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RESEARCH ARTICLE

Status of Rice (*Oryza sativa* L.) Genepool Collected from Western Ghats Region of India: Gap Analysis and Diversity Distribution Mapping using GIS Tools

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This paper analyses the genetic resources of cultivated and wild rice in Western Ghats region (WGR) spread in six states of the country. Landraces and wild relatives of rice (*Oryza sativa* L.) always form a priority germplasm for exploration, collections, conservation, evaluation and utilization. Western Ghats region is one of the 35 biodiversity hot-spots of the world and harbour large diversity of rice under its varied climatic and edaphic conditions. So far, ICAR-NBPGR, New Delhi has collected 2,758 accessions of cultivated and 49 of wild rice germplasm from 42 districts of WGR of India. Germplasm collecting sites linked with geo-coordinates forms geo-referenced map which showed that Kerala had significant representation (2,036 accessions), followed by Karnataka (203), Maharashtra (201), Tamil Nadu (153), Gujarat (116) and Goa (49). Highest numbers of landraces were collected from Kerala (386), followed by Tamil Nadu (92), Karnataka (88), Gujarat (56), Goa (30) and Maharashtra (26). GIS-based grid map shows that highest numbers of landraces were collected from north and central regions of Kerala, validated by the highest Shannon-Weaver diversity index (2.1-2.8). Diverse agro-ecosystems as well as selection by farmers for various uses and traits, coupled with extensive exploration efforts might have lead to the assemblage of such landraces collection from Kerala. Collected wild rice germplasm consists six taxa - *Oryza meyeriana* var. *granulata* (11), *O. nivara* (4), *O. officinalis* (4), *O. rufipogon* (10), *O. sativa* f. *spontanea* (19) and *O. officinalis* subsp. *malampuzhaensis* (1). Literature analysis revealed that, out of 678 rice landraces of this region, 43 have been identified/ used in crop improvement as source of important traits *viz.* early and late maturity, aroma, high iron content, medicinal value, drought/cold/salt tolerance, resistance to brown plant hopper, etc. This analysis identified gaps and priority areas for future explorations.

Key Words: Diversity distribution mapping, GIS, Rice landraces, Western Ghats Region, Wild rice

Introduction

Rice (*Oryza sativa* L.) is one of the three major food crops of the world and forms staple food for more than 1.5 billion people. While 20 per cent calories and 15 per cent protein requirements of world's human population are met out from this cereal (Brar and Khush, 1997). Rice accounts for 35 to 75% of calories consumed by more than 3 billion Asians (Khush, 2005). In South Asia, rice is cultivated over 60 m ha with production of more than 225 m tons, accounting for 37.5% and 32% of global rice area and production, respectively (FAOSTAT, 2015). In India, rice is cultivated in 44.11 m ha and is the major food crop for more than 70% of the population (FAOSTAT, 2015). It is widely recognized that ensuring food and nutritional security in developing countries through increase in rice grain production is a challenge under shrinking land resources and the adversities arisen due to climate change (Aggarwal *et al.,* 2000; Kumar *et al.,* 2011).

In the Western Ghats region (WGR) rice is cultivated in 2.68 lakh ha area, with production of 0.65 m t and productivity of 2,387 kg/ha (Kumar *et al.*, 2011). In Western Ghats rice is grown under different agro-ecosystems influenced by soil, topographic, altitudinal and seasonal variations; this along with diverse use pattern by local people had resulted in rich landraces diversity (Vaughan, 2003). In Kerala, rice landraces diversity offers wide range to adapt to multiple agro-ecologies provides resistance to biotic and abiotic stresses carries special culinary traits and has cultural significance (Gopi and Manjula, 2018). Landraces, also known as local varieties and traditional cultivars (Zeven, 1998), are genetically heterogeneous in nature, often confined to specific agro-ecological niche, and identified by distinct

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vernacular names. These precious genetic resources consisting of large genetic variability are very useful in complementing and broadening the gene pool of advanced genotypes (McCouch *et al.,* 1997). They are the most-sought after germplasm for rice improvement against tolerance to abiotic stresses (drought, cold, salinity) and quality traits (Vanaja *et al.,* 2009).

Western Ghats is one of the 35 biodiversity hotspots of the world and the second most biodiversity rich zone in India, covering about 5% land area (159,000 sq. km) (Mittermeier *et al.,* 2004). 625 wild species related to 78 crops from this region have documented by John *et al*. (2015). In the genus *Oryza* L., richness of species diversity in WGR is evident by the occurrence of five taxa, *viz*., *Oryza meyeriana* (Zoll. & Moritzi) Baill. var. *granulata* (Nees & Arn. ex G. Watt) Duist, *O. nivara* S.D. Sharma & Shastry, *O. officinalis* Wall. ex G. Watt, *O. rufipogon* Griff. (syn. *O. jeyporensis* Krishnasw. & Chandras.) and *O. officinalis* subsp. *malampuzhaensis* Krish. et Chand. (Pradheep *et al.,* 2014). *Porteresia coarctata* (Roxb.) Tateoka, a species often included under *Oryza* and known for salinity tolerance, is reported from mangrove pockets of this region. Forest reserves *viz*., Bhoothathankettu, Parambikulam and Karulai along the Western Ghats have been also identified for *in-situ* conservation of wild rices (Vaughan and Muralidharan, 1989). Tetraploid wild rice (*O. malampuzhaensis*) closely resembling to diploid *O. officinalis* was reported in 1958 from two localities in Malampuzha in Kerala (Krishnaswamy and Chandrasekharan, 1958). This endemic taxon now kept under *O. officinalis,* has a localized distribution along the Western Ghats, particularly in forest reserves (Vaughan, 1994; John and Nizar, 1998).

In present study we have analyzed the status of rice landraces diversity, cultivation and germplasm utilization in WGR through geo-referencing of germplasm collection sites and grid mapping using DIVA-GIS tools (Hijmans *et al*., 2001), and also extent of utilization in breeding programmes, besides identifying gaps in collections and conservation.

Materials and Methods

Study Area and Cclimate Data of the Regions

Western Ghats extends from 8.32° to 21.23°N latitude and 72.91° to 77.15°E longitude, along with coast of the country comprising 42 districts in the state of Gujarat (4), Maharashtra (8), Goa (2), Karnataka (7), Kerala (14) and Tamil Nadu (7) formed the study site (Fig. 1). The WGR starts from the southern districts of Gujarat, south of the Tapti river and runs approximately 1600 km long chain of hills, plateaus, plains in the rainy and rain shadow areas in the above six states ending near Kanyakumari (Gadgil, 1996). While almost all the parts of Goa and Kerala come under WGR, only a few districts of other four states form the part of this region. Altitude varies considerably from sea level (in West Coast) to above 2,694 m in Anamalai of Kerala and Nilgiris of Tamil Nadu and merges with rain shadow areas in eastern slopes and plains in Tamil Nadu and with the Deccan Plateau in Karnataka and Maharashtra. In the Konkan region, hills are comparatively lower and form plateau.

Soils play an important role in vegetation and agriculture. Red soils, lateritic soils, black soils, humic forest soils and coastal alluvial soils are the major soil types found in WGR (Bhattacharyya *et al.* 2013) and played a role in the evolution of distinct, locally adapted landraces. WGR experiences extreme variation in the climate over the annual seasonal cycle. Average annual rainfall of study area is 2,030 mm while maximum rainfall is 2,540 mm. Among states maximum rainfall (3,107 mm) was recorded in Kerala state. Mean temperature (min. & max.) ranged between 24.2-28.3°C and 31.2-35.0°C during last 65 years (Geethalakshmi *et al.,* 2011).

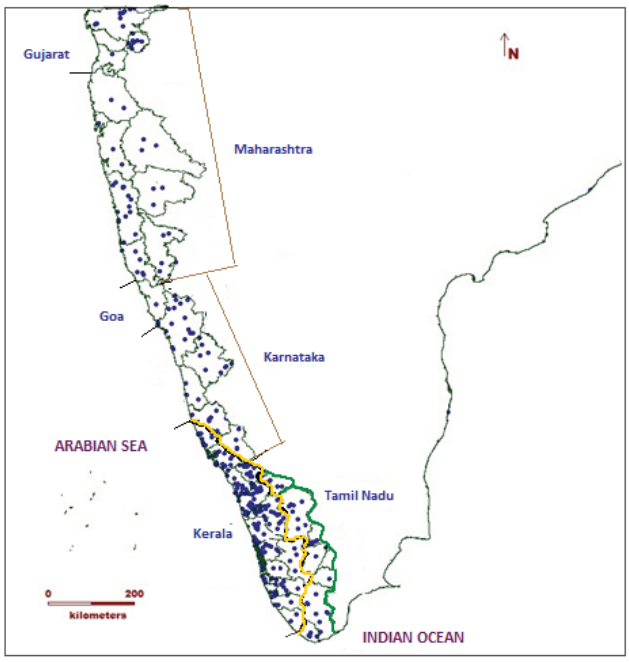

Fig. 1. Rice germplasm collection sites in Western Ghats region of India

In Kerala state rice is grown in widely diverse ecological niches *viz*., from deeply submerged areas below sea level in Kuttanad (-10 m) to upland areas in high altitudes like Anamudi (1200 m) (John and Nizar, 1998; Kumary 2016). Based on altitudinal gradients, the entire rice growing tracts of Kerala are categorized into four distinct regions *viz*., high ranges (>750 m MSL), high lands (75-750 m) midlands (7.5-75 m) and lowlands (up to 7.5 m) (Kumary, 2016; Farm Guide, 2009). In Goa, rice is mostly cultivated in low-lying coastal lands reclaimed from marshy mangroves by construction of dykes, sluice gates and canals etc., known as *khazan* ecosystem (Manohara and Singh, 2013). In Gujarat, rice occupies about 7 to 8% of gross cropped area of the state and accounts for around 14% of the total food grain production. It is grown on an average about 6.5 to 7.25 lakh hectares of land comprising nearly 55 to 60% of low land (transplanted) and 40 to 45% of upland (drilled) rice (Pathak *et al.,* 2011). In Western Ghats region of Maharashtra rice is cultivated on small scale because 85-90% area is rainfed and known as Konkan region in the state (Thaware *et al.,* 2011). In drill sowing of rice under rainfed condition is being practiced in the Western Ghats area of Karnataka (Hanamaratti *et al.,* 2008). In Western Ghats region of Tamil Nadu rice is cultivated on small scale because maximum area is covered under forests. State is severely affected by cyclones, floods and salinity which have led to a decline in rice production (Sathya *et al.,* 2011).

Scrutiny of Passport Data and Diversity Analysis

Since inception in 1976, ICAR-National Bureau of Plant Genetic Resources (NBPGR) has augmented rice germplasm from various parts of the WGR through crop-specific/ multi-crop explorations conducted in collaboration with crop-based institutes and State Agricultural Universities. This resulted in collection of a total of 2,739 accessions from all 42 districts, which were used in this study (http://192.168.1.5 /NBPGR/ Search Passport.aspx; NBPGR Annual Reports 1976-2016; Plant Germplasm Reporters 2002-2015). Passport data of these accessions was checked for botanical names, landraces and geo-coordinates of collection sites (village/block/tehsil, district and state) using GIS tools. GIS-based grid mapping technique is used to analyse species richness, assess variability and occurrence of trait-specific germplasm of crops in different parts of the country (Ramirez-Villegas *et al.,* 2010; Semwal *et al.*, 2013).

Gap Analysis

After comprehensive screening of passport/germplasm data geo-referenced map was prepared using geo-coordinates, WGS84 datum and projection systems. To know spatial distribution and assessment of landraces richness, DIVA-GIS software is useful for point-to-grid analysis using simple-circular neighborhood method (Hijmans *et al.,* 2001). Landraces diversity is calculated using Shannon-Weaver diversity index (Shannon and Weaver, 1963). In view of the diversity assessment *vis-à-vis* germplasm collected/conserved, literature survey/reports (Kumary, 2016; Vanaja *et al.,* 2009) and personal communications with crop experts, the gaps are identified.

Results and Discussions

Rice Germplasm Geo-referencing and Collection vs Conservation Status

The geo-referenced map of collected accessions showed that southern and coastal part of WGR had significant representation (Fig. 1). The states of Kerala (2,036 acc.) followed by Karnataka (203) and Maharashtra (201) account for the highest number of collected accessions. Out of 2,037 accessions from Kerala, maximum accessions were collected from the districts of Palakkad (827) followed by Malappuram (185), Wayanad (172), Ernakulam (164), Kannur (154), Thrissur (152), Kasaragod (110) and Idukki (93). Majority of accessions (539) from Palakkad district was assembled by the Rice Research Station located at Pattambi, which has augmented germplasm from adjoining areas for past two decades. District wise maximum germplasm collections in remaining states include: Uttara Kannada (104), Dakshina Kannada (51) and Shivamoga (40) in Karnataka; Ratnagiri (78) and Kolhapur (20) in Maharashtra; Nilgiris (54), Coimbatore (52) and Tirunelveli (32) in Tamil Nadu; Surat (43) and Dangs (42) in Gujarat; and North Goa (30) and South Goa (19) in Goa (Fig. 1). Germplasm database maintained at ICAR-NBPGR revealed that considerable variability for grain characteristics (e.g. grain shape, size, colour and taste) had been assembled from these districts. Highest collections of wild germplasm (>80%) were made during the execution of World Bank-funded National Agricultural Technology Project on Plant Biodiversity (1999 to 2005), spearheaded by the Bureau.

Out of a total of 2,739 accessions collected, only 1,656 (60.46%) are conserved in the National Gene Bank

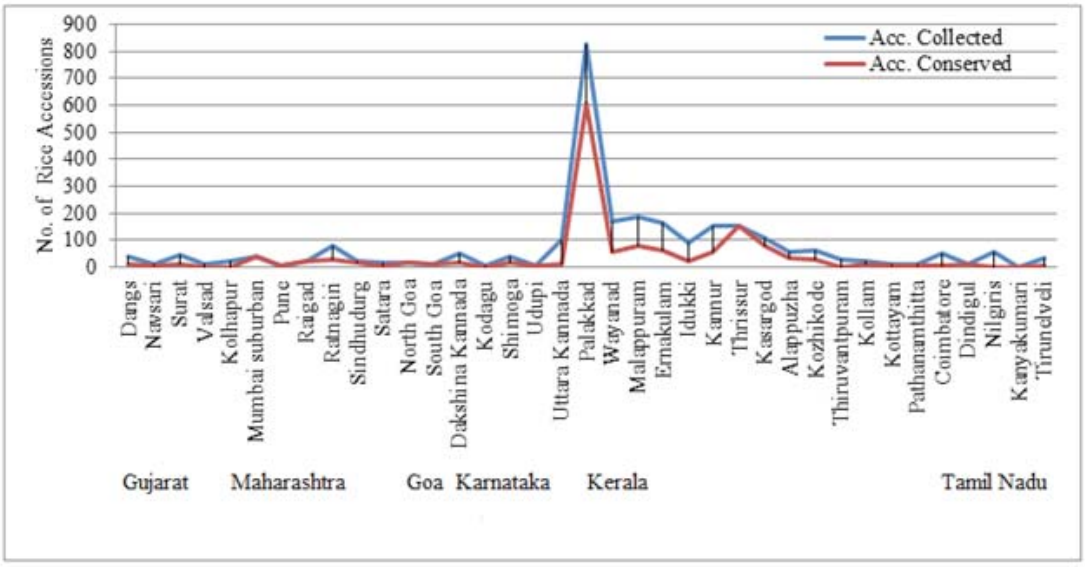

Fig. 2. Rice landraces collected from different districts of Western Ghats

(NGB) of ICAR-NBPGR. All the collected germplasm samples did not qualify for conservation in genebank. Maximum accessions were conserved from Kerala (1,431) followed by WGR districts– in Maharashtra (119), in Karnataka (48), in Goa (30), in Gujarat (28) and in Tamil Nadu (24) (Fig. 2). None of the collected accessions from Tiruppur, Theni and Virudhunagar districts of Tamil Nadu; and Palghar and Thane of Maharashtra could reach NGB indicating the need for revisit on priority. Not all the collected accessions could be preserved in NGB, owing to reasons such as low sample size, requirement of niche-specific habitat for regeneration, seeds often exhibiting post harvest dormancy (Dr. Kalyani Srinivasan, ICAR-NBPGR, Pers. Comm.), besides some accessions are still under seed multiplication/rejuvenation. There are also instances of collaborators often reluctant to return back the multiplied germplasm for deposition in NGB.

Rice Landraces Status and Mapping using GIS Grid Method

Conserved germplasm accessions represent 678 landraces (belonging to 1,440 accessions), of them, highest numbers were from Kerala (386) followed by Tamil Nadu (92), Karnataka (88), Gujarat (56), Goa (49) and Maharashtra (26). Out of 386 landraces from Kerala, maximum were from Palakkad (78, mainly through the efforts of RRS, Pattambi), followed by Malappuram (63), Ernakulam (52), Wayanad (47) and Kannur (41) districts. Other districts with significant number of landraces (≥20) collected were Uttara Kannada (63) in Karnataka; Nilgiris (49) and Tirunelveli (29) in Tamil Nadu; Surat (38) in Gujarat; and Ratnagiri (20) in Maharashtra (Fig. 3). However, there would be possibility of some rice landraces known by different names across the districts/states which needs further study.

Shannon-Weaver diversity index has grouped 678 landraces in four groups namely 0-0.7 (grid no. I),

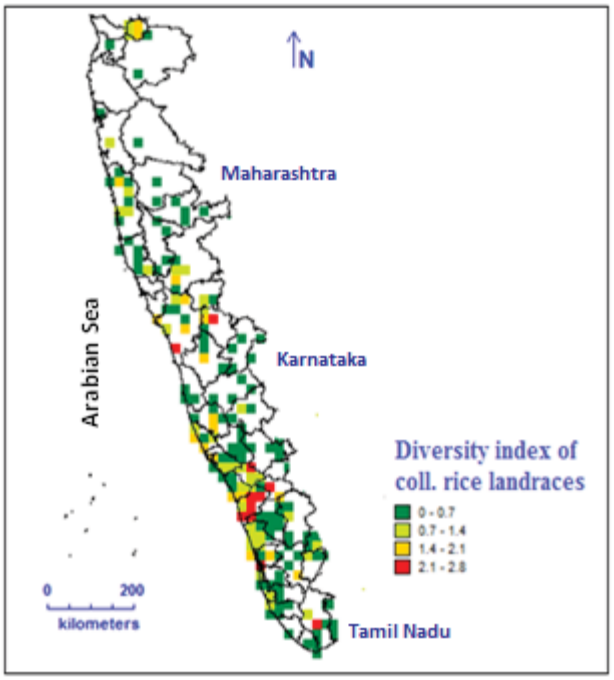

Fig. 3. Variability mapping based on passport information in rice landraces collected from Western Ghats region of India

0.7-1.4 (II), 1.4-2.1 (III) and 2.1-2.8 (IV), which is depicted in GIS-based grid maps (Fig. 3) with different colours according to the extent of diversity and variability in the germplasm accessions. In the map, orange/dark red colour of the grid (nos. III & IV) indicated high diversity areas while dark green/light green (grid nos. I & II) indicated low diversity areas. North and central regions of Kerala, exhibited the highest Shannon-Weaver diversity index (2.1-2.8) indicating the richness of landraces and diversity in these areas.

Cultivation and Use Pattern of Landraces

Besides topographic, soil and climatic factors, farmers have played crucial role in developing, maintaining and conserving rice landraces since time immemorial. In Kerala, there are popular landraces adapted to different habitats, for instance - deep water or floating rice (in submerged localities with 1 to 5 m depth); *pokkali* rice adapted for saline conditions; *Modon* or upland rice grown in dry situations (Latha *et al.,* 2013). *Kaima* is most popular red bold rice of irrigated belt (Latha *et al.,* 2013; John and Nizar, 1998). It is long duration cum photo-period sensitive type having rapidly elongating internodes. Landraces which are adapted to high altitudes are normally referred to as *Malanellu* rice. Within the *Pokkali* varieties, there exists high genetic diversity as represented by different primitive cultivar names *viz*., *Pallippuram Pokkali, Kuzhippalli Pokkali* and *Vettikkal Pokkali. Kuthiruvithu, Kochumundon* and *Mundon* are the saline tolerant varieties of the *Kaipad* system of Kannur District (Kumary, 2016).

Highly heterogeneous land pattern in WGR is conducive for novel genetic diversity in rice through adaptation in different microhabitats; this pattern is attributed to undulating topography, sloppy terrains, high rainfall, deltaic formations of the large network of rivers, large wetland systems and saline water intrusion in pockets of lowland. Kerala has different agro-climatic zones and intentional or natural selections of crop varieties in such agro-climatic zones have resulted in a large number of traditional varities suited to each region (Gopi and Manjula, 2018). In WGR, landraces differ for a range of characters including maturity duration, plant height, tillering, pigmentation in various plant parts, grain characters (grain shape and size, husk and kernel color, aroma) and consumption qualities (puffing, flattening, popping, flour, cooking). Nevertheless, there exists a strong traditional preference among local people of Kerala for coarse varieties with red kernel.

Scented rices mostly grown in the high ranges of Kerala are *Gandhakasala, Jeerakasala,* (grown 750m above msl), *Neycheera, Pookkulathari* and *Rajak* (Kumary *et al*., **2003**). Some important medicinal rices which were in cultivation in Kerala during ancient times like *Chennellu, Chembavu, Erumakkari, Kalamappari, Kunjinellu, Neduvali, Narikar, Poovali, Velvali, Varakan, Tanavala etc.* are believed to be *saali* varieties (group of owned grains) having medicinal value. Local people in Kerala use *Navara (Nijavara)* and *Varinellu* (a weedy relative of rice) as medicine for treatment of small pox. These landraces possess tolerance to drought and resistance to diseases like blast and are adapted to the low light intensity. *"Karanellu"* landrace grown by the tribal people of Attappadi (Palakkad) needs special mention that is highly competitive to weeds through profuse tillering and fast growing nature. Nevertheless, vast conversion of traditional rice growing areas into banana-ginger-coconut over the last 40 years, especially midlands, and replacement of landraces by high yielding varieties (e.g. Kuttanad belt) and real state and had resulted in drastic erosion on both level *viz.*, decline in number as well as acreage under landrace cultivation in Kerala. Goa had a rich diversity of native cultivars/ landraces *viz.*, *Korgut, Asgo* and *Shidde*, which are tolerant to salinity and cultivated in coastal saline soils (Manohara and Singh, 2013).

Wild Rice Status in WGR

Wild relatives possess desirable traits/genes, which are generally not available in cultivated genepool, are increasingly recognized as valuable resource for crop improvement. Species-wise account showed that maximum number of accessions were collected in *O. sativa* f. *spontanea* (19), followed by *O. meyeriana* var. *granulata* (11), *O. rufipogon* (10), *O. nivara* (4), *O. officinalis* (4), and *O. officinalis* subsp. *malampuzhaensis* (1) from this region. Among the states, highest number of accessions was collected from Kerala (26) while meagre collections were made from other states (Table 1). Variability was recorded for grain shape, size, colour and awn size in *O. sativa* f. *spontanea*.

Utilization of Landraces in Rice Breeding

Rice landraces valuable in the crop improvement programme played a vital role in achieveing **self**-sufficiency in the country. Literature analysis revealed that, out of 678 landraces, only a handful of landraces (43) have been identified/utilized for possessing breeding

Table 1. Wild rice collections in Western Ghats region of India

Species	Germplasm accessions collected from different states				Total accn.
	Karnataka (7)	Kerala (26)	Maharashtra (12)	Tamil Nadu (4)	
O. nivara	-	-	4	-	4
O. rufipogon	4	5	1	-	10
O. officinalis	2	2	-	-	4
O. sativa f. *spontanea*	1	11	7	-	19
Oryza meyeriana var. *granulata*	-	7	-	4	11
O. officinalis subsp. *malampuzhaensis*	-	1	-	-	1

traits of potential value. These traits include early and late maturity, aroma, high iron content, medicinal value, drought/cold/ salt tolerance and resistance to brown plant hopper (Table 2). Earlier Kumary (2016) reported that more than 36 rice landraces have been utilized for different traits, mostly suited to different ecological regions in Kerala state alone.

Gaps in Germplasm Collection and Conservation

Apart from 678 landraces collected/conserved from WGR, another 119 landraces documented/reported in various reports (Table 3) are yet to be assembled and conserved in the NGB. However, it is observed that considerable number of these (unassembled) landraces lie with the SAUs/NGOs/other stakeholders in this region who are almost reluctant to part them with ICAR-NBPGR. This indicates that priority needs to be given for their collection through fine grid survey coupled with grass-root level linkage with state department official and custodian/ conservation-oriented farmers. In general, the state of Kerala has been extensively explored for rice germplasm, though systematic collection of wild genepool needs attention. Besides focus is needed for wild rice (including *Porteresia coarctata*) collecting areas/tehsils representing deficit collection:

Kerala: Vaikom (Kottayam district); Karunagappalli (Kollam).

Karnataka: Madikeri, Somvarpet and Kundapura (Udupi).

Gujarat: Dharampur, Kaprada, Pardi and Umbergaon (Valsad); Bansda, Chikhli, Gandevi and Jalalpore (Navsari).

Table 2. Trait-specific rice landraces collected from Western Ghats region of India

S.No	Traits	Named rice landraces*	References
1.	Drought tolerance	Vaigunda[f]	Sathya 2013
		Sattari Saw[b], Shamari[b], Tranpandad[b] and Sathi[b]	Pathak *et al.,* 2011
		Chuvannamodan[c], Eravapandi[c], Kalladiyaryan[c], Kallele[c], Karuthapandi[c], Karavalu[c], Mundon[c]	Gopi and Manjula 2018
2.	Tall and late maturing (122days)	Damgo[a] and Babri[a]	Manjunath *et al.,* 2009
3.	Early maturing	Dhavi Patni[a] and Morod Kendal[a]	Manjunath *et al.,* 2009
4.	Medicinal uses (anti-dysenteric, diarrhoea and vomiting)	Njavara[c], Chennellu[c], Kunjinellu[c], Erumakkari[c], Karuthachembavu[c] and Kavunginpoothala[c]	Leena Kumary 2003
	(Treatment of cough)	Erumakkari[c] and Annoori[c]	Leena Kumary 2003
5.	Medium duration	Nermar[a], Kochri Patni[a] and Belo[a]	Manjunath *et al.,* 2009
6.	Cold tolerance	Chettuveliyan[c], Koduveliyan[c], Raajani[c], Malanellu[c]	Latha *et al.,* 2013
7.	Salt tolerance	Shidde[a]	Manohara and Singh 2013
		Kuthiru[c], Rajkayam[c] and Orkayama[c]	Vanaja *et al.,* 2010
		Pokkali[c]	Vanaja *et al.,* 2010; Latha *et al.,* 2013
8.	Aroma	Dhan Had[b], Ambamor[b]	Pathak *et al.,* 2011
9.	Deep water and salinity tolerance	Kuzhippulipokkali[c], Nedungodu pokkali[c], Odachan[c], Orpandy[c], Orkyma[c], Orumundakan (black kernel)	Latha *et al.,* 2013
10.	Resistance to brown plant hopper	Sigappu Kuruvikar[f]	Sathya 2013
11.	High iron content	Lal Kada[b]	Pathak *et al.,* 2011
12	Pest and diseases resistant	Adukkan[c], Chomala[c], Edavaka[c], Karindon[c], Odacha[c], Pokkali[c], Thondi[c], Thekkan[c], Viliyan[c]	Gopi and Manjula, 2018

a-Goa; b-Gujarat; c-Kerala; d-Karnataka; e-Maharashtra; f-Tamil Nadu

Table 3. Gaps in collection of rice landraces from different states of Western Ghats region of India

States	Rice Landraces	References
	Reported but yet to collect	
Gujarat (16)	Lal Kavchi, Hara, Dodi lal, Lal Kada, Sat paniu, Dodiu, Jiryu, Odibhat, Dhan had, Ambamor, Bhadravi, Kali tapki, Dolatpura, Chandrapura, Shamari, Tranpandad	Pathak *et al.,* 2011
Maharashtra (20)	Bhai bhat, Chimansal, Dangi, Dhundhunya, Jira bhat, Jhini, Kolpi, Kolam, Lal kudai, Malghudya, Masuri, Patanya, Agha Dhan, Ambimohar, Rajghudya, Sag bhat, Solam, Surati, Tornya, Tychun.	Marathe and Bhaskar, 2011
Goa (26)	Asgo, Dhave, Ek Kadi, Ghansal, Girga, Kalo Damgo, Kala Belo, Kalo Korgut, Kalo Novan, Karo Mungo, Khochro, Mudgo, Kolyo, Red Kochri, Kotimirsal, Muno, Kusago, Novan, Patni, Saalsi, Shidde, Taysu, Tamdi, Valay,Walayo, White Kochri.	Manohara and Singh, 2013; Bhonsle and Krishnan, 2016
Karnataka (21)	Adenkelthe, Ajippa, Allyande, Bilinellu, Gandhasale, Giddabatha, Gulvadisanna, Kalame, Kariadadi, Kavalakannu, Kayame, Kolakedora, Mascatti, Meesebattha, Medumsali, Mutalaga, Turumuri, Rasi, Gopal Dodiga, Dambersali, Bolasali.	Hanamaratti *et al.*, 2008; Prakash *et al.*, 2004
Kerala (22)	Malayudumban, Mavilan, Malakkaran, Mannuveliyan, Kalladiyaran, Jeerakachampav, Njavara (Red), Njavara (Unden), Cheriya Orpandy, Karunagapalli pokkali, Kulapandi, Kuzhippuli pokkali, Nedungodupokkali, Odachan, Oorpandy, Cherumundakan, Cheru virippu, Vettakkal, Kamanalichetti virippu, Malmoodan, Vella pokkali and Vettakkalchetti virippu	Vanaja *et al.,* 2010, Latha *et al.,* 2013, Leena Kumary, 2003
Tamil Nadu (14)	Arupatham, Poombalai, Kottarachenba, Kitchilichenba Ottadiyan, Kallundai, Kuruvai, Kumbaalai, Paal Kudavaalai, Sivappu Kudavaalai, Kalundai Samba, Suran Kuruvai, Sivappu Kuruvikkar, Suran Kuruvai.	Kasivenbaiyan, 2013; Ponambalam, 2015; Sathya, 2013; Sathya *et al.* 2011

Maharashtra: Ambegaon, Bhor, Indapur, Khed and Shirur (Pune); Dahanu, Talasari, Vada and Vasai-Virar (Palghar); Jaoli, Karad, Koregaon and Man (Satara).

Tamil Nadu: Agastheeswaram, Kalkulam and Vilavancode (Kanyakumari); Andipatti, Bodinayakanur, Periyakulam and Uthamapalayam (Theni); Rajapalayam and Srivilliputhur (Virudhunagar); Udumalaipettai and Avinashi (Tiruppur).

Conclusion

WGR is home to a number of rice landraces containing unique/trait-specific value and suitable for diverse agro-ecosystems that can help in sustaining nutritional/food security of the region. Rice landraces from Kerala are mostly collected while other state/areas representing deficit collection need to be explored on priority before they are lost forever due to ever-increasing developmental and anthropogenic activities in the region. Sustained research interest in incorporating salient traits of these landraces would strengthen the utilisation of precious germplasm conserved in *ex situ* repositories. In changing climate, their on-farm conservation and adaptation are also important.

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