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Chakhao (Black Rice; *Oryza sativa* L.): A culturally important and stress tolerant traditional rice variety of Manipur

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Chakhao (Black rice; *Oryza sativa* L.) is one of the lesser known traditional rice varieties of Manipur which provides not only nutraceutical benefits, but also plays a significant role in socio-cultural practices of the local *Meitei* community. This paper describes indigenous agro-ecological knowledge and socio-cultural practices of *Meitei* farmers associated with black rice cultivation. A total of 72 knowledge holders were identified through chain referrals method in three representative villages in Imphal East district of Manipur. Semi-directive interview and group discussion methods were employed for documentation of their knowledge and socio-cultural practices. In all four black rice landraces (viz., *Chakhao poireiton*, *Chakhao angouba*, *Chakhao amubi* and *Chakhao pungdol amubi*) were recorded in the study area. About 57 % of the farmers in the study area cultivated black rice in < 10 % of their land holdings. According to the farmers all these landraces of black rice are relatively stress tolerant and disease resistant and require less care and energy inputs. Black rice is used in different religio-cultural feasts and rituals of *Meiteis*. Beside it is also used as a medicine for diabetic patients and traditionally given to pregnant women. Cultural practices of *Meiteis* help conserving the agro-biodiversity in the study area.

Keywords: Traditional landraces, *Meitei* community, Socio-culture practices, Agro-ecology and Farmers' knowledge
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Manipur is one of the eight North eastern states of India and famous for diverse traditional rice (*Oriza sativa* L.) varieties, cultivars and landraces known for their cultural as well as nutraceutical values[1]. Socio-cultural values including taste and preferences for foods prepared from any specific crop variety play vital role in farmers' crop selection criteria and maintaining agrobiodiversity[2-4]. The lesser known scented black rice of the state, locally called '*Chakhao*', meaning delicious rice in *Manipuri* language, has drawn attention of the scientific community in most recent times owing to its higher nutraceutical properties such as antioxidant, anticarcinogenic, fiber, vitamin and mineral contents[1,5-9]. The high anthocyanin content in the pericarp gives the rice dark purple colour which has antioxidant property[7-8]. Historically, black rice was considered to be a royal delicacy and forbidden for common people in Asian countries such as China and Indonesia[9]. As the legend has it, in China during imperial period, common people were not allowed to store/cultivate black rice without the approval from authorities and hence it was called 'forbidden rice' or 'imperial rice'[10]. In India it has been playing a significant role in socio-cultural practices of indigenous *Meitei* community of Manipur since long[1,5]. Cultural beliefs and practices have a symbiotic relationship with conservation of agrodiversity[11]. Understanding of such relationship is critical for *in situ* conservation of crop diversity in traditional agro-ecosystems for sustainable development of local communities[12-14].

Though few studies have described the genetic diversity and neutraceutical properties of the black rice of Manipur[1,5-6], agro-ecological and socio-cultural values linked with black rice cultivation yet to be documented comprehensively. In the wake of fast changing socio-cultural milieu and most importantly the climate, the present study attempts to document and describe the traditional knowledge and cultural practices of *Meitei* community associated with black rice cultivation inhabiting three villages, viz. Sanjenbam, Kombongput and Yaralpat in Imphal East district of Manipur.

Methodology

Socio-economic profile of the Meiteis

Among several indigenous groups, *Meitei* is the dominant non tribal community constituting about 60 % of the total population[15] of Manipur and commonly

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identified as *Manipuris.* The community is distributed throughout the state especially the Imphal valley and foothills areas. Majority of *Meiteis* follow Hinduism embracing Vaishanvism. The major festivals of the community are *Cheiraoba, Yaoshang, Heikru Hindongba* and *Laiharaoba*[16]. Agriculture is the core economic activity of the society. They cultivate a large number of indigenous rice including black rice varieties and collect wild edibles comprising leafy vegetables, tubers, mushrooms and bamboo shoots mainly for self consumption and sometimes for earning livelihood as well.

Study area

The study was conducted in Imphal East district of Manipur. The total geographical area of the district is 709 km^2. Rice is cultivated over 60 % area of agricultural land of the district (405 km^2)[17]. The population of the district is 456113, of which 60 % is rural[17]. The district is characterized by humid sub tropical climate where monsoon season starts from the mid of May and ceases in September. The average annual rainfall is about 1580 mm while the average minimum and maximum temperatures are 10 ºC and 19.5 ºC, respectively[18].

In the present study, three representative *Meitei* villages, viz. Sanjenbam, Kombongput and Yaralpat with population of 895, 480 and 595, respectively, were selected purposefully for widespread black rice cultivation (Fig. 1).

Data collection

A total of 72 knowledge holders (comprising 58 men and 14 women) more than 40 yrs old were identified through "Chain Referrals" method[19]. Thus, 20 knowledge holders (17 men and 3 women) were identified from Sanjenbam, 24 (20 men and 4 women) from Kombongput and 28 (21 men and 7 women) from Yaralpat. Semi-directive interviews and focused group discussions were held with the identified knowledge holders to elicit knowledge associated with rice cultivation[19]. The study was conducted in the months of October-November 2017 coinciding with the harvesting season of the black rice. The quantitative information such as cultivated land area and production of black rice per household was recorded from the individual knowledge holder in local measuring units and converted in metric units. During the field survey additional scientific data on morphological parameters such as plant height, panicle length and number of grains in each panicle of the black rice landraces were also recorded. Further, a total of 100 panicles of individual landrace of the black rice cultivated by the *Meitei* farmers were brought to laboratory and 30 grains of each landrace were randomly picked from the panicles and dehusked for estimating the size and shape of kernels. Average weight of kernel was estimated considering 100 kernels with three replicates for each landrace. Shape of the kernels of each landrace was determined by length and width ratio as suggested by Dela-Cruz & Khush[20].

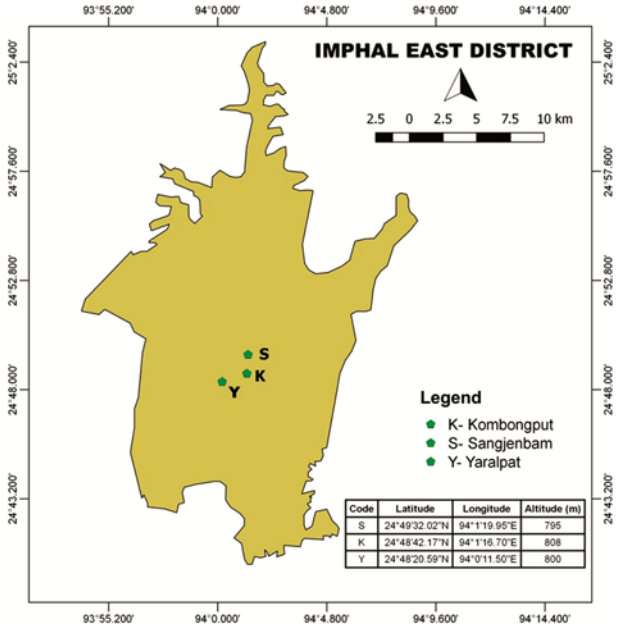

Fig. 1 — Location of the study area (K-Kombongput village, S-Sangjenbam village, Y-Yaralpat village in Imphal East district of Manipur).

Results and discussion

Black rice landraces

A total of four landraces of black rice, viz. *Chakhao poireiton, Chakhao angouba, Chakhao amubi* and *Chakhao pungdol amubi* were recorded from the studied villages (Fig. 2). Among the recorded landraces, *Chakhao poireiton* is cultivated by most of the farmers (43 %) because of its higher productivity and delicacy. As per local belief, black rice was first cultivated by the 12th *Meitei* king Poireiton Khunthokpa during 38-18 BC in his capital Poi located at the foothills of Heirok range[21]. Thus the rice landrace came to be known as *Chakhao poireiton*.

Black rice plants attain 136-166 cm height which was comparatively higher than the other traditional non black rice varieties cultivated in the study area. *Chakhao amubi* was the tallest black rice landrace (165.5 cm) (Table 1). The highest panicle length,

number of grains, and tillers were recorded for *Chakhao poireiton*, however, average grain weight of *Chakhao angouba* was higher than other landraces. The kernel length of *Chakhao amubi, Chakhao pungdol amubi* and *Chakhao angouba* was considered long (6.57-7.45 mm) and *Chakhao poireiton* as medium. Most of the studied morphological parameters differed significantly ($p < 0.05$) among different black rice landraces (Table 1).

Agro-ecological practices of the black rice cultivation

A sizable number of *Meitei* farmers (57 %) cultivated black rice while the remaining did not show interest in its cultivation because of low productivity, non use as staple food and associated cultural taboo for not to abandon its consecutive cultivation before three years. Traditionally black rice is cultivated under rainfed condition by direct seeding in the months of June-July and harvested in October-November. Land area under black rice cultivation ranged from 0.06 to 0.25 ha/household (3-8 *Feidom* per household; *Feidom* is a local term used for a small plot of paddy field which covers 0.02 to 0.04 ha land area), accounting only 7-10 % of the total cultivated land per household across the selected villages. Of the total number of black rice cultivators, about 48 % preferred cultivating various black rice landraces on rainfed croplands that can no longer sustain higher yields of other traditional non-black or hybrid rice varieties due to repeated cultivation year after year and become low productive necessitating crop rotation. However, after meeting the cultural needs of cultivation of black rice uninterruptedly for three years, the farmers may switch over to cultivate non black rice varieties again resuming the application of farmyard manure and sometimes chemical fertilizers as well. About 24 % preferred to grow these on marginal rainfed lands which were prone to soil erosion due to higher slope around adjoining hillocks while the remaining had no such preference (Figs. 3a & 4). All the informants reported that yield of the black rice remains unaffected in such croplands, whereas the other rice varieties show 50-60 % reduction in the yield. According to the informants, under relatively stressful (poor soil nutrient and water) conditions, yield of all the black rice landraces remains more or less stable (Fig. 3b). However, yield of these is generally lower (~1.3-1.8 t/ha) as compared to hybrid and other traditional rice varieties (~2.0-5.5 t/ha) under normal conditions. Thus, in general the black rice landraces possess higher stress tolerance while *Chakhao poireiton* is the most stress and drought tolerant among the cultivated landraces. Farmers do not apply

Fig. 2 — Panicle, grain and kernel of (i) *Chakhao amubi* (ii) *Chakhao pungdol amubi*, (iii) *Chakhao poireiton* and (iv) *Chakhao angouba* landraces of black rice.

Table 1 — Morphological characteristics of different black rice landraces with their critical difference's (CD) recorded in the study area, Imphal East district, Manipur, India

Characteristics	*Chakhao poireiton*	*Chakhao amubi*	*Chakhao pungdol amubi*	*Chakhao angouba*	CD value
Height of the plant (cm)	148.4 ± 3.1^{a}	165.5 ± 4.8^{b}	143.0 ± 2.5^{c}	136.4 ± 4.0^{d}	3.21 (n=10)
Length of the panicle (cm)	26.3 ± 1.0^{a}	$25.3 \pm 1.^{ac}$	24.6 ± 1.6^{bc}	23.4 ± 1.4^{b}	1.08 (n=10)
No of grains on each panicle	176.2 ± 22.3^{a}	168.2 ± 14.3^{ac}	163.3 ± 9.1^{bc}	109.3 ± 14.3^{d}	9.77 (n=10)
Length of a grain (mm)	9.75 ± 0.09^{a}	9.91 ± 0.15^{bd}	9.94 ± 0.11^{b}	9.92 ± 0.14^{b}	0.06 (n=30)
Width of a grain (mm)	2.63 ± 0.04^{a}	2.89 ± 0.06^{b}	$3.35 \pm 0.20c^{a}$	3.65 ± 0.07^{d}	0.11 (n=30)
Weight of a grain (mg)	26.01 ± 2.41^{a}	18.27 ± 0.44^{b}	25.46 ± 0.44^{ac}	27.64 ± 0.83^{d}	0.61 (n=300)
Length of the kernel (mm)	6.50 ± 0.49^{a}	6.57 ± 0.19^{ab}	6.71 ± 0.24^{c}	7.45 ± 0.21^{d}	0.13 (n=30)
Width of the kernel (mm)	2.41 ± 0.19^{a}	2.19 ± 0.09^{b}	2.36 ± 0.16^{a}	2.61 ± 0.21^{c}	0.08 (n=30)
Weight of kernel (mg)	20.32 ± 0.04^{a}	14.76 ± 0.711^{b}	23.10 ± 1.66^{c}	19.7 ± 0.89^{d}	0.88 (n=300)
Shape of the kernel	Medium	Long	Long	Long	-
Colour of the kernel	Dark purple	Black	Black	Light beige	-

Means followed by the same superscript alphabet(s) are not significantly different ($p > 0.05$) across the landraces

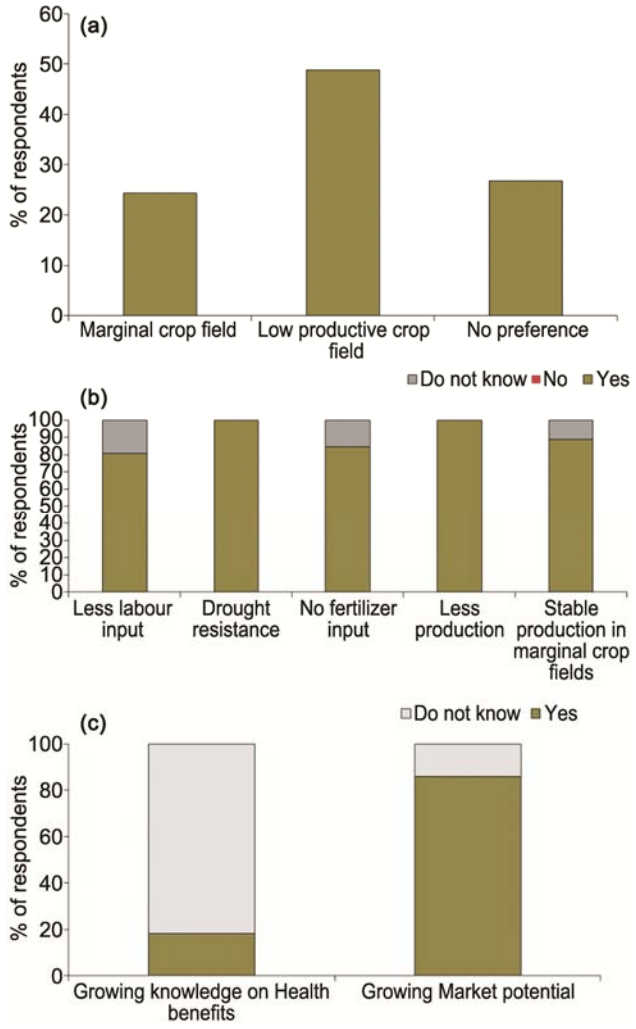

Fig. 3 — Responses of identified knowledge holders on (a) Preferences for type of arable land for cultivation of black rice (b) Agro-ecological attributes and (c) Awareness about emerging knowledge on neutraceutical and market potential of black rice.

chemical fertilizers and farmyard manure in black rice fields because such applications enhance vegetative growth of the black rice and increase in production of chaffy grains (Fig. 3b).

Black rice cultivation in general requires less labour inputs in terms of ploughing, weeding and care compared to other rice varieties (Table 2). According to the informants, no severe disease or pest attack has ever been observed on all the landraces of black rice whereas, other rice varieties are susceptible to pest and diseases such as rice bug, stem borer, thrips, green caterpillar, rots, leaf blight, and false smut[22]. This could be attributed to high phenolic and anthocyanin contents in black rice landraces[22-24]. With the agro-ecological values (such as stress tolerance and disease and pest resistance) and agronomic values

Fig. 4 — Black rice cultivation in a marginal crop fields at the foothills of a hillock in Kombongput village, Imphal East district of Manipur.

Table 2 — Comparative account of traditional agronomic practices of black rice cultivation with other rice varieties in the study area, Imphal East district, Manipur, India

Practices	Black rice	Other rice varieties
Ploughing	2-3 times	4-5 times
Nutrient input	Not required	Required
Weeding	once	2-3 times
Pesticide application	Not applied	Applied

(such as lesser labour, no application of fertilizer and pesticide), black rice cultivation helps *Meitei* farmers in yield optimization in marginal lands and maintaining crop diversity (Table 3).

Socio-cultural values

Despite lower grain yield, there is close relationship between ethnic cultural practices of *Meiteis* and black rice cultivation. Black rice dish (*Chak*) is offered to the deities and ancestors in *Usob* (death ceremonies) and *Kang-pali* (religious festival); while it is served as dessert (*Kher*) in *Chakumba* (first rice-eating ceremony) by the *Meitei* people (Figs. 5 a&b). The black rice also used occasionally to prepare as *Ethe tan* (flatbread), *Kabok* (puffed *rice*), *Kabok-aafaba* (puffed *rice laddu*), flakes (*Chengpak*), *Utongchak* (rice cooked in bamboo stick) and *Yu* (alcoholic beverages). Traditional beer from the black rice called '*Chakhao-atingba*' is one of the most relished beverages among the *Meiteis*. However, black rice is not used as staple food as it takes more time for cooking and feels rubbery while chewing due to high fiber content[9].

Pregnant women are traditionally served with black rice a few days before delivery. Black rice is also consumed in small quantities by persons afflicted with

Table 3 — Advantages and issues related to Black rice cultivation in the study area, Imphal East district, Manipur, India

Advantage/Issue	Parameter	Attribute
Advantages	Agronomic	Less ploughing.
		Lower water requirement.
		No application of fertilizers and farmyard manure.
		Pest and disease resistant.
		Stable production on marginal farmlands.
		Higher by product yield.
	Cultural	Used in community feasts and rituals.
		Offered to pregnant woman before child birth.
	Nutraceutical	Medicine for diabetic patient.
		Reduce complexity during child birth.
		Antioxidant property.
		High fiber contents.
	Market	Increasing market value.
		Used in confectioneries.
Issues	Cultural	Abandoning cultivation before three years of its consecutive cultivation considered as taboo.
	Grain yield	Comparatively less productive than the other rice varieties under normal condition.
	Awareness	Lower awareness on the emerging medicinal properties and market potential.

diabetes, condition locally called as *Ising-pukchatt*. The antioxidant and anticarcinogenic properties of black rice have recently been recognized[1,9]. Due to its cultural value and health benefits, black rice is sold in the local market at high prices (₹ 150-200 per kg). Looking at the growing popularity not only in Manipur but also outside, the local agro based industries have started making confectionaries of black rice and selling in the local markets (Figs. 5 c&d). Like other rice varieties, black rice by-product (straw) is used as fodder and in preparing traditional shampoo (*Ooti masum*), and traditional soda (*Ooti*). The black rice straws are preferred as thatching material because of higher length and durability. Husk is another by-product used as livestock feed and in preparing farmyard manure.

Meiteis believe that once a household starts cultivation of black rice, it is considered to be a taboo to abandon its consecutive cultivation before three years. Such a cultural belief had and has been helping in uninterrupted cultivation of black rice among the community but in recent times, due changing socio-economic scenario, sometimes also deters few households to take up its cultivation. Though *Meitei* farmers prefer their own seeds, occasionally the seeds are also exchanged among the relatives and neighbors. Seed selection, storage and exchange play a vital role in conserving and maintaining the vigor of traditional landraces of the black rice. *Ningei, Kei, Kot* and *Apu achouba* are the traditional rice storage structures of the studied community which act like a seed bank at household level. The practice not only helps in maintaining the germplasm, but also in strengthening the social relationships.

Fig. 5 — (a-b) Offering of black rice dishes to deities in a *Usob*, (c) Selling of black rice in local market in Imphal city and (d) Black rice cake prepared by local agro based industries in Imphal Town, Manipur.

Conclusion

A sizable number of *Meitei* households cultivate black rice in the study area. *Chakhao poireiton* was the most preferred landrace among the farmers due to its unique taste and higher grain production than other landraces. Black rice possesses antioxidant and anticarcinogenic properties; it is also traditionally served to pregnant women to reduce complexity during child birth and used as medicine by diabetic patients. Black rice cultivation has agronomic qualities like stable grain

yield in marginal lands, stress tolerance, and pest and diseases resistance. Cultural beliefs such as it should be cultivated consecutively at least for three years, helps in uninterrupted cultivation of black rice in the study area and growing knowledge on its medicinal properties increasing its market potential. Therefore though black rice faces no threat to its continued cultivation as such, the study may help in preservation and protection of socio-cultural and traditional knowledge of the studied community associated with the black rice cultivation and use in the wake of modernization and more importantly climate change in present times.

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