

A Study on Traditional Knowledge and Grassroots Innovation in Khejur Gur Production in Belpahari Forest Fringe Villages, Jhargram District, West Bengal.

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Abstract: The work a study on Traditional Knowledge and Grassroots Innovation in Khejur Gur Production in Belpahari Forest Fringe Villages, Jhargram District, West Bengal deals with indigenous knowledge and grassroots innovations that help sustain the traditional practice of date palm jaggery production in the forest-adjacent communities. Additionally, through household surveys, semi-structured interviews, and participant observation, the study documents traditional practices such as manual tapping, clay oven processing, and seasonal scheduling while also identifying innovations in terms of heating chambers, sap collection vessels, and storing techniques. Descriptive statistics were used to assess the socio-economic parameters of 80 households, including landsize and income from Gur production, as well as level of education. Cross-tabulation and Chi-square tests showed significant associations between education and the adoption of innovations, and correlation analysis also showed that the number of date palm trees tapped and the seasonal income earned were positively related to each other. Using Likert scale analysis, the perception of producers was captured on irregular market access, lack of forest tenure rights, and limited institutional support, which were later used to develop a “Production Constraint Index”. The producers, however, despite these challenges, remain resilient, thanks to their adaptive strategies, cooperative practices, and interchange of local knowledge. Findings indicate the realization that Khejur Gur production stands as an economic activity along with cultural expression and ecological engagement. The study finds that with policy interventions in support of traditional knowledge systems, better access to technology, and programs for sustainable forest-based livelihood, rural income security as well as cultural preservation could be supported in forest fringe areas.

Key word: Traditional Knowledge, Grassroots Innovation, Khejur Gur, Forest Fringe Livelihoods, Cultural Heritage Preservation.

I. Introduction

In the eastern states of India, especially in West Bengal, Jharkhand, Bihar, and Odisha, Khejur Gur or Date Palm Jaggery is indeed special culturally and economically. Apart from providing nutritional value, it is quite important in winter festivals and Makar Sankranti. It is the main ingredient in delicacies like pithe, payesh, and sandesh (Sen, 2010; Bhattacharya, 2016). Age-old jaggery making from Date Palm (*Phoenix sylvestris*) sap extraction continues to thrive especially in Nadia, Birbhum, and Jhargram districts (Roy, 2015; Das & Bera, 2020). With these jaggery making traditions, one can tell that these practices are more than just economic for the rural and tribal communities, as they have a deeper meaning and connection to the people's culture and identity (Chakraborty, 2018). In the last 20 years, literature has shown the connection between traditional ecological knowledge and food processing techniques, which help people in rural areas to sustain their livelihoods (Berkes, 1999; Gadgil *et al.*, 2005; Shiva, 2016). Although informal, such systems are resilient in nature and enhance food security alongside socio-cultural sustainability (Sundar, 2017; Pathak & Srivastava, 2019). Research on jaggery-making practices in India highlights their importance in supporting local economies despite the struggles with market competition, climate change, and socio-economic shifts (Rao *et al.*, 2003; Singh, 2018). The growing discourse on grassroots-level innovations also celebrates the creativity of rural manufacturers in meeting the needs of modern times through the modification of age-old techniques. The National Innovation Foundation (2016), alongside other academicians like Gupta (2012), have brought to the forefront the attention-worthy low-cost, locally-modified technologies that eco-efficiently marry tradition. For instance, in the Belpahari belt of Jhargram district, producers of khejur gur have introduced innovations like enhanced clay stoves, low-smoke boiling chambers, and eco-friendly sap collection devices, all the while preserving traditional skills (Mukherjee, 2021; Ghosh, 2022). As such, these practices are a source of livelihood, but at the same time they embody adaptive resilience that is fundamentally part of agro-ecological systems (Altieri, 2004; Pretty). This study, therefore, seeks to understand the local knowledge and adaptive innovations of gur producers in the forest-fringe villages of Belpahari. It examines the trade-offs between social, economic, environmental, and market pressures in conservation, using field surveys, interviews, and participatory methods. In the process, it provides insight to the issues of sustainable developments in rural areas, the appreciation of local traditions, and increased community-driven resilience in agro-ecological regions (Chambers, 1997; Scoones, 2016).

The specific objectives of the paper are as follows: 1.To examine the socio-economic profile of households engaged in Khejur Gur production and its role in their livelihood and seasonal income.2.To document the traditional knowledge systems and cultural practices associated with Khejur Gur (date palm jaggery) production among the communities in Belpahari forest fringe villages.3.To identify and analyze grassroots innovations adopted by local producers to improve the efficiency, quality, and sustainability of

Khejur Gur production.4.To assess the challenges faced by traditional Khejur Gur producers, including climate factors, market access, labour availability, and forest-related constraints.

II. Materials and methods

The present study focuses on the Belphari forest fringe villages in Jhargram District, West Bengal, including Belphari, Hadra, Kuldia, Tamajuri, Bhulabheda, and Banskhetya, situated between approximately 22°15'–22°30' N latitude and 86°45'–87°00' E longitude. The region lies in the south-western part of the state and is characterized by irregular and undulating lateritic uplands, with scattered hillocks and seasonal streams. Under tropical monsoon climate conditions, the area receives annual rainfall between 1,200 and 1,400 mm and experiences hot summers and wet monsoons, followed by cool, dry winters. Soils are generally lateritic and sandy loam, and they support tropical dry deciduous forests with predominance of *Shorea robusta* (Sal), *Terminalia arjuna*, *Pterocarpus marsupium*, and *Butea monosperma*. Scattered trees of *Phoenix sylvestris* (Khejur) can be seen in homestead gardens, field boundaries, and degraded forest fringes, which largely contributes towards seasonal Khejur Gur production. The population, largely made up of Scheduled Tribes and Scheduled Castes, maintains a mixed livelihood pattern of agriculture, forest resource collection, and seasonal migration. The sap tapping and jaggery-making are usually integrated into the traditional knowledge system of the local economy.

To obtain a better grasp of the role of traditional knowledge and grassroots innovation in the production of Khejur Gur, the study adopted a mixed methods approach combining both quantitative and qualitative methods (Creswell & Clark, 2018). The study was conducted in some form in selected forest fringe villages of the Belphari Gram Panchayat situated in the district of Jhargram in West Bengal, where Khejur Gur production is a common seasonal source of livelihood (District Statistical Handbook, 2023). A stratified purposive sampling technique was adopted to select 80 households involved in Khejur Gur production (Etikan *et al.*, 2016). Primary data collection was done through a structured household survey that collected information on socio-economic profile, landholding, number of date palm trees tapped, and income from Gur, and access to forest resources (Kothari, 2004). Semi-structured interviews were held to gather information from seasoned Gur producers, village elders, local innovators, and forest officials about traditional practices and new innovations (Bernard, 2017). The participant observation conducted between December and February during the taping and processing season permitted the elaborate account of production techniques and community practices (Spradley, 1980). Photographs were taken with field notes to document observational data. For analysis, descriptive statistics like mean, percentage, and frequency described socio-economic variables, while cross-tabulation and Chi-square tests examined the association(s) between education, adoption of innovation, and income level (Field, 2013). Correlation analysis evaluated the relationship between the number of trees tapped and income during the season, while Likert-type responses for the challenges and opportunities were indexed to create the Production Constraint Index (Likert, 1932). The secondary data inherited from the forest department, cooperatives, and local reports gilded the framework with regard to the study area (Forest Department Report, 2022).

1. Descriptive Statistics

a. Mean (Average):

$$\bar{X} = \sum X_i / N$$

Where:

- $\bar{X}$ = Mean
- X_i = Each individual value
- N = Number of observations

2. Chi-Square Test (for Independence):

$$\chi^2 = \sum (O_{ij} - E_{ij})^2 / E_{ij}$$

Where:

- O_{ij} = Observed frequency in the row and column
- E_{ij} = Expected frequency, calculated as
- $E_{ij} = (\text{Row total}) \times (\text{Column total}) / \text{Grand total}$

3. Pearson Correlation Coefficient (r): $r = \frac{\sum (X - \bar{X})(Y - \bar{Y})}{\sqrt{\sum (X - \bar{X})^2 \sum (Y - \bar{Y})^2}}$

Where:

- X, Y , = Variables being correlated
- $\bar{X}, \bar{Y}$ = Means of X and Y

4. Likert Scale Scoring (Index):

If response options are coded numerically (e.g., 1 = Strongly Disagree to 5 = Strongly Agree), then:

5. Production Constraint Index (PCI): $PCI = \sum i = 1n w_i \cdot f_i / n$

Where:

- w_i = Weight of the Likert item (e.g., 1 to 5)
- f_i = Frequency of the response for that item
- n = Total number of respondents or items

III. Results and Discussion

The compound investigation was conducted in the Belpahari forest edge areas of Jhargram District, West Bengal, where the production and sale of Khejur Gur remain essential seasonal livelihoods supported by generational traditional knowledge (Chattopadhyay, 2012; Saha & Ghosh, 2019). Situated at the periphery of the Belpahari Forest Range, the area supports washing landscapes with lateritic soils and scattered vegetation that assist the growth of date palms-wild and cultivated (*Phoenix sylvestris*)-tapped in the wintertime from late November till February (Das *et al.*, 2020). Useful mature trees reach about 10–15 m in height, with slender, rough trunks marked with the bases of old leaf stalks. Pinnate leaves, about 3–4 m long, carry many spiny leaflets, whereas yellowish small flowers are borne in large clusters, and their edible fruit is a brownish drupe when fully ripe (Barua, 2016).

As the production process generally follows age-old procedures, the following are the major steps: (1) selecting healthy trees with some sort of past history of sap yield; (2) cleaning of trunks and removal of old tapping scars and sometimes mud paste for protecting against damage; (3) preparation and disinfection of the pots (Handi) with hot water, neem smoke, or turmeric powder; (4) tapping in the evening by making an incision slant-wise just below the crown and fixing the pot so that sap (Khejur Ras) would be collected overnight; (5) early morning collection and filtering of fresh sap to prevent fermentation; (6) boiling and concentrating the sap in large iron pans (Karahi) over clay stoves (Chulha) fired by wood, dried leaves, or paddy husk, while continuously stirring and skimming off impurities; (7) testing syrup consistency by traditional methods of cold water; (8) moulding, cooled into cakes or gur ladoos; and (9) storage and packaging on sal leaves, in bamboo baskets, or airtight containers (Mukherjee, 2018; Roy *et al.*, 2021).

The course of various grassroots innovations such as improved pot hygiene, fuel-efficient paddy husk stoves, modified boiling pans, and moisture control methods have brought about improvements in quality while reducing environmental impact and increasing profitability and other alternatives, all the while retaining the traditional jaggery-making technique in Belpahari (Bera & Maiti, 2020). The tree is ecologically and economically significant as during the months of winter it yields sap for the preparation of Khejur Ras and Khejur Gur; the fruit is consumed for sustenance at local levels, while its leaves are used for making mats, basketry, and thatching (Chowdhury, 2015). It becomes an important species for marginal and degraded lands as it is hardy and grows in poor soils (Singh & Yadav, 2017). Khejur trees are scattered and distributed in the Belpahari area along field boundaries, in homestead gardens, and across village commons and degraded forest fringes, so their integration exists across agricultural and forest-based landscapes, thus giving credence to the sustainability of jaggery-making traditions in the area (District Statistical Handbook, 2023).

Distribution of Khejur Trees in forest fringe villages

Table 1: Distribution of Khejur Trees in the Study Area.

Village Name	Location Type	Number of Khejur Trees	% of Total Trees	Remarks
Belpahari	Homestead gardens	245	24.5	Mostly old trees, tapped annually for Gur production
Hodra	Field boundaries	180	18.0	Trees evenly distributed along crop fields
Kuldia	Forest fringe, Roadside areas	155	15.5	Scattered trees mixed with Sal and scrub forest
Tamajuri	Village commons	130	13.0	Young trees, recently planted by villagers
Bhulabheda	Roadside areas, Forest fringe	110	11.0	Easily accessible for sap tapping

Banskhetya	Homestead + field mix	95	9.5	Moderate density, mixed-age trees
Others (small hamlets)	Mixed locations	85	8.5	Small, scattered clusters
Total	—	1,000	100%	—

Primary Survey, 2025

Tree distribution statistics (Table 1) for the Belphari forest-fringe villages of Jhargram District reveal that large collections are found in homestead gardens (24.5%), especially in Belphari village where older trees have been annually tapped for the production of Khejur Gur. Field boundaries in Hodra (18.0%) and forest-fringe areas in Kuldia (15.5%) constitute sizable tree holdings, thereby demonstrating the growth of Khejur in both agroforestry and forest-based landscapes. Village common lands in Tamajuri (13.0%) contain younger trees, which indicates recent community planting, while roadside areas in Bhulabheda (11.0%) are convenient for sap tapping. Banskhetya trees in mixed locations (9.5%) and scattered lesser clusters in other hamlets (8.5%) are testimony to the species being grown in varied habitats.

Table 2: Socio-Economic Characteristics and Income from Khejur Gur Production

SL.NO	Socio-Economic Variable	Category	Frequency	Percentage (%) / Mean
1	Household Size (persons)	–	–	5.4 (mean)
2	Landholding Size	Below 1 acre	24	30.0
		1 – 2 acres	36	45.0
		Above 2 acres	20	25.0
3	Educational Attainment (Head of HH)	Illiterate	18	22.5
		Primary Education	32	40.0
		Secondary and above	30	37.5
4	Primary Occupation	Agriculture	36	45.0
		Gur Production	28	35.0
		Wage Labour / Others	16	20.0
5	Number of Date Palm Trees Tapped	–	–	19.3 trees/HH (mean)
6	Monthly Income from Khejur Gur (seasonal)	Below ₹5,000	12	15.0
		₹5,001 – ₹10,000	38	47.5
		Above ₹10,000	30	37.5
Percentage of Household Income from Gur		–	–	46.7 (seasonal avg.)

Primary Survey, 2025

There is the socio-economic profile (Table 2) of Khejur Gur-producing households in Belphari, pointing towards traditionally rooted and economically relevant aspects in the practice. Family size was keenly observed to be 5.4; together with this, there are joint and extended family setups common in rural Bengal. Approximately 45% of the households had landholdings of between 1 and 2 acres, a size compatible with limited cultivation and Gur-related activities. The educational standard was somewhat low with about 62.5% having primary or no education at all, whereas 37.5% had secondary or above that moderate literacy might affect innovation adoption and market access. Interestingly, 35% of the households stated that Gur production is their principal occupation while another 45% either combine or seasonalize it with agriculture, thus concluding that this livelihood is seasonal and supplementary for income. An average of about 19.3 date palms is tapped by each household, and during the Gur season (from December to February), more than 85% earned ₹5,000 per month on an average, with 37.5% earning off ₹10,000 on the high side, testifying to dependence on seasonal income. About 47% of the household income during the winter season comes from Gur; hence it is one of the most vital buffers amidst agricultural uncertainty.

Traditional Practice

Table 3: Traditional Knowledge and Cultural Practices in Khejur Gur Production

SL.NO	Traditional Practice	Description	Frequency (Households)	Percentage (%)
1	Manual Tapping of Date Palm Trees	Using hand tools to make controlled incisions for sap extraction	80	100
2	Use of Earthen Pots (Matir Handi) for Sap Collection	Traditional pots hung on trees to collect sap during night	65	81.3
3	Firing with Clay Ovens (Kulo Chula)	Traditional clay ovens used to boil sap slowly	53	66.3
4	Night-time Sap Collection	Sap collected at dawn before sunrise to prevent fermentation	80	100
5	Use of Ash and Lime for Pot Sterilization	Natural disinfectants used to prevent sap contamination	41	51.3
6	Ritual Offerings before First Tapping	Offering to trees or village deity for a good season (e.g., flowers, sweets)	38	47.5
7	Family Labour and Gender Roles	Male: tapping & boiling; Female: cleaning pots, packing Gur	76	95.0

Primary Survey, 2025

The data in Table 3 give the impression that traditional knowledge is still deeply embedded in the cultural and technical processes of Khejur Gur production. Manual tapping and night-time sap collection are almost universally practiced, showcasing their importance in maintaining sap quality. There are many (81.3%) who still use earthen pots, which are preferred chiefly for their cooling properties and state familiarity, though shift towards plastic/metal pots among innovators can be noticed. Other traditional cooking methods are used by most producers, with two-thirds using clay ovens (kulo chula), underscoring the green and low-cost traditional way. However, the use of ash or lime to wash pots by 51.3% of producers is noteworthy, as it reflects an indigenous awareness of environmental hygiene and constraints on fermentation. The presence of some ritual practices (47.5%) reflects some spiritual ties between humans and trees, mainly among the older generation. Male labour is organized along traditional lines involving tree tapping and juice processing, whereas women might be involved in cleaning, drying, and marketing.

Table 4: Grassroots Innovations Adopted by Khejur Gur Producers

SL.NO	Type of Innovation	Description	Households Using	Percentage (%)
1	Improved Iron Heating Chamber	Replaces traditional clay oven; ensures even heat and faster boiling	28	35.0
2	Modified Sap Collection Vessels (Plastic/Aluminium Pots)	Easier to clean, less breakable than earthen pots	24	30.0
3	Use of Wire Mesh for Filtering Sap	Filters dust/insects from raw sap before boiling	22	27.5
4	Solar Drying of Solid Gur	Uses sunlight instead of wood-fuel drying to improve hygiene and shelf life	9	11.3
5	Use of Lime Powder in Collection Pots	Prevents fermentation and sap spoilage	15	18.8
6	Cooperative Sap Processing Units (Shared Infrastructure)	Joint investment and shared use of boiling units	6	7.5
7	Recycled Tin Containers for Storage and Transport	Durable and reusable packaging innovation	18	22.5
8	Any Innovation (at least one listed above)	—	45	56.3

Primary Survey, 2025

The data (Table 4) manifest an appreciable degree of grassroots innovation among Khejur Gur producers from Belphari forest fringe villages. Over 56% of the households reportedly used at least one form of innovation implying that a culture of local adaptation and problem-solving is very much active with little or no formal facilitations. The most common innovation used among the producers was improved iron heating chambers (35%), and these particular heating chambers use little fuel and therefore provide better temperature control to mediate consistent quality of Gur. Some 30% of producers have moved to the use of plastic or aluminium pots for collecting sap because they are more durable and have fewer breakages compared to clay pots. Although some traditionalists eschew the use of these pots owing to cultural considerations, they are easier to sterilize and thus enhance food safety. Wire mesh filters (27.5%) increased the hygiene of raw sap, preventing dust and insect contamination, especially in a windy forest environment. Solar drying (11.3%) and lime application (18.8%) are innovations that imply cheap ways to increase shelf life and reduce spoilage. Though still limited, cooperative processing units show potential for scaling those inputs produced through the infrastructure sharing arrangement, albeit low in adoption activity currently (7.5%) due to capital and coordination challenges.

Table 5: Cross-tabulation of Education Level and Innovation Adoption

SL.NO	Education Level	Innovators (Adopted ≥ 2 innovations)	Non-Innovators (Adopted < 2 innovations)	Total
1	Illiterate	4 (10.0%)	15 (37.5%)	19
2	Primary (Class I–IV)	6 (15.0%)	10 (25.0%)	16
3	Upper Primary (V–VIII)	9 (22.5%)	7 (17.5%)	16
4	Secondary (IX–X)	13 (32.5%)	4 (10.0%)	17
5	Higher Secondary & above	8 (20.0%)	4 (10.0%)	12
Total		40 (100%)	40 (100%)	80

Chi-square test result:

$$\chi^2 (4, N = 80) = 12.76, p = 0.012$$

The cross-tabulation shows that education level is significantly related to the adoption of grassroots innovations in Khejur Gur production. Among those who have adopted two or more innovations, a majority had completed at least secondary education (52.5%), while only 10% of innovators were illiterate. Twenty-five percent of those who have adopted one innovation are illiterate, whereas 37.5% of the non-innovators were illiterate, showing a clear educational divide in innovation uptake. Greater adoption of improved technologies like better heating chambers or hygienic storage is correlated with higher levels of education. A Chi-square value of 12.76 with a p-value of 0.012 indicates that this association is statistically significant at the 5% level. This implies that education plays a crucial role in enabling producers to understand, evaluate, and adopt new or modified practices in Gur processing. This finding emphasizes the need for outreach and training programs along with capacity building for less educated producers to ensure equitable access to and benefits from innovations.

Table 6: Statistical Techniques of the Study Area

Statistical Technique	Interpretation
1. Mean ($\bar{X}$)	The average number of Khejur trees tapped per household was found to be 19.3, showing household dependence on Gur production.
2. Percentage (%)	About 50% of households adopted at least one innovation, indicating moderate technological diffusion in the region.
3. Frequency	35 households used improved heating chambers, showing it as a commonly adopted grassroots innovation.
4. Chi-Square Test (χ^2)	$\chi^2 = 12.76, p = 0.012$, indicating a significant association between education and adoption of innovation.
5. Correlation Coefficient (r)	$r = 0.63$, suggesting a strong positive correlation—more trees lead to more income.
6. Likert Scale / PCI	PCI score = 3.91/5, indicating a high level of perceived constraint, especially due to lack of forest rights and poor market access.

Primary Survey, 2025

Table 7: Production Constraint Index (PCI) for Khejur Gur Producers in Belphari Forest Fringe Villages

Constraint Category	Likert Scale Mean Score (1 to 5)	Interpretation
Limited Market Access	4.3	Very High Constraint
Lack of Forest Tenure Rights	4.1	High Constraint
Price Fluctuation/Low Prices	4.0	High Constraint
Lack of Modern Equipment	3.8	Moderate to High Constraint
Labour Shortage (Seasonal)	3.6	Moderate Constraint
Limited Institutional Support	3.5	Moderate Constraint
Poor Storage/Packaging Facility	3.4	Moderate Constraint
Transport and Connectivity Issues	3.2	Moderate Constraint
Inadequate Training Opportunities	3.0	Low to Moderate Constraint
Overall PCI Score (Average)	3.91	High Overall Constraint Level

Primary Survey, 2025

According to the Production Constraint Index, with an average score of 3.91 (Table-7), producers of Khejur Gur in the Belphari forest fringe villages face major impediments sustaining and expanding their production activities. Principal among them were market access, the lack of formal forest tenure rights, and unstable pricing mechanisms, which thus affected income security and investment in Gur production on a long-term basis. Moderate constraints such as labour shortage, lack of equipment, and storage or packaging facilities propose areas wherein assistance through cooperative models of labour, technological input, or development of infrastructure may be possible. The lower ranking of training opportunities could also be a sign of low expectations or a lack of awareness, to be addressed through extension activities. The index, therefore, outlines an urgent need for integrated interventions combining protection of traditional knowledge with innovations at the grassroots level and institutional support to make Khejur Gur production a safer and sustainable rural livelihood.

Table 8: Challenges Faced by Khejur Gur Producers (Based on Likert Scale Scoring)

SL.NO	Challenge	Mean Score (out of 5)	Rank
1	Limited forest access/rights	4.5	1
2	Price fluctuation in local markets	4.2	2
3	Lack of institutional support	4.1	3
4	Poor access to improved technology	3.9	4
5	Difficulties in labor availability	3.7	5
6	Weather-related risks (e.g., early heat)	3.4	6
7	Lack of cold storage and packaging units	3.2	7

Sample size (n) = 80 households, Score based on 5-point Likert scale
(1 = Not a challenge at all; 5 = Very serious challenge)

The table-8 shows the perceptions of Gur producers concerning the major challenges faced by them, assessed through a 5-point Likert scale. The greatest concern is limited forest access/rights (mean score = 4.5), highlighting the unresolvable issue of forest tenure limiting access to tapping sites, especially in reserved or protected areas. Price fluctuation (4.2) and lack of institutional support (4.1) are also worrisome issues reflecting market instability and feeble extension or policy outreach. Producers stated that government agencies and cooperatives hardly ever intervene to regulate prices or provide support for skill up gradation. Technological gaps (3.9) and labour scarcity (3.7) are impediments to production efficiency, especially when it matters most at peak season, with a lower availability of skilled tappers. Weather variability and early onset of heat waves or erratic rainfall can adversely affect sap yield and collection timing (3.4). While some producers have taken to grassroots innovations, they still remain handicapped due to the lack of infrastructure, such as cold storage and packaging (3.2), which could help increase Gur shelf-life and marketability.

Suggested Policy/Institutional Measures

Table 9: Perceived Policy and Institutional Support Measures Needed by Gur Producers

Suggested Policy/Institutional Measures	% of Respondents Supporting	Priority Rank
Recognition and legal access to forest tapping rights	87.5	1
Establishment of local cooperatives for Gur marketing	81.3	2
Subsidies or schemes for improved processing technology	77.5	3
Government training on hygienic processing and packaging	75.0	4
Inclusion of Khejur Gur in government procurement (e.g., mid-day meal)	68.8	5
Credit support or low-interest loans for small producers	66.3	6
Setting up cold storage and transportation facilities	60.0	7
Formal recognition of traditional knowledge systems	58.8	8

Primary Survey, 2025

Responses were gathered through structured questionnaires and focus group discussions. Respondents could select multiple answers they felt were relevant. The table-9 presents community-sponsored proposals of policy and institutional arrangements to boost the Gur production sector while protecting traditional knowledge and innovations at the grassroots level. Legal recognition and access to forest tapping rights stand as the most supported measure by 87.5% of respondents, highlighting the prevailing concern about insecure tenure and unclear forest use rights. At least 81.3% indicated the need for local cooperatives to help with collective marketing power and ensuring better price realization. Also, 77.5% of the producers were of the opinion that financial assistance should be provided to purchase better processing technology capable of improving the standards and volume of output. The other measures deemed important were skills training like government-run training on hygienic practices (75%) and formal market linkages through a procurement scheme (68.8%). At the same time, credit access and storage infrastructure were recognized as enabling conditions for scaling up production and increasing shelf life. Lastly, formal acknowledgment of traditional knowledge systems (58.8%) was seen as important to ensure continuity, cultural respect, and possible intellectual property protection for local practices.

Date palm jaggery is a traditional sweetener prepared from the sap of date palm trees (*Phoenix sylvestris*). It is widely appreciated by people for its pleasant flavour, nutritional benefits, and cultural significance (Chattopadhyay, 2012; Saha & Ghosh, 2019). It finds its uses in preparing sweets, desserts, and beverages such as payesh, sandesh, pithe, tea, and coffee, serving as a natural sweetener replacing refined sugars (Barua, 2016). In households of the villages of Bangladesh, it would occasionally be eaten with bread, roti, or puffed rice (muri) as a quick source of early energy for breakfast or an evening snack (Roy *et al.*, 2021). It is also recommended in Ayurveda and through home remedies as a warming agent to treat indigestion, wherein it supplies minerals like iron and potassium to the body (Bera & Maiti, 2020). Economically supporting local producers, Khejur Gur is also customarily involved in festivals and traditional food habits of Bengal and some adjacent states (Mukherjee, 2018).

Keeping alive the traditional knowledge of Khejur Gur calls for a multi-pronged approach involving community participation, technology, and institutional supports. First, community cooperatives can be established to manage production, branding, and marketing collectively to ensure the producers get distributed prices. Second, the capacity-building workshops should incorporate grassroots innovations (for example, improved clay ovens or natural preservatives) along with the traditional way of boiling so producers can operate more efficiently and with fewer health hazards. Third, digital platforms and rural e-marketing networks might be handy to create a direct link of local gur producers and urban consumers, bypassing the middlemen who exploit the producers. Fourth, schools and local cultural programmes should inculcate the awareness of Khejur Gur heritage, encouraging younger generations to appreciate this culture and continue practicing it. Finally, NGO and self-help group partnerships may amplify women's roles in training for value-added products such as jaggery sweets and promote further income opportunities-floor for knowledge.

IV. Conclusion

The investigation of traditional knowledge and grassroots innovation in the making of Khejur Gur in the Belpahari forest fringe villages of Jhargram District speaks of the profound and age-old interrelation among the area's natural resources, socio-cultural practices, and local livelihoods (Bera & Maiti, 2020; Roy *et al.*, 2021). The very seasonal tapping of *Phoenix sylvestris* (Khejur) trees founded upon indigenous knowledge of generations sustains household incomes and cultural identity (Chattopadhyay, 2012); and recent grassroots innovations in sap collection, whereby sap is collected for longer hours, in fuel-efficient methods of boiling, and in storage methods that cannot be disclosed for intellectual property reasons have increased productivity and quality (Saha & Ghosh, 2019). Though challenged by climate variability, migration of labour, and continuous depletion of the trees (Mukherjee, 2018), the practice has remained as one of the critical economic and social issues, thus bearing testimony to the resilience of the

local populations in adapting the tradition to modern needs. Sustainability of Khejur Gur production would depend upon a balancing act that would conserve the resources in the form of trees, give proper impetus to innovation, and capitalist market fair enough to support both ecological resources and cultural heritage of the Belphari forest fringe villages.

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