

Traditionally cultivated rice varieties in coastal saline soils of India

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Abstract

India produces 106.29 million tonnes of rice (2013-14). Rice is the most important cereal crop in India with regards to production, consumption as a principal food and area occupied and thus occupies a prominent place in Indian agriculture. It is cultivated over an area of 45.54 million hectares. Rice ecosystems are classified into 5 major types: irrigated, uplands, rainfed lowlands, deep water and coastal wetlands (saline soils). The salt affected soils in the coastal area spread over 2.52 Mha, covering 11 states and union territories, comprising about 30 % of the total salt affected soils of India are recognized by different local terms. These ecosystems are characterized by sea water intrusion, low lying water logged areas, flood prone and ill drained lands. The soil texture of coastal saline soils is coarse sandy to fine loamy, slightly calcareous, and moderately saline to alkaline. These soils are low in nitrogen, phosphorous, zinc and organic matter. Rice cultivation in kharif (monsoon season) along with fresh water fish and vegetables like brinjal or okra followed by brackish water aquaculture during summer without rice is observed. Traditionally cultivated local rice varieties have tolerance to salinity and submergence but are low yielding. Some of the widely used varieties are: Vikas, Korgut, Sathi, Picha neelu, Kuthiru, Kalundai samba, Bhurarata, Karekagga and Nona Bokra. These diverse traditional rice varieties are precious genetic resources that provide ecological balance and their conservation is crucial for future food security.

Keywords:

Coastal, India, Paddy, Rice, Saline soils, Salt-tolerant

1. Introduction

Rice (*Oryza sativa* L.), belonging to the family Gramineae, is a primary source of food for more than half of the world population. It is planted on about one-tenth of the earth's arable land in 114 countries across the world, occupying a total area of 150 Mha. India has the world's largest area growing rice with 44.0 Mha and is the second largest producer (106.29 million tones - 2014) next only to China. It contributes 21.5 percent of global rice production. Within the country, rice occupies one-quarter of the total cropped area, contributes about 40 to 43 percent of total food grain production and continues to play a vital role in the national food and livelihood security system. More importantly rice is a choice crop of millions of poor and small farmers, not only for gaining income but a household food security. Major growing states in the country are West Bengal, Andhra Pradesh, Chhattisgarh, Tamil Nadu, Karnataka, Assam, Maharashtra, Odisha, Punjab and Gujarat [1,2,3,4].

In India, rice is cultivated round the year across different seasons in diverse ecologies. These ecosystems are classified into 5 major types: irrigated, uplands, rainfed lowlands, deep water and coastal wetlands (saline soils). Irrigated rice is grown in bunded fields; Irrigation is the main source of water in the dry season and is used to supplement rainfall in the wet season. Upland rice is mostly grown as direct seeded. Fields are unbunded. Rainfed Lowland Rice Ecosystem is usually transplanted, and is grown in levelled, bunded fields that retain surface water, but the depth and duration of flooding of the soil varies greatly from year-to-year within a growing season. Flood-prone rice is adapted to conditions of temporary submergence of 1-10 days, or long periods (1-5 months) of standing water ranging in depth from 50 cm to 400 cm or more, or daily tidal fluctuations that sometimes may also cause complete submergence [5].

1.1 Coastal wetlands (coastal saline soil)

Soil salinity is one of the serious global problems telling upon economic utilization of land resources in arid and semi arid environments. About one third of the cultivable land under irrigation in the world is presently known to be under the influence of salinity [6]. Saline soils are classified based on electrical conductivity (EC) of the soil solution which detects osmotic problems and exchangeable sodium percentage (ESP) indicative of a physical dispersion problem. Salt affected soils are classified as nonsaline/ non-sodic soils ($ESP \leq 15\%$; $EC \leq 4 \text{ dSm}^{-1}$), saline soil ($ESP \leq 15\%$; $EC > 4 \text{ dSm}^{-1}$), sodic soil ($ESP > 15\%$; $EC \leq 4 \text{ dSm}^{-1}$) and as saline

sodic soil ($ESP > 15\%$; $EC > 4 \text{ dSm}^{-1}$). The pH of saline soils is generally less than 8.5, of saline sodic soils about 8.5 and of sodic soils more than 8.5 [7]

In India, an area as large as 8 Mha is reported to be under salinity effect. Such areas are spread over the Indo-Gangetic plains, arid and semi arid areas of Rajasthan, Gujarat and Haryana, heavy black clay soils of Deccan and coastal areas [6]. Thus saline lands may be further classified as inland saline and coastal saline soils. More than 2 Mha is in coastal regions. Monoculture of rice is predominant during the monsoon season in these areas because of the inherent genetic mechanism for salinity tolerance but with poor yields [8].

Coastal saline soils have coarse sandy to fine loam nature, slightly calcareous and moderately saline to alkaline. They are low in Nitrogen, phosphorous, zinc and organic matter [9]. These saline soils are characterized with a saturated extract conductivity of more than 4 dSm^{-1} , pH of less than 8.5 and Exchangeable sodium percentage (ESP) of less than 15 per cent. Chlorides and sulphates of sodium, calcium and magnesium are the dominant salts present in saline soil. Besides these, smaller amount of potassium salts and bicarbonates and nitrates are also present in the soil [10].

The coastal saline soils in India may broadly be classified into two physiographic groups viz., the coastal soils of East coast i.e., along the sea coast of the Bay of Bengal and coastal soils of West coast i.e., along the sea coast of the Arabian Sea. These soils are spread across Orissa, Andhra Pradesh, Pondicherry, Tamil Nadu, Kerala, Karnataka, Maharashtra, Gujarat, Goa and Andaman and Nicobar Island and occur in river deltas and in narrow strips of land ranging from a few kilometers to about 50 km close to the sea coast along the low lying lands, estuaries and inland depressions. The salinity of the soil varies with the season. It reaches the maximum between the month of January and May and decreases thereafter with the onset of monsoon season. This cyclic salt accumulation and intermittent flood make these regions predominant in rice cultivation. The excess rainfall during monsoon cause flooding and deep water submergence and low crop yields [11]. The problem is further complicated by inundation through backwash from sea, tidal waters, wind borne salts and underground intrusion of sea water in sub soils. This ecosystem is characterized by sea water intrusion, low lying water logged areas, flood prone and ill drained lands. The salinity of the soil varies with the season. It reaches the maximum between

January and May and decreases thereafter with the onset of monsoon. This cyclic salt accumulation and intermittent flood make these regions predominant in rice cultivation and the unique physicochemical conditions have enabled the cultivation of rice varieties specific to each region [6, 11]. Traditionally cultivated local rice varieties have tolerance to salinity and submergence but are low yielding [4]. They are tastier and healthier. Some possess nutraceutical properties [12].

The diversity of rice varieties is nowhere as great as in India. Subduing to the conventional agro-techniques, rice forged into innumerable landraces and traditional varieties with least interference from man. They hold appreciable genetic integrity and are morphologically distinct. Native cultivars or landraces are highly heterogeneous within populations in contrast to modern improved varieties, which are genetically homogenous [13]. Indian rice (*Oryza sativa* var. indica) is believed to have consisted of more than 100,000 landraces until the advent of the Green Revolution in the 1960s, when most of the traditional varieties were replaced with a handful of modern cultivars. The remaining traditional varieties, still surviving on marginal farms, are testimony to the amazing range of adaptation of local landraces to different abiotic and biotic environmental conditions [12]. This article thus reviews the local rice varieties grown in coastal saline soils spread across India.

2. Rice cultivation in coastal saline soils:

Along the long (8,129) km coastline diverse ecologies exist depending upon the geographical and climatic conditions. In India, the saline soils are identified and recognized by different local terms, such as Khar or Kshar in Gujarat and Maharashtra; Usar or Reh in Uttar Pradesh; Luni in Rajasthan; Chouddu or Uppu in Andhra Pradesh; Chopan, Choulu, in Karnataka and Kari, Papali, Kaipad or Khar in Kerala. The nature of salinity in different areas varies from State to State and from one region to another within the same state. While in most of the areas, lack of drainage system has been the main contributing factor, in some areas, overdraft of ground water, ingress' of saline sea water and unscientific agricultural practices are also adding to the problem in a big way. The following is an account of state-wise distribution of local rice varieties in their specific ecologies [14].

2.1 Andaman and Nicobar Islands

The Andaman and Nicobar archipelago comprises of about 556 small and big islands. These islands have 11,000 ha area under rainfed rice, and average productivity is about 2.7 t ha⁻¹. The soils are moderately deep, acidic and low in fertility. The major constraint in production is soil salinity. Of the total rice area, about 3000 ha area of rice has come under varying degrees of salinity due to long coastline and especially because of tsunami – 2004 [15]. **Swarna** - long duration (140 days) high-yielding variety has been cultivated [16]. It is amongst the healthiest varieties as it has low glycemic index and thus lowers the risk of diabetes [17]. Traditionally, salt tolerant varieties have not been cultivated. It is suggested by ICAR that developed varieties like **Mahamaya, BTS24, BTS 28, CSR 10, CSR 13, CSR 27** and **CSR 36** should be tried [16].

2.2 Andhra Pradesh

A report by Planning Commission, Government of India [18] states that nearly half of the food production in Andhra Pradesh is contributed by eight coastal districts extending over a coast line of approximately 900 km namely Srikakulam, Vizayanagram (Visha khapatnam), East Godawari, Krishna, Guntur, Prakasam and Nellore. About 6.3 lakh ha of land is affected by salinity in Andhra Pradesh out of which about 1.76 lakhs is in the coastal districts [18]. Two growing seasons are observed, Saarva (Kharif) from June to November and Dalva (Rabi) from November to March. According to a report by Rice Knowledge Management Portal [5], **Samba, Mahsuri, Sagar, Early Samba, Rajavadlu, Chandan, Kavya, Salema, Satya, Ramallelu, Tellahamsa, Sumathi, Taramathi, Suganda mathi, Swarna, Phalguna Surekha, Kavya, Vikas** are the traditional rice varieties from the state, out of which only **Vikas** is grown in coastal saline soils. The duration is 130 -135 days and the grain type is long and slim [5]. Other varieties suggested to be cultivated are **Indra, Somasila, Deepti and MCM** [19, 20]. **Indra** is a long duration rice (150 days) and has fine grains. **Somasila** has duration is 105 to 110 days and has superfine grains. Fine rice varieties like **Swarna, Sona and Samba Masoori** are popular during the kharif season in north Coastal Andhra region. **Budda Mologolakulu (MCM 2)** has been used for selective breeding [20].

2.3 Goa

The coastal saline soils are locally known as *Khazan* lands and are subjected to periodical inundation of sea or creek water during high tides. As a result, these lands are progressively rendered saline. Even if these lands are protected from the ingress of sea or creek water by constructing embankments, salts from the shallow water table rises to the surface through capillaries making the surface soils, saline in Goa. The problematic area is estimated to be around 18,000 ha, out of which about 12,000 hectares are utilized for cultivation of rice in *kharif* [3]. A detailed description of the khazan ecosystem has been presented by Sonak *et al.* [21]. Khazans are the low-lying coastal lands that have been reclaimed from marshy mangroves by the construction of an intricate system of dykes, sluice gates and canals, and put to multiple productive uses such as agriculture, aquaculture and salt panning. The dykes prevent saline water from coming onto the lands, the sluice gates regulate the flow of saline water, and the canals help in the drainage and circulation of water. Crops grown in the khazan fields currently are mainly the salt tolerant varieties of rice. S. Krishnan *et al.* [22] have documented 45 traditionally-cultivated and 22 high yielding varieties from farmers across Goa. However, all the traditional varieties are not available and probably the germplasm has already disappeared. Bhosale *et al.* [23] have surveyed the traditionally cultivated salt tolerant rice varieties and affirmed the presence of 10 varieties namely, **Assgo, Bello, Damgo, Kalo Damgo, Kalo Korgut, Kalo Novan, Khochro, Korgut, Munno** and **Shiedi**. Cultivation of some of the varieties such as **Kalo Novan, kalo damgo**, and **Bello** are becoming rare, due to the introduction of high yielding rice varieties, hence local germplasm and their genetic diversity are being eroded. The rice varieties like **Korgut, Munno** and **Assgo** are still popularly cultivated in khazan lands of Goa due to its high salinity tolerance [23]. **Korgut**, literally means small coloured grains. It is of medium duration (100-130 days). It is tall, husk and kernel are dark brown in colour. Korgut goes well with lady fish curry and fried prawns. It has been registered as unique germplasm, for 'tolerance to salinity stress at seedling stage', with the National Bureau of Plant Genetic Resources (NBPGR), New Delhi and thus can be used as genetic stock in future breeding programmes aiming at the development of high yielding salt tolerant rice varieties for coastal saline areas [22,24]. **Munno**, literally means shortened grain, is an early variety of duration 80-110 days. It is tall, husk is light brown in colour and kernel is reddish brown. It goes well with rainbow sardines curry and dry salted fish. **Assgo**, literally means grain of paddy. It is an early rice variety with

duration 80 – 100 days. It is tall, husk is light brown colour and the kernel is light brown in colour. It goes well with pomfret fish curry and fried clams [22].

2.4 Gujarat

The salinity ingress has affected vast areas of fertile and productive tract in the narrow coastal plain of Saurashtra. The most adversely affected region lies within a coastal strip about 160km in length between Madhavpur and Una and includes the talukas of Mangrol, Maria, Veraval, Kodinar and Una [25]. Well known elite traditional varieties are **Sathi-34-36**, **Sukhwel-20**, **Kamod-118**, **Pankhali-203**, **Jirasal-280**, **Kada-176-12**, **Zinia- 31**, **Nawagam-19**, **Krishna Kamod** and **Bhurarata** . Using these local and traditional varieties either as male or female parent the present day improved rice varieties were evolved through hybridization and selection [26]. **Sathi** is coarse, pink streaked rice with a mild sweet taste when cooked. The rice releases so much starch when cooked that the cooked rice looks like a pink lumpy porridge when the rice is new, aged rice cooks to more separate grains though. This rice variety gets ready in 60 days (saath din) and hence the name sathi. It is an early variety which can be sown on the onset of monsoons and gets ready till the heavy monsoons last in the plains, giving way to late rabi crops in the last leg of monsoons. Sathi is known to thrive in waterlogged lowlands, so the wastelands of villages where nothing can be grown due to water logging, Sathi is the best option. This cultivar of rice is marked by short strong stems, ear (panicle) partially closed in the sheath and the grain husk dark coloured. It is a low yielding variety which is suitable for broadcast method of sowing. Sathi rice is considered to be easily digestible and nourishing in rural areas. **Krishna Kamod** also known as Basmati of Gujarat is known for its taste and aroma [27].

2.5 Karnataka

The coastal saline soils occupy approximately an area of 12,000 ha in the two districts of North Kanara and South Kanara of Karnataka [28]. The coastal saline soils in Karnataka are called as Gajni lands. Farming and fishing practices, cultivation plan and fishing techniques on Gajni land are unique. Farmers blend their cultivation methods to suit the peculiarities of tidal waves, active through the year, and the sandy loam soil structure. In July, when monsoon water from the hills fill it, farmers cultivate paddy. Salinity resistant **Kagga** varieties (**karekagga** and **Bilekagga**) of

rice are sown. The crop is harvested in November and the farmers here use boats to move and pluck the spike of the paddy. From November, sea water fills the land and fishing is done. Fish, shrimps, bivalves and crabs are harvested. In summer, the water is drained out and the land is left to dry. After a month, farmers loosen the soil manually and river waters allowed in. The land is then ready for cultivation by July [29]. Anitha Reddy [30] writes, farmers of Tumkur and Chitradurga areas of the state are going back to growing traditional saline tolerant paddy as the soil has no fertility and has become very hard. Karnataka state has many saline tolerant traditional rice varieties that are high in nutritional value and have medicinal properties, and most are resistant to extreme drought conditions, diseases and pests and are popular for their taste. Some of the significant saline tolerant varieties are: **Sanna vadlu** is a fine grained variety, the grains are of superior quality than sona masuri variety. Crop duration is 4 months and yield is about 20 to 25 bags per acre, superior in taste and very soft when cooked. **Picha neelu** is most popular saline tolerant variety, with crop duration of 4½ months, and grows 4 to 5 feet in height. It has good cooking quality and the grains are grayish black and white in colour and yields about 20 to 25 quintals per acre. **Beli picha neelu** is highly tolerant to saline conditions of soil and grows within 4½ to 5 months. A unique method followed by the farmers for good yield is to broadcast the germinated seeds directly on to the main field. For good germination, the seeds are dried well and then germinated. This yields about 25 to 30 quintals per acre and is very tasty when cooked. It is popular among the farmers of Madakasira taluka. **Thokapichaneelu** (Thoka means tail in Telugu), as the grain has awns on both side, hence the name ‘Thokapichaneelu’. Duration of crop is 4 ½ months and yield is about 20 to 25 quintals per acre. Paddy varieties like Bilitopu vadlu, Kasanella are unique and highly saline tolerant, these grow in places where salinity problem occur due to erratic rainfall. **Choluchangi** is also known as **Koralu changi**. Tip of the grain has 6 awns and grows profusely with one application of farm yard manure. **Kasarnellu, Bilitokavdlu, Kari tokavdlu, Bilipichanellu, Pichanellu** and **Jowguri** have a crop duration of 4 to 5 months and yield about 20 -25 bags per acre. The grains are bold and long and are cultivated in Chitradurga and Pavagada. **Sannanellu** and **Tokepichanellu** are small and fine grain varieties. **Mullubatha, Chintapolavodlu, Karichannangi, Bilichannangi, and Cholu channangi** are medium grain varieties, grown in Sira and Pavagada region [31]. **Jholaga** gives long straw [32].

2.6 Kerala

Kerala state has a coastline of 560km. One fifth area of Kerala state of India is wetland. This coastal belt has a unique system of rice cultivation in the saline soils known as *pokkali/kaipad/kaikandam* cultivation. The waterlogged swampy fields do not require the use of labour-saving heavy equipment and addition of manure. The seedling just grows the natural way. In order to survive in the water logged field, the rice plants grow up to 2m. But as they mature, they bend over and collapse with only the panicles standing upright. While harvesting, only the panicles are cut and the rest of the stalks are left to decay in the water, which in time become feed for prawns. Also, the use of fertile bottom mud of this field as manure for the coconut plantation is also a common practice in North Malabar [2]. Kaipad is a unique coastal wetland rice production tract which is saline prone and naturally organic production tract of North Kerala spread across Kozhikode, Kannur and Kasargod districts. The rice produce from this particular ecosystem is purely organic. Kaipad is the shortened version of 'Kayal padam'. 'Kayal' and 'padam' are Malayalam terminologies of 'salt water area' and 'rice field' respectively. The approximate area of Kaipad tract is about 4100 ha. The Kaipad system of rice cultivation is an integrated organic farming system in which rice cultivation and aquaculture go together in coastal brackish water marshes which is rich in organic matter. The Pokkali tract of south Kerala is said to be synonymous to Kaipad tract of North Kerala [33]. Rice farming in Kaipad, which faces tidal in flow and tidal outflow twice in a day, is carried out in a peculiar way in a low to medium saline phase of production cycle during June to October. Harvesting takes place by the end of October. This is followed by traditional fishing, in the high saline phase, during November to April. **Kuthiru** and **Orkayama** are the traditional land races widely grown in Kaipad rice tracts. **Mundon**, **Kandorkutty**, **Orpandy**, **Odiyan**, **Orissa**, **Punchakayama** and **Kuttadan** are the other land races cultivated in some pockets of Kaipad. These land races are tolerant to low and medium salinity. The average rice yield of these local cultivars is about 1.0 – 1.5 t ha⁻¹[33]. They differ in their morphological, physico-chemical characteristics and cooking qualities. Panicles of these cultivars are long with bold grains. Duration of **Kuthiru** is 110 -120 days, and that of **Orkayama** is 135 -140 days. Using these land races for the first time in breeding program, as donors for salinity tolerance, two saline tolerant non-lodging high yielding red rice varieties, **Ezhome -1** and **Ezhome -2** were commercially released for cultivation in Kaipad rice tract of Kerala state, India in 2010 [34].

Kerala's Pokkali farming, similar to Kaipad farming is facing extinction. Rice varieties grown are **Pokkali, Chotupokkali (Vytila -1), Oormundakan, Cheruvirippu, Chettvirippu (Mo1), Kalladachampavu(Mo 2) and Kunjathikkara (Mo 3)** [35] .

2.7 Maharashtra

In this state extensive area of Khar land occur along with coast which have become unfit for cultivation on account of unproductivity of the soil mainly due to salinity. The sea water enters through the creeks during high tides and submerges large area of cultivable land. These periodical inundations render the land progressively saline and in time makes it completely unfit for growing any crop. From the Zai creek in North to the Terekhol creek in South, Maharashtra state has got about 720 km of coastal belt [36]. The Khar lands in Maharashtra do not have any source of irrigation. Thus, the cultivation in the area is possible only in kharif season. Sapkale *et al.* [15] have reported that mudflat, salt marshes, coastal rice farms, kharland etc. are protected by sand spits, sand dunes and sand bars. Alibag, Panvel, Mangaon, Mahad, Roha and Karjat talukas are important producers of rice. These areas have twenty-four varieties belonging to two broad categories, red and white. Red rice is an inferior quality grown in low-lying salt lands near creeks which are liable to be flooded by spring tides. White rice is a superior quality grown in lands beyond the reach of salt waters. The salt tolerant varieties of rice include **manjarvel, harkhel, ratal, malkudai, vailechi, morchuka, kilanz and bhadas**. In salt lands, the seed is germinated and then broadcast. This method is locally known as rahu [37]. Other varieties like **Bhurarata** and **Kalarata** are being used for breeding programs [35].

2.8 Odisha

The total salt affected soils in the State estimated to cover about 4.04 lakh ha, distributed over the four coastal districts of Balasore, Cuttack, Puri and Ganjam. There are large chunks of saline land around Basudevpur and Chandable area of Balasore district, and Rajkanika, Mahakalpada and Rajnagar area of Cuttack. In addition, there is a strip of land about 18 miles in width running along the Bay of Bengal in Kujang and Kanika of Cuttack district which is uninhabited [18]. In coastal Orissa, salinity is severe due to seawater intrusion and shallow saline groundwater, especially during the dry season. During the wet season, rainfall and river flow

help to flush out some of the salt, making rice cropping possible, but yields remain low because of the saline conditions [38]. About 300,000 ha of the coastal alluvial land suffer from tidal inundation. Tall indica varieties such as **Patnai 23**, **SR 26B**, and **Lunishree** are grown during the kharif season and yield is very low (500–700 kg/ha). Getting a good crop stand is a problem because, at the early stage, the crop is highly sensitive to salinity [39]. The traditional tall types are still favored by farmers despite their low yield potential, due to their favorable traits such as early seedling vigor, rapid germination, deep root system with higher proportion of thick roots, superior grain quality, better yield stability, and tolerance of moisture stress, submergence, and salinity. Dixit and Challam collected nearly 3,000 rice germplasm accessions mainly from the six districts then constituting the state of Odisha: Balasore, Cuttack, Puri, Ganjam, Koraput, and Sambalpur. Some of the traditional tall varieties such as **Kalakartik** in Sambalpur; **Saruchinamali** in Cuttack and Puri; **Bayahunda** and **Ratnachudi** in Ganjam; **Karandi** in Koraput; **Machhakanta**, **Pateni**, and **Kalambanka** in Balasore; and **Magura** in Puri and Cuttack are the most adaptable types and are widely grown [40]. Kohli *et al.* [41] have studied the extent of diversity and heterogeneity of two land races namely Galleiganthi and Bankosa still being cultivated by rural farmers in coastal Orissa. Other local varieties include **Kalambank**, **SR-8**, **Raspanjore**, **Velki (Bhanuki)** and **Nonasail (CSR6)** [37].

2.9 Puducherry

The Union Territory of Puducherry has a coastline of 45 kms, stretching along the Bay of Bengal and to some extent along the Arabian Sea out of which Puducherry region alone has 24 km of coastline, Karaikal has 20 km stretch and Mahe has 1km stretch of coastline, with a very wide range of coastal ecosystems such as estuaries, lagoons, mangroves, backwaters, sandy stretches, etc which are characterized by unique biotic and abiotic properties and processes [42]. An area of 25,600 and 13,300 ha of land lies in the coastal region of Pondicherry and Karaikal, respectively. Rice is grown as the major food crop in an area of about 30,000 ha. In the recent past, these lands are left either fallow or converted for industrial use as the cultivation was uneconomical. [43]. The local varieties of Tamil nadu (2.10) are also cultivated in Puducherry.

2.10 Tamil Nadu

In this State, the problem of salinity exists both in coastal areas and inlands. The soils of coastal areas offer many unique problems like salinisation, water logging, clay pan formation and sea water inundation. These soils occur all along the east coast from Chingleput, South Arcot, Tanjora, Ramnad to Tirunelveli. It has been estimated that about one lakh hectares in the coastal belt pose salinity problems [18]. In the coastal area bordering Thanjavur district, salinity problem exists in parts of the talukas of Sirkali, Mayuram, Nagappatinam, Pattukottai and Thiruthuraiipoondi. The entire area is cultivated mainly to long duration rice crop, except in Sirkali taluka where double crop is followed. In all other talukas, only a single crop of rice is raised. In certain areas of Thiruthuraiipoondi local rice variety 'Kar' is raised and only panicles are harvested due to water stagnation. Salinity problem exists in the talukas of Tiruvandari, Ramanathapuram and Mudukulathur **in Ramanathapuram** district. Most of the area in this belt is mono cropped to rice both under irrigated and rainfed conditions. In the coastal belt from Ramanathapuram to Mandapam, a fragipan has developed about 30 cm below the soil surface and rice is grown under semidry conditions in such soils [18]. It has been reported by Gillespie [44] that 400 traditional varieties have been slowly replaced by HYVs, narrowing the number to hundreds. This has led to the loss of the genetic pool of many landraces that can adapt to the ongoing climate change in Tamil Nadu. Tamil Nadu has now been left with nearly a hundred traditional landraces of paddy that have the capability to cope with ongoing climate change in Tamil Nadu. Quintal et al. have tried cultivation of 3 local rice varieties namely Kalundai Samba, Suran Kuruvai and Arupatham Kuruvai for a project started in August 2009 for a period of one year, covering one season – purely under rain fed conditions with organic methods of crop cultivation and were successful in cultivation of Kallundai Samba and Arupatham Kuruvai [47]. Kalar samba and kallimadyan varieties are widely grown [28]. Panag Kattu Kudavazai is a lost local variety that has been revived for cultivation [46]. AD-26 is a pureline short duration (105 days) red rice variety [47].

2.11 West Bengal

Among all the states in India West Bengal has the highest area at coastal saline lands. The coastal areas of West Bengal are spread over 4 districts, viz. North 24 Parganas, South 24 Parganas, Haora and Medinipur. [50]. The entire saline belt lies in the active deltaic plains of the Ganga where in the aquifers occur under confined condition [18]. **Patnai (23, 298), Damodar**

(CSR1), Dasal(CSR2), Getu (CSR3), Benisail (Matta), NonaBokra(Hamilton), Velki (Bhaluki), Rupsal, and Nonasail (CSR6) are the widely used varieties [39]. **Getu, Dasal** and **Damodar** have been evolved by pureline selection from a wide collection of locally grown germplasm. They are of short duration , can be grown in both kharif and boro seasons and are characterized by white kernel with good cooking and milling qualities. **Rupsal** variety has the highest salinity tolerance [49].

In the present review, we have enumerated the most commonly cultivated landraces and traditional rice varieties. However, there are hundreds of local varieties which have not been documented and cultivated. The information of these varieties still remains only with the farmers and thus there is a need to preserve the germplasm along with the traditional knowledge. The traditional varieties of rice have many desirable traits like high iron, protein and vitamin B content; resistance to abiotic stresses, resistance to pests. Some have medicinal value and are also healthier and tastier than the developed varieties. They have adapted locally and thus are genetically more diverse than the modern rice varieties developed in the laboratories. Rising sea levels, changing rainfall patterns and the increasing frequency of cyclones are expected to continue eroding our coastal lands. The resulting salt intrusion will likely render crop fields unsuitable for modern rice varieties. These diverse traditional rice varieties are precious genetic resources that provide ecological balance and the conservation of this gene pool is crucial for the future food security.

Acknowledgements

The authors thank all the contributors of the cited papers in this review. Authors are also thankful to Head of the Department of Biotechnology, Goa University for the facilities. A.B. thanks the University Grants Commission, New Delhi for UGC-NET fellowship.

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