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Research Article

Traditional Rice Cultivation: A comprehensive study on wet rice and jhum cultivation in Lohit district, Arunachal Pradesh, India

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Abstract: Rice (*Oryza sativa* L.), a staple cereal crop belonging to the Poaceae (Gramineae) family, is often referred to as the "grain of life," serving as a primary source of nutrition for nearly half of the world's population. The genus *Oryza* can be found cultivating in tropical and subtropical areas. India is blessed with an abundance of diverse rice landraces in its traditionally cultivated areas. The rice landraces of Northeast India, with their vast genetic variety, are valuable for future crop breeding efforts. This study explores the traditional rice cultivation practices in Lohit District, Arunachal Pradesh, with a focus on rice cultivation. A total of 100 farming households from ten villages in the district were surveyed to document traditional knowledge about rice cultivation, including rituals and agricultural practices. Results showed that rice cultivation in the district is based on two methods: wet rice cultivation, which involves nursery preparation, seed soaking, transplanting, and manual weeding, and jhum cultivation, where the land is cleared through controlled burning and seeds are broadcast directly onto the soil. The study also emphasises the rich biodiversity of rice landraces in the district, the rituals associated with rice farming, and the challenges posed by modern farming practices and other reasons.

Keywords: Jhum-cultivation, Wet-rice cultivation, Lohit district, Rice landraces, Tamla.

1. Introduction

Rice (*Oryza sativa* L.), a staple cereal crop belonging to the Poaceae (Gramineae) family, is often referred to as the "grain of life", serving as a primary source of nutrition for nearly half of the world's population (Shivani et al., 2021). The genus *Oryza* can be found cultivating in tropical and subtropical areas. Of the 25 species in this genus, two (*O. sativa* and *O. glaberrima*) are cultivated and 23 are wild. India is blessed with an abundance of diverse rice landraces in its traditionally cultivated areas. Landraces are elite cultivars

with a high level of genetic variation, and they stand for a transitional stage in the domestication of rice between wild rice and the elite cultivar (Choudhury et al., 2023).

Farmer varieties provide farmers with an "agricultural survival kit" to ensure the welfare of their households in changing conditions (Pfeiffer et al., 2006). These cultivars are a living archive of ancestors' traditions, including recipes, songs, handicrafts, origin stories, and special planting, harvesting, processing, and storage rituals and techniques. Cabanting & Perez (2016) were the first to report, confirm and provide documentation on the contribution of specific indigenous rice landraces to the health system of particular local communities in the Philippines. They also reported local cultural practices and environmental requirements. Locally known as "Kambong" or "Ishing-kambong" (in Manipuri), wild rice (*Zizania latifolia* (Griseb.) Turcz ex stapf.) is a wetland plant native to Manipur that local ethnic groups utilise for a variety of purposes, including food, feed, thatch roofing, firewood replacement, house wall plastering material, etc. (Jain et al., 2012). The traditional rice wine, without which the social and cultural life of the tribal community would not be complete, as in the case of the Dimasa people in Assam, where rice wine is known as “Judima”, is used in celebrations of significant rituals, such as birth, death, and worship. It is crucial in marriages since bringing rice beer to the bride's home represents the tying of the knot (Gogoi, 2016). Rice has been widely used for various medicinal purposes in many countries since ancient times (Umadevi et al., 2012), with reports of its use in preventing and treating digestive and nutritional maladies from the Philippines (Cabanting & Perez, 2016).

O. sativa L. has a high genetic diversity in Northeast India, which could be a potential genetic resource for future crop improvement to fulfil the rising demand for food production. The Northeast region is rich in both floristic and crop diversity due to the region's high rainfall, humidity, varied topography, and altitude (Anupam et al., 2017). Jhum tradition in the tribal area of Arunachal Pradesh goes back to the beginning of human involvement in agricultural activities to provide food security and have a consistent source of food (especially rice) supply for the households, community, and village as a whole (Tayo et al., 2013). Due to multiple generations of cultivation and selection by farmers, landraces have genetic variation built in (Caldo et al., 1996). Although North East India's rice landraces are rich in biodiversity, their nutritional makeup is still unknown (Longvah & Prasad, 2020).

Thus, the rice landraces of Northeast India, with their vast genetic variety, are valuable for crop breeding efforts in the future. The biological and cultural legacy of the area is intricately linked to these landraces, which are essential to local communities' day-to-day existence. To guarantee sustainable farming methods and maintain the ecological and cultural diversity of the area, their research and protection must be given priority.

2. Methodology

Study area: Lohit district, nestled amid vast plains and majestic ranges with towering snow-covered peaks, lies in the northeastern part of Arunachal Pradesh, India. Geographically, it spans from latitudes 28°22'25.532" N to 27°34'11.765" N and longitudes 95°46'15.332" E to 96°41'59.555" E. The district is bordered by Namsai district of Arunachal Pradesh and Tinsukia district of Assam to the west, Anjaw district to the east, Changlang district to the south, and Lower Dibang Valley district to the north. The district experiences a sub-tropical, wet and highly humid climate, particularly in the lower elevations and valleys. It falls within a heavy rainfall belt, receiving an average annual rainfall of 2523.5 mm (NEDFi, 2023). The district is predominantly inhabited by the people of the Mishmi community (Mizo, digaru and edu) who have a vibrant biocultural heritage that is deeply connected with the land (Moyong et al., 2019).

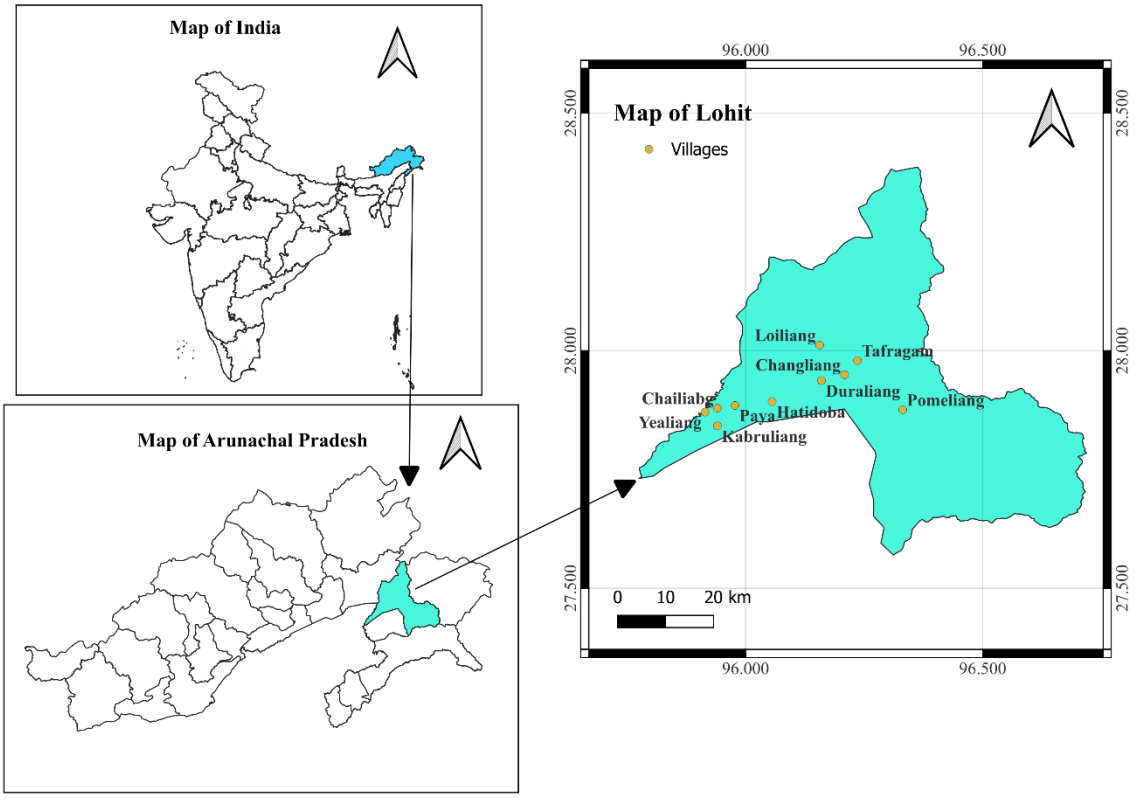

Figure 1: Map of Lohit district

Data collection: Household surveys were conducted using structured questionnaires to collect various information on Indigenous agricultural practices (Wangpan et al., 2019). The field study was done following the methodology of Jain & Mudgal (1999). A total of 100 farming households actively engaged with rice cultivation from ten villages were surveyed, viz. Tafragam, Changliang, Duraliang, Loiliang, Pomeliang, Paya, Hatidoba, Chailiang, Kabruliang, and Yealiang. Thus, data was collected from 100 people in total. To document

their traditional knowledge about indigenous rice agricultural practices, rice cultivation, socio-cultural dimensions, personal interviews were conducted with village heads (gaon burhas), elders and farmers who were actively engaged in agriculture, followed by group discussions. In every village, ten households were surveyed. The questionnaire addresses a broad range of questions related to the agricultural practices of Indigenous rice, including cultural, traditional, and landrace knowledge.

Data analysis: The diversity data of rice landraces was calculated using PAST software version 4.13, following the formula.

A. **Simpson's Dominance (*D*)**

Simpson's Dominance was calculated using the formula:

$$D = \sum_i \left(\frac{n_i}{n}\right)^2$$

where n_i is the number of individuals of the taxon i, and n is the total number of individuals.

B. **Shannon-Wiener Index (*H*)**:

Shannon-Wiener Index was calculated using the formula:

$$H = -\sum_i \left(\frac{n_i}{n} \ln\frac{n_i}{n}\right)$$

where n_i is the number of individuals of the taxon i, and n is the total number of individuals.

C. **Evenness ($E^{\frac{H}{S}}$)**Evenness was calculated using the formula:

$$E^{\frac{H}{S}} = \frac{H}{\ln S}$$

where S is the number of species, and H is the Shannon Index.

D. **Menhinick's Richness Index:**

Menhinick's Richness Index was calculated using the formula:

$$\text{Menhinick} = \frac{S}{\sqrt{n}}$$

where S is the number of species and n is the total number of individuals.

3. Results

Agricultural Activity:

In Lohit district, two complementary farming methods, wet-rice cultivation and jhum cultivation, have developed side by side over generations and together sustain biodiversity of rice landraces. The wet-rice cultivation begins with the preparation of a nursery bed, where the soil is manually loosened, levelled to create optimal conditions for seed germination. Following this, rice seeds are soaked in water for approximately two

days to initiate the germination process. After that, the water-soaked rice seeds are allowed to sprout over the next three days. Once sprouted, the seeds are sown in the nursery bed, where they remain for about 20 to 30 days, allowing the seedlings to develop young roots and shoots. During the same period, the main agricultural field is simultaneously prepared through manual tilling, whereby the soil is loosened and turned to enhance the structure and fertility. Subsequently, the young seedlings are transplanted from the nursery to the main agricultural field. The process ensures optimal plant spacing and resource utilisation. The transplanted rice plants are then managed in the agricultural field for approximately 180 days. During the time manual weeding is carried out to ensure healthy crop growth. After the plant matures, the rice is harvested through a series of labour-intensive steps, such as cutting with sickles, gathering, threshing and winnowing. Once harvested, healthy seeds are carefully set aside for future rice cultivation. While the rest of the rice grains are stored in traditional granaries designed to protect the crop from wild animals and pests. Notably, the entire agricultural cycle, from nursery preparation to grain storage in traditional granaries, usually takes about five to six months, highlighting traditional knowledge and sustainable farming methods.

Meanwhile, Jhum cultivation remains a prevalent practice, particularly in the foothills area of the district. This method starts with the selection of a suitable site, which is then cleared and subjected to controlled burning. The process prepares the land and enriches the soil with ash-derived nutrients. Subsequently, the soil is manually tilled to create a friable seedbed. The seeds are directly broadcast across the prepared seedbed without prior sowing in a nursery. Regular weeding is done throughout the growing season to ensure healthy crop growth. Once the rice reaches maturity, it is harvested in a similar way to wet rice cultivation. Notably, after harvest, the field is left fallow for several years, allowing natural regeneration of soil fertility. A defining feature that differentiates wet rice cultivation from jhum cultivation.

Biodiversity:

Traditional farming methods are a wealth that is passed down through families and into each household's subsequent generations. The process of growing rice is dynamic and varied, with different types of rice being grown in every household. Every year, varieties are based on the cultural and productivity of rice landraces. Rice is farmed exclusively during the cultivation time using a monocropping strategy in wet-rice cultivation. Beyond wet-rice cultivation, people tend to mix-crop in jhum cultivation, a treasured tradition passed down from their ancestors. In mixed cropping, the jhum fields are cultivated with *Setaria italica, Sesamum radiatum, Solanum tuberosum, Brassica spp., Zea mays, Coriandrum sativum, Raphanus sativum,* etc.

Soil fertility:

Soil fertility management is a straightforward process, as farmers rely on the natural decomposition of crop residue without the use of external agents. After harvesting, the remaining crop residues are left to break

down organically, enriching the soil. The cultivation period lasts for six months, followed by a fallow period of another six months, allowing the rice stalks to decompose naturally and restore soil nutrients.

Water management:

Although rice cultivation in Lohit district predominantly dependent on seasonal rainfall during the pre-monsoon and monsoon season, land preparation for wet rice cultivation is heavily dependednt on the monsoon rainfall. Data from the Rainfall Statistics of India, 2022, shows that Lohit district in the eastern region of Arunachal Pradesh receives substantial precipitation, recording aveage per month of 188.5 mm during the pre-monsoon season and a significant 358.5 mm during the monsoon season. However, no irrigation system for wet-rice cultivation acroos Lohit district was recorded during the period of study. The lack of proper irrigation systems for a rainfall-dependent rice cultivation remains a serious point of concern, especially when considering the increasing unpredictability of rainfall patterns caused by climate change.

Table 1:The total rainfall (mm) in Lohit district during the Pre-Monsoon, Monsoon and Winter seasons reported by North Eastern Development Finance Corporation Limited [NEDFi], 2023

Season	Months	Total Rainfall (mm)	Average per Month (mm)
Pre-Monsoon	Jan, Feb, Mar, Apr, May	942.5	188.5
Monsoon	Jun, Jul, Aug, Sep	1 434.0	358.5
Winter	Oct, Nov, Dec	147.0	49.0

The cultural and social dimension:

Traditional knowledge for the selection of those rice landraces that give more production and are culturally important is passed down from generation to generation; the methods of planting in nursery beds and choosing different types of rice to cultivate at various times throughout the cultivation duration. This protects biodiversity and agricultural history by guaranteeing the maintenance of both the germplasm and traditional cultivation techniques. Rice farming is closely linked to rituals and beliefs. To safeguard the land and secure a plentiful harvest, the people of the Lohit district observe a ritual called "***Tam-La***". ***Tam-La*** is an important ritual rooted in the Mishmi culture, reflecting the tribe's profound connection with nature. Practised for generations, Tam-La is an intricate worship ceremony dedicated to the spirits, seeking blessings for land fertility, prosperity, and the abundance of essential crops such as *O.sativa*, *Brassica rapa*, *Sesamum indicum*, *Setaria* sp., and *Solanum tuberosum*, etc. These crops are vital to the Mishmi people's sustenance, and the ritual is a plea for a bountiful harvest. The offering must-have things are ***Yu-shie (rice beer) and Chambai (traditional dish)***. ***Tam-La-Du*** is a more communal version of the traditional ***Tam-La*** ritual, where the entire Mishmi tribe unites to honour and worship the spirits, seeking blessings for collective well-being, prosperity,

and a bountiful harvest. This significant event is held annually on the 14th of February, a tradition that has been faithfully observed since long immorial. Unlike the smaller, more localized ***Tam-La*** rituals, ***Tam-La-Du*** brings together every priest within the tribe, who collaborate in leading the worship ceremonies. These gatherings underscore the importance of unity and shared purpose within the community, as they collectively seek to ensure health, prosperity, and abundance not just for individuals but for the entire tribe. ***Tam-La-Du*** serves as both a spiritual and social cornerstone for the Mishmi people, reinforcing their cultural heritage and the bonds that tie the community together through shared rituals and collective aspirations.

Challenges and threats:

The local people of Lohit district sustain their inherited agricultural heritage through the selection of rice varieties with high yielding capacity compared to other varieties. Although the output is high and the input is low, the population is growing rapidly, putting a threat to maintaining the traditional method. The wave of modernisation is sweeping away the conventional practices of rice cultivation, along with the government food distribution programmes. Deforestation in the nearby forest area in the Lohit district, particularly in the foothills, leads to the habitat loss of wildlife. As a result, elephants roam around the human settlements near the fringe villages. The elephants raid the agricultural plots, frequently damaging the crop, leading to economic loss. However, this phenomenon is largely localised and does not have a widespread impact on all parts of the district.

Diversity analysis:

The Simpson's Dominance Index (D) was found to be 0.19, suggesting that no single rice landrace dominates the other. The Shannon Index (H) was found to be 2.21, representing considerable diversity. The evenness index value was recorded as 0.61, while Menhinick's Index of species richness was recorded as 0.97. These indices inferred that the rice landraces' diversity in the Lohit district is both rich and relatively evenly distributed, with no single landrace showing pure dominance (Konjengbam et al., 2021).

Table 2. Local names of rice landraces, cultivation methods, and frequencies.

Sl. No.	Local name	Cultivation method	Frequency
1	Bajdhan	Wet-rice cultivation	43
2	Bora	Wet-rice cultivation	1
3	Chinni lahi	Wet-rice cultivation	4
4	Joha bor	Wet-rice cultivation	3
5	Kala lahi	Wet-rice cultivation	33
6	Karthik	Wet-rice cultivation	42
7	Ke-botha	Jhum cultivation	3
8	Ke-chama	Jhum cultivation	8

9	Ke-jawya	Jhum cultivation	7
10	Ke-mebo	Jhum cultivation	14
11	Ke-ne	Jhum cultivation	5
12	Ke-phobo	Jhum cultivation	8
13	Ke-piyong	Wet-rice cultivation	18
14	Ke-shi	Jhum cultivation	1
15	Ke-tuilu	Jhum cultivation	50

Table 3. Genetic Diversity Indices of Rice Landraces in Lohit District.

Diversity Indices	Value
Dominance $\boldsymbol{D}$	0.19
Shannon $\boldsymbol{H}$	2.21
Evenness $\boldsymbol{e^{H/S}}$	0.61
Menhinick	0.97

4. Discussions

Rice cultivation, a cornerstone of global food supply, has a deep-rooted history in Asia, particularly in the wetlands where it has been traditionally practised in submerged soils. This wet rice cultivation method has played a crucial role in maintaining soil fertility (Sahrawat, 2006). In Arunachal Pradesh, rice farming encompasses a diverse range of practices, including wetland, terrace, upland, and jhum cultivation (Choudhary et al., 2013). Among these practices, the Apatani tribe of Ziro Valley stands out for their innovative rice-fish farming system. This unique practice integrates terraced fields, fish trenches, and bamboo plantations, allowing for an annual yield of 3-5 tons of rice and 200-500 kg of fish per hectare (Baruah & Singh, 2018). This method is hailed as one of the most advanced and sustainable, providing consistent yields compared to shifting cultivation, which often faces challenges of soil depletion (Rai, 2005). In Lohit District, rice cultivation is of paramount importance, covering a substantial area of 6,005 hectares, with an annual production of 14,217 metric tons. The district experiences diverse agricultural land use, with 24,769 hectares of net area sown, including 105 hectares dedicated to wet rice cultivation and 1,994 hectares to jhum cultivation (Government of Arunachal Pradesh, 2022). The district receives an average annual rainfall of 2,523.5 mm, with the majority of this rainfall occurring during the Pre-Monsoon (942.5 mm) and Monsoon (1,434 mm) seasons (NEDFi, 2023). The abundance of rainfall during these months supports rice cultivation, which is critical for food security in the region. However, rice and maize farmers in the district face several challenges, including decreasing yields, pest and disease infestations, and weed problems. A comparative study in East Siang District found that natural farming methods, although resulting in lower yields, incur lower

cultivation costs and provide higher net returns compared to conventional methods (Athawale et al., 2024). Similarly, a study conducted by Tangjang and Sharma (2021) over the period from 1987 to 2018 in East Siang and Lohit districts highlighted these ongoing issues in rice cultivation. The researchers suggest that one potential solution for enhancing productivity in this region is the development of location-specific high-yielding rice varieties that incorporate the region's native landraces. Ethnic traditional cultures have improved the genetic diversity of rice landraces while also protecting the landrace germplasm resources on farms (Wang et al., 2016). However, the Green Revolution, which introduced modern agricultural methods, has significantly changed traditional wet rice farming practices. These modern approaches, largely replacing local knowledge and gender-specific roles, have shifted the focus of rice cultivation. Despite these changes, preserving traditional agricultural practices and the knowledge they carry remains essential for the sustainability and diversity of rice farming (Partasamita et al., 2018).

Figure 2. Interviews with the Gaon bura and people of Yealing village

Figure 3. Preparation of the agricultural field

Figure 4. Jhum cultivation

Figure 5. Wet-rice cultivation

Figure 6. Harvesting of rice

Figure 7. Traditional granary for storing of rice

Figure 8. Preparation for the Tamla ritual

Figure 9. The place where Tamla is performed

Figure 10. Local women with collected rice

5. Conclusion

The rice cultivation in the Lohit district of Arunachal Pradesh reflects two different but complementary farming methods. The wet rice cultivation involves meticulous practices such as nursery preparation, seed soaking, transplanting and manual weeding. The cultivation practices have been passed down through generations and are connected with the local culture, including rituals like "*Tamla*", which are believed to safeguard the land and ensure an abundant harvest. While jhum cultivation practices in the foothills integrate a sustainable method where the agricultural plot is left fallow for regeneration after the cultivation, promoting soil fertility and ecological balance. However, traditional farming methods in the Lohit district face challenges such as modern agricultural techniques and crop raiding by elephants. Despite these challenges, the sustainability of rice cultivation in the Lohit is maintained by the cultural and traditional dimension, which has been honed over generations. The diversity highlights the richness and considerable diversity among the rice landraces. The sustainable management of rice landraces in the district, along with practices like low-input, high-output methods and natural fertility restoration, ensures that agricultural activities continue to support the local communities and environment.

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