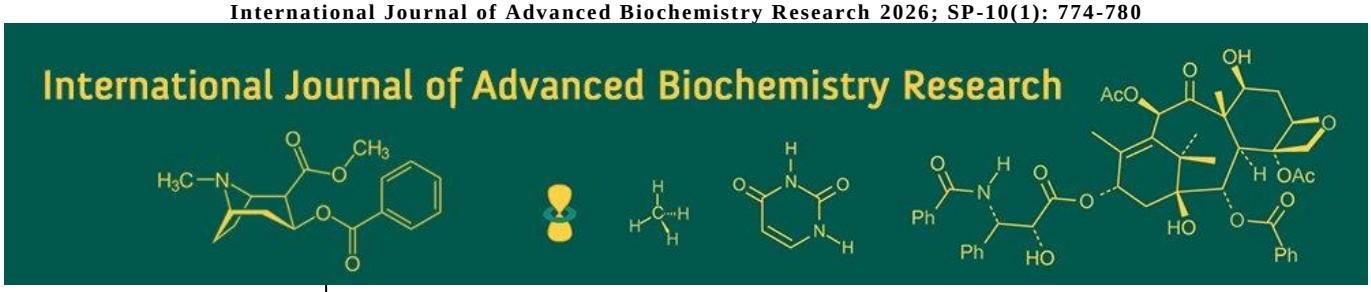

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Pejua Biri: An underexplored indigenous blackgram (*Vigna mungo* L.) landrace of Keonjhar district of Odisha with significant genetic and agronomic potential

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Abstract
Pejua Biri is a traditional landrace of blackgram (*Vigna mungo* L.) cultivated predominantly by tribal farmers in Telkoi, Banspal, Sadar, and Harichandanpur blocks of Keonjhar district, Odisha. It represents an important component of local agrobiodiversity, food security, and cultural heritage. The crop exhibits a trailing growth habit, and farmers provide simple supports using sticks, shrubs, or crop residues. This practice promotes branching, increases pod formation, and ultimately enhances yield, reflecting a low-input, sustainable cultivation system. Despite its adaptability and resilience, Pejua Biri produces lower yields compared to high-yielding modern varieties. However, its superior seed quality, cooking properties, and flavor justify this compromise, making it highly valued for traditional culinary uses, particularly in festive and ritual contexts. Pejua Biri has a strong market and cultural connection with *Phula Badi*, a traditional sun-dried blackgram product prepared from its seeds. *Phula Badi* is highly preferred across Odisha and by Odias residing outside the state and abroad, demonstrating national-level demand. While tribal farmers often sell Pejua Biri at low prices to traders, the processed *Phula Badi* commands significantly higher market value, highlighting a gap in equitable benefit-sharing. Despite its cultural and culinary importance, Pejua Biri has considerable potential for genetic improvement to enhance yield, stress tolerance, and adaptability. Simultaneously, optimizing agronomical practices such as field preparation, trailing support, pest management, and intercropping can further increase productivity while maintaining its superior quality. Combining traditional knowledge with modern breeding and agronomic interventions is, therefore, the need of the hour to ensure both conservation and enhanced livelihood benefits for tribal farmers.

Keywords: Blackgram, climate change, genetic improvement, landrace, Pejua Biri

Introduction
"Pejua Biri" is a traditional landrace of blackgram (*Vigna mungo* L.) indigenous to the Keonjhar district of Odisha, India. This local variety, cherished by farmers for generations, has adapted over time to the unique agro-climatic conditions of the region. Despite its potential, Pejua Biri has remained largely unexplored in terms of its genetic resources, limiting its use in modern agriculture and crop improvement programs (Majhi *et al.*, 2024) [7]. Pejua Biri holds cultural and economic importance in the Keonjhar district. It is well-regarded for its resilience to local environmental stresses, including drought, low soil fertility, and pest pressures. This resilience is a result of the landrace's natural adaptation to the local conditions over many years. Additionally, Pejua Biri is known for its nutritional quality, particularly its high protein content, which makes it an essential component of the local diet. However, the cultivation of Pejua Biri has declined in recent years, largely due to the introduction of high-yielding, commercially bred blackgram varieties (Majhi *et al.*, 2024) [7]. These modern varieties often overshadow traditional landraces like Pejua Biri due to their higher productivity and market demand. Although Pejua Biri produces lower yields compared to modern high-yielding blackgram varieties, its superior seed quality, taste, and suitability for traditional products like Phula Badi justify this compromise (Anon., 2020) [6]. Farmers and consumers prioritize its unique culinary and cultural attributes over quantity, making Pejua Biri a valuable landrace despite modest productivity.

Yet, Pejua Biri's genetic diversity offers a rich resource for breeding programs aimed at developing new varieties with enhanced resilience, nutritional quality, and adaptability to changing climatic conditions. Thus, the present review discussed the significance of Pejua Biri, the efforts to unlock its hidden genetic potential, and the broader implications for sustainable agriculture and food security.

Geographic Distribution of Pejua Biri Cultivation in Keonjhar District

Pajua Biri is largely cultivated in Telkoi, Banspal and pockets of Sadar and Harichandanpur blocks of Keonjhar district, Odisha. This locally adapted genotype has been maintained by farmers for generations and forms an important component of household cropping systems and food culture in the region (Majhi *et al.*, 2024) [7]. Pajua Biri typically exhibits moderate plant height, indeterminate growth habit and a spreading canopy suited to mixed cropping and marginal soils. Farmers report reliable flowering and maturity under the district's variable rainfall, good tolerance to short dry spells, and stable yield across heterogeneous micro-environments. Seeds are medium-sized, glossy black and preferred for local culinary uses because of favorable cooking quality and taste. The landrace often shows resilience to local pests and diseases compared with improved, non-adapted varieties, likely reflecting valuable genetic variation for stress tolerance. Pajua Biri is integral to local food security and traditional diets, used in dals, snacks and seasonal preparations. Because seed is saved and exchanged within communities, the landrace also underpins social seed networks and local agrobiodiversity. Pajua Biri represents a locally valuable genetic resource for Keonjhar; conserving and studying it will benefit both farmer livelihoods and blackgram improvement efforts.

Pejua Biri makes the Phulabadi of Keonjhar exclusive-A marketing connection

Pejua Biri has a deep and inseparable connection with Phula Badi, one of the most cherished food products of Odisha. The superior cooking quality, taste, and texture of Pejua Biri make it highly preferred for preparing Phula Badi (Anon., 2020) [6]. Unlike ordinary blackgram, it yields a smoother paste and better puffed texture, giving Phula Badi its distinct identity. The marketing link is significant: while farmers in Keonjhar cultivate and sell Pejua Biri, it is the processed product, Phula Badi, that captures wide consumer demand (Majhi *et al.*, 2024) [7]. The floral design, texture, taste and process of preparation are distinctly different from the badi-making culture of rest of Odisha. It not only looks like a flower but is also light-weight like a flower like the various hues of flowers (Figure-1). It is crispy and puffy unlike the varieties of badis prepared across Odisha that makes it popular both as snacks and as supplements with meals," explained several women of Atopur in Keonjhar town who are known to be the oldest and best producers of Phulabadi. Phula Badi prepared from Pejua Biri is not only popular within Odisha but also has a national market reach, being highly sought after by Odias living outside the state and abroad. This cultural delicacy has become a medium through which Pejua Biri connects local tribal agriculture with global Odia communities. However, the economic benefits are uneven. Farmers often sell the raw grain at low prices to traders, while the value-added Phula Badi fetches much higher prices in state and national markets. Despite this, the cultural reputation of Pejua Biri remains intact, as consumers continue to associate it with authentic Phula Badi (Anon., 2020) [6]. This creates a strong opportunity for branding and market recognition, which could ensure fairer returns to the tribal cultivators who conserve and grow this valuable landrace.

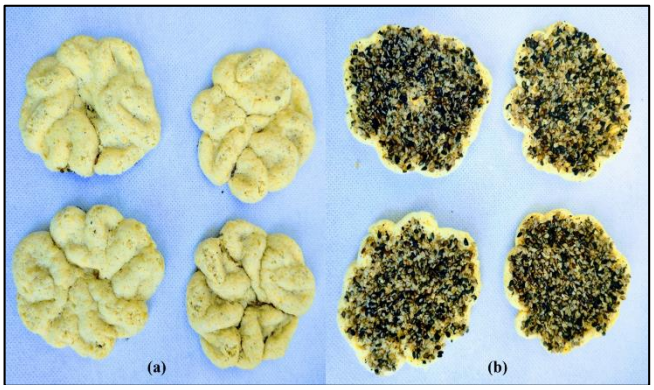

Fig 1: Traditional Phulabadi prepared from Pejua Biri (blackgram) of Keonjhar district, Odisha: (a) freshly shaped and sun-dried flower-like Phulabadi (front view) and (b) Phulabadi coated with sesame seeds (til) (back view).

Agronomical Practices of Pejua Biri Cultivation by Tribal Farmers in Keonjhar

Pejua Biri holds immense cultural and agricultural significance for the tribal communities of Keonjhar district. Unlike improved varieties, this landrace is deeply rooted in local traditions and is cultivated through indigenous practices that have been handed down across generations. The agronomical practices followed by the tribal farmers reflect a close integration of agriculture, culture, and environment.

Cultural Link and Sowing Time

The sowing of Pejua Biri is closely associated with the festival of *Rakhya Bandhan*, which is celebrated in August. Tribal farmers consider this festival an auspicious marker of the agricultural calendar, and sowing begins immediately after its celebration. The timing coincides with the late monsoon showers, ensuring sufficient soil moisture for seed germination and early growth. This cultural linkage not only determines sowing time but also strengthens the community's sense of harmony with nature and tradition.

Field Preparation and Cropping System

Before sowing, farmers prepare the land by clearing hill slopes and uplands, a practice that aligns with traditional *podu* or shifting cultivation systems. Vegetation is cut, dried, and sometimes lightly burnt to enrich the soil with organic matter. This method, though labor-intensive, provides fertile conditions for short-duration crops like blackgram. Sowing is usually done by broadcasting or line sowing with simple hand tools, reflecting minimal input use but maximum reliance on ecological balance.

Cultivation Practices

Pejua Biri is grown without chemical fertilizers or pesticides. The crop largely depends on natural soil fertility and residual moisture from the monsoon. Weeding is carried out manually once or twice during the crop cycle to reduce competition from weeds. The hardy nature of this landrace, coupled with its resilience to local pests and diseases,

ensures a stable yield even under low-input conditions. Harvesting is done by hand when the pods turn black and crisp, and seeds are stored for household consumption and the next season's sowing.

Crop Growth and Trailing Support

Pejua Biri has a trailing growth habit. To utilize this feature, farmers provide natural support using small wooden sticks, crop residues, or nearby shrubs. This practice allows the plants to spread properly, reduces lodging, and improves light interception. With better support, plants develop more branches, which in turn bear a higher number of pods. This traditional practice significantly contributes to enhancing yield without additional costs, making it a farmer-friendly innovation.

Yield and Sustainability

Despite being cultivated under shifting cultivation and marginal conditions, Pejua Biri provides good yields according to farmers' experiences. Its ability to thrive in rainfed uplands makes it a reliable food source for tribal households. Moreover, the practice of saving and sharing seeds maintains genetic diversity and ensures self-reliance within the community. The agronomical practices followed by tribal farmers for Pejua Biri cultivation exemplify sustainable farming rooted in cultural traditions. By linking agricultural operations with festivals, utilizing shifting cultivation for soil fertility, and relying on indigenous knowledge rather than external inputs, tribal communities preserve not only a landrace of high value but also a holistic farming system. Pejua Biri thus stands as a symbol of resilience, tradition, and food security for Keonjhar's tribal farmers.

Seed Sharing and Barter Practices

A unique aspect of Pejua Biri is the traditional barter system practiced in Keonjhar villages. Farmers exchange blackgram with rice through local vendors in weekly village markets (haats). In the tribal communities of Keonjhar, *mana* is a traditional unit of measurement used for selling and buying seeds, including Pejua Biri. In this system, one 'mana' (approximately, 800 g by weight) of blackgram is traded for two mana of rice. This practice reflects the deep-rooted traditional economy of the region, where seeds are not only valued as commodities but also as symbols of food security and community-level food exchanges. Such barter not only sustains traditional seed systems but also strengthens social ties among farming families.

Trade and Market Exploitation

Despite its importance, tribal farmers often face exploitation in the market chain. Traders purchase blackgram directly from them at low prices but later sell it in urban and local markets for ₹100-150 per kg. This disparity limits farmers' economic gains, even though the landrace holds high culinary and cultural demand.

Cultural and Festive Significance

Pejua Biri plays a special role during Prathamastami, a festival celebrated in December to honor the first-born child of the family. The freshly harvested seeds are highly sought after during this period. They are used in preparing a variety of traditional dishes and puddings, showcasing the deep culinary connection of this landrace. The demand during the festival season boosts its cultural value, though the profits are often reaped more by traders than the primary cultivators.

Research Progress and achievements on Pejua Biri

Despite the immense cultural, culinary, and economic importance of Pejua Biri, research on this valuable blackgram landrace has been very limited. Recognizing its significance, the Regional Research and Technology Transfer Station (RRTTS), Odisha University of Agriculture and Technology (OUAT), Keonjhar, has recently from the year 2021 reinitiated systematic research activities on Pejua Biri (Majhi *et al.*, 2024) [7]. The current research encompasses germplasm collection from major cultivation areas, including Telkoi, Banspal, Sadar, and Harichandanpur blocks. Morphological characterization of the collected accessions is being conducted to document agronomic traits such as plant height, pod length, branching pattern, seed size, and yield components (Figure-2). Special attention is given to its trailing growth habit, which contributes to better branching and pod formation when supported, and its superior seed quality, which makes it highly suitable for traditional dishes and Phula Badi (Majhi *et al.*, 2024) [7]. Genetic characterization using modern tools is underway to assess variability within the landrace and identify traits associated with disease resistance, stress tolerance, and cooking quality. These studies aim to develop improved lines through breeding while conserving the original genetic identity and culinary attributes of Pejua Biri. In addition to agronomic and genetic studies, research is also focusing on value chain analysis and market linkages, particularly its connection with Phula Badi, a sun-dried blackgram product with national demand. Understanding the market dynamics will help in devising strategies for fair pricing, farmer empowerment, and promotion of Pejua Biri as a niche product.

The renewed research initiative has thus laid the foundation for conservation, genetic improvement, and sustainable utilization of Pejua Biri. It integrates traditional knowledge with modern scientific approaches, aiming to enhance productivity, maintain quality, and strengthen livelihoods of tribal farmers while preserving this culturally important landrace. The ongoing efforts demonstrate that Pejua Biri is not only a crop of local significance but also a promising resource for future breeding and value addition programs. Given its adaptation and desirable grain quality, Pajua Biri is a promising candidate for on-farm conservation, participatory varietal selection, and inclusion in genetic improvement programmes as a donor of adaptive traits. Actions recommended include systematic characterization (morphological and molecular), multi-site evaluation, community seed-banking, and participatory breeding with local farmers to retain its unique qualities while improving yield and market traits.

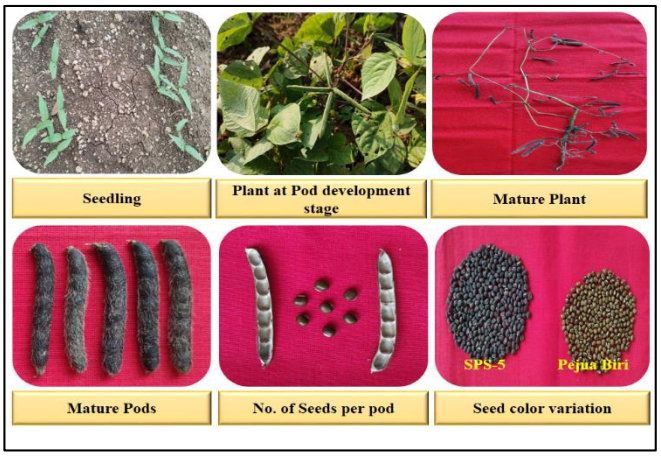

Fig. 2: Growth stages and key morphological characteristics of the indigenous blackgram landrace Pejua Biri from Keonjhar district, Odisha, depicting seedling establishment, plant at pod development stage, mature plant architecture, mature pods, number of seeds per pod, and seed colour variation in comparison with the check variety SPS-5.

Germplasm collection and Genetic purification

The first step was to thoroughly characterize the Pejua Biri landrace, including its morphological, physiological, and genetic traits. Recognizing its importance and the urgent need for conservation, the scientists of the Regional Research and Technology Transfer Station (RRTTS), OUAT, Keonjhar have initiated systematic research beginning with germplasm collection and awareness creation. The germplasm collection drive was carried out in the major cultivation areas of Pejua Biri, namely the Telkoi, Banspal, Harichandanpur, and Sadar blocks of Keonjhar district (Majhi *et al.*, 2024) [7]. Farmers from different villages actively participated in this initiative by contributing seeds of Pejua Biri from their own saved stock. Each collection was carefully documented, noting the village of origin, block, and the name of the farmer who shared the seed, thereby ensuring traceability and honoring the contribution of farming families. To ensure community participation, awareness programmes were organized across villages to sensitize farmers about the significance of conserving local landraces like Pejua Biri. Farmers were educated about the role of genetic diversity in ensuring long-term food security and were encouraged to maintain purity of the genotype through careful seed selection and preservation. Such initiatives also highlighted how traditional crops like Pejua Biri carry immense value for both livelihood improvement and cultural identity.

The collected germplasms were subsequently sown in observation strips at RRTTS, Keonjhar, where they are being grown, monitored, and characterized. Each plot bears the name of the farmer who provided the seed, reflecting a farmer-scientist partnership and recognizing the community's role in conserving this genetic resource. Importantly, the process has been mutually enriching. Scientists did not just collect seeds but also learned from the experienced traditional farmers about the cultivation practices associated with Pejua Biri. Farmers shared insights on shifting cultivation methods, sowing after Raksha Bandhan, supporting the trailing habit for better branching, and traditional seed exchange systems. These farmer-driven practices provide valuable context to scientific research and can guide future agronomic recommendations. Characterization focuses on documenting morphological traits such as growth habit, branching pattern, pod formation, seed size, and yield potential, alongside resistance to local stresses. This initiative marks an important milestone in the systematic conservation and scientific evaluation of Pejua Biri. By combining traditional farmer knowledge with scientific research, OUAT aims to conserve the genetic wealth of this landrace and create opportunities for its future genetic improvement, wider recognition, and sustainable utilization (Majhi *et al.*, 2024) [7]. Thus, the germplasm collection and documentation efforts represent a collaborative model of conservation, where scientific inquiry is strengthened by traditional knowledge. This partnership between farmers and researchers ensures that Pejua Biri is not only preserved as a genetic resource but also celebrated as a living tradition of the tribal communities of Keonjhar.

Agro-morphological characterization of Pejua Biri

Based on the agro-morphological characteristics, Pejua biri can be very distinctly differentiate than the other type of blackgram genotypes as reported by the research findings of RRTTS, OUAT, Keonjhar. This landrace is having several distinctive morphological characteristics compared to other improved varieties (Annual Report, 2022-23; 2023-24; Majhi *et al.*, 2024) [1, 2, 3, 7]. The leaves of Pejua Biri are flat and light green, whereas improved varieties have pointed, dark green leaves. Additionally, Pejua Biri's leaves are more glabrous (hairless) compared to the less glabrous leaves of the improved varieties. In terms of pod and flower characteristics, Pejua Biri produces flat pods, while improved varieties have round pods. The flowers of Pejua Biri are yellow, contrasting with the light yellow flowers of the improved varieties. Seed attributes also differ notably. Pejua Biri has large, bold, olive green seeds, while improved varieties feature medium-sized, bold, black seeds (Annual Report, 2021-22; 2022-23; Majhi *et al.*, 2024) [1, 2, 3, 7]. Pejua Biri yields 6-7 seeds per pod compared to 7-8 seeds per pod in improved varieties. Furthermore, the 100-seed weight for Pejua Biri is 7.6 grams, which is higher than the 6.2 grams observed in improved varieties. Seed yield per plant is 10.66 grams for Pejua Biri, significantly lower than the 18.68 grams per plant of improved varieties. Pejua Biri plants are bushy, in contrast to the straight growth habit of improved varieties. The branching habit of Pejua Biri is trailing, while improved varieties exhibit top branching. Pejua Biri has a longer duration of 85-90 days to maturity, compared to the shorter to medium duration of 70-75 days for improved varieties (Annual Report, 2021-22; 2022-23; 2023-24; Majhi *et al.*, 2024) [1, 2, 3, 7]. This comparison underscores the unique traits of Pejua Biri and highlights potential areas for enhancement when evaluated against modern improved blackgram varieties.

Prospective Avenues for Genetic enhancement of Pejua Biri-A forward-looking Approach

Being well-adapted to the local agro-climatic conditions, Pejua biri possesses good quality traits. However, it remains underutilized in mainstream breeding and seed systems. With focused research, this landrace can be improved and promoted for wider adoption and commercialization. Future research can focus on the genetic enhancement of Pejua Biri through participatory plant breeding, molecular characterization, and introgression of desired traits such as disease resistance and improved yield. Marker-assisted

selection (MAS) and genomic tools can be employed to conserve its unique alleles while introducing favourable genes for broader adaptability and productivity.

Improvement in Plant Architecture

To enhance the productivity potential of Pejua Biri, efforts are being made to improve its plant architecture while retaining its unique quality traits (Annual Report, 1986, 1988) [4, 5]. The original Pejua Biri genotype, though well-adapted to local conditions and valued for its taste and resilience, often exhibits a spreading growth habit, medium plant height, and moderate pod number per plant, which limit its yield potential. Genetic improvement programs undertaken at the Regional Research and Technology Transfer Station (RRTTS), Keonjhar, aim to modify the plant type toward a more compact, erect, and determinate architecture (Majhi *et al*., 2024) [7]. Such improvement facilitates better light interception, ease of intercultural operations, and higher pod density per unit area. Selection and hybridization approaches are being utilized to combine desirable traits such as short internodes, synchronized maturity, higher pod-bearing branches, and resistance to lodging. The improved plant architecture is expected to support higher harvest index, suitability for high-density planting, and mechanized harvesting. Through these breeding interventions, *Pejua Biri* can be transformed into a high-yielding, region-specific variety that maintains its genetic identity while meeting the modern demands of sustainable pulse production in Odisha.

Breeding Innovation with Pejua Biri

Molecular markers and genomic tools can be employed to identify unique genetic traits that contribute to its resilience and adaptability. This genetic profiling is essential for understanding the underlying mechanisms that make Pejua Biri a robust variety. Pejua Biri can be cross-bred with other blackgram varieties to combine its desirable traits with those of higher-yielding or commercially viable strains. The goal of such breeding programs is to develop new blackgram varieties that retain Pejua Biri's resilience and nutritional quality while enhancing yield and market appeal. Alongside breeding efforts, it is crucial to conserve the original genetic material of Pejua Biri. Seed banks and in-situ conservation methods should be established to preserve this valuable genetic resource for future generations.

Earliness in the Variety

Earliness, or early maturity, is a desirable trait in *Pejua Biri*, because it allows the crop to complete its growth cycle before the onset of terminal stresses such as drought, pest infestation, or erratic rainfall. Early-maturing varieties help farmers achieve multiple benefits: timely harvest, better crop management, and reduced exposure to adverse weather conditions, which often affect yield and quality. Moreover, early maturity enables intercropping and fits well into cropping systems, providing flexibility in land use and ensuring food and income security for smallholder farmers. Breeding programs should target earliness in flowering and pod maturity to fit into short-season windows and mitigate climate-related risks. This would make Pejua Biri more suitable for double or relay cropping, enhancing overall farm productivity. By selecting and breeding *Pejua Biri* for earliness, the productivity and adaptability of this local landrace can be improved while maintaining its unique taste and market value.

Geographical Indication (GI) Tagging

The process for obtaining the Geographical Indication (GI) tag for Pejua Biri is presently under progress through the efforts of the Regional Research and Technology Transfer Station (RRTTS), OUAT, Keonjhar. The initiative to secure a GI tag aims to formally acknowledge the uniqueness and geographical identity of this local pulse variety. GI tagging will help preserve its genetic purity, protect it from commercial misuse, and enhance its market value by linking it to its origin. Moreover, it will create economic opportunities for local farmers by promoting value addition, branding, and sustainable marketing of Pejua Biri. The RRTTS, Keonjhar, is coordinating with local farmers, community-based organizations, and agricultural authorities to collect historical, genetic, and cultural evidence supporting the GI registration. Once granted, the GI tag will not only safeguard the indigenous agricultural heritage of Keonjhar but also strengthen the identity of Pejua Biri as a symbol of the district's rich biodiversity and traditional farming wisdom.

Varietal Release for Wider Adoption

To mainstream Pejua Biri, efforts should be made to evaluate it in multi-location trials under All India Coordinated Research Projects (AICRP) or State Varietal Release Committees. Data on agronomic performance, quality attributes, and farmer preference can support its official release, making it eligible for government schemes and seed subsidies.

Seed Production Programme

To ensure the widespread adoption of *Pejua Biri*, a structured seed production program must be initiated. This program should begin with the identification of nucleus and breeder seed sources to maintain genetic purity and high quality. Following this, seed villages can be established in Keonjhar and neighboring regions to promote localized production and availability of quality seeds. To ensure effective seed production and widespread adoption of *Pejua Biri*, a coordinated approach involving Seed Villages, local seed banks, farmer producer organizations (FPOs), and NGOs is essential. Seed Villages can facilitate localized production of high-quality seeds, while local seed banks ensure timely availability and preservation of genetic purity. FPOs and NGOs can play a crucial role in training farmers on quality seed production, post-harvest handling, and certification processes. By leveraging these community-based structures and partnerships, certified seeds of *Pejua Biri* can reach a larger number of farmers, supporting increased cultivation, maintaining genetic integrity, and promoting sustainable livelihoods. Farmers should be provided with training and capacity-building programs focused on best practices in quality seed production, handling, and storage. Finally, the certified seeds should be distributed through well-coordinated public-private partnerships to ensure accessibility and encourage adoption by local farming communities, thereby enhancing productivity and preserving the genetic integrity of this traditional landrace.

Value Addition and Market Dynamics

Combining culture with commerce, Phulabadi the flower-shaped badi is a centuries-old indigenous snack of Odisha's Keonjhar district. Over time, it has emerged as a distinctive symbol of Odisha's culinary heritage, conferring a unique identity on the region while providing sustainable livelihood opportunities to numerous rural women (Anon., 2020) [6]. Phulabadi is traditionally prepared from black gram, locally known as biri in Odisha, along with sesame seeds (Figure-). The preparation process of Phulabadi is unique and highly specialized. A specific local variety of black gram, known as pejua-biri, is used as the principal ingredient, as it imparts the characteristic puffiness and crunchiness to the product. The grains are soaked in water and then manually ground to form a smooth paste, which is shaped into flower-like badis. These are placed in sunlight early in the morning, and remarkably, they dry completely by sunset. This rapid sun-drying process distinguishes Phulabadi from other varieties of badi, which generally require several days of sun exposure for proper drying (Anon., 2020) [6]. Although badi preparation is a common household practice across Odisha and has traditionally been an age-old, women-centric activity, the legacy of Phulabadi remains largely confined to Kendujhargarh, the district headquarters of Keonjhar. The production of Phulabadi is a centuries-old tradition that once enjoyed royal patronage. Until India's independence, Keonjhar functioned as a princely state under the rule of the Bhanja dynasty, which governed the region from the 12th century onward. According to octogenarian Pandit Madan Mohan Mishra, a noted writer and researcher closely associated with the royal family, the queens of the Bhanja dynasty actively promoted this distinctive food tradition by encouraging local women to create diverse designs of Phulabadi through organized Phulabadi-making competitions (Anon., 2020) [6].

To harness the full potential of Pejua Biri, the development of strong market linkages and effective value-addition strategies is imperative. Enhancing farm-to-market connectivity through farmer producer organizations (FPOs), cooperatives, and digital marketing platforms can enable farmers to secure better price realization while minimizing reliance on intermediaries. The creation of region-specific branding particularly if reinforced through Geographical Indication (GI) registration can significantly improve market visibility and consumer preference for Pejua Biri. Further income enhancement can be achieved through value addition by processing Pejua Biri into products such as dal, ready-to-cook mixes, traditional snacks, and protein-rich health foods, thereby diversifying product portfolios. Adoption and promotion of eco-friendly and organic production practices can also help tap into premium and health-conscious niche markets. Capacity-building initiatives focusing on processing, packaging, quality assurance, and standardization, along with improved access to credit and infrastructure such as small-scale processing units, can empower rural entrepreneurs, particularly women and self-help groups (SHGs). Overall, a holistic strategy integrating marketing, branding, and value addition has the potential to elevate Pejua Biri from a local landrace to a high-value commodity with both national and international market prospects. With timely support from the Odisha Rural Development and Marketing Society (ORMAS), Keonjhar's distinctive Phulabadi has successfully gained access to wider marketing channels across India. Over the past decade, ORMAS has facilitated the establishment of two major producer groups in the vicinity of Keonjhar, engaging nearly 300 women from 25 SHGs in the large-scale production and promotion of Keonjhar's *badi* for national and international markets. In addition to providing modernized infrastructure and essential skill-development training, these women are actively encouraged to participate in fairs, festivals, and exhibitions organized across the country (Anon., 2020) [6]. In addition, focused government initiatives such as policy support for GI registration, dedicated subsidies for processing and packaging units, inclusion of Phulabadi under One District One Product (ODOP) and Pradhan Mantri Formalisation of Micro Food Processing Enterprises Scheme (PMFME) schemes, and promotion through state-and national-level food festivals, e-commerce portals, and tourism campaigns can further strengthen visibility, market penetration, and long-term sustainability of this unique indigenous product.

Conclusion

Pejua Biri, the traditional landrace of black gram from Keonjhar, holds immense potential for future research and development due to its local adaptation and unique traits. Genetic improvement efforts can focus on enhancing yield, disease resistance, and stress tolerance while preserving its native qualities. Modification of plant architecture to promote erect growth can improve harvesting efficiency and reduce lodging, while breeding for early maturity would allow better crop rotation and climate resilience. Establishing a structured seed production programme involving farmer participation can ensure the availability of quality seeds and conservation of genetic purity. Furthermore, documentation and promotion of its distinctiveness can support Geographical Indication (GI) tagging, adding value through market recognition. As the adaptation of Pejua Biri is highly region-specific, its limited cultivation has become a major constraint to the large-scale production of Phulabadi in recent years. Consequently, targeted genetic improvement of Pejua Biri aimed at enhancing yield, adaptability, and quality traits while retaining its unique processing attributes can play a pivotal role in expanding raw material availability and driving value addition in the Phulabadi market. Finally, with multi-location testing and performance evaluation, Pejua Biri can be officially released as a variety, encouraging its wider adoption and contributing to regional food security and biodiversity conservation. The sustainable promotion of Pejua Biri and the traditional Phulabadi sector requires a coordinated approach integrating government support, focused research, and systematic value addition. Government initiatives can play a catalytic role by prioritizing Pejua Biri. From a research perspective, concerted efforts by agricultural universities, ICAR institutes, and state research organizations are essential for the genetic improvement of Pejua Biri to enhance yield, stress tolerance, and wider adaptability without compromising its unique processing quality required for Phulabadi preparation. Research on seed systems, participatory varietal selection, and sustainable agronomic practices will further ensure consistent raw material availability. Value addition through standardized processing, improved packaging, quality certification, and development of diversified products such as ready-to-cook mixes and protein-rich foods can substantially enhance

income opportunities. When combined with capacity building of women SHGs, FPOs, and rural entrepreneurs, these initiatives can transform Pejua Biri from a region-specific landrace into a commercially viable crop, while preserving the cultural heritage and strengthening the livelihoods associated with Keonjhar's iconic Phulabadi.

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