Farming System in Jeypore Tract of Orissa, India

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Abstract

The Jeypore tract of Orissa, India is famous for the genetic diversity of Asian cultivated rice and has been considered the center of origin of aus *ecotype. The landraces or traditional varieties growing here are thought to harbor dominant genes for biotic and abiotic stresses, aroma, and palatability and hold promise for their utilization in future plant breeding and biotechnology programs. The tribal farm families inhabiting this area have been responsible for the domestication and conservation of rice genetic resources for several generations. Traditional cultivation practices suitable for diverse agro-ecological zones are still carried out by the tribal communities, proving their indigenous technical knowledge in rice farming and antiquity of rice in the region. These practices, which are of great value for sustainable agriculture and food and nutrition security, have not been largely recognized for sharing of benefits or rewards accruing to the community for conserving these landraces. The vast rice genetic resources would help to meet the future necessities of the farmers. Also, the local genotypes will adapt to the ever-changing environment.*

The term 'farming' covers a wide spectrum of agricultural practices. At one end of the spectrum is the subsistence farmer, who farms a small area with limited resource inputs, and produces only enough food to meet the needs of his/her family. At the other end is the commercial intensive agriculturist, who has large fields and/or a large number of animals with large resource inputs (pesticides, fertilizers, etc.) and a high level of mechanization. These farmers generally attempt to maximize financial income from grain, produce, or livestock.

The twentieth century saw massive changes in agricultural practices with the beginning of the green revolution, particularly in the application of chemical fertilizers, insecticides, and pesticides, increasing agricultural products, and nutritional needs of farm animals, with varying successes throughout the world. One amongst the other recent changes in agriculture includes genetic engineering which has yielded crops that have capabilities beyond those of naturally occurring plants, such as higher yields and disease resistance. The packing,

processing, and marketing of agricultural products are closely related activities and have also been influenced by science.

In modern period, the word 'agriculture' covers all activities essential to produce food/feed/fiber, including all techniques for raising and 'processing' livestock. The history of agriculture is a major element of human history, as agricultural progress has brought a worldwide socioeconomic change, including wealth-building rarely seen in hunter-gatherer cultures. Farmers became capable of producing food beyond the needs of their own families with the help of modern agricultural practices and started commercializing the food crops. But again with the increasing consumer awareness of soil conservation and nutrient management, the community-supported organic farming has taken a lead in agriculture. In this context, the undivided Koraput district popularly known as Jeypore tract (in Orissa, India) in rice literature deserves special mention as this area has been a confluence of primitive tribes who have been preserving their culture and conserving the traditional crops and their wild relatives for thousands of years (Sharma *et al.*, 1998). The undivided Koraput district, which presently comprises four districts namely Koraput, Nawarangpur, Rayagada, and Malkanagiri, is located in the northern part of the Eastern Ghats and is home to a vast tribal population which belongs to Proto-Australoid ethnic stock and speaks the Munda language of the Austro-Asiatic ethno-linguistic group (Government of Orissa, 2004).

Twenty-nine different tribes reside in this region and constitute about 55% of the total population (Government of Orissa, 2004). Nine of them are dominant tribes, of which three are primitive tribes. The dominant tribes are Bhottada, Gond, Paroja, Bhumia, Gadaba, Kandha, Langia Soura, Bondo, and Koya (Fig. 1) (Mohanti *et al.*, 2006). The noted primitive tribal groups among them are Bondo, Langia Soura, and Gadaba (Behura and Mohanti, 2006). Rice researchers have established this area as a center of genetic diversity and origin of rice (Fig. 2) (Ramiah and Ghose, 1951; Ramiah, 1953; Govindaswami and Krishnamurty, 1958, 1959; Oka and Chang, 1962; Govindaswami *et al.*, 1966; Sharma *et al.*, 2000), and the tribal people residing in this region have played a major role in the domestication of rice, its cultivation, conservation, and enhancement.

Distribution of tribes

The Eastern Ghats in Orissa is broadly divided into three physical sections: the Northern Section, the Central Section, and the Rayagada Section. This paper refers mainly to the Rayagada Section of the Eastern Ghats where the Jeypore tract is located.

The Khonds and the Souras are the tribal groups predominantly found in the Rayagada Section. This section is also inhabited by the primitive tribes Langia Soura and the Souras of Thumba area. This is also the area where the Bondo and Paroja tribes live. The Bondo highlanders are considered to be very primitive and most indigenous. Based on elevation, the Rayagada Section is further divided into

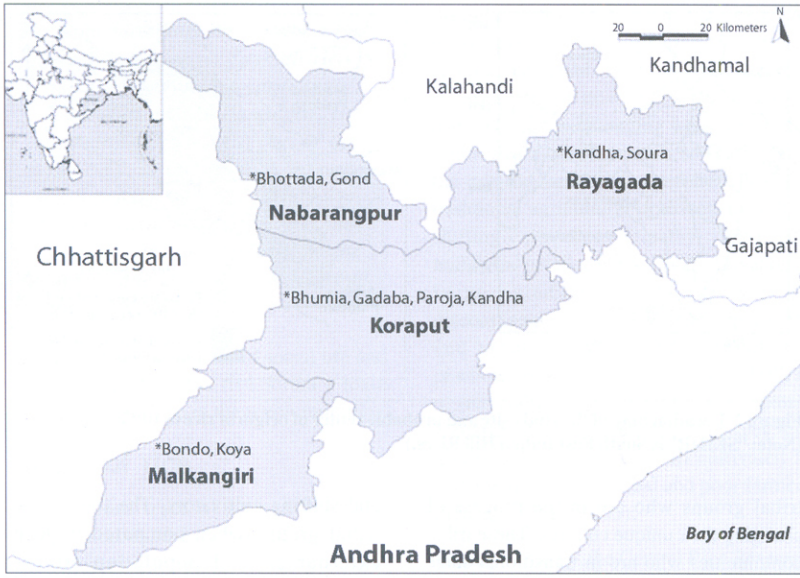

Figure 1. Distribution of dominant tribes (*) in Jeypore tract of Orissa, India.

three plateaus. The highest elevation (3000 ft) is inhabited by 33 tribal communities of whom the Khond, the Paroja, and the Gadaba are more predominant. In the plateau at 2000 ft, 40 tribal communities live, of whom the Bhottada is the major tribe. The lowest elevation (1000 ft) is inhabited by many tribal communities, of whom the Koya and the Bhunjia form the majority (Patnaik, 2005).

The tribes are distributed in varying concentrations at different heights of the hilly tract. The three primitive tribes are distributed in the 3000 ft high plateau and have been of great attraction to the ethnographers and anthropologists.

Socioeconomic condition of the tribes

The socio-cultural characteristics of the different tribes found in Jeypore tract vary and are geographically distinct with unique cultures, traditions, and practices. Some tribes have changed their socio-cultural and value system based on displacement and interaction with other cultures. The tribes are at various stages of socioeconomic development. On one hand there are tribal groups which lead a relatively isolated and primitive mode of life, while on the other hand there are groups which are indistinguishable from the general agricultural communities. There are also

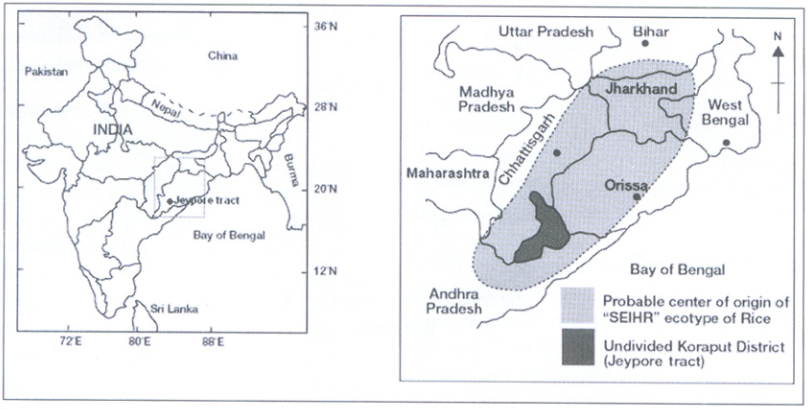

Figure 2. Location map of the study site and probable center of origin of rice in India. (Note: "SEIHR" is South East Indian Hill Rices.)

tribal groups who are in the process of changing their unique cultures. These tribal communities who are in transitional stage have continued to retain some of their own cultural traits while absorbing some of the characteristics from their neighboring non-tribal communities. The former group comprises earlier stages of cultural evolution, such as hunters, food gatherers, and shifting cultivators. The transformed tribal groups when compared with the external general population attain a socioeconomically backward status. Settled agricultural economy can be considered as the watershed for distinguishing the communities belonging to the former group from the communities belonging to the latter group (Patnaik, 2005). In the gradation of economic activities, of the primitive groups, hunting and food gathering activities are at the lowest stage of technology, and shifting cultivation forms the highest stage of technology. Again shifting cultivation itself is a gradation from hunting and food gathering to that of settled agriculture. The communities who carry out pre-agricultural economic activities may be called primitive groups (Behura and Mohanti, 2006). Here, Bondo, Langia Soura, and Gadaba depend on shifting cultivation for their sustenance and follow patterns of settled agricultural

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communities with organized social life and village councils. Thus rice forms a main agricultural produce in these communities.

Origin of rice

The Jeypore tract of Orissa has been established as the center of origin of cultivated rice (*Oryza sativa*) by several rice researchers (Ramiah and Ghose, 1951; Ramiah, 1953; Govindaswami and Krishnamurty, 1958, 1959; Oka and Chang, 1962; Govindaswami *et al.*, 1966; Sharma *et al.*, 2000). This tract covers a contiguous geographical area including parts of northeastern Andhra Pradesh, eastern Madhya Pradesh, the whole of Orissa (except its coastal belt), southern Bihar and the hilly tracts of southwestern West Bengal with similar topography, cultural characteristic, and varietal diversity of rice. A large part of this area is inhabited by primitive tribes belonging basically to the Proto-Australoid ethnic stock, still patronizing the age-old landraces and following their traditional agricultural practices, including shifting cultivation (Tripathy, 1994). The traditional practice like shifting cultivation is being gradually reduced due to discouragement by the Forest Department and promotion of modern agricultural practices and high-yielding varieties (HYVs) of rice and other crops by the Agricultural Department. However, the landraces and traditional cultivars are still cultivated in interior areas by the tribal and poor farmers (Tripathy *et al.*, 2005).

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During 1955–59, the Central Rice Research Institute (CRRI), Cuttack collected 1,745 germplasm accessions of cultivated rice and 150 accessions of wild rice from Jeypore tract of Orissa under a project Jeypore Botanical Survey (Govindaswami and Krishnamurty, 1959). Among the collections, some perennial wild species (*O. rufipogon*), annual wild species (*O. nivara*), and natural hybrids (*Spontanea* rices) were dominant. Natural hybrids are still available in plenty in the cultivated fields as weeds. Resource poor and tribal people

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harvest the grains of these weeds from the cultivated fields for their own consumption. Processed wild rice is sold during festivals as *Titing chuda* and eaten on days of fasting (Tripathy, 1994; Sharma, 2005; Das, 2006).

Evolutionary process

The evolution of an annual wild species (*O. nivara*) from a perennial wild species (*O. rufipogon*) is a natural sequence of evolution. *Oryza nivara* has evolved from *O. rufipogon* through mutation and natural selection (Sharma, 1964; Chang, 1976). Domestication of *O. nivara* growing in small shallow ditches with synchronous flowering and bolder grains is easy as compared to *O. rufipogon* which grows in greater depths of water and has staggered flowering and small grains. Besides, the habitat of *O. rufipogon* is too swampy to have been habitable by early man. Morishima (1984) rightly points out that "the deltas of big rivers were not accessible for early people. Apparently, the hilly areas seem to have played an important role in making contact with rice." It is, therefore, highly probable that the people of the northeastern Deccan plateau of which Jeypore tract forms a part, domesticated the annual wild rice (*O. nivara*) and developed the primitive upland varieties (Tripathy, 1994).

The primitive cultivars or landraces growing in the uplands of the northeastern Deccan plateau show many primitive features such as black, brown, or light brown husk, red to light red kernel, opaque endosperm, presence of awns, etc. and are mostly photo-insensitive and early maturing. Tall plants, low tillering, weak culms, susceptibility to lodging, poor panicle features, and poor yield characterize these primitive cultivars. In fact, these primitive upland rice cultivars of eastern India represent a "genecological" group. The *aus* ecotype seems to have evolved from this basic ecotype and played a major role in the origin of cultivated rice in India (Tripathy, 1994).

The morphological and physiological variation available in *O. sativa* is far greater than that available in *O. nivara*. Chang (1985) has rightly remarked, "Cultivators' preferences and socio-religious traditions have added much morphological diversity to the cultivars: panicle size, panicle length, panicle density, grain size and shape, grain thickness, panicle rachis color, awn presence and length, sterile lemma color, hull color, seed coat color, amylose content and gelatinization characteristics of the starchy endosperm."

With its long history of cultivation and selection under diverse environments, rice acquired wide adaptability, enabling it to grow in a range of environments, from deep water to swamps, irrigated and wetland conditions, as well as on dry hill slopes. Probably far more than any other crop, rice can grow under diverse geographical, climatic, and cultural conditions (FAO, 2002).

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Tribes involved in domestication

The domestication of rice dates back to antiquity, although the precise place and time of its domestication may never be known. The hill areas were the ideal areas for habitation by Neolithic hunting-gathering man who domesticated plants including rice. It is believed that Souras, Gadabas, and Bondos improved the cultivation of wild rice gradually (Sahu, 1965; Senapati and Sahoo, 1966). The seeds of wild rice would have been selected initially. Environment and adoption might have played a greater role in domestication than genetics. The method of seed selection used by the primitive tribes is not known. But the practice of single earhead/panicle selection and multiplication might suggest that this was the procedure used by them and has been inherited by subsequent generations. The primitive farmers must have selected non-shedding grains and awnless varieties. Through repeated selection, the diversity of rice has been generated (Lenka, 2001). The details of cultivation practices in ancient times cannot be traced, but it can be inferred that in some areas, the shrub or the jungle was cut, burned, crudely leveled, and the seeds of crops were sown. In river valleys and deltas, the procedure would be slightly different, suggesting a more advanced agriculture (Lenka, 2001). The chronological sequence in rice cultivation is from broadcasting to transplanting. Land use pattern is from shifting cultivation to settled cultivation in unbunded permanent fields and then bunded fields. Rainfed lands were first used for rice cultivation, followed by irrigated lands (Chang, 1985). Upland to lowland is the evolutionary process, which is likely to have taken place in Jeypore tract (Tripathy, 1994; Sharma, 2005).

Among the collections, some perennial wild species (**O. rufipogon**)*, annual wild species* (**O. nivara**)*, and natural hybrids* (**Spontanea** *rices*) *were dominant. Natural hybrids are still available in plenty in the cultivated fields as weeds. Resource poor and tribal people harvest the grains of these weeds from the cultivated fields for their own consumption.*

The Soura and Gadaba tribes were the first rice cultivators, according to archaeological evidence as the 14 Carbon (C^{14}) dating of fossil grains and other evidences suggest (Sahu, 1965; Senapati and Sahoo, 1966; Lenka, 2001). The Souras made terraces in the valleys and hills for rice cultivation, extending up the hill slopes in most cases and in some, up to the hilltops, with 10 ft (3.3 m) high boulder walls. These terraces must have taken several centuries to build and to come up to the present state. Looking at the primitiveness of the Souras and their ancient cultivation practice, it is considered that the Soura hills might be the original home of rice (Sahu, 1965; Senapati and Sahoo, 1966). The Gadabas follow the *myda* system of rice cultivation in which two varieties of rice are grown together in the plateau regions. This shows the antiquity of rice cultivation in this region.

The Soura tribe

The Souras are one of the most primitive and ancient communities; occasional references of them are found in Hindu mythology and classics. They are widely found all over central India, comprising Bihar, Orissa, Madhya Pradesh, Maharashtra, and West Bengal. Soura villages are situated in the most inaccessible areas and in many cases lie hidden in forest-clad hills (Mohanty, 2004).

The economic life of the Souras rests on shifting cultivation, which is known as *bagada chas*, to a large extent and wet cultivation to some extent. Each and every family has a few patches of swiddens, either on the hill slopes or hilltops. A mixed crop of cereals, minor millets, and pulses are grown in the swiddens. This practice of growing mixed crops is dictated by their food habits and the ecological conditions. They use only a hoe in the swiddens. Rituals are followed for both the cultivation practices and animal sacrifices are made to satisfy the Gods.

The Souras are the best terraced-land cultivators. The upper terraces, which are dry, are used for cultivating *ragi* (*Eleusine coracana*; finger millet), black gram (*Vigna mungo*), and horsegram (*Dolichos uniflorus*). The terraced fields in which water flows throughout the year are exclusively meant for rice cultivation. Two varieties of rice are grown in the terraced field, an early-maturing and a late-maturing variety. The former is harvested in May/June while the latter is harvested in November/December (Mohanty, 2004).

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The principal food of the Souras is rice gruel or *ragi* gruel. Besides, they consume vegetables grown in kitchen gardens and fruits, roots, leaves, tubers, and honey collected from the forest. They go for occasional hunting and fishing. They relish non-vegetarian food more than the vegetarian diet (Government of Orissa, 2004).

The Bondo tribe

The Bondos are sparsely populated primitive tribes, living in the Jeypore tract since ancient times (Patnaik, 2005). They are quoted in the Ramayana (events c. 5000 BC) in which Ram spent 14 years in the forest. They are mainly agriculturists and their livelihood depends on food collecting, hunting, fishing, and animal husbandry and also wages earning. Bondos are expert and skilled cultivators but also practice shifting cultivation quite extensively. They cultivate in four types of lands: wetland (*jhola* – deep lowland and terraces in the valleys, irrigated by perennial springs), upland, hill slopes for shifting cultivation, and kitchen gardens. Except hill slopes for shifting cultivation, other lands are individually owned. Irrigated and terraced fields are used for paddy

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cultivation. Apart from rice which is the main crop, farmers also grow different varieties of cereals, millets, pulses, and oilseeds. Maize, tobacco, and vegetables are grown in the kitchen garden. They also engage in rearing of cows, bullocks, buffaloes, goats, pigs, sheep, and fowls (Government of Orissa, 2004).

The Gadaba tribe

The original home of the Gadabas was the north of the Vindhya Mountains and they derived their name from '*gada*', which means 'brook' or 'stream' in the local language. They may have migrated into the hills of Visakhapatnam district when driven from their native settlement (Government of Orissa, 2004). Agriculture is their principal source of livelihood. Shifting cultivation was extensively practiced formerly but has declined considerably. A mixed crop of millets, minor millets, and oilseeds is also grown in their swiddens. Different varieties of rice are grown in the lowermost portion of the hillocks where patches of plain land are available and irrigated by the uphill streams.

Anthropologically, the whole area, from the western coast of India to the eastern coast of south China and Vietnam, was inhabited in the pre-historic period by the Proto-Australoid people. The language spoken by these people has two main divisions namely, Munda or Koi and Mon-Khmer. The Munda group of languages is spoken in India by the tribals of Bihar and Orissa, and the Mon-Khmer group of languages by the people of southern Burma (Myanmar) and Cambodia (Gray, 1939). These people were not in the same stage of economic development; many of them were still in the food-gathering economy, not knowing the use of metal except a few who practiced shifting cultivation (or *podu*) and hoe cultivation (Government of Orissa, 2004). It is, therefore, probable that the people associated with the domestication of rice were Proto-Australoids (Hamada, 1949).

Language

According to Kumar (1988), the words for rice and rice products are maximum in the tribal languages of eastern India where these people abound. Abundant occurrence of wild rice in that area and the long tradition of rice cultivation suggest that plants may be indigenous to that place. The tribes of Koraput belong to the Munda ethno-linguistic group. The specific term for rice or related to rice is limited in this language family. Primitive tribes like the Soura, Paroja, and Bondo have different words in their dialect whose meaning is liquor. There are probably more such terms, which have not been studied in depth. Zide and Zide (1973) suggest that the bimorphemic form composed of *run* and *kug* denotes husked, uncooked rice among the tribes of Jeypore tract. All these taken together prove the antiquity of rice among these tribal people. The Jeypore tract of Orissa inhabited by these tribal people has been considered to be the center of origin and diversity of cultivated rice (Ramiah and Ghose, 1951;

Ramiah, 1953; Govindaswami and Krishnamurty, 1958, 1959; Oka and Chang, 1962; Govindaswami *et al.*, 1966; Sharma *et. al.*, 2000).

Dependence of tribes on forest and food gathering

Jeypore tract is rich in forest wealth. The forests consist of many economically useful plants including timber-yielding species and plants of medicinal importance. Tribes depend solely on the adjoining forests for their daily requirements like food, fodder, firewood, fiber, leaves, bamboo, cane, hill broom, gums, tannins, resins and a variety of medicinal drugs and herbs, throughout the year (Sharma *et al.*, 1999). Traditionally, the forests provided genetic diversity of wild gene pool of crop plants such as *Colocasia* spp., *Dioscorea* spp., *O. nivara*, *Musa* spp., *Mangifera indica*, and *Artocarpus* spp. These crops, once dominating the forests are slowly dwindling (Senapati and Sahoo, 1966). Many of the species that sustained the tribal economy have vanished or exist at a stage of depletion. Resource-poor tribal communities still depend on the forest resources during the periods of food shortage (seasonal need) for their livelihood. Of the three primitive tribal groups, Bondos are still in the habit of going to distant forests to collect bamboo, wood, bark, wild grass, fruits, greens, and vegetables. In their leisure time they trap birds and animals. They go for ceremonial hunting in groups in March and April. The Langia Soura depends on forest collection throughout the year, with occasional hunting and fishing. The Gadabas supplement their livelihood by the collection of forest produce, fishing, and hunting which are only seasonal and practice these activities more as a matter of routine.

Agrobiodiversity in Jeypore tract

Rice is the principal crop in Jeypore area. The other crops grown are maize (*Zea mays*), finger millet (*Eleusine coracana*; *ragi*), green gram (*Vigna radiata*; mung bean), black gram (*Vigna mungo*), mustard (*Brassica juncea*), sesame (*Sesamum indicum*), groundnut (*Arachis hypogaea*), etc. Tribals living in the hills cultivate minor millets such as little millet (*Panicum miliaceum*), foxtail millet (*Setaria italica*), niger (*Guizotia abyssinica*), pigeonpea (*Cajanus cajan*), and horsegram (*Dolichos uniflorus*) in addition to rice. In recent years, sugarcane (*Saccharum officinarum*), tobacco (*Nicotiana tabacum*), potato (*Solanum tuberosum*), ginger (*Zingiber officinale*), vegetables, and fruits are grown as cash crops (Sharma *et al.*, 1998). Uniform cropping pattern is not followed in the district owing to its peculiar feature arising out of its topography, people's habit and attitude. Cultivation is carried out at different altitudes varying from 150 to 1000 m above sea level (Senapati and Sahoo, 1966).

Agriculture is mostly rainfed and 75% of lands are under rainfed condition. The economy of the district is mainly agriculture-based but tribal agriculture is characterized as unproductive and uneconomic, due to the use of traditional skill and primitive

implements. In addition to that, land alienation, indebtedness, lack of irrigation facilities in the undulating terrains, lack of easy or soft credit facilities, seasonal migration to other places for earning wages, lack of education, and adequate scope for modernization have made the situation worse (Patnaik, 2005).

The agricultural land of the district has traditionally been classified into the following broad divisions: (1) *Donger* (land on the hill slopes for shifting cultivation); (2) Upland (unbunded as well as bunded); (3) Medium land (irrigated and rainfed); (4) Lowland; and (5) *Jhola* land (terraces between hills). Within each land category, numerous rice varieties are grown, depending on the local preferences for food preparation, cultural practices, palatability, etc. Rice is raised in three distinct seasons, namely, autumn locally known as *beali* (July–September), winter known as *sarad* (June/July–November/December), and summer known as *dalua* (February–May).

Special cultivation practices followed by tribal communities

Various cultivation practices are carried out by the different tribes, dictated by their customs as well as the terrain.

Shifting cultivation

The hill forests are used as agricultural fields by the tribal people, who practice the slash and burn method of agriculture, also called shifting cultivation, or locally *podu*. The important tribes practicing this primitive form of agriculture are the Kondh (Dongaria and Kutia), the Lanjia Soura, the Bondo, the Paroja, and the Gadaba. Generally, tribal people hold the land for shifting cultivation for 2–3 years and wait for 5–6 years for regeneration of forest cover. A particular hill slope or the area that is to be cultivated in a particular year is chosen during a common village meeting. According to the needs and the consent of the community, plots are alloted to the families. Individual ownership of the plots of land on the hill slopes is recognized on a hereditary basis. But when any plot lies fallow, it reverts to communal ownership. All activities connected with this type of agriculture are performed mostly by communal labor. Work is distributed among the family members according to the ability of individual members.

However, the head of the family assumes all the responsibilities in the practice and operation of shifting cultivation. The adult males between 18 and 50 years of age undertake the strenuous work of cutting trees, plowing and hoeing, and watching the crops at night, whereas cutting of bushes and shrubs, cleaning of seeds for sowing, and weeding is done by women. All agricultural activities are accompanied by ritual performances. The tribal people's success in agriculture depends upon their extensive knowledge of crops suitable for cultivation on the hill slopes, the geographic condition of that locality, their hard work and reciprocal labor organized with a team spirit. A mixed crop of millets, pulses, and oilseeds is grown on the hill slopes, and this practice of growing a mixed crop is dictated by their food habits and ecological conditions.

From February onwards, the process is begun by felling the trees and burning them. The ashes fertilize the lands and as the summer monsoon sets in, farmers prepare the land by simply stirring it with hand hoes. Seeds of dry crops are scattered in the cleared space. The produce is not sufficient to fulfill the minimum food requirements. Farmers supplement their economy by food gathering and hunting. For tribal people, money is not a greater factor than fulfilling their immediate food needs. They are satisfied with the meager produce they get from shifting cultivation.

The three primitive tribal groups of Koraput practice shifting cultivation extensively (Senapati and Sahoo, 1996; Government of Orissa, 2004). These groups prefer mixed cropping with four or five crops to avoid any risk of crop failure and ensure production of pulses, millets, and oilseeds from the small patch of land. In the Soura hills, this is known as *bagada chasa* (Senapati and Sahoo, 1966; Lenka, 2001; Patnaik, 2005; Behura and Mohanti, 2006; Das, 2006).

Jhola (terrace) cultivation

Tribes like the Paroja, Gadaba, Langia Soura, Kotia Kondh, and Bondo are well-known *jhola* cultivators. The valleys of the hilly tract are being converted into terraced paddy fields. Perennial springs are used to irrigate these narrow terraces during the late winter and summer months. In certain hilly areas, terraces are constructed along the slopes. It is believed to be a step towards settled agriculture. The extent of terraced land in the possession of a family is not much. The terraces are puddled during February and March, after which paddy is broadcast or first sown in nursery beds and then transplanted in the terraces. Usually sprouted seeds are broadcast and two varieties (early and late types) are mixed and sown at the same time. The early variety matures in May and the late variety is harvested in November. This is done in order to have one additional crop of paddy before the rainy season and allow the late variety to establish itself and withstand the force of the running streams. The yield of late paddy varies from 1.4 to 1.7 t ha^{-1} while the early variety gives 0.5 to 0.6 t ha^{-1} (Sahu, 1965; Senapati and Sahoo, 1966; Lenka, 2001; Das, 2006).

Myda system of rice cultivation

Myda is an ancient system of cultivation. The Gadabas grow two rice crops together in the same field during *kharif* (rainy season). At the lower level of the plateau, the lands are classified as *gedda, bedda*, and *jhola*. The *gedda* lands get running flow of water from May to November along with silt and clay. During February/March when the three types of lands get partially dried

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up, the Gadabas start their field operation. The land is plowed semi-dry or wet. *Chipti* (short duration) and *Kerandi* (long duration) rice seeds are mixed in 5:2 proportion. The seeds are germinated and broadcasted at 100 kg ha^{-1} in the field, with a little standing water. *Chipti* matures in June/July and when this crop is harvested the top portion of the *Kerandi* crop is also cut; this reduces excess vegetative growth and prevents lodging. The height of water in the fields increases and the water remains flowing, the maximum being at the *jholas* (deep lowlands). At places where stubbles rot due to excess water in the *jholas,* vegetative propagation by splitting the tillers from the surviving hills of *Kerandi* is practiced (vegetative propagation is a part of *myda* cultivation.) The *Kerandi* grows tall as the water level rises. The fields are not fertilized. If necessary, standing rice crop is again defoliated in September/October. This saves the crop from lodging. The *Kerandi* rice is harvested in December–January (280–300 days). The yield is 0.4 to 0.5 t ha^{-1} from *Chipti* and 1.5 to 2.2 t ha^{-1} from *Kerandi*. Harvesting of *Chipti* in May–June meets the food demand of the people when no other grain crop is available in the field (Sahu, 1965; Senapati and Sahoo, 1966; Lenka, 2001).

Traditional rice cultivation practices

There are three systems of rice cultivation, dry, semi-dry, and wet, followed in the uplands, medium land, and lowlands respectively. Generally, the broadcasting method is followed (Fig. 3). Transplanting occupies a small portion of the total paddy area. Under the broadcasting method, dry and wet sowing is practiced. Agricultural implements used in cultivation are commonly primitive types. They are the traditional wooden plow, wooden plod breaker, and two types of wetland leveler, spade, sickle, and hand axe. The tribal farmers cannot pay much attention to the quality of seeds and seedlings. Mostly from the threshed rice a portion of grains are separated for seed purpose and processed for next year's sowing (Fig. 4a). Occasionally good and healthy panicles are harvested from the standing crop if the family can spare labor and time for seed. Otherwise selection of panicles is done at the threshing yard from the harvested crop (Fig. 4b). Seeds are generally stored in *pudugos* (baskets made of paddy straw) and in bamboo baskets or in earthen pots, the mouth of which is sealed with straw and cow dung (Fig. 5). In case of rice pests and diseases, the cultivators resort to chanting of hymns by the *Desari* (astrologer-cum-medicine man of the tribal village) and planting of twigs of *karada* (*Cleistanthus collinus*) and *kendu* (*Diospyros* sp.) in the paddy fields to drive the pests from the field. For restoring soil fertility, two traditional methods are followed: application of farmyard manure (FYM) and leaving the land fallow; these methods are most predominant in the region.

Compared to the coastal areas of Orissa, the crop productivity is low in Jeypore tract (Senapati and Sahoo, 1966; Government of Orissa, 2007). About 70% of the farmers are small or marginal, with poor economic resources, which hinders effective utilization of modern rice production technology. Delay in sowing, nursery raising, and transplanting (due to late monsoon), water management

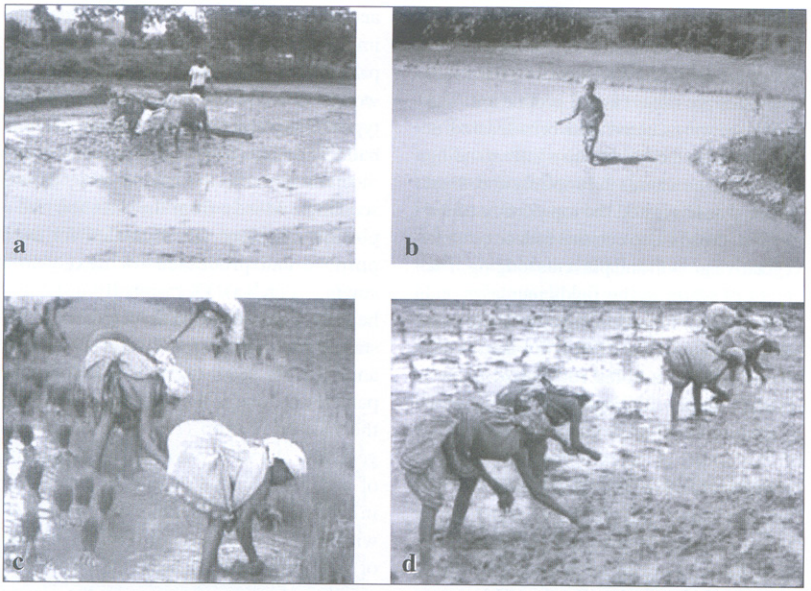

Figure 3. Traditional rice cultivation practices: (a) Plowing with wooden plow; (b) Broadcasting of seeds; (c) Uprooting seedlings from nursery; (d) Random transplanting.

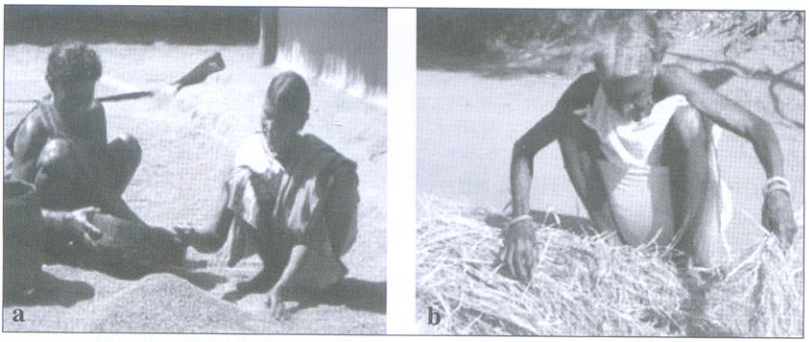

Figure 4. Traditional seed selection practices: (a) Seed selection from grains; (b) Panicle selection.

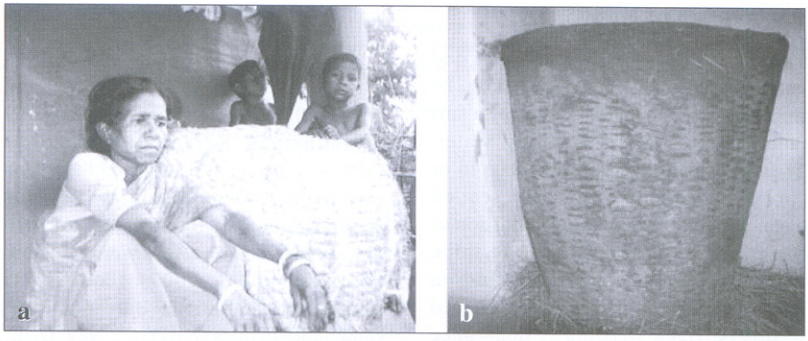

Figure 5. Seed storage containers: (a) *Pudugos*; (b) Bamboo basket.

and shortage of efficient farm laborers are the reasons for poor yield.

Dry system of cultivation

The dry system is followed in rainfed uplands, which do not have standing water in the field. The soil is red in color, and poor in organic matter content. The land is plowed several times to get the desired tilt. With the onset of monsoon in May–June, farmers broadcast the seeds. Early and extra-early varieties (maturing in, or less than, 90 days) are cultivated in this type of land and high seed rate (100–120 kg ha^{-1}) is followed.

Tribes like the Paroja, Gadaba, Langia Soura, Kotia Kondh, and Bondo are well-known* jhola *cultivators. The valleys of the hilly tract are being converted into terraced paddy fields. Perennial springs are used to irrigate these narrow terraces during the late winter and summer months.

After broadcasting, normally farmers leave the uplands unattended till the crop matures. Normally, weeding is not done in upland fields. Due to the dry and hard soil, uprooting is difficult. They get a poor yield, i.e., 0.8 to 1 t ha^{-1} (Pani and Patra, 2003).

Semi-dry system of cultivation

The semi-dry system is followed in rainfed/irrigated medium lands. The field is prepared and dry seeds or sprouted seeds are broadcasted, depending on the rain/standing water. If rain is heavy, farmers sow sprouted seeds to save the seeds from rotting and if the field is dry, they sow dry seeds. Sowing is done in May–June, using a seed rate of 80–100 kg ha^{-1}. When the crop is one month old, plowing of the field is done in 5–10 cm standing water. This operation is known as *beushening*. A week or ten days after *beushening*, laddering is done, weeds are removed, and thinning is done followed by gap filling using uprooted seedlings. *Beushening* saves labor charge needed for weeding. Farmers get medium yield, i.e., 1.3 to 2.3 t ha^{-1} (Pani and Patra, 2003).

Wet system of cultivation

The wet system of cultivation is carried out in rainfed and irrigated lowlands. The field is plowed repeatedly to bring a soft puddle with 5–7 cm standing water. Then rice seedlings are transplanted or sprouted seeds are directly seeded depending on the economic condition of the farmers. Transplanting is done usually in July/August by random method, using 4- to 6-week-old seedlings. Hand weeding is done once or twice, depending upon the weed population and labor cost. Farmers apply FYM and take care of the field as they get a better harvest from this crop. Average yield from lowlands is around 2.5 to 3 t ha^{-1} (Pani and Patra, 2003).

Exploration of rice germplasm in Jeypore tract

The first systematic exploration mission to this region was made during 1955–59 for rice germplasm, which is popularly known as the Jeypore Botanical Survey. The survey team collected 1,745 accessions of cultivated rice and 150 germplasm accessions of wild rice (Govindaswami and Krishnamurty, 1959).

Though established in 1937, the Rice Research Sub-Station at Jeypore, Orissa hardly ever utilized these landraces in rice breeding. Only eleven popular landraces were purified over the years (Table 1). The CRRI, Cuttack also did not utilize these landraces as the then breeders were too pre-occupied with the *Indica-Japaonica* hybridization program, which at that time was considered of prime importance.

After about 40 years, when MS Swaminathan Research Foundation (MSSRF), Chennai resurveyed the major part of the Jeypore tract in 1995–96 for documentation of Intellectual Property Study, only 256 accessions were available (Tripathy *et al.*, 2005). The CRRI, Cuttack and the National Bureau of Plant Genetic Resources (NBPGR), New Delhi jointly explored the undivided Koraput district (1995–96) for rice germplasm covering a distance of over 3080 km by road. In all, 318 accessions were collected, of which 120 were upland varieties and 198 were medium land and lowland varieties, which were less than one-third of the collections made during the Jeypore Botanical Survey in the late 1950s (Patra and Dhua, 2003).

For the first time HYVs were introduced in the tract in 1970 by government agencies. By 1990–91, HYVs were cultivated in 52.91% of the rice area and the percentage increased at a steady rate. In 2004, 2005, and 2006, the area under HYVs of rice was 83.97%, 84.17%, and 85.75%, respectively indicating a clear genetic erosion of landraces of rice. There are several reasons for genetic erosion of rice in Jeypore tract such as introduction of HYV rice, subsidy on seeds and chemical fertilizers, lack of proper seed storage structures which leads to non-availability of pure seeds, insect and pest attack, and natural calamities like flood and drought.

Table 1. Characteristics of purified rice landraces of Jeypore tract.

Accession no.	Landrace name	Land type	Duration (days)	Leaf sheath color	Husk color	Kernel color	Quality
J1	*Bobbli Bhutta*	Upland	105	Purple	Fawn	White	Superfine
J2	*Mohulkunchi*	Upland	110	Purple	Brown	White	Medium fine
J3	*Chitikana*	Upland	125	Green	Fawn	White	Coarse
J4	*Sourmundabali*	Medium land	145	Green	Fawn	White	Medium fine
J5	*Chudi*	Medium land	150	Green	Fawn	White	Medium fine
J6	*Ratnamali*	Medium land	150	Green	Yellow	White	Superfine
J7	*Karandi*	Lowland	165	Green	Fawn	White	Coarse
J8	*Lakadi Machi*	Upland	135	Green	Fawn	White	Coarse
J9	*Khichidi Samba*	Lowland	150	Green	Fawn	White	Medium fine
J10	*Barang Chudi*	Upland	130	Green	Fawn	White	Coarse
J11	*Bayagunda*	Lowland	150	Green	Fawn	White	Medium fine

Dying cultures

Changing cultural and economic conditions led to erosion of knowledge about natural resources in the Jeypore tract. In the central area of the Jeypore tract, the recent irrigation facilities originating from the Kolab river have replaced the landraces with HYVs and changed the traditional agricultural practices. The new crops introduced are high-yielding rice and cash crops like sugarcane, cotton (*Gossypium* sp.), and sunflower (*Helianthus annuum*) and improved vegetable varieties (Sharma *et al.,* 1998). However, the Agriculture Department has not been able to approach all the farmers either because of the remoteness of the area or because the marginal farmers are not willing to adopt the modern high input varieties. Landraces are still cultivated by small and marginal farmers of remote areas. Hence on-farm (in-situ) conservation of landraces needs a different approach towards management.

The practice of rotation of landraces every third year has been a method of controlling the weeds and maintaining the diversity. Seed selection was done by picking single healthy panicles. Slowly, with increasing labor costs, a part of the field was kept aside as seed material or the seed selection was taking place on the threshing floor. Thus there was a dilution in the quality of seed material leading to mixtures. Seeds were stored in bamboo or straw rope baskets lined with cow dung to make them airtight; insect repellents were kept inside these baskets. Gradually, with easy access to cement bags and earthen pots, the practice had changed (Sharma *et al.,* 1998).

Government-sponsored developmental work has given the villagers opportunities to work and earn. Migration in search of work has also resulted in labor problem. After the peak agricultural period, members who can be spared for labor work are sent out, resulting in shortage of labor on the farms (Sharma *et al.,* 1998).

Organizational interventions

Work carried out by MS Swaminathan Research Foundation (MSSRF)

In 1973, Prof. MS Swaminathan, Chairman, MSSRF, Chennai stated in his second Coromandel lecture that "We live in a world of sad scientific ironies and economic enigmas. The regions where man first settled to cultivate plants and thereby initiated what we now call 'agriculture' are also the regions, which contain the greatest number of hungry people today. The regions, which scientists designate as the centre of origin of crop plants, are strangely enough the areas where the same plants yield today the poorest averages. The Jeypore tract of Orissa, which is believed to be an ancient centre of origin of rice, is a good example" (Swaminathan, 2001). Even after 35 years the district of Koraput comes under the "hunger hot spots" of the world and has been reported for starvation deaths from time to time. About 84.6% of the population are below poverty line (Government of Orissa, 1997). Per capita income is less than Rs 206 per month according to 1993–94 prices. The per capita availability of cultivated land has reduced as a result of population growth by 93% when compared to 1961 Census (Government of Orissa, 2007).

In this backdrop, MSSRF conceived a project with the major objectives of chronicling the intellectual property rights of tribal and rural men and women with relation to rice genetic resources conservation and enhancement in Jeypore tract of Orissa.

Documentation of intellectual property rights

The tribal and rural families of this area have been developing and conserving the plant genetic resources from time immemorial with their traditional knowledge. Today's landraces, which are cultivated, are the products of careful and continuous selection by tribal women and men that were allowed to evolve naturally with the changing environment and agricultural practices. These tribal women and men have largely remained unrecognized and unrewarded (Swaminathan, 1996). A project was formulated to document and characterize the landraces of rice still conserved and cultivated by these tribal/rural women and men, to safeguard their intellectual property rights, enabling them to derive economic benefit from their past and present contributions to the conservation of genetic resources and has been shaping the operational content of the concept of farmers' rights developed by FAO (Food and Agriculture Organization of the United Nations) under the leadership of Prof. MS Swaminathan.

In all, 256 landraces were documented from 67 tribal villages. These landraces were claimed to harbor many dominant genes, including genes for resistance to diseases, insect pests, and physiological stress situations, as well as for characters of nutritive quality and palatability (Tripathy *et al.*, 2005).

Biodiversity conservation project

In 1998, MSSRF initiated a project on conservation, enhancement, and sustainable

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and equitable use of biodiversity in seven tribal villages of Jeypore tract, supported by Swiss Agency for Development and Cooperation (SDC) against the backdrop of the Convention on Biological Diversity (CBD). Its chief goal was to promote sustainable management of agrobiodiversity and develop procedures for recognizing and rewarding the contributions of tribal and rural families, particularly those of women in the conservation and enhancement of genetic diversity in accordance with the provisions of the CBD.

Simple feasible agronomic practices were introduced in the farmers' fields to increase the productivity of the landraces. People's institutions like Grain, Seed, and Gene Banks were facilitated to store excess grains, avail quality seeds, and conserve genes for future, respectively. Application of FYM and biopesticides and organic farming were encouraged. At the end of the fifth year, the tribal farmers were able to realize high yields that made them possible to save a considerable quantity of grain for sale.

Recognition and reward to the farm communities of Jeypore

National and international organizations have recognized and rewarded the communities of Jeypore in appreciation of their invaluable contributions to the conservation of genetic resources and their improvement through selection, preservation, and knowledge addition.

Equator Initiative Award

Tribal communities of the Jeypore tract won the Equator Initiative Award at the World Summit on Sustainable Development (WSSD) in Johannesburg on 30 August 2002, for community conservation and directing it to poverty reduction. The Equator Initiative is a global movement committed to identifying and supporting innovative partnerships that reduce poverty through the conservation and sustainable use of biodiversity. The program is based on the recognition that, while biodiversity losses and poverty are increasing in most tropical countries, indigenous and other local communities are rising to meet the challenges in creative and effective ways.

Innovative approaches were made in the Jeypore tract, linking partnerships with local communities for conservation of traditional practices and knowledge related to agriculture that seeks commercialization as a trigger for conservation. In recognition of this partnership effort, the tribal communities of Jeypore were presented with the Equator Initiative Award (MSSRF, 2003).

Facilitating formation of village development societies

The PGUS (*Panchabati Gramya Unnayana Samithi*) was formed by representatives from 16 villages and is located in Tolla village. It is now a registered

body and has an executive committee, a constitution, and bylaws. The total number of General Body members is 100 (52 men and 48 women), and the Executive Committee consists of 32 members (17 men and 15 women). Of the 100 members, 77 are Scheduled Tribes and 33 belong to 'Other Castes'. The Executive Committee of the PGUS operationalizes activities related to biodiversity conservation, its enhancement and sustainable use, and equitable sharing of benefits.

Genome Saviour Award

The PGUS was selected by the Protection of Plant Variety and Farmers Rights (PPV&FR) Authority of the Government of India for the Genome Saviour Award 2006. The award is instituted under the PPV&FR Act to recognize and reward the communities and farmers for their contribution to genetic resources conservation and improvement. The tribal community of Koraput has been selected for this recognition, for their outstanding and seminal contribution to the conservation of plant genetic resources particularly rice, in the biodiversity rich center of southern Orissa. The MSSRF has been assisting the tribal communities of Koraput for undertaking conservation of traditional rice varieties of the region and linking it with livelihood improvement. It is notable that such an award is the first of its kind in any biodiversity rich country in the world (Swaminathan, 2007).

In 1998, MSSRF initiated a project on conservation, enhancement, and sustainable and equitable use of biodiversity in seven tribal villages of Jeypore tract, supported by Swiss Agency for Development and Cooperation (SDC) against the backdrop of the Convention on Biological Diversity (CBD).

Conclusion

Traditional agriculture has its own merits. When the traditional crops or cultivation practices are replaced with modern ones without adequate consideration of the local people and existing ecosystems, the expected benefits are not realized. Therefore, to develop sustainable agricultural practices, the people, their social traditions and cultures should be well understood.

In-situ on-farm conservation of crops is the best way not only to conserve the biodiversity but also to make the best use of traditional knowledge and experience for its utilization and to safeguard the intellectual property rights of the community. The local genetic diversity not only helps to meet the changing requirements of the farmers, but also helps the local genotypes to adjust themselves under the ever-changing biotic and abiotic stresses.

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