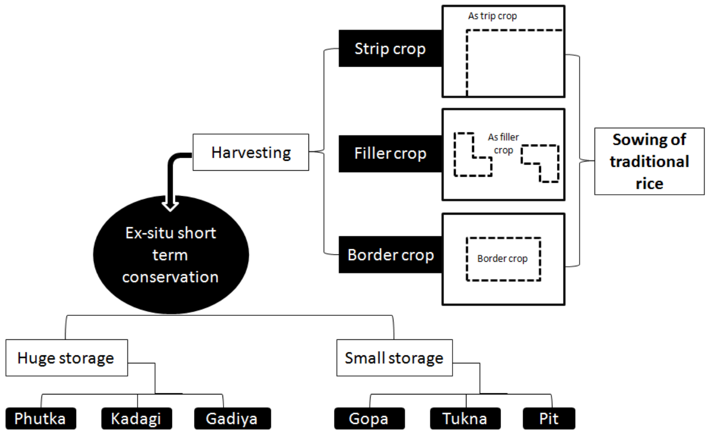


Figure 7. Schematic diagram of rice storage

3. Maintaining as hanging panicles: In rural areas of Bastar, "*Sela*" is a form of artefacts which is prepared by weaving rice panicle in beautiful manner and hang in roof of mud houses and it protect from vertebrates as well as from pest up to next year.
4. Barter system: Age old practice of exchanging seed material with reliable source in conserving old rice varieties in which small quantity of seed is distributed among the close relatives were considered as one method of conservation among the tribals is barter system in which seeds are shared with exchange offer promotes conservation of traditional rice varieties in rural areas. Different places are used for cultivation of paddy because of uncertainty of weather in specific place hamper the maintenance of valuable landraces of rice germplasm (Fig 8). Government policy supports that rice varieties which are notified in the Gazette of Government of India, discourage the conservation of old traditional varieties. The Barter system purposely works among close relatives or familiar persons that's why are not required much quantity of seeds; the business is still existed in remote villages where people prefer these rice landraces. Some medicinal or auspicious rice varieties were also included under such conservation practices.
5. Conservation plots: In the concept of conservation plot, some farmers used to grow a little quantity of seed in the main rice fields on a tiny plot of land designated as a conservation plot each year of the same farming situation to grow a small quantity of paddy for next year's seed. It plays a crucial role in preserving old rice varieties that are sustained in their agro-ecosystem.

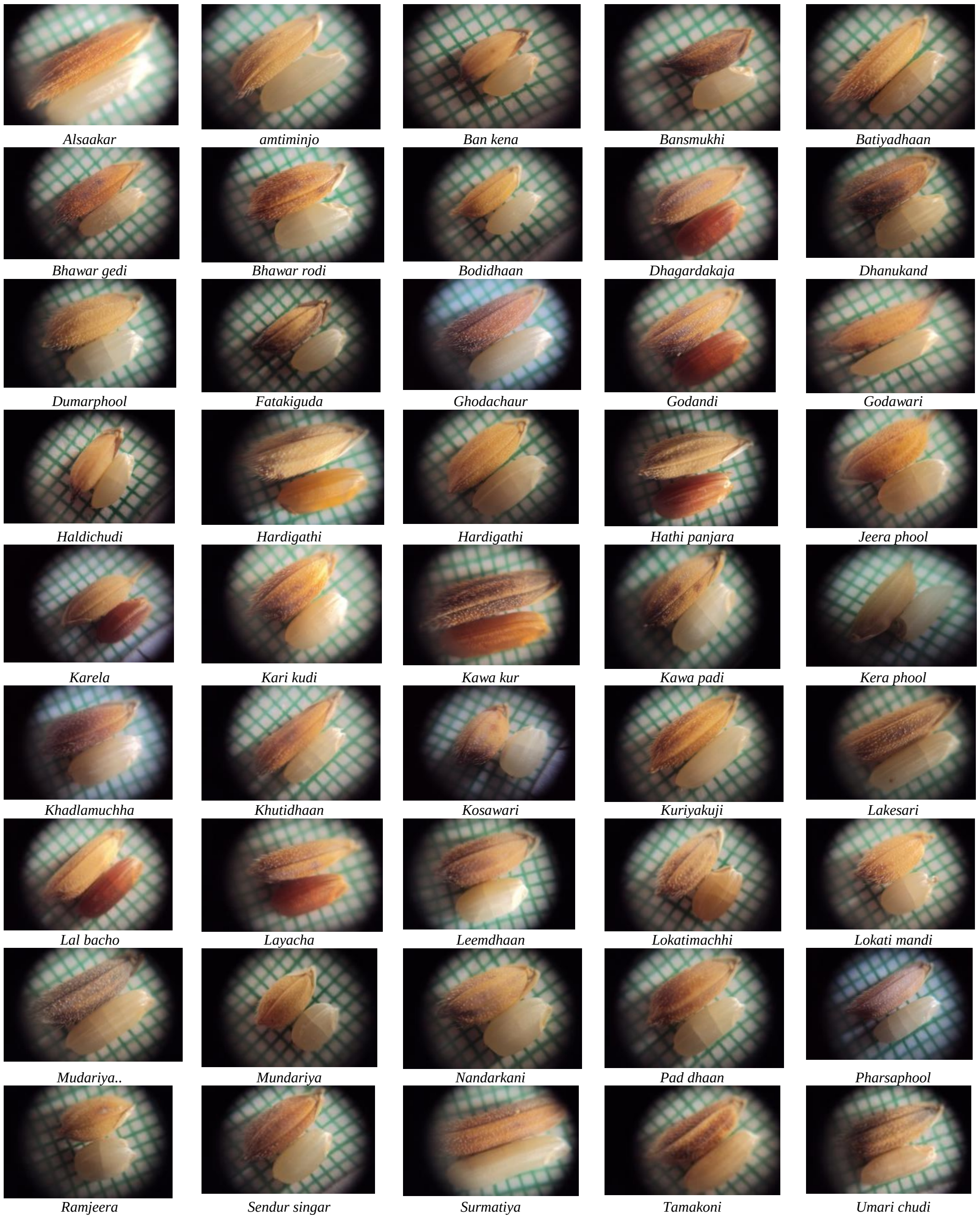


Figure 8. Seed and grain dimension of traditional rice landraces

CONCLUSION

Traditional rice cultivation in the southern region of Bastar, Chhattisgarh is rich with wide range of diversity of land races and cultivation practices. Due to climate change, farmers often suffer unpredicted weather and attempt to adapt by choosing varieties with traits that make them more resilient, such as short duration and drought/flood tolerant etc. Large number of traditional varieties disappeared from cultivation basket due to vagaries of rainfall by dwindling, uncertainty, shortage etc impacts the sowing window, yield potential, conservation and possible way of production. Tribal farmers maintain these varieties in remote pockets, with no seed production programs or seed chain promotion schemes. Support price systems discourage non-preferring traditional varieties, but some varieties offer better yields, sustainability, and fitted well in the socio-economic aspects of livelihoods. In order to ensure food security, it is critical to improve indigenous peoples' and smallholder farmers' technical skills and develop local to global policies on the sustainable use of rice genetic resources for food security under conditions of climate crisis.

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KONZERVACIJA I PROCENA PROSTORNE I VREMENSKE VARIJABILNOSTI LOKALNIH POPULACIJA PIRINČA U BASTAR REGIJI ČATISGARA, INDIJA

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Izvod

Pirinač (*Oriza sativa* L.) je osnovna hrana za više od polovine svetske populacije. U Indiji, obezbeđuje sigurnost hrane i ishranu za više od dve trećine stanovništva i doprinosi 20-25% u indijskoj poljoprivredi. Država Čatisgar ima bogatu genetsku raznovrsnost gajenih i divljih srodnika pirinča. Gajenje pirinča se praktikuje u nekoliko agroekoloških uslova, u rasponu od ekosistema pirinča sa planinskim kišom, ekosistema pirinča sa kišom, ekosistema pirinča sa navodnjavanjem i ekosistema pirinča sklonog poplavama. Opsežna terenska istraživanja i lični intervjui sprovedeni su u okrugu Bastar u Čatisgarhu, Indija, od septembra do novembra tokom 2017-2019, a uzorci pirinča su prikupljeni. Tokom terenskog pregleda, prikupljene su ukupno 193 sorte koje se razlikuju po karakteristikama semena tj. prikupljene su crvene, tamnocrvene, svetlo crvene i bele boje zrna. Veličina zrna sorti se kreće od vitkih do masnih tipova, a dužina zrna varira od dugačkih (8,1 do 11,0 mm), srednjeg (5,0 do 8,0 mm) do malih (2,5 do 4,0 mm). Crveni pirinač je veoma omiljen među plemenskim ljudima u regionu zbog svoje boje i ukusa sa sporom svarljivošću jer im održava energiju duže vremena na polju. Od ukupno prikupljenih sorti iz regiona, 41 sorta je zabeležena kao tip crvenog zrna, 36 u kategoriji smeđeg pirinča i pet u svetlobraon tipu. Regresiona linija bila je R^2= 0,211 u poređenju boje semena i zrna.

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