Speciality rice biodiversity of Kerala: need for incentivising conservation in the era of changing climate

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Genetic diversity is integral to food security and sustainable agriculture. The erosion in genetic diversity across the globe raises serious threats to food security and our capacity to adapt to climate change. This article discusses the status of genetic diversities of rice varieties in Kerala, and the contributing factors for the genetic diversity. The rich genetic diversity of rice in Kerala offers scope to adapt to multiple agro-ecologies, provides resistance to biotic and abiotic stresses, carries special culinary traits and has cultural significance. Thus, these rice landraces are important in creating an enabling environment for farming in the context of climate change. However, shift from landraces to modern varieties and large scale conversion of rice fields for alternate uses poses challenge to *in situ* conservation of rice landraces. The existing policy environment, research and development strategies and markets are skewed in favour of modern varieties. It is argued that the need for 'conservation incentive' is a key strategy for promoting *in situ* conservation of rice landraces of Kerala.

Keywords: Climate change, conservation incentive, genetic diversity, *in situ* conservation, rice landraces.

GENETIC heterogeneity is the key to achieve 'productivity in perpetuity'[1]. Before the advent of commercial agriculture, farmers across the globe have been conserving and cultivating a large number of landraces. Farmers have conserved these landraces for their potential to tolerate flood, drought, salinity, shade and for their medicinal, nutritional, culinary and cultural values. However, severe erosion in plant genetic diversity has been observed since the early 1900s.

The three major staples, rice, wheat and maize contribute to about 60% of the energy and protein sourced from plants by humans[2]. Rice, an important cereal crop in the world, has its centre of origin in India. Archaeological evidence points to rice cultivation in India between 1500 and 1000 BC. Centuries of cultivation, adaptation to diverse environments and culinary preferences have given rise to a rich genetic diversity in rice varieties. India has one of the highest diversities of rice in the world. An estimated 140,000 landraces of rice are recorded in the world and India alone has about 86,330 accessions[3].

Speciality rice varieties refer to the diverse group of traditional rice varieties that have been conserved and cultivated across the globe. The state of Kerala has an estimated 2000 traditional rice varieties[4] which are adapted to a wide range of agro-ecological conditions. The biodiversity of speciality rice varieties with its rich and diverse gene pool can be the foundation for building climate resilient agriculture. Further, the speciality rice varieties cater to the nutritional and cultural needs of the different communities in the state. They also play an important role in traditional healthcare practices. Many of the traditional rice varieties are inevitable in lifecycle rituals of many communities.

Agriculture across the globe and in India faces the threat of increasing temperature, severe water stress, flood, drought and sea level rise. Given the wide range of adaptation of speciality rice varieties, and their ability to perform under harsh climatic conditions, conservation of these varieties is imminent for promoting climate resilient agriculture. However, speciality rice varieties are observed to be gradually vanishing from the cropping systems in Kerala. A major reason for the disappearance of landraces is the replacement of modern high yielding varieties and commercialization of agriculture.

Agriculture in Kerala has been increasingly commercialized with the ratio of non-food to food crops standing at 10 : 90 in 2015–16. This has been accompanied by a shift to high yielding varieties from traditional varieties in food crops. Rice being an important food crop, large scale conversion of rice fields in the past four decades is considered as a major reason for decline in area under food crops in the state. During 1973–74, the area under paddy was 8.73 lakh ha, which came down to just 1.98 lakh ha during 2014–15. Similarly, the coverage of high yielding varieties in gross rice area was 18.17% in 1970–71, which increased to 92.98% in 2010–11 (refs 5, 6). The reduction of area under rice cultivation and displacement of traditional rice varieties in the state raise serious threats to conservation of valuable rice genetic resources required to meet the challenges of regional food security and changing climate.

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This article highlights the current status of speciality/ traditional rice varieties in Kerala, its relevance in climate resilient farming and in ensuring food, nutrition and medicine to the rural and tribal communities across Kerala. It also explores the genetic diversity and factors contributing to genetic diversity of these traditional rice varieties. Further, the article explains the use values of the speciality rice varieties. The article goes on to elaborate the issues and challenges related to conservation of speciality rice varieties and proposes policy options to promote conservation of these valuable plant genetic resources.

Methodology

The present study relies upon both primary and secondary data. Field surveys, research studies, published and unpublished reports of government departments and other rand development institutions, are used for analysing the status of traditional rice varieties and conservation issues. Primary data is collected through key informant interviews with farmers, researchers and environmental activists interested in rice agro-biodiversity. Further, the paper draws heavily on the field experience of the authors about rice farming in Kerala.

Genetic diversity of rice landraces

Agro-ecological and climatic variations, differences in cultivation practices, traditional knowledge associated with farming, culinary preferences, traditional healing practices and cultural values are the major precursors for the existence of wide genetic diversity in traditional rice varieties of Kerala. The following section details the nature of influence of these factors on the genetic diversity of traditional rice varieties in Kerala.

Agro-ecology

Rice in Kerala is grown in varied ecological situations. High rainfall coupled with undulating topography, interlinked rivers and their deltaic formation, backwater systems and saline water inundation from the Arabian Sea, have created a variety of heterogeneous environment for paddy to grow and survive. From centuries, farmers have selected, with their knowledge and experience, a diversity of cultivars suitable for all conceivable ecosystems[7]. These ecosystems extend from about 3 m below mean sea level (Kuttanad) to 1400 m above mean sea level (Munnar and Wayanad). These consist of varied ecological conditions such as *Modan* (purely rainfed uplands), *Palliyals*/*Myals* (single crop terraced uplands), double cropped uplands (both transplanted and semi-dry conditions), Kuttanad area (flooded conditions), *Kole* and *Pokkali* (saline soils), deep ill drained regions, *Onattukara* (sandy area), *Poonthal padam* (marshy conditions), laterite midlands and high altitude regions[8].

Varieties of crops are cultivated in a time span ranging 80 to 200 days in diverse agro-climatic conditions during all the seasons. The laterite midland ecosystem contributes to the major share of wetlands where rice is cultivated. Kuttanad and Palakkad, considered as rice bowls of Kerala, occupy 7% and 11% of the total rice area respectively, while the unique *Pokkali* rice system contributes to less than 1% (ref. 9).

Farmers over centuries have evolved a traditional rice culture, specific to each of the diverse ecology. This genetic stock consists of pure line selections of farmer varieties, wild relatives, primitive cultivars or landraces, natural hybrids between cultigens and wild relatives and other commercial types. These include landraces which are both photosensitive and photo-insensitive and are diverse in terms of agro-morphology, grain quality, grain colour and shape, kernel colour, kernel size and shape. Several of these varieties have been exclusively nurtured in order to meet the utilitarian concerns of the people.

Environmental heterogeneity, resistance to pests and pathogens, climate risk management, culture and ritual preferences, and dietary preferences are the five concerns of farmers that account for intra-species diversity[10]. Such concerns vary among farmers and are influenced by factors like wealth, land and labour resource endowment, and policies. Nature and type of land, culture, taste preferences, local value systems, and social organization among farming communities influence rice landrace conservation decisions[11,12].

Traditional ecological knowledge and practices

Traditional ecological knowledge plays a vital role in the management of agro-ecosystems and conservation of crop varietal diversity. Alcorn[13] argued that many landraces and their wild relatives can be preserved only in traditionally maintained agro-ecosystems. Traditional farming system represents accumulated experiences of interaction with the environment and resources by farmers without access to modern agricultural extension services, external inputs, credit and market[14]. On the basis of soil texture, mud content, percolation and retention of water, fertility of land and location of the field, the *Kurichiya* farmers classified rice fields into three distinct types[12]. Classification of *Vayals* helped in the efficient utilization of natural and human resources and thereby evolved management practices in favour of diverse landraces suitable for the land types they hold[12]. These diverse ecological situations and management practices promoted a genetic diversity that is most suitable for exploiting the highly varied micro-environment.

Agro-morphological characteristics

Farmers usually define local landraces in terms of agro-morphological characteristics[15]. Agro-morphological characteristics influence farmers' choice over a variety. Early/late flowering, short, medium or long growing cycles, plant height, tillering potential, aroma, colour, shape, yield and taste are the important agro-morphological characteristics preferred by the farmers. Livestock rearing households prefer cultivating rice varieties that grow tall and provide more biomass to cater the fodder needs. Preference for short, medium and long growing cycle is linked with the availability of family labour for rice production and to ensure rice availability throughout the year.

Agronomic features

Traditional cropping systems are genetically diverse, containing numerous varieties of domesticated crop species as well as their wild relatives[16]. Major agronomic features that influence the choice of variety are resistance to disease and pests and tolerance to flood and drought[17]. Traditional varieties are composed of different traits and are better adapted to different conditions or combination of conditions than the others. Within Kerala, the presence of different agro-climatic zones and intentional or natural selection of crop varieties in such agro-climatic zones have resulted in a large number of traditional varieties suited to each region. These traditional varieties are resistant to biotic and abiotic stresses, can survive under extreme agro-edaphic situations, and are tolerant to salinity and acidity[17]. Traditional varieties in Kerala exhibit one or multiple traits that help the farmers to ensure yield against unfavourable environment. For example, a variety called *Veliyan* is believed to have the potential to tolerate abiotic stress like drought and flood conditions and biotic stress like pests and disease. Table 1 lists the traditional rice varieties that are tolerant to flood and drought, and are resistant to pest and diseases.

In the marginal environment, farmers are keen to cultivate varieties that exhibit multiple traits. Similarly, farmers have conserved and cultivated traditional rice varieties that provide good yield even in harsh environment when compared to modern varieties. These varieties are high on straw yield too, thereby increasing the profitability of traditional rice varieties. Table 2 lists high yielding traditional rice varieties cultivated across the state.

Culinary preferences

Rice is cultivated mainly for meeting household food and nutrition requirements. Traditional rice varieties provide more energy in comparison to modern varieties on a per unit basis and the consumption of such varieties helps in meeting high energy requirements for carrying out physical activities[17]. In Kerala, people consume rice thrice or more in a day. They prepare different dishes made out of rice and consume in combinations with or without leafy greens, tubers, fish, meat, pulses, fruits, etc. Cooking quality, palatability, grain colour, aroma, calorie content, satiety are the main attributes that influence the choice of a traditional cultivar for consumption[17]. For example, the *Kurichiya* tribes in Wayanad prefer to consume a variety *Veliyan*, which according to them, give satiety and provide energy to carry out physical hard work. Specific varieties are cultivated to suit specific consumption requirements. For instance, rice varieties like *Kayama*, *Uruni Kayama* and *Thonnuran Thondi* which have white kernel are preferred for making breakfast, red kernel varieties like *Chettu Veliyan*, *Mara Thondi*, *Chenthadi* and *Chomala* are preferred for lunch. Varieties like *Pal Veliyan* and *Pal Thondi* are preferred for preparing rice gruel. Aromatic rice varieties like *Gandhakasala* and *Jeerakasala* are served to distinguished guests. Culinary importance of traditional rice varieties being cultivated in Wayanad district are summarized in Table 3.

Traditional cultivation practices

Punamkrishi (upland farming): *Punamkrishi* or upland rainfed rice cultivation was mainly practised in Malabar region in the past. There are specific varieties suitable for *Punamkrishi*. Most of the *Punam* cultivars are extinct or is being maintained by one or two farmers. A restricted form of *Punam* cultivation still exists in the name of 'karakrishi' or upland cultivation in some parts of Kannur and Kasrgode districts. Important *Punam* cultivars are listed in Table 4.

Podividha

Podividha or dry sowing is practised when there is a prediction of delay in rain or lack of enough rain for taking up rice cultivation under conventional methods. Under this circumstance, farmers select drought-resistant varieties and sow it in dry conditions of the field. Moisture present in the soil helps to germinate the seed. Farmers feel that occasional rain or moisture available in soil helps plant growth. Dry sowing is practised in various parts of the state including Wayanad, Kozhikode, Kannur and Malappuram. A variety called *Kalladiyaran* is mainly used for dry sowing in Wayanad.

Valicha

Valicha is a cultivation method adopted by tribal farmers in Wayanad. They use long duration varieties for *Valicha* method of cultivation. Under this practice, seeds are

Table 1. Major rice varieties that are tolerant to drought and flood, and resistant to pest and disease

Flood tolerant varieties	Drought tolerant varieties	Pest and diseases resistant varieties
Thulunadan	*Kalladiyaryan*	*Mundon*
Karingon	*Veliyan*	*Karindon*
Vayilathure	*Thondi*	*Orpanndi* (*Karuthapandi*)
Orppandi	*Mundon*	*Virippe*
Swarnapandi	*Kallele*	*Pokkali*
Pokkali	*Eravapandi*	*Kuruka*
Kuruka	*Karuthapandi*	*Odachan*
Kattamodan	*Pookulathari*	*Mullanchanna*
Kodiyan	*Kochuvithu*	*Poothadikayama*
Aryan	*Vellathan*	*Chomala*
Kozhivalan	*Vykatharayan*	*Thekkancheera*
Karimala	*Karavala*	*Thekkan*
Orkazhama	*Champavu*	*Thondi*
Kuttadan	*Parapilarppan*	*Mangalapuram Puncha*
Thavalakannan	*Kettamodan*	*Edavaka*
Karuthaallikkannan	*Karuthamodan*	*Odacha*
Adukkan	*Parambuvattan*	*Veliyan*
Veliyan	*Karnellu*	*Adukkan*
Thulunadan	*Chuvannamodan*	*Chenthadi*
Chenthadi	*Vykatharyan*	*Kodiyan*

Source: (1) Primary data; (2) Compiled from unpublished reports of Krishi Bhavans in various places in Kerala.

Table 2. High yielding traditional rice varieties of Kerala

Muthucheri	*Cheruvellari*
Valiyaththaravila	*Vrishchikapadi*
Kallan	*Arikalari*
Thulunadan	*Rajakazhama*
Kuthippan	*Karutha Aryan*
Chambakannan	*Aryan*
Padannavella	*Chegazhama*
Kappachembavu	*Kumbalan*
Cherumalliyarian	*Vethandan*
Malayarian	*Chamodan*
Vykatharyan	*Karunda*
Kochuvithu	*Onattan*
Cherady	*Kammalevithu*
Rajameni	*Malaporon*
Amakodi	*Kazhugumputhada*
Cheerachemban	*Kothapalarikayama*
Karutheyani	*Karumkayama*
Mundobald	*Veluthirikayama*

Source: (1) Primary data; (2) Compiled from unpublished reports from different Krishi Bhavans in Kerala.

directly sown, instead of normal transplanting method. When the crop is about 5–6 months old, cattle are left to graze on the field and then a traditional field levelling implement, *Pakka*, driven by cattle is run on the field. The rice plants along with all the weeds are trampled into mud. While weeds get decayed, the trampled rice plants regenerate because of profuse tillering capability of long duration traditional rice varieties cultivated under this method. Each node produces at least 5–6 tillers to re-establish a good crop stand. This method is considered more profitable, as they never require weeding. Availability of quality green fodder makes it more attractable to the tribal farmers. They cultivate varieties like *Veliyan*, *Thondi* and *Chomala* under *Valicha* method.

Pokkali/Kaippad cultivation

Long coastal belt and other topographic features of Kerala make it susceptible for intrusion of saline water. It is estimated that about 26,400 ha of rice fields across Alappuzha, Ernakulam and Kannur districts face perennial saltwater intrusion. The farmers across these regions developed unique cultivation practices with the help of saline resistant traditional rice varieties. The cultivation practices followed in southern parts of Kerala is called *Pokkali* and in the northern parts it is known as *Kaippad*. Saline-resistant varieties and practices are useful in addressing anticipated impacts of climate change in agriculture. Sea level rise is an anticipated consequence of climate change. Rise in sea level can increase sea water intrusion in more areas in the coastal belt, and can create setbacks in agriculture, which can be countered through the use of these varieties. Table 5 lists the important saline-resistant varieties of Kerala.

Ethnic healthcare practices

The communities involved in ethnic healthcare have been conserving medicinal rice varieties over generations. *Susrutha* and other Ayurvedic literature testify the medicinal and curative properties of different types of rice grown in India. According to *Susrutha*, rice can be broadly

Table 3. Traditional rice varieties preferred by farmers in Wayanad, Kerala for consumption

Name of the variety	Culinary importance
Veliyan	Noon-meal preparation, provides energy to carry out physical tasks; brewing liquor
Palveliyan	Good for preparing rice gruel and breakfast dishes
Cheetu Velyan	Noon-meal preparation, provides energy to carry out physical tasks
Thondi	Noon-meal preparation
Palthondi	Preparing rice gruel and breakfast dishes
Marathondi	Noon-meal
Chennel thondi	Noon-meal
Tonnuranthondi	Noon-meal
Chennellu	Medicinal, treatment of diarrhoea
Kalladiyaryan	Noon-meal
Chomala	Breakfast dishes
Edavaka	Taste
Gandhakasala	Served to distinguished guests; breakfast dishes
Jeerakasala	Breakfast dishes
Poothadikayama	Breakfast dishes and beaten rice
Chenthadi	Noon-meal
Mundon	Noon-meal
Mullanchanna	Consumed during special occasions
Mullanpuncha	Breakfast dishes
Urunikayama	Sweet dishes
Adukkan	Tasty, for preparing noon-meal

Source: Field survey.

Table 4. Important *Punam* cultivars in Malabar region

Chennel	*Karuthachoman*
Karuthanvara	*Kallarikoyala*
Karakkozhivalan	*Chingappadan*
Keeripallan	*Keeriputhada*
Vellakoyala/ Veluthon	*Mundodan*
Palkaima	*Chembery*
Veluthadichal	*Veluthanavara*
Ambaladan	*Mullankoyala*
Chuvvannachoman	*Karuthan*

Source: Adapted from ref. 28.

Table 5. Saline resistant varieties of Kerala

Pallippuram Pokkali	*Cheruvirippu*
Kuzhippali Pokkali	*Chettivirippu*
Vettikkal Pokkali	*Karuka*
Chovvaryan	*Anakondan*
Eravapandi	*Orpandy*
Orkayama	*Oorumundakan*
Kuthiru	*Kandurkutty*

Source: Primary data.

classified into *saali* and *vreehi*. *Saali* rice varieties are characterized by red husk, white kernels, and are mostly grown during the winter season. *Vreehi* rice varieties have different husk colours with red kernels and are grown during the rainy season.

Medicinal rice varieties of Kerala like *Chennellu*, *Chembavu*, *Erumakkari*, *Kalamappari*, *Kunjinellu*, *Narikari*, *Neduvali*, *Poovali*, *Janavala*, *Varakan* and *Velval*, are believed to be *Saali* varieties. Varieties like *Navara*, *Karimkuruva*, *Perunellu*, *Uliamkathi*, *Valanellu*, *Chitteni*, *Modan* and *Aarunellu*, are the important *vreehi* varieties in Kerala[18]. *Anoori* is a rice variety used by the *Kani* tribes for the treatment of small pox[19]. *Kunjinellu* is indigenous to North Kerala. *Erumakkari* and *Karuthachembavu* are indigenous to South Kerala[20]. Table 6 shows the indigenous medicinal rice varieties cultivated in different parts of Kerala.

Njavara is the most popular medicinal rice variety in Kerala. Most of the medicinal rice varieties are confined to certain districts and their surroundings only except *Njavara*. Because of its popularity and wide range of uses, *Njavara* has been cultivated across the state.

Culture and tradition

Specific rice varieties hold significant cultural and traditional value for many of the rural and tribal communities across Kerala. Among these, aromatic rice varieties are the most important. The most popular aromatic rice varieties in Kerala are *Gandhakasala* and *Jeerakasala.* Dishes made from these varieties are served to distinguished guests as a mark of respect and love. Most of the aromatic rice varieties are found in northern Kerala. The tribal farmers of Wayanad attribute a lot of value to these varieties as they consider it to be handed over to them by their forefathers. They believe it to be their responsibility to conserve and hand over the same to posterity. They consider, cultivation of traditional rice varieties is an integral part of their culture and traditions. Table 7 depicts the aromatic rice varieties being cultivated in Kerala.

Table 6. Indigenous medicinal rice varieties of Kerala

Name	Medicinal uses
Erumakkari	Treatment of cough and respiratory disorders
Jaatthisughi	Anti-dysenteric properties Suggested for lactating mothers to rejuvenate health
Jeerakachembav	Anti-dysenteric properties Control vomiting and stomach ache
Anoori	Treatment of small pox
Karuthachembav	To treat nausea, vomiting and stomach ache
Kolaran	Recovering health of patients and lactating mother
Kunjinellu	Patients recovering from jaundice
Nallachennellu	Treatment of diarrhoea and vomiting
Naron	Rejuvenating health. Used as a substitute of *navara* in Ayurvedic treatment
Navara	Widely used for arthritis, muscle degeneration, burn, dyspepsia, bilious fever, and diabetes. Regular consumption of this variety helps in the growth of muscles, maintains youthfulness and longevity
Vatton	Rejuvenating health
Kavunginputhala	Recommended for diabetic patients
Pokkali	Treatment of diarrhoea and vomiting

Sources: Primary data.

Table 7. Aromatic rice varieties of Kerala

Gandhakasala	*Poothadikayama*
Jeerakasala	*Valumbala*
Kothampalarikayama	*Chomala*
Mullanchanna	*Kunjinellu*
Kazhama	*Neycheera*
Urunikazama	*Pookkulathari*

Source: Primary data.

Value of traditional rice varieties

Genetic resources are treated as public goods, having both direct and indirect use values. People consume various products derived from genetic resources. Crop genetic resources provide food, fuel, fodder, medicine and industrial raw materials. They are also instrumental in ensuring the flow of ecosystem services. The economic/use value of crop genetic resources summarized in Table 8.

Traditional rice varieties are valuable to local communities as they provide food, fuel, fodder and medicine. Similarly, the traditional rice agro-ecosystems ensure flow of ecosystem services, which are essential for the welfare of the people in rural areas. Rice fields play a vital role in hydrological functions and it serves as water reservoir. Traditional rice agro-ecosystems ensure availability of diverse edible flora and fauna and thus supplement the nutritional requirement of low income people in rural areas. Narayanan *et al.*[21] documented 22 edible plant species from paddy fields. The impressive faunal diversity includes edible crabs, snails, frogs, fish and birds. Rice fields also provide services like maintenance of fertility and productivity, ensuring hydrological cycles, and water purifications[22].

Traditional varieties have unique traits that help better adaption to different harsh conditions or combination of conditions than modern varieties. They provide a consistent yield in the face of pests, diseases, competition and unfavourable environment[23] and hence are risk reducing in nature. Farmers across Kerala had nurtured a diversity of rice landraces that can meet heterogeneous environmental conditions including prolonged droughts and floods, salinity, acidic soils, etc. Brush[24] found that farmers prefer local crop varieties as they perform better than other varieties in marginal environment. Traditional rice varieties are valuable plant genetic resources in the context of climate change and are essential for developing climate resilient agriculture.

Future food security, in the context of climate change, depends on development of climate resilient varieties. Genetic diversity in crop species is a pre-requisite for breeding a variety with desirable traits. Advent of biotechnology and genetic engineering has increased the demand for genetic resources. The rich diversity in rice landraces increases our potential for future breeding process and hence developing varieties with desired traits. Diversity in landraces is good for future food security and they should be conserved for exploring future improvement of crops and/or for facing new production constraints.

Traditional rice varieties have a value in the culture and rituals of people in Kerala and essential during auspicious occasions. Certain rice varieties are preferred as offerings to God. For example, *thambaikanji* meaning the food of gods is the local name given to rice gruel made out of an aromatic rice variety called *Gandhakasala*.

Farmers are concerned about the direct use value of plant genetic resources. If lucrative substitutes are available, they either replace genetic resources with modern varieties or opt alternate land uses, which may affect the diversity at farm level. The option value may be an

Table 8. Economic value of crop genetic resources

Value	Description
Direct use values	Production of food, medicine, fibre, fuel, fodder and raw materials Source of agricultural inputs • Genes for plant and animal breeding • Microorganism useful for agricultural production
Indirect use values	Role genetic resources play in the larger ecosystem
Option values	Value of maintaining the option for any direct or indirect use in the future
Quasi-option values	Value of information held in conserved resources
Bequest values	Value of passing resources on to future generations
Existence value	Value derived from the existence of a resource, apart from any use

Source: Adapted from Barbier *et al.*[22].

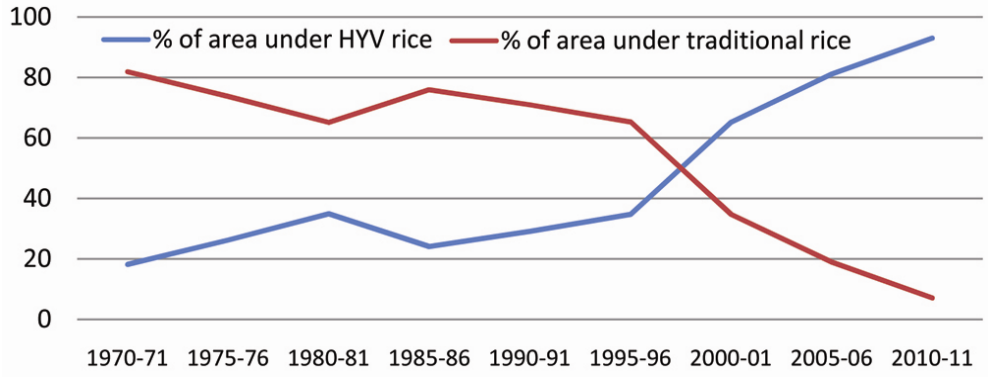

Figure 1. Area under HYV and traditional rice varieties in Kerala from 1970–71 to 2010–11 (Source: GoK, Economic Review various years; Panchayath Level Statistics 2006 (ref. 29) and 2011 (ref. 29) for various districts.)

important motivation for their conservation. But the private return for the conservation of genetic resources for future use is relatively lower to farmers[25]. Traditional rice varieties have economic value even if they are not currently being used. By conserving crop genetic resources, we are retaining the options to use them in the future, as they have the potential to become important for agricultural, pharmaceutical, ecological, or industrial applications. Even if they are never used, diverse genetic resources may be valued by some people simply for their existence, or as a bequest left intact for future generations[26].

Status of traditional rice varieties in Kerala

The area under traditional rice varieties in Kerala has been showing a declining trend since mid-1970s (Figure 1). Spread of high yielding variety (HYV) rice in Kerala was just 15.56% during 1969–70, which increased to 93.55% in 2011–12.

There is no reliable information about the exact number of traditional rice varieties being cultivated in Kerala. Leena Kumari[4] stated that there were about 2000 traditional rice varieties, predominantly cultivated in Kerala. In 1976, the Kerala Agricultural University collected over 1000 traditional rice varieties from different parts of the state. A study by the M.S. Swaminathan Research Foundation[30] shows that there were more than 75 traditional rice varieties cultivated in Wayanad before the advent of commercial agriculture.

On the other hand, the coverage of HYV rice was less than half the total rice area in the state until 1995–96. There was a quantum jump in the area under HYV after 1995–96. The percentage of area under HYV rice doubled in five years during 1995–96. Area under traditional varieties shows a steady decline since 1970–71 both in actual and relative terms.

In actual terms, the gross area under HYV rice was 2.3 lakh ha in 1975–76, which declined to 1.98 lakh ha in 2010–11. However, the coverage of HYV increased from 26.27% to 92.98% during the same period. This indicates the overall sharp decline in gross area under rice cultivation as well as displacement of traditional rice varieties from existing areas. District-wise comparison of area under HYVs and traditional rice varieties gave an interesting picture about the spread of traditional and high yielding rice varieties across the state. Palakkad, Alappuzha and Thrissur districts possess first three positions respectively in terms of area under rice cultivation. All the three together contribute 68% of gross cropped area

under rice in the state. However, in comparison, the coverage of HYVs in these districts is 96.1%, 98.9% and 95.3% respectively.

Palakkad leads in terms of area of cultivation (3453 ha) of traditional rice varieties in 2010–11. This is followed by Malappuram (2387 ha) and Kozhikode (2163 ha). Even though the area under rice cultivation is comparatively less, farmers in Kozhikode district prefer to cultivate traditional rice varieties. In Kozhikode, the spread of HYVs is restricted to just 840 ha, that is around 27.9% of the total rice area in the district. The area under HYVs in total rice area is high in Pathanamthitta (99.7%), Kottayam (99.6%), Alappuzha (98.9%) and Thiruvananthapuram (97.1%) respectively. Traditional rice varieties occupy 28.2% of the total rice area in Kollam district.

Altogether, seven districts in the northern region of Kerala contribute 86% of the total area under traditional rice varieties in the state. Of these, Palakkad, Malappuram and Kozhikode account for more than 53% of the traditional rice variety area. Figure 2 explains the district wise contribution in total traditional rice area of the state.

Decline of area under traditional rice cultivation indicates the vulnerable status of these genetic resources in the state. Cultivation of traditional rice varieties is confined to northern parts of Kerala.

Conservation issues

Conservation of genetic resources is a challenge faced across the world. Agriculture has witnessed tremendous technological advancement. Technological changes and mechanization in agriculture are disposed favourably towards modern crop varieties. Further, the over emphasis on productivity to address food insecurity, in current agricultural policies, led to an increased reliance on modern high yielding varieties. The investment in agricultural infrastructure and prevailing subsidy mechanisms are also skewed in favour of high yielding varieties. The increasing market orientation of agriculture has prompted farmers to prioritize productivity over sustainability, prompting a shift from the cultivation of traditional rice variety.

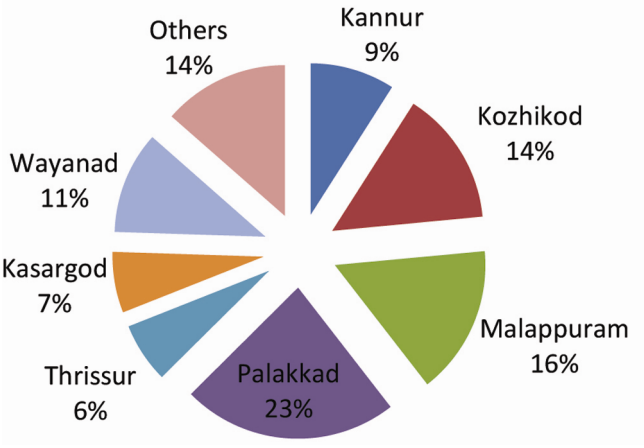

Figure 2. District wise distribution of area under traditional rice varieties in Kerala, 2010–11. (Source: GoK, Panchayath Level Statistics 2011 for various districts[30].)

Further, the lack of premium market for traditional varieties makes their cultivation less economical compared to high yielding modern rice varieties. Thus, the advent of modern agriculture and policy thrust on productivity has contributed to displacement of rice crop diversity leading to severe erosion of landraces. Similarly, lack of institutional mechanism to promote the cultivation of traditional rice varieties deteriorates the prospects of conservation.

An immediate outcome of this is reduction in *in-situ* conservation efforts in traditional rice varieties. Conservation of crop genetic diversity takes place at three levels: (i) in farmers' fields, (ii) in ecosystems that contain wild relatives of cultivated varieties, and (iii) in national or international germplasm collections/gene banks. The first two conservation methods are referred to as *in-situ* conservation, where genetic resources are conserved in their natural habitats. *Ex situ* conservation, on the other hand, takes out the genetic resources from their original habitats or environment and is conserved either in botanical gardens/germplasm garden or in gene banks. Cryogenic preservation through gene banks helps to store large amounts of genetic materials for longer periods. The cost of *ex situ* conservation is usually borne by authorities interested or designated for conservation. Similarly, the high security storage of genetic resources in gene banks can overcome natural disasters.

The *in-situ* conservation of germplasm is a more sustainable conservation approach compared to *ex situ* conservation. The proponents of *in-situ* conservation approach criticize *ex situ* conservation on many grounds. Regeneration of preserved genetic resources is expensive and time-consuming. Since *in situ* conservation of crop genetic resources takes place in farmers' field or original habitats, species continue to evolve with changing environmental conditions. Similarly, *in-situ* conservation can provide valuable knowledge about species development and evolutionary process. The disadvantage is that to conserve genetic diversity *in situ*, farmers have to forgo the opportunity to grow a higher yielding variety.

Henemann[25] pointed out lower private returns compared to social returns in *in-situ* conservation of biodiversity as a main reason for the low adoption of conservation by farmers. In Kerala, at present, the cultivation of traditional rice varieties is restricted to geographical pockets, in tribal hamlets and among farmers who value the importance of these genetic resources. To encourage *in-situ* conservation of existing land races, the state needs to pitch in with favourable policy environment aimed at incentivizing conservation efforts by farmers, protection

of their rights over resources, and provision of infrastructure and market support. One of the options would be to effectively utilize the provisions under 'The Protection of Plant Varieties and Farmers' Rights' Act, implemented by the Government of India, to encourage and incentivize conservation efforts of farmers who manage and preserve valuable plant genetic resources at their personal cost. Further, the existing legislation in the state of Kerala, namely, the Kerala Conservation of Paddy Land and Wetland Act, 2008, needs to be strengthened to include protection of traditional rice cultivars. The current legislation applies to paddy lands in general and does not have a special provision for conservation of traditional rice varieties. Moreover, the continuous decline in area under rice cultivation in the state is an evidence of the ineffectiveness of the legislation in even arresting conversion of paddy lands.

Conclusion

Kerala has a rich diversity of traditional rice varieties which have been evolved to suit various ecological conditions. An analysis of status of traditional rice varieties in the cropping pattern of Kerala reveals that traditional rice varieties in Kerala have clearly lost out to modern high yielding varieties. There has been a steady declining trend in their acreage over the decades and confinement of these varieties in certain geographical pockets.

The emphasis on productivity without due consideration to sustainability, in the national and state level agricultural policies has been a major trigger in the indiscriminate spread of modern varieties across the agro-ecosystems in Kerala. In the absence of favourable policy environment and lack of institutional mechanisms to promote traditional rice varieties, farmers find it less rewarding to maintain the diverse mixture of landraces handed over by their ancestors.

Nevertheless, climate change and associated risks in agriculture has renewed the interest in conservation of these traditional varieties. Traditional rice varieties have the potential to adapt to climate change and are best suited for climate resilient agriculture providing a rich source of genetic material for anticipatory research to combat the impact of climate change on agriculture and food security. Given the huge economic and use potential of traditional rice genetic resources, there is a pressing need for a paradigm policy shift in favour of protecting and conserving land races.

Challenges in promoting traditional rice varieties are its inherent low productivity and absence of an enabling policy environment. Concurrent research focussing on productivity enhancement of traditional rice varieties needs to be carried out to address the issue of low productivity. On the policy front, Kerala recognizes the ecological significance of rice ecosystems and has in place a regulatory framework for preventing the conversion of rice fields. However, there is no state level policy aimed at conserving traditional crop genetic resources. A regulatory framework with special emphasis on traditional varieties coupled with positive market interventions and consumer awareness on the ecological, nutritional and medicinal benefits of traditional rice varieties can go a long way in conserving, promoting and ensuring premium open market price for these varieties. Further, the state needs to recognize the efforts of the farmers who conserve these traditional varieties and incentivize their conservation efforts through provision of ecological incentives. These ecological incentives will help in creating a market for the positive externalities provided by conservers of these speciality (traditional) rice varieties.

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