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AN INDIGENOUS SALINE RESISTANT ORGANIC RICE TRACT IN NORTH KERALA- PRACTICES AND CHALLENGES

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***Synopsis*– Rice, the most important cereal and staple carbohydrate source of Asia is cultivated in diverse ecological conditions and many such agro ecosystems are fragile and critically endangered. Some such systems are very special in terms of their ecological singularity and subsistence value and their conservation would invariably add to availability of food and protection of genetic diversity. The present study is an investigation in to *kaippad,* a very unique rice farming system in Kerala state of India, in which rice is cultivated in the first crop season in saline wetlands that are subjected to regular tidal action, taking advantage of the heavy south west monsoon which results in flushing out the salt content from the farmland. *Kaippad* system of rice farming has been studied presently based on specialities of the area, practices, the varieties used and the major challenges. The study showed that the *kaippad* rice land area is a unique ecosystem characterized by periodic sea inundation, and the farming system is organic and the farming practices are highly indigenous. The major rice varieties cultivated in the area are the native cultivars. The study has been carried out at a time when the world fritters time and money on researching new varieties of paddy that are flood and saline resistant and the indigenous organic varieties in coastal Northern Kerala that thrive on salinity and water are finding survival a tough proposition.**

1. INTRODUCTION

Explosive increase in the world population, deterioration of arable land and availability of quality irrigation water are forcing rice production into more and more marginal environments facing abiotic stresses. In future, the chances of a major increase in land area available for cropping will be meager. Simultaneously cultivated area is declining fast in most of the developing countries due to a variety of reasons. To tackle these problems, the ability of the crops to tolerate unfavorable environmental conditions such as drought, salt, flooding or cold conditions has become a key research issue in the world. Among different parameters, abiotic environmental stresses contribute most significantly to the reduction in potential yield, of which salinity is the foremost one. Rice, the staple food of South East Asia is a more amenable crop to marshy soils near sea coast, the unexploited areas where we have to pay more attention to extend the area of rice cultivation in future. This soil is saline due to sea water intrusion and due to the erratic climate changes, normal non-saline rice lands are also becoming saline due to decrease in the level of sea water table. At this context, salinity tolerant genetic resources and varieties of rice can play a major role to attain the goal of food security. Further, some degree of cultivar tolerance for salinity stresses available with certain traditional land races not exploited so far has great relevance in crop improvement.

Rice has massive variability for tolerance towards most abiotic stresses and it is the only economic crop that can grow well in waterlogged environments while tolerating salinity up to a certain extent. The crop can be grown in coastal belts that are always prone to inundation by sea water during high tides, resulting in salinization. Under these conditions, only salt- and submergence-tolerant crops are economically viable farming options. Estimates of salt-affected areas range from 0.34 to 1.2 billion ha globally (Massoud, 1974). In south and Southeast Asia where population pressure is high and arable land is scarce, about 100 million ha of land climatically, physiographically, and hydrologically suited to rice production lie idle largely because of soil toxicities. About 48 million ha of this idle land are saline soils in humid parts of the region. About 380 million ha of soils on the earth's land surface are saline. The actual area of saline soils in the regions may be considerably higher than estimated (Ponnamperuma and Bandyopadhya, 1980). The nearly 30 million ha of coastal saline soils in South and Southeast Asia offer promise as potential rice lands.

According to the survey carried out by the Ministry of Environment and Forests in 1990, about 4.1 million hectares are covered by wetlands of different categories in India. They are predominantly located in the Himalayan Terai, Gangetic and Brahmaputra floodplains, deltaic regions of east-coast, forested valley swamps of north-eastern India, saline expanses of hot-arid regions of Gujarat and Rajasthan, the deltaic region of east and west coast, the wet humid zones of the peninsula and the fringing mangrove swamps of Andaman and Nicobar (Srinivasan, 2010). Total rice area under coastal salinity rice in India is estimated to be about 1

million ha, which accounts for 2.3% of area under rice cultivation. Average yield in coastal saline area is about 1 tonne as against the average national yield of 1.9 tonnes per ha. (Randhawa et al, 2006).

The coastal saline soils of South India are highly under-utilized because the use of ground water for normal crop production is not possible due to the poor water quality. At present, the entire coastal area is mostly monocropped with rice being the only crop during the monsoon period. The land remains fallow during the rest of the year due to lack of good quality irrigation water and high soil salinity. Hydromorphic saline soils are common in Kerala and are found near the coastal tracts of the state in the districts of Ernakulam, Alleppey, Tirchur, and Cannanore. The network of backwaters and estuaries serve as inlet for tidal waters to flow inland into these areas causing salinity. Only one crop of rice is raised in these areas during August to December using salt resistant varieties. Kerala with its long coastal line of about 580 km has several lagoons or backwaters covering a very large area linked to the sea. In most of the coastal land, deltaic areas at river mouths and reclaimed backwaters are either at sea level or 1.0 to 1.5 m below MSL. This leads to intrusion of sea water up to a distance of 10 to 20 km upstream during high tides. These periodically saline water inundated lands constitute the major saline soil areas of the State covering an area of 30,000 ha (Leenakumari, 2004). The major rice cultivating areas in Kerala include the lowland flooded areas like kuttanad, pokkali, koal, *kaippad*, etc. and the midland and high range areas. 37% of rice production in the state is contributed by the law land ecosystems.

In the coastal regions of India, a complex and ecologically responsive farming system has evolved over centuries. In this system, rice and fish cultivation alternates through a mechanism of water control (Nair et al, 2004). No accurate estimate of the area under this cultivation exists. According to one estimate, it is about 0.7 million hectares. Rice culture in these lands takes place either under deep or floating water conditions. The rice varieties cultivated are traditional types with an average yield of about 1.5 to 2 tonnes per hectare. There exist variations in these farming systems across regions depending on the ecological, technological, institutional, and organizational arrangements conditioning the wetland resources base (Vanaja et al, 2009). Forty years ago, about 2500 ha of *kaippad* rice fields existed in Kannur District of Kerala, but now it has been restricted to about 600 ha. Most of the kaipad fields either lie barren or produce low yields (Maclean et al, 2002).

The present effort is to study the *kaippad* rice cultivation in Kerala which is significant since in recent decades, the wetlands under rice-fish farming have been facing severe threats due to a variety of factors including shift from the ecologically fragile rice- fish farming to the semi-intensive fish farming. Kerala State on the south western coast of India in the tropical humid zone has a predominantly agricultural economy, very high population density and therefore high pressure on cultivable land (Nair and Sreedharan, 2006). Rice farming in the conventional farming areas of the state is intensive to a considerable extent and improved varieties are generally used. However, speciality rice farming systems which are habitat specific and cultivar specific are popular throughout the costal belt of Kerala. In areas that are subjected to tidal action and hence the soil is saline , a crop of rice is grown during *virippu* taking advantage of the heavy south west monsoon by a system of flushing out the salt from the land. The system is known as *pokkali* in Central Kerala and *kaippad* in Northern Kerala (Leenakumary, 2004). *Kaippad* system of rice farming in the Ezhome and Keezhara regions of Kannur district of Kerala state of India has been studied presently based on habitat features, farming practices, varieties used and the challenges confronted.

2. MATERIALS AND METHODS

The area of present study is such an area that is subjected to tidal action and hence the soil is saline and out skirted by mangrove plants which provide a special habitat for rice cultivation.

The study area is located at Ezhome region of Ezhome village panchayat and Keezhara region of Kannapuram village panchayat of Kannur district of Kerala. Fifty farming units in the Ezhome and Keezhara regions were used for the study. The units were frequently visited and the farming system observed and analysed in the first cropping season of 2013-14. Details of the commonly used cultivars and varieties were collected and the frequency of their cultivation observed. The farming units were observed from land preparation to harvest and observations were made on the agronomic characters of the crop cultivars used based on systematic sampling selecting 30 plants per farming unit. The entire study was carried out in participatory mode in farmer's field. Farmers were interviewed to identify the present obstacles they faced in practicing the rice cultivation.

3. RESULTS AND DISCUSSION

Kaippad wetland ecosystems consist of marshes, swamps, ponds and paddy fields. These swampy and water logged areas experience flood during monsoon and salinity during summer owing to their proximity to estuaries. Tidal currents enter the fields during high tide and flow out during low tide. Saline water from the sea enters the estuaries during summer when the flow is low and it spreads in the low lying *kaippad* wetlands and this water keeps the area moist even in summer months. *Kaippad* farms are made by making bunds around the wetlands and these are protected by the mangrove plants growing along their outer boundaries. The fertility of the land is naturally maintained by the periodic tidal currents and the flowing in of the rain water from the nearby hilly areas crammed with organic stuffs and also by the decaying of the remnants of rice stubbles and fish excreta. The *kaippad* system of agricultural practice is traditionally empowered with local knowledge and it is interwoven with traditional lifestyle.

3.1. The farming system

Agricultural operations are started with the drying of the low lying *kaippad* fields in the month of April. The tidal flows are controlled by constructing bunds with about 10 feet breadth at the outer boundaries adjacent to estuaries using sticky mud and wild grasses which are available in the river banks. Locally the bunds are known as *chira* or *kandy*. The flow of water is regulated by sluice wooden gates, locally known as m*ancha*.

Normally only one crop of rice is raised in the area. Cultivation starts in April and ends by October. Before the starting of agricultural operations the saline water is drained out completely and the fields are left to dry for about one month. Germinated rice seeds are sown on mounds known as *potta* in the low to medium saline phase of the ecosystem. The soil mounds are prepared by the end of April. Two kinds of mounds are common: hemispherical mounds with 30-45cm height and 50-60cm diameter and long strips with 30cm width. The mounds help to leach away the high salinity by the heavy rains during early June. The bunds are opened as soon as the river is filled with fresh water. The fresh river water tides wash away the salinity.

The seeds are soaked in fresh water for one day and the wet seeds are kept for 3 days in jute sacks for germination by the beginning of June. Local salinity tolerant rice varieties are used for the purpose. After the onset of southwest monsoon, seven day old germinated seedlings are sown on the flattened tops of the mounds. After 45 days of vegetative growth, the mounds are dismantled and the seedlings in clefts are dispersed around the flattened mounds using spades. There are no other cultural operations till the harvest except removal of weeds. No fertilizer is also added. Harvesting is done by the end of October. 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 the prawns that are grown subsequently.

Traditional fish rearing is carried out in *kaippad* farms during the high saline phase from November to April. Mud-bunds and sluices are made around the fields to regulate the entry of tidal water. Prawn filtration in the fields begins after the monsoon. The sluices are kept open to allow tidal water and prawns and fish to enter the farm. Fish is caught during low tide when water is released through the sluices. A net is fixed to the sluices to catch fish. Neither chemical fertilizers nor plant protection chemicals are used in rice, fish or shrimp farming. The daily tidal inflows and outflows, besides the tremendous microbial activity owing to the presence of large quantities of organic matter (decomposed aquatic weed mass and paddy stubbles) make the *kaippad* fields fertile.

The fish, shrimp, prawn, etc. which swim in from the sea and the backwaters after the rice harvest, feed on the leftovers of the harvested crop. The rice crop draws nutrients from the excrement and other remnants of these sea creatures. Further, diversity of flora and fauna in this area is rich when compared to modern rice-farming system. In addition, fertility of the field is increased due to left-over rice stubbles and post harvest vegetation. This ecofriendly farming method has been practiced for many years with no change even to this day.

3.2. Crop cultivars/ varieties used

The *kaippad* 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. Five local salinity tolerant rice cultivars, namely *Chovverian*, *Kuthiru*, *Kuttusan*, *Orkazhama*, and *Orthadian* have been found to be cultivated in this area (Table 1). However, the cultivar *Kuthiru* is used more commonly, followed by *Orkazhama* and *Kuttusan*. The remaining two cultivars are only very rarely cultivated.

In situ observations on the phenotypic traits of these land races are presented in Table 2. All the five rice varieties are tall and plant height is relatively higher in *Chovverian* with an average of 150.4cm. Number of tillers at harvest was 9.8 in *Kuthiru* and 6.93 in *Orthadian.* Ear bearing tillers are

relatively more in *Orkazhama* with an average of 8.4. Panicles of these cultivars are long but less in number of grains, and grains are bold type with red kernel. Hundred grain weight is higher in *Orthadian* and lesser in *Kuttusan*. Yield per plant is higher in *Kuthiru* and lower in *Orthadia*n. The varieties differ in their morphological and physicochemical characteristics and cooking qualities. Duration of *Kuthiru* and *Orthadian* is 110 -120 days, that of *Orkazhama* and *Kuttusan* is 135 -140 days and that of *Chovverian* is 125-130 days. These saline tolerant traditional land races are low yielders and are susceptible to lodging, because of the poor culm strength and excessive culm length, with poor grain qualities like awn on grains and heavy shattering of grains. However, these cultivars are resistant to pests and diseases in natural field conditions of *kaippad* and the cooked rice is delicious.

Cultivar	Number of farming units out of the 50 units visited	Percentage
1.Kuthiru	28	56
2.Orkazhama	10	20
3.Kuttusan	10	20
4.Chovverian	1	2
5.Orthadian	1	2
Total	50	100

Table 1. The rice cultivars used by the farmers and the frequency of their cultivation

Rice cultivar	Plant height at harvest (cm)	No. of tillers at harvest	EBT%	Panicle length (cm)	Spikelet number per panicle	Seed number per panicle	Hundred grain weight	Yield per plant (gm)
Kuthiru	143.00	8.53	95.19	26.45	129.35	97.60	3.32	26.22
Orkazhama	142.15	9.14	94.75	25.82	124.67	89.69	2.91	22.72
Kuttusan	140.09	8.19	94.87	24.08	142.65	110.07	2.34	20.04
Chovverian	150.40	7.73	87.58	24.60	99.73	88.40	3.41	20.38
Orthadian	140.57	6.93	92.78	22.73	80.23	65.67	3.53	14.90

Table 2. Phenotypic characters of five local rice cultivars

Two new rice varieties, Ezhome-1 and Ezhome-2 have been developed recently by Kerala Agricultural University with the participation of farmers of Ezhome panchayat for the area. These varieties are high yielding and non-lodging red rice varieties with awn less, non-shattering grains and favourable cooking qualities better than local cultivars. The average yield of Ezhome -1 and Ezhome–2 is 3.5 tones/ ha and 3.2 tones/ha respectively under close planting and zero management conditions of *kaippad*. This yield is 70 % and 60% more than that of local cultivars. These varieties differ in duration, and are having distinct morphological qualitative traits and different mode of salinity tolerance mechanism imparting varietal diversity to the unique ecosystem of *kaippad* (Anonymous, 2010).

3.3. **Major challenges:** Major challenges confronted by this special habitat in general and indigenous rice cultivation in particular are:

1. Since the land preparation and cultivation practices are highly climate specific, uncertainty in the rainfall upset the whole practices
2. Ambiguous temperature changes affects the yield
3. Fertility of the soil is usually elevated by the flow of rain water from the nearby hill tracts which contains high amount of biodegradable

substances. But at present the presence of non biodegradable substances reduces the water and soil quality
4. Lack of proper drainage system
5. Occurrence of relatively high salinity in water and soil
6. High labour cost
7. Change of *kaippad* land to mangrove areas due to non cultivation for one or more cultivating seasons
8. Lack of proper modernization in cultivation practices

4. CONCLUSION

This system exists as a world acclaimed farming model complementing the natural system, utilising indigenous knowledge and ensuring efficient utilisation of local resources. The proximity to sea and subsequent periodical seawater inundation ensure the uniqueness of the rice varieties cultivated and contribute to the high degree of specialisation in the cultural practices followed in the region. The less remunerative rice cultivation compliments a highly profitable prawn culture, making it a unique agro-ecological continuum. The farming system is traditionally organic, as farmers desist from use of agrochemicals in rice farming which hampers the productivity of the succeeding crop, i.e., the prawn culture. But lately, monoculture of prawn has caught up, which though provides higher net return over rice-prawn culture in short run, is found to be unsustainable both from ecological and social contexts. *Kaippad* rice is distinguishable in taste, quality and utility from the conventional rice varieties.

The present effort is significant since in recent decades, the wetlands under rice-fish farming have been facing severe threats due to a variety of factors including shift from the ecologically fragile rice- fish farming to the semi-intensive fish farming. The study has been carried out at a time when the world fritters time and money on researching new varieties of paddy that are flood and saline resistant and the indigenous organic varieties in coastal Northern Kerala that thrive on salinity and water are finding survival a tough proposition.

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