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Farmer-Preferred traditional green gram varieties: Keys to climate resilience and agrobiodiversity in Odisha, India

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Abstract
Agriculture in Odisha is closely linked to traditional knowledge systems, particularly among small and marginal farmers who depend on Traditional Varieties (TVs) for food, nutrition, and ecological sustainability. Green gram (mung bean) plays a vital role in rain-fed and rice-fallow ecosystems, yet its productivity remains low due to climatic variability, limited seed access, and poor market linkages. To understand the current status of traditional mungbean cultivation, a pilot study was undertaken in five tribal-dominated districts, *viz*., Balangir, Bargarh, Boudh, Nuapada, and Sambalpur, using participatory surveys, group discussions, and workshops alongside field-based agro-morphological evaluations. Results showed that TVs account for about 95% of the mungbean area, with 'Chaiti', 'Chikni Kali', and 'Sagua Moog' being majorly preferred for their yield, drought resilience, early maturity, local adaptability, and cooking quality. Beyond agronomic advantages, these TVs contribute to agrobiodiversity conservation and hold socio-cultural importance. The findings highlight the need for greater support to decentralized seed systems and the mainstreaming of farmer-preferred TVs. Strengthening policies that enhance the productivity and climate resilience of traditional farming systems is essential for sustainable agriculture in Odisha.

Keywords: Farmers perspective, green gram, traditional varieties, Western Odisha

Introduction

Mungbean (*Vigna radiata* L.), commonly known as green gram, is a short-duration, nitrogen-fixing pulse crop of considerable agronomic and nutritional significance in India. It is widely cultivated across diverse agro-climatic zones and plays a pivotal role in enhancing soil fertility (Nayak *et al*., 2022; Rajini & Kumawat, 2022) [20, 15], supporting cropping system diversification (Dahiya *et al*., 2015; Singh *et al*., 2023; Nair *et al*., 2019; Mangaraj *et al*., 2022) [5, 29, 19, 16], and contributing to dietary protein intake, particularly in vegetarian diets (Mekkara Nikarthil Sudhakaran & Bukkan, 2021; Jha *et al*., 2025) [17, 12].

In Odisha, mungbean is the primary pulse crop grown by small and marginal farmers. It covers approximately 8.36 lakh hectares and produces around 0.39 million tonnes annually, with an average productivity of 434 kg/ha (Pradhan & Dash, 2024) [22]. The crop is cultivated across a range of topographies and seasons, on uplands during the *kharif*, on medium lands and rice fallows during *rabi*, and in irrigated lowland fallows in summer (Dash *et al*., 2018) [8]. Odisha's ten agro-climatic zones incorporate mungbean into various cropping systems, including monocropping, mixed cropping, and sequential cropping with rice (Dash *et al*., 2018; Sain *et al*., 2023) [8, 25].

Despite its wide adaptation, mungbean productivity in Odisha lags behind that of leading states like Rajasthan and Madhya Pradesh (Directorate of Pulses Development, 2023) [10]. Unlike those states, where it is primarily a *kharif* crop, in Odisha, mungbean is predominantly cultivated during *rabi*, depending heavily on residual soil moisture (Sahu & Patnaik, 2021; Dash & Sahu, 2023) [24, 7]. Additionally, recurring climatic stresses, such as floods, droughts, and cyclones (Das *et al*., 2024; Vijayakumar *et al*., 2022; Samal & Padhy, 2015) [6, 32, 26], along with fragmented landholdings, degraded soils, and inadequate irrigation facilities further constrain mungbean yields (Naik *et al*., 2014; Behera & Mishra, 2017; Hoda *et al*., 2021) [27, 3, 11].

Issues such as soil erosion, salinity from recurrent flooding, and inadequate irrigation during the *rabi* season further compound production losses (Pradhan & Dash, 2024; Joshi *et al*., 2002) [22, 13].

A critical limitation is the weak seed system. In 2023–24, Odisha's estimated mungbean seed requirement was over 18,000 metric tonnes, but formal sector distribution met less than 3% of this demand, resulting in a Seed Replacement Rate (SRR) of just 25.15% (Directorate of Agriculture & Food Production, Odisha, 2024). As a result, most farmers rely on farm-saved seed (over 97%), often involving traditional or farmer-bred varieties.

These TVs, also known as folk or farmer-bred varieties, are dynamic crop populations that have been selected and maintained over generations by farmers. These varieties are well adapted to local agroecological conditions and are often intertwined with cultural practices and food traditions. Their resilience and stable yields under stress make them valuable assets for sustainable agriculture (Harlan, 1975) [47], especially in Odisha's rainfed, risk-prone landscapes. As 93% of Odisha's (48.7 lakh) farms are below 2 hectares (Mishra *et al*., 2025) [18], and many tribal communities depend on traditional ecological knowledge (Behera, 2021) [2], understanding and integrating these traditional mungbean varieties into mainstream farming is essential.

Traditional agricultural knowledge has been increasingly recognized for its contributions to sustainability. These practices support soil health, crop resilience, and biodiversity. For example, mixed cropping, common in traditional systems, helps mitigate risks related to pest outbreaks and crop failure while promoting ecological balance (Altieri, 2004; Thrupp, 2000; Vandermeer, 1992; Kheam *et al*., 2024) [1, 30, 31]. Although traditional methods alone may not meet the growing food demands, their integration into modern systems is critical for ecological restoration and long-term resource management (Singh & Singh, 2017; Patel *et al*., 2020) [28, 21].

In view of the importance of traditional farming systems in Odisha, especially among smallholders and tribal communities, this study seeks to document the extent of traditional mungbean cultivation across five districts. It aims to identify the most widely used traditional varieties and understand the factors shaping farmers' varietal preferences. Mainstreaming these indigenous varieties holds promise for improving productivity, enhancing climate resilience, and supporting the livelihoods of marginal farming communities in the face of growing ecological and socio-economic challenges.

Materials and Methods

a) **Study Area:** The study was carried out in five tribal-dominated districts of Odisha, *viz.*, Balangir, Bargarh, Boudh, Nuapada, and Sambalpur, encompassing a total of ten blocks (two per district) (Figure 1) and ten Gram Panchayats in each district, with five villages selected from each block, capturing the geographical diversity. An overview of the selected locations is provided in Table - 1.

Table 1: District-wise Distribution of Surveyed Blocks and Gram Panchayats for Green Gram Cultivation in Western Odisha

S. No	District	Blocks	Gram Panchayat
1	Balangir	Khaprakhol, Turekela	Padiabahal, Dhandamunda, Chanria, Matiabhata, Dameipali, Chaulsuka, Kandei, Mahakhanda, Karuamunda
2	Bargarh	Gaisilet, Padampur	Raisalpadar, Dangbahal, Kathaumal, Jagalpat, Kandagad, Kansinga, Barihapali, Jamla, Charpali, Sargibahal
3	Boudh	Boudh, Kantamal	Kampara, Gobindapur, Badhigaon, Jankipur, Pauka, Ambagan, Deuli, Rekdole, Reghamunda, kandabahali
4	Nuapada	Boden, Sinapali	Babbir, Boden, Larka, Karangamal, Litisargi, Hatibandha, Bargaon, Chatiaguda, Niljee, Litiguda
5	Sambalpur	Jujomura, Naktideul	Meghapal, Chhamunda, Kayakud, Kansar, Jhankarpali, Kisinda, Panimura, Sarapali, Girischandrapur, Balam

Participatory survey of farmer's demographics in green gram cultivation: Data collection was conducted through face-to-face, one-on-one interviews and focused group discussions, with each group comprising 10 farmers. The groups were gender-inclusive and represented a range of age groups. Participants were marginal farmers cultivating between 0.5 to 2 hectares of land. Prior to data collection, preliminary consultations were held with local non-governmental organizations (NGOs) and Gram Panchayat (GP) leaders in the selected study areas to ensure contextual relevance and community participation.

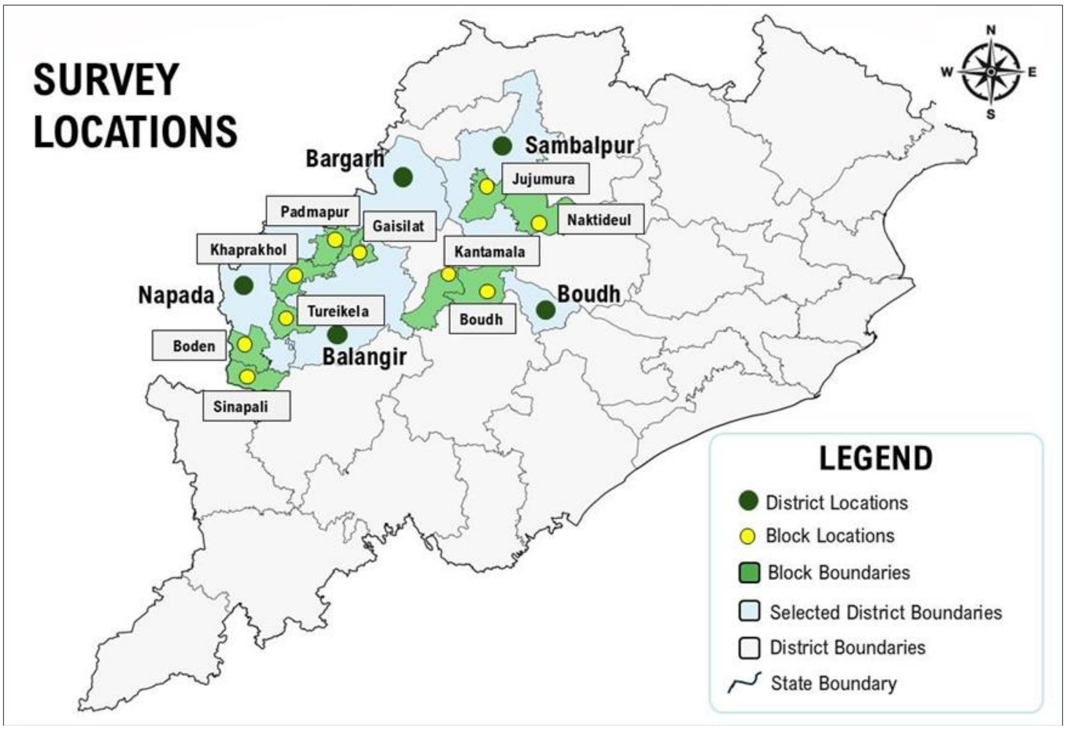

Fig 1: Location Map of Surveyed Districts and Blocks for Traditional Green Gram Varieties in Western Odisha

A structured questionnaire was developed in collaboration with agricultural experts, local NGOs, and selected farmers. The instrument was pretested with a small number of farmers in each village to assess clarity, cultural appropriateness, and ease of administration. Revisions were made based on feedback from the pretest.

Farmers with extensive experience and in-depth knowledge of landrace cultivation under natural farming conditions, as well as an understanding of crop diversity in their respective areas, were identified and engaged to support accurate and context-rich data collection. The survey was administered using printed questionnaires. For participants who were illiterate, trained interviewers recorded responses on their behalf, ensuring accurate transcription of oral inputs.

Each interview or group discussion session began with a brief explanation of the study objectives. When necessary, interviewers provided clarifications to facilitate participants' understanding of the questions. Group discussions / interviews aimed to collect information on specific themes, including the Number of Households (HH), HH cultivating green gram and area under GG by each HH, popular traditional varieties, and shared knowledge on key agronomic traits such as drought tolerance, landrace specific unique traits, duration, cultural importance etc. Responses in group settings were recorded only after achieving consensus among participants.

Workshop based approach for traditional varieties mapping and seed collection: Based on the encouraging outcomes from the demographic survey on green gram cultivation, a dedicated workshop was organized to map diverse green gram traditional varieties using a structured questionnaire. This tool captured a range of characteristics, including climate resilience, aromatic profile, nutritional benefits, yield consistency, market value, and culinary value, and the most suitable cultivation seasons.

Farmers were grouped according to their respective blocks, and the questionnaire was distributed and completed accordingly. During the workshop, participants were actively engaged in identifying and describing green gram traditional varieties, those are currently under cultivation. They shared in-depth knowledge on each landrace's distinctive traits, their resilience to various biotic and abiotic stresses, cooking and nutritional values etc.

To support community-based conservation efforts, farmers voluntarily contributed seed samples of the identified traditional varieties. These samples were collected to initiate a Crop Diversity Block (CDB) for on-farm conservation, and for potential future selection and multiplication. Each seed sample was meticulously labeled with relevant details, including the place of origin, donor farmer information, quantity of seed, and date of collection.

Results

The survey conducted across five districts (50 villages) of western Odisha *viz.*, Balangir, Bargarh, Boudh, Nuapada, and Sambalpur, encompassed a total cultivated area of 22,948 hectares, out of which 7,158 hectares (31.1%) were devoted to green gram cultivation, of which 6803 ha is occupied by TVs (Figure 2). Green gram featured prominently in the regional cropping systems, with 7,449 out of 14,242 households (52.3%) engaged in its cultivation. However, the extent of cultivation and household participation varied significantly between districts (Figure 3).

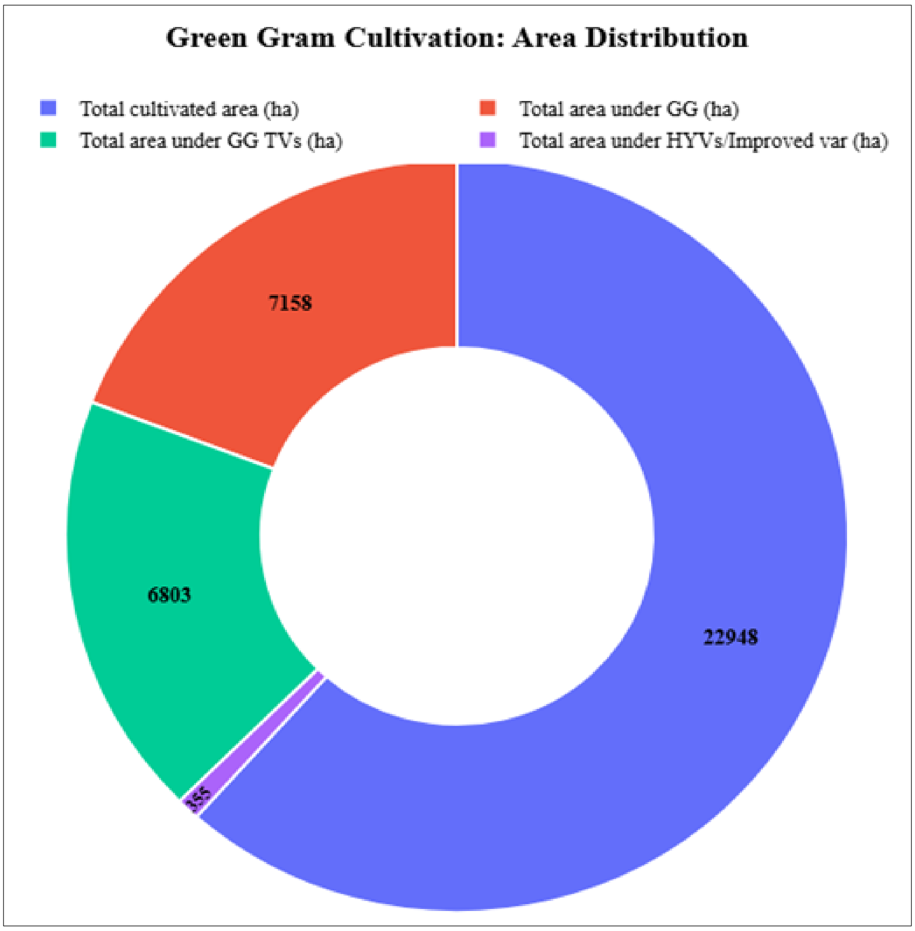

Fig 2: A Spatial Overview of Cultivated Areas (ha)

Among the surveyed districts, Boudh recorded the highest absolute area under green gram at 2,533 ha (39.17%), followed by Bargarh (1,810 ha; 22.77%) and Balangir (1,714 ha; 62.51%). Although Balangir had a smaller total cultivated area compared to Boudh and Bargarh, it exhibited a higher proportion of land under green gram. On the other hand, Nuapada (649 ha; 26.06%) and Sambalpur (452 ha; 13.7%) had lower green gram coverage, with Sambalpur registering the lowest share among all districts (Table - 2 and Figure - 3).

A key highlight of the study was the widespread dominance of traditional green gram varieties across all districts. Overall, 6,803 hectares (95.04%) of the green gram area was under traditional varieties, while only 445 hectares (6.21%) were occupied by high-yielding or improved varieties (HYVs) (Table 2 & Figure 2). Nuapada and Bargarh reported complete (100%) reliance on traditional varieties, while Boudh (96.24%) and Balangir (88.17%) also showed very high adoption. Sambalpur, although majority dependent on traditional varieties (89%), showed the 11% use of HYVs, 'Virat' (Table – 2 & Figure 3).

Household engagement in green gram cultivation also varied notably. Boudh led with the highest household participation, with 80.54% of its farming families (2,546 out of 3,161) growing green gram. This was followed by Balangir (69.09%) and Bargarh (57.08%). In contrast, Nuapada had the lowest household participation (21.59%), despite its complete reliance on traditional varieties. Sambalpur showed moderate engagement, with 47.25% of households cultivating green gram (Figure – 3).

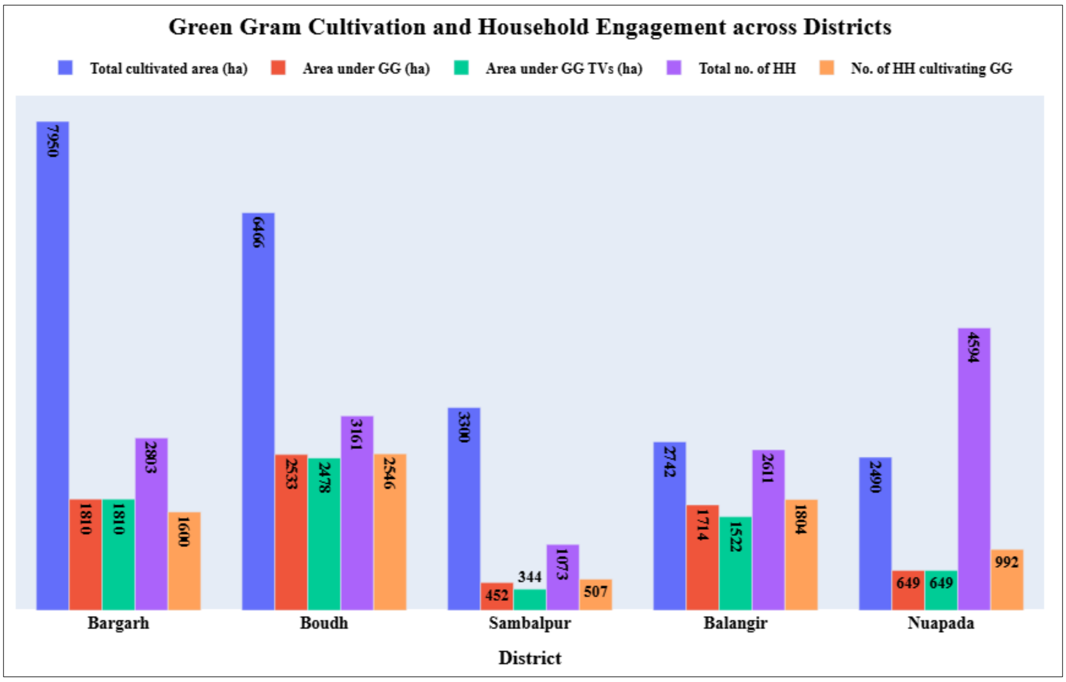

Fig 3: District-Level Insights into Green Gram Cultivation Area and Household Engagement

Table 2: Comprehensive Overview of Green Gram Cultivation by District: Traditional Varieties and Farmer Engagement

S. No	District	Total Cultivated Area (ha)	Area under Green Gram (ha)	Total Area under GG traditional varieties (ha)	Total Households (HH)	HH Cultivating Green Gram	Green Gram Varieties Cultivated (Area in ha) - arranged in descending order
1.	Balangir	2,742	1,714 (62.51)	1,522 (88.17)	2,611	1,804 (69.09)	Jhain Moong (458), Kali (405), Sagua Moong (262), Khersal (219), Chikni Kali (178), Virat* (130), Sikha* (62)
2.	Bargarh	7,950	1,810 (22.77)	1810 (100)	2,803	1,600 (57.08)	Chikni Kali (689), Kharsel (528), Sagua Moong (426), Jhain Moong (65), Kadua Moong (45), Ampolia Moong (35), Baishaki Moong (18), Moradi Moong (4)
3.	Boudh	6,466	2,533 (39.17)	2,438 (96.24)	3,161	2,546 (80.54)	Chaiti (2,235), Tula (95), Desi (58), Sikha* (45), Methi (40), Kadua Moong (40), Kala Moong (10), Badal Farm* (10)
4.	Nuapada	2,490	649 (26.06)	649 (100)	4,594	992 (21.59)	Kala Moong (239), Jhain Moong (122), Dhain (87), Khaira (57), Tola (54), Kala (35), Atha (25), Dhala (18), Kadua Moong (5), Sagua Moong (7)
5.	Sambalpur	3,300	452 (13.7)	344 (76.1)	1,073	507 (47.25)	Chaiti (267), Jhain Moong (60), Sagua Moong (58), Virat* (50), Nili (15), Kala Moong (2)
	Total	22,948	7,158 (31.1)	6,803 (95.04)	14,242	7,449 (52.3)	

Note: * HYVs/improved varieties; values in parenthesis are percentage.

The region showed significant varietal richness, with notable differences in the types and extent of traditional varieties grown across districts. 'Chaiti' was the most dominant landrace, with 2,235 hectares in Boudh and 267 ha in Sambalpur, totaling 2,502 hectares across districts (Figure 4). 'Chikni Kali' ranked next in prevalence, occupying 867 hectares in total, of which Bargarh accounted for the largest share (689 ha), followed by Balangir with 178 hectares.

'Sagua Moong' was cultivated over 753 hectares, with major contributions from Bargarh (426 ha) and Balangir (262 ha). 'Jhain Moong' had a broad geographical spread and covered 705 hectares, notably in Balangir (458 ha), Nuapada (122 ha), Sambalpur (60 ha), and Bargarh (65 ha). Other traditional varieties of regional importance included 'Kharsel' (528 ha) in Bargarh, 'Kali' (405 ha) and 'Khersal' (219 ha) in Balangir, and 'Kala Moong' (251 ha) in Nuapada and Boudh. A diverse array of localized traditional varieties such as 'Tula', 'Methi', 'Kadua Moong', 'Dhain', 'Khaira', and 'Tola' were also recorded, particularly in Nuapada and Boudh, indicating the presence of micro-regional genetic diversity (Table 2).

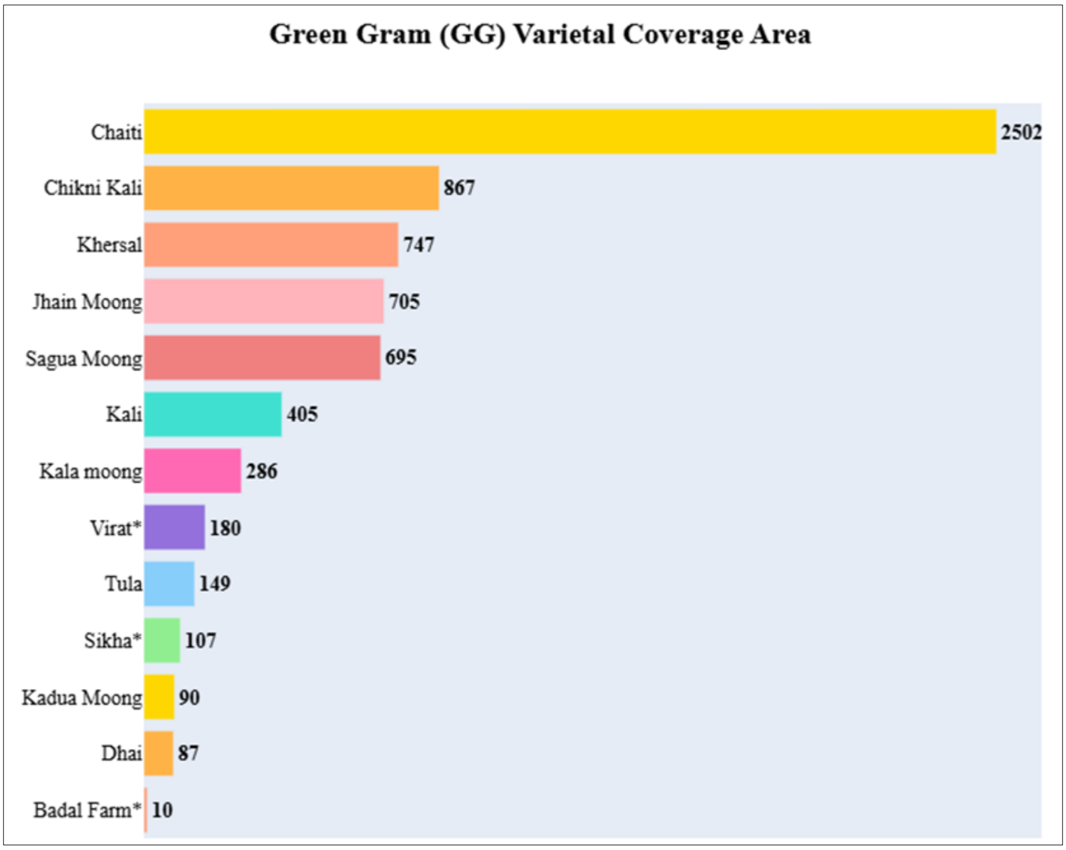

Fig 4: Cultivation Area by Green Gram Variety: Traditional vs Improved Types

In contrast, HYVs were limited in both variety and area. The improved variety 'Virat' was cultivated over 180 hectares, with the largest share in Balangir (130 ha) and the rest in Sambalpur (50 ha). 'Sikha' was found in Balangir and Boudh (107 ha), while 'Badal Farm', an improved line, occupied 10 hectares in Boudh. These varieties had minimal to no presence in Bargarh and Nuapada (Table 2 & Figure - 4).

In summary, the results underscore a strong regional preference for traditional green gram varieties, driven by their local adaptability, agronomic stability, and farmer familiarity. While Boudh and Balangir emerged as leading districts in terms of both area and household engagement, Nuapada was distinctive for its complete reliance on traditional cultivars coupled with high traditional varieties diversity despite limited participation. Sambalpur, though lagging in green gram area, exhibited the highest proportion of HYV adoption. The data highlights the existence of rich green gram agro-biodiversity and continued relevance of traditional varieties in the region's pulse-based farming systems.

Ethno-agronomic and Cultural Characterization through Farmer Participatory Approaches

Traditional mungbean varieties were characterized using both farmer participatory (PRA-based) approaches and field-based agro-morphological evaluations to capture their ethno-agronomic, cultural, and yield-related diversity. Through PRA exercises, including participatory workshops and focus group discussions, farmers highlighted the adaptation, resilience, culinary qualities, and cultural significance of the TVs (Table 3). Notable varieties identified include Chaiti moog, Chikni Kali moog, Kala Moog, and Khersali Moog, which were consistently reported to exhibit favorable characteristics such as a higher number of pods per plant, medium pod length, and bushy plant architecture. The distinctness in seeds of some of these varieties (Figure 5) further reflects their uniqueness. Farmers emphasized that the bushy growth form contributes to improved pod distribution, enhanced ground coverage, and the suppression of weed growth, features that are particularly valuable under rainfed conditions.

The survey data also highlighted the seasonal adaptability of these traditional varieties (Table 3). Chaiti and Jhaina Moog were primarily cultivated during the *Rabi* season, while Khersali and Sagua Moog were reported to be grown in the *Kharif* season. Chiknikali was mostly sown during the late *Kharif* season, and Kala Moog was noted for its flexibility to be grown in both late *Kharif* and *Rabi* seasons. Farmers indicated that these varieties typically have a duration of 60 to 90 days, allowing for better synchronization with the local rainfall pattern and supporting diverse cropping systems.

Regarding land types and soil preferences, farmers reported that Jhain Moog is cultivated across uplands, midlands, and lowlands. Chaiti Moog and Kala Moog were grown in both upland and midland areas, while Chiknikali and Khersali Moog were restricted to uplands (Table - 3). The varieties demonstrated compatibility with a range of soil types prevalent in Odisha. For example, Jhain Moog, Chikni Kali, and Chaiti Moog were grown in sandy and black soils, Khersali and Sagua Moog in sandy soils, and Kala Moog was reported to perform well in all major soil types. These observations underline the edaphic versatility of traditional mungbean traditional varieties as perceived by local farmers.

The survey also recorded farmers' perceptions of stress tolerance in these varieties (Table 3). Most respondents reported that traditional mungbean varieties generally tolerated delayed monsoons and high temperatures. Specific cases were noted where Khersali Moog endured temporary waterlogging, while Chaiti Moog was capable of withstanding extended dry spells. Several varieties were said to possess natural resistance to common pests and diseases such as Yellow Mosaic Virus (YMV), aphids, powdery mildew, and pod borers. These traits were cited as reasons for their continued preference under natural farming systems.

Table 3: Characterization of the popular Traditional Varieties of Green Gram

TVs	Districts	Suitable season	Duration (days)	Land suitability	Suitable soil	Climate resilience	Disease and Pest resilience	Cooking / Medicinal qualities	Price range	Other traits	Cultural needs
Jhain Moog	Balangir, Bargarh, Nuapada, Sambalpur	*Rabi*	60-90 (varied with location)	Upland, Midland, Low land	Sandy, Black	Delayed Monsoon, High temperature	leaf spot, Aphids and gram pod borer, Powdery Mildew,YMV (Sambalpur)	Good for lactating mothers	100-120 (Bolangir)150-200 (Boudh)	Medium height, bushy plant, light brown coloured seed	Nuakhai, Puspuni, Dasahara, Ekadasi & other festival
Chikni Kali moog	Bolangir, Baragrh	Late *Kharif*	65-75	Upland	Sandy, Black	Delayed Monsoon, High temperature	Aphids and gram pod borer, Tolerant to YMV	A creamy layer appears on the top during boiling/ Good for children and older people aiding digestion and immunity booster	120-150	Bushy plant, Higher number of pods, medium pod size	Nuakhai, Puspuni, Dasahara, Ekadasi & other festival
Kala moog	Boudh, Nuapada, Sambalpur Balangir	Late *Kharif, Rabi*	60-90 (varied with location)	Upland,Midland	All soil types	Delayed Monsoon	Aphids and gram pod borer, Tolerant to YMV	Good for children/old people aiding digestion and immunity booster	120-140	Bushy plant, Higher number of pods, medium pod size and test weight	Jayantia, Sabitri Brata,Nuakhai, Puspuni, Dasahara, Ekadasi & other festival
Chaiti moog	Boudh, Sambalpur	*Rabi*	75-90	MidLand, Upland	Sandy, Black	Sustains Delayed Monsoon, Prolong Drought	Powdery Mildew, Aphids, Fruit Borer	Good taste and aroma; good For lactating mothers	100-140	Small seed size, aroma and sweet taste	Nua Khai & Jayantia
Khersali moog	Balangir, Bargarh	*Kharif*	75-80	Upland	Sandy	Sustains 3-4 days of water logging, and 2 weeks of late monsoon Moderately Tolerant to high Temperature	Aphids, pod borer, YMV	Good taste	130-150	Bushy plant, Higher number of pods, medium pod size, small size seed, Black & rough seed	Margasira Gurubar, Nuakhai, Puajiuntia, Sabitribrata etc
Sagua moog	Bolangir, Bargarh,Nuapada	*Kharif*	80-90	Upland	Sandy	Delayed monsoon, High Temperature	Aphids, red caterpillar, moderately tolerant to YMV		100-120	Tall plant, Deep green healthy leaf. Medium size pod. Bunch pods	

Agro-morphological and Yield Characterization of TVs (Field-based)

The TVs were characterized for their phenology, growth, yield, and seed traits, revealing considerable variability (Table 4). Days to 50% flowering ranged from 40 to 45 days, while maturity occurred between 57 and 65 days, indicating their adaptability to short-duration rain fed conditions. Pod and seed traits such as pod length (6.5–8.9 cm) and number of seeds per pod (10–12) remained relatively stable across varieties. Seed lustre ranged from shiny to very dull, with colours varying between black and green. While most TVs had oval-shaped seeds, one variety, Nilia Moog, was distinguished by its unique drum-shaped seeds.

Table 4: Agro-morphological and Yield Characterization of TVs (Field-based)

S.No.	TV	Phenology		GGrowth traits			Yield traits			Morphological Traits			Seed traits		
		Days to 50% Flowering	Days to Maturity	Plant height (30 DAS)	Plant height (60 DAS)	No. of branches (60 DAS)	Avg. No. of Pods/plant	Avg. Pod length (cm)	Avg. No. of seeds per pod	Leaf hairiness	Stem hairiness	Pod hairiness	Seed Lustre	Seed Colour	Seed Shape
1	Chiknikali mung	45	63	21.05	54.05	3.55	49.90	8.86	11.00	3	3	3	Very Shiny	Black	Oval
2	Jhain mung	40	58	31.15	60.85	3.27	17.07	7.38	11.67	1	1	1	Very Dull	Black	Oval
3	Kali mung	40	57	35.54	64.38	3.53	20.60	6.97	10.67	3	3	3	Very Dull	Black	Oval
4	Kharsel mung	45	63	35.51	60.68	3.87	24.00	6.66	11.60	5	5	5	Very Dull	Black	Oval
5	Virat	40	57	34.59	59.51	3.53	22.40	6.49	10.33	3	3	3	Shiny	Green	Oval
6	Sikha	45	65	34.87	61.47	3.20	22.60	8.49	11.73	3	3	3	Shiny	Green	Oval
7	Nilia mung	45	62	41.65	62.49	3.27	20.40	6.79	11.87	5	5	5	Shiny	Green	Drum
	Mean	42	60.7	33.5	60.5	3.5	25.3	7.4	11.3						
	Max	45	65.0	41.6	60.5	3.5	25.3	7.4	11.3						
	Min	40	57.0	21.0	64.4	3.9	49.9	8.9	11.9						
	SD	2.7	3.3	6.3	54.1	3.2	17.1	6.5	10.3						
	SE	1.0	1.2	2.4	3.2	0.2	11.1	0.9	0.6						

Note*: 5= Very hairy, 4= hairy, 3= Medium, 2= less, 1= not hairy

Discussion

Odisha's tropical climate is characterized by high temperatures, humidity, and moderate to heavy rainfall, accompanied by short and mild winters. Despite receiving an annual average of 1,451 mm of rainfall, the state's agriculture remains vulnerable due to erratic and uneven monsoon distribution. Western Odisha, in particular, is frequently affected by floods, droughts, and cyclones of varying intensities (Panda, 2017) [36], which periodically disrupt agricultural activities. These recurring climatic shocks, coupled with sluggish agricultural growth, contribute significantly to Odisha's persistent rural poverty (Hossain and Fischer, 1995; Yadav *et al*., 2024) [34, 35].

In this challenging context, green gram emerges as a highly suitable crop. It is a short-duration, climate-resilient pulse that fits well into Odisha's variable agro ecological conditions. During the *kharif* season, rice dominates, and approximately 1.6 million hectares lie fallow in the *rabi* season due to inadequate irrigation, low soil moisture, and poor market access (Dar *et al.*, 2024; Gumma *et al*., 2016; Peramaiyan *et al*., 2023; Mohapatra *et al*., 2022) [37, 40, 33, 41]. Green gram's minimal water requirements, ability to utilize residual soil moisture, and soil-enriching properties through nitrogen fixation make it an ideal choice for these rice-fallow ecosystems (Hazra and Bohra, 2021; Liu *et al*., 2010; Meena *et al*., 2018) [43, 42, 44].

Although Odisha has officially released green gram varieties such as Virat and Sikha, field survey findings reveal that more than 95% of the area under green gram cultivation is still dominated by farm-saved Traditional Varieties (TVs). This reveals a significant reservoir of untapped agro biodiversity that continues to thrive under the care of rural farming communities. These TVs are not only valued for their resilience to climatic stresses, such as early maturity, tolerance to delayed monsoons, intermittent flooding, and high temperatures, but are also deeply appreciated for their moderate yields superior cooking qualities, alignment with local dietary preferences, and compatibility with long-standing cultural practices, including seed-sharing and ritual use.

For example, Chaiti Moog (named after season Chaitra), which, despite producing lower yields and susceptible to YMV (Mishra *et al.,* 2018) [39] compared to officially released varieties, remains indispensable to farmers and consumers alike due to its exceptional taste and unique aroma. Similarly, the variety Jhain Moog, named after the Odia word "Jhain," meaning drizzling rain, is recognized by farmers for its ability to perform reliably under conditions of erratic or moderate rainfall, making it particularly suited for uncertain rainfed environments. Also, it is preferred due to tolerance to lead spot (Sahoo *et al*., 2022) [45].

The cultural rootedness of these traditional varieties ensures their continued presence in farming systems. Varieties like Chaiti Moog, Jhain Moog, and others are integral to traditional festivals such as Nuakhai, Puspuni, Dasahara, Sabitri Brata, and Ekadasi. Their ritual and culinary significance fosters continued cultivation across generations, demonstrating how cultural heritage and ecological knowledge converge to sustain agro biodiversity in Odisha's farming systems.

The prevalence of these traditional varieties among smallholder farmers, most of whom own less than two hectares of land (Mishra *et al*., 2025) [18], highlights their importance as a low-risk, low-investment cropping option. Farm-saved seeds, passed down through generations or exchanged through informal networks, help keep input costs minimal (Behera, 2021) [2]. Furthermore, these traditional varieties often command a premium in local markets due to their superior taste, medicinal value, and cooking qualities (Jha *et al*., 2025; Patel *et al*., 2020) [12, 21]. While HYVs may outperform under optimal conditions, traditional varieties have shown more stable yields under stress, ensuring long-term income stability (Ceccarelli and Grando, 2005) [46]. As Cleveland *et al*. (1994) [4] and Altieri (2004) [1] have emphasized, such farmer-led conservation of agro-biodiversity plays a pivotal role in maintaining food security and ecosystem resilience.

However, a major constraint to the broader adoption of these climate-resilient TVs is the timely access to quality seeds. Delays in the availability of certified seeds, limited private sector involvement, and poor extension services often compel farmers to rely on deteriorating farm-saved seed stocks. To overcome these challenges, the strengthening of decentralized seed systems through Farmer Producer Organizations (FPOs), Self Help Groups (SHGs), and the promotion of seed entrepreneur programs becomes essential. Linking local seed producers with formal systems can ensure better access to quality seeds while promoting varietal diversity. In this regard, organizations like Watershed Support Services and Activities Network (WASSAN) have been instrumental in advancing community-based seed models.

The present study contributes to this growing need by identifying farmer-preferred, climate-resilient green gram traditional varieties with attributes such as early maturity, flood tolerance, high-temperature resilience, and superior cooking quality. These attributes make them suitable for rice-fallow systems, particularly in dryland regions. Moreover, the study aligns with broader efforts under the Comprehensive Rice Fallow Management (CRFM) Project, launched by the Government of Odisha in 2022 [9]. This initiative has already helped reduce fallow lands from 83.3% to 41.7% by promoting pulses and oilseeds (Dar *et al*., 2024) [37]. The studied districts reflect this trend variably: while Bargarh and Sambalpur showed notable reductions in perennial fallows, Boudh and Nuapada experienced moderate declines in ephemeral fallows, and Balangir saw an increase in fallow area (Roy *et al*., 2025) [38]. This highlights the potential for further reducing fallow lands by promoting the cultivation of the identified climate-resilient traditional varieties.

In conclusion, the identification and promotion of climate-resilient, farmer-preferred green gram traditional varieties offer a triple win: enhanced climate resilience, improved rural livelihoods, and the conservation of genetic diversity. Integrating these varieties into Odisha's formal seed system, while empowering local farmers and FPOs through participatory research, seed enterprises, and value-added markets, can transform these TVs from relics of cultural heritage into foundational elements of a sustainable and resilient pulse-based economy.

Way Forward

Although the survey was limited to selected blocks in five districts, it revealed the extensive use and continued relevance of traditional mungbean varieties. Expanding such efforts to other districts could help uncover further genetic diversity and deepen understanding of region-specific adaptations. Since the findings are based on farmers' perspectives, scientific validation through agro-morphological and nutritional evaluation is essential to confirm the potential of these traditional varieties and support their integration into sustainable farming systems. Strengthening decentralized seed systems, through FPOs, SHGs, and local seed entrepreneurs, with institutional backing and participatory varietal release mechanisms can enhance timely access to quality seeds, ensuring varietal purity and broader outreach. Collaborative participatory selection involving farmers, NGOs, and research institutions can further refine and disseminate these varieties while conserving their local adaptability. Additionally, developing niche value chains through branding and targeted market linkages can increase the economic value of traditional varieties, improve farmer incomes, and promote their wider adoption. Ultimately, the sustained cultivation of these traditional varieties contributes significantly to *in-situ* agrobiodiversity conservation and climate-resilient agriculture.

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