Rice cultivation in the saline wetlands of Kerala- an overview

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Abstract: *Rice cultivation in marginal and ecologically fragile farming systems constitute one major source of staple food to the poor farmers of Asia. Kerala state of India has a long coastal belt enriched by backwaters. But the wetlands around them are saline in nature and agricultural practices in the area are highly site specific. Three traditional organic systems of rice cultivation namely pokkali, kaipad and kole are practiced in these wetlands. The systems are unique in the sense that they are organic, traditional cultivars are used and the input required is very low. However, the productivity of these rice farming systems is considerably low. Efforts should be made to conserve the systems in terms of cultivation practices, genetic potential and uniqueness of the cultivars and moreover as a system of sustenance of poor and marginal farmers. Efforts to augment the returns should be made without a compromise in conservation strategies.*

Key words: saline wetlands, rice cultivation, pokkali, kaipad, kole.

INTRODUCTION

Biodiversity maintained *in situ* or conserved *ex situ* is the most important treasure that humanity should protect without fail so that nature's valuable genetic wealth is not becoming extinct. However, the loss of biodiversity is taking place at a rate that threatens the very survival of mankind. Since agriculture gave emphasis to increasing yield in the second half of the 20th century, the release and spread of high yielding crop varieties caused the fast replacement of locally grown crop cultivars. This replacement was the most extensive in crops like rice. More over, explosive increase of world population, deterioration of arable land and reduction in the availability of quality irrigation water are forcing rice production into more and more marginal environments facing abiotic stresses. In future, one cannot expect a major increase in land area available for cropping. At the same time, cultivated area is declining fast in most of the developing countries due to various reasons. To address these problems, the ability of the crops to tolerate unfavourable environmental conditions such as drought, salt, flooding or cold conditions has become a key research issue in the world. The global effort to collect, document and utilize the resources is enormous, and the genetic diversity in the collections is critical for food security. Of all the parameters, abiotic environmental stresses contribute most significantly to the reduction in potential yield, of which salinity is the major one. It limits growth and productivity of all major crops including rice. 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 saline sea water intrusion. Similarly, due to the vagaries of climate changes, normal non saline rice tracts 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 stress available with certain traditional landraces not exploited so far has got great relevance.

Rice has enormous 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 for 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. The most common of the soil problems is salinity. About 380 million ha of soils on the earth's land surface are saline. Of the 240 million ha that are not strongly saline about 49 million ha are in the humid regions of South and Southeast Asia; 27 million ha of these are coastal saline soils. The actual area of saline soils in the regions may be considerably higher than estimated The nearly 30 million ha of coastal saline soils in South and Southeast Asia offer promise as potential rice lands. Varietal tolerance for salinity and accessory growth limiting factors should be exploited in bringing marginal land under rice. The use of improved, salt tolerant, disease and insect resistant rice varieties, coupled with the correction of nutrient deficiencies, will enable farmers to double or triple their present yields on saline soils and also to expand rice growing into surrounding uncultivated land (Ponnamperuma and Bandyopadhyay, 1980).

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 terrain, 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, deltaic regions of east and west coasts, 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 the 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 underutilized 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 during the monsoon period with rice as the only crop. 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, Alappuzha, Thrissur and Kannur. 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 tolerant cultivars. 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).

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, kaipad, etc. and the midland and high range areas. 37% of rice production in the state is contributed by the law land ecosystems. The present effort is to review the pokkali, kaippad and kole systems of 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. The close association of agricultural crops, tree crops and animals in the homesteads represents an excellent example of sustainable and productive agroforestry (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 through out the costal belt of Kerala. In areas that are subjected to tidal action and hence with saline soil, 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 kaipaatu in Northern Kerala (Leenakumary, 2004).

THE POKKALI FARMING SYSTEM

The *pokkali* system of rice cultivation in the acidic saline soils of south central Kerala is a unique method of rice production. In this method, a single crop of rice is taken in the low saline phase of the production cycle (June to mid October) on mounds, followed by prawn farming during the high saline phase (November to April) (Fig. 1). A noteworthy feature of this traditional rice cultivation method is that neither chemical fertilizers nor plant protection chemicals are applied to the crop. The *pokkali* fields are also subjected to periodic submergence. 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 pokkali fields particularly fertile. In spite of this, the average rice yield realized by *pokkali* farmers is only ~2000 kg ha^{-1}, making rice cultivation in this region somewhat unprofitable. Shylaraj and Sasidharan (1998) released VTL5, a promising 'Mashuri' mutant for cultivation in the coastal saline ecosystems of Kerala, with high yield potential and ability to perform well under the acid saline situations and with the essentiality of little or no external inputs to sustain rice cultivation in the *pokkali* areas of Kerala. Kerala Agricultural University has developed five saline tolerant, high yielding rice cultivars suited to the *Pokkali* ecosystem of Kerala. The cultivars are Vyttila-1, Vyttila-2, Vyttila-3, Vyttila-4 and Vyttila-5.

Fig. 1. Pokkali rice farming system of Kerala state of India (http://blog.emergingkerala2012.org)

THE KAIPAD FARMING SYSTEM

Kaipad is a saline prone natural organic rice production tract of North Kerala, India, like the pokkali tract of South Kerala (Fig. 2). 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 are rich in organic matter. The network of backwaters and estuaries serves as an inlet of sea water and causes salinity in the area. Rice farming is carried out in a purely natural way in kaipad relying on the monsoon and the sea tides. Single crop of rice is cultivated on mounds in a low-to-medium saline phase of the production cycle during June–October (Vanaja *et al*., 2009). The soil type is saline hydromorphic (Swarajyalakshmi *et al*., 2003). Within a period of forty years the area of kaipad rice fields got reduced from 2500 ha to about 600 ha in Kannur district of Kerala. Most of the kaipad fields either lie barren or produce low yields. Traditional cultivars namely *Kuthiru*, *Orkayama*, *Mundon*, *Kandorkutty*, *Orpandy*, *Odiyan* and *Orissa*, tolerant to low and medium salinity have been cultivated in various kaipad fields in Kerala. The average rice yield of these local cultivars is about 2000 kg ha^{-1}, making rice cultivation in this region unprofitable (Vanaja *et al*., 2009). Lack of realization of the potential of high yielding rice varieties to this rain fed, shallow lowland is the major reason for the low productivity and shrinkage of kaipad fields. The traditional cultivars are susceptible to lodging, because of the poor culm strength and excessive culm length. Panicles of these cultivars are long but less in the number of grains. However, these cultivars are resistant to pests and diseases in natural field conditions of kaipad and the cooked rice is delicious. The high yielding saline resistant pokkali varieties do not

perform well in kaipad saline tracts. This may be due to the difference in the physicochemical properties of soils. (Swarajyalakshmi et al, 2003).

Vanaja *et al*. (2009) have developed two high yielding and non lodging organic red rice varieties meant for the saline prone rice fields of Kaippad, namely Ezhome1 and Ezhome2. They are awn less with non shattering grains and favourable cooking qualities. The average yields of Ezhome1 and Ezhome2 are 3.5 tones/ ha and 3.2 tones/ha respectively which is 70% and 60% respectively higher than that of the 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 Kaipad. The new varieties are expected to transform the vast kaipad area into an arable and highly productive farming land, leading to increase in the production and export of organic red rice from Kerala.

Fig. 2. Kaipad rice farming system of Kerala (photographed by the first author)

THE KOLE FARMING SYSTEM

The *Kole* lands which form one of the rice granaries of Kerala are part of the unique Vembanad-Kole wetland ecosystem, the largest brackish, humid tropical wetland ecosystem in the Southwest coast of India comprising of 1,51,250 ha, fed by 10 rivers and are exposed to diurnal tidal cycles. Within the Vembanad-Kole wetland ecosystem, the *Kole* lands cover an area of about 13,632 ha spread over Thrissur and Malappuram districts (Fig. 3). The name *Kole* refers to the peculiar type of cultivation practice carried out on these lands and in the regional language Malayalam *kole* indicates bumper yield or high returns in case floods did not damage the crop. *Kole* lands extend from the northern bank of Chalakudy River in the south to the southern bank of Bharatapuzha River in the north. The Kole lands remains submerged under flood water for about six months in a year and this seasonal alternation gives it both terrestrial and water related properties which determine the ecosystem structure and process which in turn gives rise to various provisioning services. Rice is the most important crop cultivated in the *Kole* land. *Virippu* is usually cultivated in higher rice fields around the Kole land where the duration of flood lasts only for few days. *Mundakan* is cultivated in medium elevation fields around the Kole lands where the flood water reside by August. The Kole lands are to be protected by bunds. When the flood water in the Kole fields starts subsiding by the end of south west monsoon season, pumping out of water using *petti and para* which is an indigenous pumping device will be carried out in 10 to 15 days. After this, bunds around the fields (*padavu*) are raised and strengthened by means of locally available materials and laterite soils to a height of 1 to 1.5 m above the field level. Crop is directly sown or transplanted when water is around 10 to 15 cm. A few decades back a number of local varieties of paddy were cultivated in the Kole fields but nowadays improved varieties like Jyothi, Uma and Jaya are the major varieties cultivated. Fish farming is usually carried during March to September (Srinivasan, 2010).

Fig. 3. Kole rice farming system of Kerala (http://en.wikipedia.org)

CONCLUSION

The increasing global concern over environmental protection and human health problems caused by agrochemical residues in food and environment and the resulting raise in demand for organically produced commodities assures brighter future for such systems like kaipad and pokkali which also depend fully on organic farming measures. The internationally accepted salinity resistance source in rice is the Pokkali land race from Pokkali rice tracts of Kerala state. Kaipad system of cultivation practiced in North Kerala, like pokkali system is a locally developed system which is accustomed with the existing local environmental conditions. Despite rice cultivation being not profitable under the organic farming, the overall kaipad and pokkali farming system is made highly profitable by including prawn cultivation in the succeeding season.

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