



Registering farmers' native varieties in Nepal: a review of policy provisions and future prospects

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Received: 9 August 2026 / Accepted: 12 October 2026
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Abstract Globally, many smallholder farmers cultivate crop varieties that have been developed, selected, and maintained over generations, known as farmers' varieties. This paper examines the policy provisions, existing gaps, and prospects for the registration of farmers' native varieties in Nepal through systematic review of relevant literature, legislation, regulations, and policy documents. It synthesizes key findings on the procedures for registering native varieties and the institutional and regulatory mechanisms for managing farmers' seed systems. The finding showed that the procedures for notifying different categories of crop varieties were established under the Seed Regulation (2013) in four schedules (A, B, C, & D). The revised Seed Regulation (2024) further expands this framework through provision of six annexes. Notably, Annex 5 specifically addresses the registration

of farmers' native varieties. Up to date, total of 24 farmers' native varieties representing ten different crops were officially registered under schedule D (Annex 5 provision of seed regulation, 2024) through the National Seed Board (NSB). These registrations reflect increasing institutional recognition of farmers' roles in varietal conservation, improvement, and seed system development. Despite notable progress in the registration of farmers' varieties in Nepal, several policy-level gaps and implementation challenges exist including limited awareness of the relaxed registration provisions among farmers and stakeholders and inconsistent interpretation of registration criteria. This paper proposes an integrated, farmer-centered approach to strengthen the farmers' variety registration, source-seed maintenance, and benefit sharing mechanisms through clear technical guidelines, capacity building, and coordinated engagement of farmers, government agencies, the private sector, NGOs and other relevant stakeholders.

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Keywords Farmers' varieties · Source seed maintenance · Seed systems · Policy provisions · Varietal registration

Background

Nepal's agriculture relies on a diverse range of seed systems, including formal, non-formal, and farmers' (informal) systems (Joshi et al. 2020a). Among

these, the farmers' seed system, managed primarily by farmers and their communities—plays a central role in sustaining agricultural production. In this system, farmers produce, preserve, and exchange their own seeds through both monetary and non-monetary means such as gifting, bartering, and trading, practices deeply rooted in local social and cultural traditions (Poudel et al. 2015). The coexistence of farmers' and formal seed systems reflects the historical specialization of seed production and breeding that began in the early twentieth century (Almekinders and Louwaars 2002). Farmer seed systems are characterized by low-input farming practices, seed exchange within communities, and strong sociocultural connections, collectively supporting alternative knowledge systems and sustaining evolutionary processes in crops (Biber-Klemm 2018; Joshi 2000). Through continuous selection for desirable traits and adaptation to local environmental conditions, farmers impose selection pressure that progressively shapes crop varieties over time (Harlan 1992). Consequently, the farmers' seed system not only fulfills local seed demand—especially in remote areas but also conserves crop genetic diversity at the field level. It safeguards agricultural biodiversity and traditional knowledge, contributing to food and nutritional security for rural households (Jarvis et al. 2004; Nabuuma et al. 2022).

According to Nepal's National Seed Vision (2013–2025), the formal seed system in 2010 supplied less than 10 percent of the national cereal seed requirement, whereas its contribution to vegetable seed supply was approximately 66 percent, primarily due to the widespread cultivation of hybrid varieties that require farmers to purchase new seed each season (MoALD 2013). In contrast, farmers' own saved seeds (67–91 percent) and those exchanged among neighbors remain the dominant sources within the informal system (Adhikari 2016; Baniya et al. 2005). Despite this, linkages between formal and informal systems remain weak due to their structural and operational differences. The farmers' system operates as an integrated process encompassing of seed production, farmer-to-farmer dissemination, crop development, and in situ conservation, whereas the formal system functions as a linear, institutionally driven chain (Almekinders and Louwaars 2002). Over a period of approximately ten years, the seed replacement rate for cereals increased to from 10% to around

20%, driven by the expanded supply of improved-quality seed, whereas the rate of seed replacement in vegetable crops showed only marginal improvement because it was already high due to the widespread use of hybrid seed (Gauchan 2019).

Within farmer-managed seed systems, locally adapted native crop varieties constitute an important component of on-farm genetic diversity and seed management. In the context of crop species, a genotype refers to the genetic constitution of a plant comprising one or more genes or alleles that determines its heritable characteristics and contributes to the expression of observable phenotypic traits. Globally, many smallholder farmers cultivate and maintain locally adapted crop varieties that have evolved through generations of farmer-led selection and management, commonly referred to as farmers' varieties (De Jonge et al. 2024). Farmers' varieties include local and native varieties cultivated by the farmers, that are locally adapted in the local farming systems. These native and locally adapted varieties, managed through traditional practices of conservation, exchange, and selection, represent farmers' customary rights over seeds and knowledge, recognized in national and international frameworks (Villa et al. 2005; Andersen 2016). Although lower yielding than modern hybrids, they are genetically diverse, resilient to climate change, and valuable for breeding high-yielding, stress-tolerant crops (Gauchan et al. 2018; Ravi 2004). Integrating farmers' varieties into farming systems enhances agroecosystem resilience and provides a genetic reservoir crucial for sustainable agricultural development (De Jonge et al. 2021; Salazar et al. 2007; Shrestha 1998).

Historically, all crop seeds were developed by farmers, but these were gradually replaced by varieties bred in public institutions and later by private companies, especially in industrialized regions (Batur et al. 2021). In Nepal, the growing adoption of improved and hybrid varieties has increasingly displaced traditional farmers' varieties. Approximately 95% of the germplasm used in agricultural research in Nepal is of exotic origin (Joshi 2017). Nevertheless, local landraces remain a vital component of the country's native agro-biodiversity, serving as a valuable reservoir of genetic diversity and adaptive traits. It is estimated that nearly 50% of Nepal's traditional landraces or their unique genetic traits have already been lost, while many of the remaining landraces

are becoming increasingly rare and threatened with genetic erosion (Upadhyay and Joshi 2003).

Since the first Seed Act 1988, Nepal has introduced 17 policy instruments, 16 of them related to seeds, genetic resources, or agricultural development. Among these, the Seed Act, Seed Regulations, National Seed Vision, and Agrobiodiversity Policy provide the primary framework for managing Nepal's plant genetic resources (Joshi et al. 2017). Farmer's native variety registration is one of the suitable approaches for native agrobiodiversity conservation and utilization (Joshi et al. 2020b). The Seeds Act and Seeds Regulation of Nepal provide for two systems for the notification of crop varieties in the National Gazette: release and registration. The requirements for research trial data and the annexes for application differ between these two processes. For varietal release, a minimum of three seasons of field trial data is required to demonstrate the variety's Distinctness, Uniformity and Stability (DUS) characteristics of the candidate variety. In contrast, varietal registration follows less stringent requirements for verification and documentation. For the inclusion of farmers' native varieties into the formal system, Nepal's revised Seed Regulation (2013) provides a specific provision—Schedule D for the registration of farmers' native varieties, commonly referred to as the “Relaxed Provision” for varietal registration. Under this provision, a farmer or farmers' organization can develop a registration proposal using single-season agronomic data collected from farmers' fields and submit it to the Variety Approval, Release and Registration Sub-Committee (VARRSC) of the National Seed Board for approval. To date, 24 varieties representing 10 different crops including rice, common beans, proso millet, foxtail millet, amaranths, finger millet, soybean, cucumber, broad leaf mustard and chilli have been registered under this provision, marking a significant achievement for Nepal (SQCC 2025).

The farmers' varieties were registered through the Schedule D provision mainly to obtain formal recognition and legal inclusion of locally developed genetic resources within Nepal's national seed system. The schedule D specifically serves as a simplified mechanism for registering farmers' native varieties that are not developed through formal breeding techniques. Farmers were motivated to register farmers' native varieties because of their superior adaptation to local agroecosystems, resilience to biotic and

abiotic stresses, and desirable traits such as good taste, aroma, nutritional value, and stable yield under low-input farming conditions (Joshi et al. 2026; Neupane et al. 2023; Sthapit et al. 2006). Registration also created opportunities for formal seed production, branding, marketing, and commercialization while supporting the conservation and sustainable utilization of native agrobiodiversity.

Despite progress in varietal release and registration, challenges persist particularly in ensuring effective seed quality regulation, which remains a major concern among farmers (Puneeth et al. 2024). This study adopts a qualitative research approach to analyze existing government policies, regulations, and institutional frameworks governing the registration and maintenance of farmers' native varieties in Nepal. It systematically reviews relevant literature, legal instruments, and policy documents of the past three decades from available sources and databases to assess the current status, key provisions, gaps, and future prospects for the registration and formal recognition of farmers' native varieties in Nepal. Global literature and database such CABI were used to review farmers' registration and seed systems related process, programmes and policies relevant to Nepal. The major inclusion criteria in the data search included registration and notification process for farmers' varieties, local and native varieties and landraces including regulation and management of farmers' seed systems.

Some previous studies have examined Nepal's farmers' variety registration system, focusing primarily on its historical development and evolution. However, a comprehensive and up-to-date assessment of the current status, implementation, progress, registered varieties, institutional and procedural gaps, and future prospects of the system remains lacking. Therefore, this review assesses the current status and implementation of the farmers' native variety registration system in Nepal by comparing with international practices, identifies major institutional, policy, and procedural gaps and challenges, and examines opportunities for strengthening the recognition, registration, and promotion of farmers' varieties. By integrating these procedures, practices and systems, the review provides a comprehensive assessment of the current status, key gaps, and future directions for strengthening Nepal's farmers' variety registration system.

International practices in farmers' variety registration

The regulation of farmers' varieties and traditional crop populations varies considerably across countries depending on national seed laws, plant variety protection systems, and agrobiodiversity conservation policies. In the European Union, specific regulatory provisions have been developed to facilitate the registration and marketing of conservation varieties and heterogeneous materials. EU Directives 2008/62/EC, 2009/145/EC, and 2010/60/EU recognize farmers' varieties as genetically diverse and locally adapted populations with traditional denominations and limited formal breeding history. These directives establish procedures for the registration, certification, origin identification, and controlled marketing of conservation varieties, particularly to support on-farm conservation of plant genetic resources. The directives distinguish between agricultural and vegetable species, with comparatively less restrictive provisions for vegetable varieties developed under specific local conditions (Spataro and Negri 2013). The agricultural species generally refers to cereals, forage crops, oilseed crops, pulses, potatoes, and other broad-acre field crops mainly grown for food, fodder, or industrial uses. In contrast, the vegetable species

refers to crops primarily cultivated for direct human consumption such as vegetable or horticultural products e.g. tomato, cabbage, onion, cucumber, bean etc. used as vegetables. Despite these enabling provisions, the registration process in Europe remains relatively formalized and technically demanding, and by 2024 only 191 conservation varieties had been registered in the European Common Catalogue, representing approximately 0.88% of the total registered varieties (Didonna et al. 2024). Most applications were submitted by research institutions, public agencies, and farmer associations rather than individual farmers or private seed enterprises (Didonna et al. 2024; MacDonald 2023; Pham 2019). In addition to this, several countries have established separate policy provisions for the registration of farmers' native varieties (Table 1).

Compared with registration systems of some other countries, Nepal's Schedule D under the Seed Regulation (2013) provides a flexible and farmer-friendly mechanism for registering farmers' native varieties. It accepts genetically heterogeneous and locally adapted varieties and uses simplified, participatory characterization based on locally relevant qualitative, nutritional, cultural, socio-economic, and adaptation-related traits. Registration can be based on key distinguishing traits assessed during a single growing

Table 1 Policy provisions for the registration of farmers' native varieties in selected countries

S.N	Country	Provisions for the registration of farmers' varieties
1	United States of America	The Plant Variety Protection Act of 1970 primarily focuses on protecting commercially bred varieties that meet Distinctness, Uniformity, and Stability (DUS) criteria. Although farmer-developed populations may theoretically qualify for protection, most traditional and heterogeneous farmers' varieties do not meet the uniformity requirements necessary for intellectual property protection. There is no dedicated legal category specifically designed for the registration and protection of farmers' native varieties (Batten et al. 2021; Perrin et al. 1983; Yu and Chung 2021)
2	India	The Protection of Plant Varieties and Farmers' Rights Act (2001) allows applications to be initiated by individual farmer or by farming communities for registration, thereby providing a legal pathway for formal recognition and protection of farmers' varieties (Lushingtonn 2012). Consent is required from the concerned farmers or communities when an essentially derived variety is developed from a farmers' variety
3	Bangladesh	The Plant Variety Protection Act (2019) provides for the registration of farmer-developed varieties, benefit-sharing, farmers' participation in conservation-related decisions, and protection against the misappropriation of farmers' varieties, including the rejection of applications made without prior consent (Islam 2019)
4	Laos	Two parallel systems operate for variety registration: a conventional DUS-based system and an alternative variety registration system introduced in 2020. The latter enables provincial-level registration of "promotion varieties" based on locally relevant characteristics, such as yield, pest resistance, and farmer preference, without applying UPOV-based DUS criteria (Gauchan et al. 2018)
5	Zimbabwe	In Zimbabwe, the Seed Act (1965) requires all marketed varieties to be registered under strict DUS and Value for Cultivation and Use (VCU) criteria. However, seed authorities have recently introduced more flexible protocols allowing farmers' varieties to be listed in national registers through alternative pathways (Gauchan et al. 2018)

season, rather than rigorous multi-season testing, thereby supporting the formal recognition, conservation, and sustainable utilization of farmers' native varieties.

Collectively, the review of the country experiences demonstrates increasing recognition of farmers' varieties but also reveal persistent challenges related to complex procedures, limited technical capacity, inadequate farmer awareness, and weak institutional support. Simplified, decentralized, and farmer-centered registration approaches, combined with technical assistance, participatory characterization, and stronger benefit-sharing mechanisms, could provide more accessible pathways for improving the registration and sustainable utilization of farmers' varieties.

Existing policy provision for release and registration of crop varieties in Nepal

A genotype can be legally recognized as a variety only after official notification in the Nepal Gazette, after which it can be formally multiplied and marketed. Nepal follows two systems for varietal notification—release and registration—with specific schedules defining the respective procedures and application formats. The seed regulatory framework was first established in 1997 and subsequently amended in 2013. The Seed Quality Control Centre (SQCC) is the secretariat of National Seed Board (NSB) and is responsible for all the secretarial activities of NSB, including the regulation of seed laboratories, licensing of private crop inspectors, seed sampler and seed analysts, and seed compensation. The VARRSC facilitates the release and registration of crop varieties by making recommendations to the national seed board for variety approval. Under the Seed Regulation 2013, four schedules (A, B, C, and D) outline the procedures for the notification of different types of crop varieties. Schedule A and Schedule B cover varieties developed within the country, whereas schedule C applies to imported varieties, and Schedule D is designated for farmers' native varieties. Varieties listed in Schedule A are released through the formal release system, whereas those in Schedules B, C, and D are registered under the registration system. For notification, three seasons of data are required for Schedule A, two seasons for Schedules B and C, and only one season

for Schedule D. Proposals for Schedules A, B, and C may be submitted by NARC, private sectors, or non-governmental organizations (NGOs) either independently or in collaboration with national or international organizations. In contrast, proposals for schedule D can be submitted by farmer groups, or cooperatives. Responsibility for maintaining the registered varieties lies with the proposing organization in Schedules A, B, and D, while private multinational companies are responsible under Schedule C. Information on Distinctness, Uniformity, and Stability (DUS) tests is mandatory for Schedules A, B, and C, but is flexible for Schedule D. Instead, registration under Schedule D is based on minimum descriptive and documentary information, including the variety's local name and origin, key distinguishing characteristics, cultivation history, and relevant morphological, agronomic, nutritional, cultural, or adaptation-related traits. This simplified approach provides greater flexibility for registering genetically heterogeneous and locally adapted farmers' native varieties.

The National Seed Board (NSB) is the national authority responsible for regulating seed-related matters, including the evaluation, approval, release, and registration of crop varieties. The NSB comprises 15 members and is chaired by the Secretary of the Ministry of Agriculture, Forest and Environment (MoAFE). To support its functions, the NSB operates through three specialized sub-committees: The Variety Approval, Release, and Registration Sub-committee (VARRSC), the Technical Sub-committee (TSC), and the Quality Control and Management Sub-Committee (QCMSC). Among these, the Variety Approval, Release, and Registration Sub-Committee (VARRSC) comprises 8 members and is chaired by the director general (DG) of the Department of Agriculture. It evaluates and reviews proposals for the release and registration of crop varieties. The Technical Sub-committee, comprising 12 members and chaired by the chief of the Seed Quality and Control Centre (SQCC), provides technical support for the development of research and study protocols required for variety release and registration. The Quality control and Management Sub-committee, consisting of 10 members and led by the Executive Director of the Nepal Agricultural Research Council (NARC), is responsible for developing and managing seed and varietal quality standards. Together, these institutional

mechanisms facilitate the review and submission of varietal proposals from public and private sectors to the NSB for approval.

A recent second amendment to the Seed Act (2022) introduced key provisions to support the conservation and promotion of farmers' native varieties, including the establishment of provincial seed boards and local seed management committees. The provincial-level seed boards are mandated to coordinate with the NSB for the registration farmers' varieties and to publish registration notifications in the provincial gazette. Following the second amendment to the Seed Act, a new Seed Regulation was introduced in 2024, incorporating key provisions for the notification of plant varieties in Nepal. Under this regulation, one of the three sub-committees, previously the Planning, Formulation and Monitoring Sub-committee, has been replaced by a Technical Sub-Committee.

The Seed Regulation (2024) provides clear definitions for both local and native varieties. A local variety is defined as a crop variety that has been continuously cultivated and maintained within a specific geographic area for at least 50 years, whereas a native variety refers to a crop variety that originated in, or evolved in situ within, a particular geographic area and possesses at least one distinctive trait associated with that region (Joshi et al. 2026; Casanas et al. 2017). The regulation also designates two seed classes for farmers' native varieties—improved seed and source seed—and introduces a truthful labeling system to ensure quality assurance. Under this new regulation, crops are categorized into priority and non-priority groups. Priority crops are those considered strategically important for national food and nutrition security, agricultural production, livelihoods, or the seed sector and therefore receive greater emphasis in research, varietal development, and seed-related programmes. Non-priority crops generally have lower strategic or commercial importance and may be subject to comparatively less intensive prioritization within the formal varietal development and seed regulatory system. A total of 15 crops including rice (*Oryza sativa* L.), maize (*Zea mays* L.), wheat (*Triticum aestivum* L.), finger millet (*Eleusine coracana* L.), buckwheat (*Fagopyrum esculentum*), potato (*Solanum tuberosum* L.), banana (*Musa paradisiaca* L.), lentil (*Lens culinaris* L.), soybean (*Glycine max* (L.) Merr.), pigeon pea (*Cajanus cajan* (L.) Mills), kidney bean (*Phaseolus vulgaris* L.), sunflower

(*Helianthus annuus* L.), rapeseed (*Brassica campestris* L.) var. toria Dutch), sarson (*Brassica campestris* L. var. sarson Prain) and sugarcane (*Saccharum officinarum* L.). has been identified as priority crops, while a flexible system has been provisioned for notification of non-priority crops. Furthermore, the regulation includes six annexes. Annex 3 provides a list of priority crops, while the remaining five annexes outline the procedures for the release and registration of crop varieties. Annex 1 is designated for the release of new varieties of priority crops and the re-release of existing crop varieties. For the re-release process, evidence of significant improvement, along with one season of data from Participatory Plant Breeding (PPB), must be submitted for the respective crop varieties. While the remaining annexes govern various forms of registration. Annex 2 covers the registration of imported varieties of priority crops, whereas Annex 4 provides for the registration of both domestic and imported varieties of non-priority crops. Among these, Annex 5 specifically addresses the registration of farmers' native varieties, while Annex 6 is intended for the registration of local varieties (Table 2).

Evolutionary history of farmer's variety registration system in Nepal

Over the past two decades, various measures have been implemented to address the challenges in crop improvement and varietal development in Nepal. Initially, the Nepal Agricultural Research Council (NARC) was the primary institution mandated to undertake varietal development activities; however, the National Seed Policy, 1999, broadened the institutional framework by recognizing the potential roles of additional stakeholders, including non-governmental organizations (NGOs) and international non-governmental organizations (INGOs), in varietal development. Subsequently, the Seed Act (2008 amendment) further expanded the framework by allowing private sector participation in varietal registration. In 2013, Nepal introduced the National Seed Vision (2013–2025), which recognized the importance of landraces and community seed banks in strengthening community-based seed systems, enhancing farmers' seed security, and supporting food and nutrition security, particularly in remote areas with limited access to formal seed systems (Gauchan 2019). Moreover, the Seed Regulation was amended in 2013

Table 2 Key provisions and regulatory requirements governing the notification of varieties in Nepal

Particular	Annex 1	Annex 2	Annex 4	Annex 5	Annex 6
Varieties notified	Varieties of priority crops developed within country	Imported varieties of priority crops	Domestic and imported varieties of non-priority crops	Farmers' native varieties	Local varieties
Notification system	Release	Registration	Registration	Registration	Registration
Requirement	Three seasons' data	Two seasons' data	Two seasons' data	Single season data	Single season data
DUS Test	Mandatory	Conducted by NSB, if required	Conducted by NSB, if required	Conducted by NSB, if required	Conducted by NSB, if required

NARC, private sector organizations, and non-governmental organizations (NGOs), either independently or in collaboration with national or international organizations, may submit applications under Annexes 1, 2, 4, and 6 while farmer groups, and cooperatives may submit applications under Annex 5. The Proposing organization shall be responsible for source seed maintenance

to allow the registration of farmers' varieties under a separate category (Schedule D) with more flexible provisions. These reforms have created space within the formal seed system for the inclusion of farmers' varieties. Notably, Isthaniya Gujmuje Rayo and Dunde Rayo of broad-leaf mustard, and Ramechhap Hariyo Latte of amaranth were among the first farmers' varieties registered under Schedule B, marking an important milestone in the formal recognition of Nepal's locally adapted genetic resources. However, the expected progress in the registration of farmers' varieties and their integration into varietal development processes did not fully materialize. To address these constraints, the National Gene Bank and LI-BIRD, in collaboration with Bioversity International, promoted participatory approach for registering farmers' varieties under Schedule D, and developed a farmer-friendly application format to facilitate the registration process. This format was developed through extensive multi-stakeholder consultations involving policymakers, farmers, and civil society representatives, and was subsequently pilot-tested, refined, and submitted to the National Seed Board, which formally approved it in 2020. The resulting template addressed earlier operational bottlenecks in implementing Schedule D by providing clear, step-by-step guidance for farmer's groups and cooperatives to effectively prepare and submit varietal registration proposals.

Enabling environment and motivation for farmers' native variety registration in Nepal

Farmers' motivation to register native varieties in Nepal has been driven by increasing awareness, institutional support, capacity-building initiatives, and the perceived socio-economic and conservation benefits associated with formal recognition. Participatory interventions such as varietal assessment, training workshops, on-farm learning, exchange visits, travelling seminars, and practical documentation exercises have enhanced farmers' technical knowledge and confidence in identifying, characterizing, and documenting local crop varieties. These activities have strengthened farmers' engagement in formal registration processes and improved their understanding of the value of conserving local genetic resources within national seed systems.

A major motivating factor has been the opportunity to obtain formal recognition and legal inclusion of farmers' native varieties under the Schedule D provision of Nepal's Seed Regulation. Farmers have shown strong interest in registering these varieties because they are highly adapted to local agroecosystems and perform well under heterogeneous, low-input farming conditions. Many registered varieties possess desirable traits such as superior taste, aroma, nutritional quality, stable yield, and tolerance to biotic and

abiotic stresses, thereby contributing significantly to household food and nutritional security. Formal recognition has also strengthened farmers' sense of ownership, custodianship, and pride in indigenous knowledge and traditional farming practices. Registration facilitates formal seed production, branding, commercialization, and access to recognized seed markets, thereby providing farmers with greater financial benefits that are otherwise unavailable under Nepal's existing seed regulatory framework for unregistered varieties. In addition to conservation benefits, farmers perceive varietal registration as an important mechanism for improving livelihoods and market opportunities. In Nepal, subsidies are available only for notified varieties, which also serves as one of the motivating factors for the notification of farmers' varieties. Participatory trials, peer-to-peer learning, field demonstrations, and community seed bank activities have further helped farmers understand the practical benefits of registration, including enhanced visibility of local varieties, improved seed exchange, institutional support, and opportunities for strengthening community-based seed enterprises. Overall, farmers' motivation for variety registration has been reinforced by the combined benefits of agrobiodiversity conservation, climate resilience, food and nutritional security, legal recognition, and livelihood enhancement through sustainable utilization of native genetic resources (Joshi et al. 2023, 2026; Yadav et al. 2026).

Diversity assessment and registration procedure of farmer's native varieties in Nepal

Farmers play a crucial role in the development, conservation, maintenance, and utilization of diverse native crop varieties. The registration process of farmers' native varieties in Nepal begins with the identification and documentation of locally maintained landraces and traditional cultivars. Participatory approaches, including focus group discussions, community consultations, and five-cell analysis, are commonly used to document varietal diversity, assess distribution and cultivation status, and identify promising landraces with high conservation and utilization value. These methods help generate baseline information on varietal characteristics, local adaptation, farmer preference, and conservation status, which are

essential for supporting the registration and long-term maintenance of farmers' varieties.

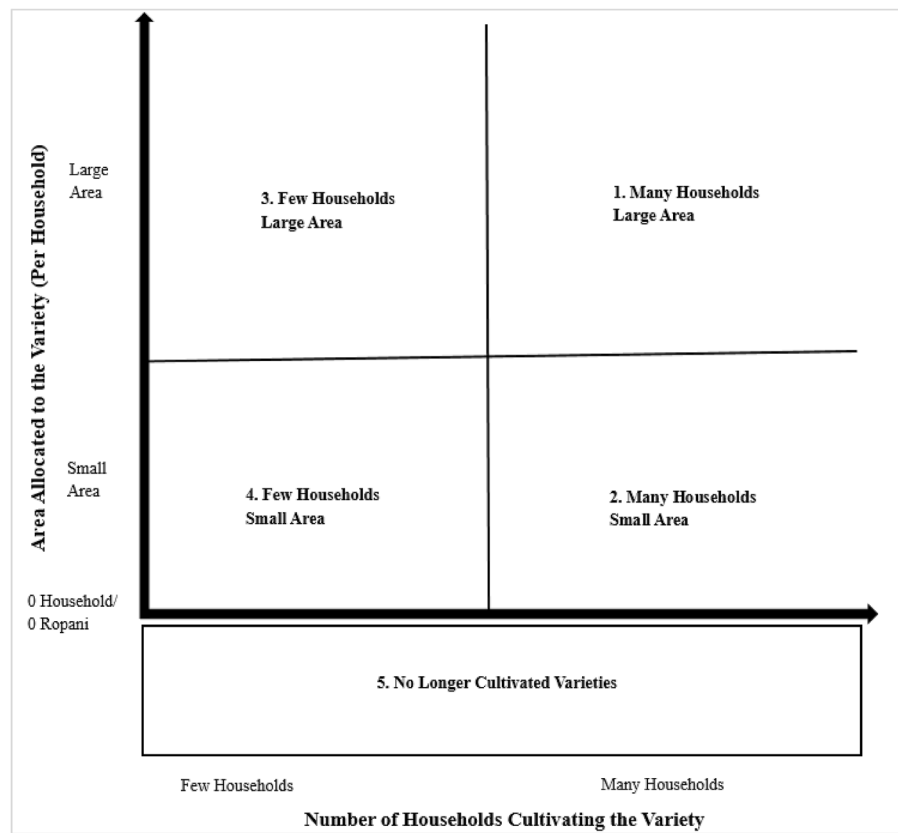
Five-cell analysis is a commonly used participatory tool for assessing the distribution, abundance, and conservation status of landraces within a given locality. This approach categorizes landraces and farmer's varieties into five groups or cells based on their area coverage, population size, frequency of cultivation, and the number of households maintaining them in a specific agroecological area (Joshi et al. 2022; Rana et al. 2005; Sthapit et al. 2003).

Five-cell analysis for farmers' native variety assessment and local agrobiodiversity conservation

The amount and distribution of crop cultivars is characterized using a five-cell analysis tool based on two key indicators: the number of households cultivating a variety and the average area allocated per household. As illustrated in Fig. 1, farmer varieties were classified according to number of households and areas under cultivation. This classification provides a relative measure of varietal abundance, distribution, and conservation status within local farming systems. The cut-off values for classifying cultivation area (large vs. small) and the number of cultivating households (many vs. few) were adapted to the baseline conditions of the study area and validated through focus group discussions and farmer interviews, reflecting the local agroecological and socio-economic context. Therefore, the five-cell analysis serves as a context-specific participatory tool rather than an absolute measure, enabling assessment of crop diversity patterns and prioritization of farmer varieties for agrobiodiversity conservation.

Varieties cultivated by many farmers on large land areas are generally preferred because of their desirable agronomic traits, market demand, multiple use values, or wider seed availability. Varieties grown by many farmers on smaller plots are socio-culturally important (traditions, religious, rituals, food culture), although required in smaller quantities. In contrast, varieties cultivated by only a few farmers on larger plots are commonly associated with niche or commercial production with specific adaptations traits (such as cultivars adapted to swampy lands, poor soil fertility, drought etc.). Varieties maintained by few

Fig. 1 Five-cell analysis tool for assessing farmers' native varieties in the study area. The X-axis indicates the number of households growing the variety (few to many), and the Y-axis indicates the area cultivated (small to large). One ropani equals to 508.72 square meters



farmers on small land areas are considered highly vulnerable to genetic erosion despite their potential socio-cultural or household importance. The fifth category includes varieties that are no longer cultivated but remain in farmers' knowledge and memory, representing genetic resources that may have been lost due to environmental stresses, changing farming systems, market shifts, or other socioecological factors.

Overall, five-cell analysis is a rapid and effective community-based tool for identifying threatened landraces, cultivars and understanding farmers' varietal preferences, prioritizing conservation interventions, and supporting the registration and sustainable utilization of farmers' native varieties.

In the context of farmers' variety registration in Nepal, five-cell analysis serves as an important analytical tool for identifying farmers' native varieties with high conservation and utilization value, strong local adaptation, and continued farmer custodianship. This approach is particularly useful for prioritizing candidate varieties for registration by documenting their distribution, cultivation status, and socio-cultural

importance within local production systems. Varieties categorized in few-farmers and low-area cells can be recognized as vulnerable genetic resources requiring urgent conservation attention, while varieties cultivated by many households across larger areas may indicate wider adaptation and greater potential for seed dissemination and commercialization.

The practical advantages of five-cell analysis include its simplicity, low cost, participatory nature, and applicability under farmer-managed conditions. It enables farmers, researchers, and local institutions to jointly generate baseline information on varietal diversity without requiring sophisticated laboratory infrastructure. In Nepal, five-cell analysis has been applied during community-level agrobiodiversity documentation and registration of farmers' varieties of crops such as rice, finger millet, taro, and beans to support varietal characterization, identify threatened landraces, and strengthen community seed systems (Joshi et al. 2022; Sthapit et al. 2003). This approach also contributes to on-farm conservation by linking varietal registration with community-based seed

maintenance, local seed exchange, and sustainable utilization strategies. Furthermore, integration of five-cell analysis into farmers' variety registration systems can enhance national efforts toward agrobiodiversity conservation, climate resilience, and recognition of farmers' roles in maintaining agricultural genetic resources.

Farmers varieties selected for registration are based on multiple criteria, including yield performance, nutritional value, and cultural or religious significance. Strengthening the capacity of local farmers and communities is essential for promoting the registration of farmers' varieties. A one-season field trial should be conducted across at least 10 farmers' fields, during which key morphological and agronomic traits are systematically recorded and documented by the applicant or registering institution. In addition, a focus group discussion (FGD) should be organized to document the variety's origin and history, cropping system, nutritional importance, and other relevant aspects. The FGD should also facilitate community-based validation of the agro-morphological data and establish a joint decision among community members regarding the application for registration. During cropping season, field monitoring and verification should be carried out by authorized agricultural institutions, including the relevant provincial seed testing laboratory and the Agriculture Knowledge Center (AKC) or Agriculture Service Center of the respective district, in coordination with the applicant organization, such as a farmers' group or cooperative.

Under the flexible provisions of Schedule D for farmers' varieties, one season of descriptor data is considered sufficient to support a simplified and farmer-friendly registration process, particularly for traditional varieties that have been cultivated and maintained by farming communities over many years with well-established local knowledge. However, if the evaluation season is affected by atypical environmental conditions, the observations are discarded and repeated in the subsequent season to ensure reliability of varietal characterization.

The varietal registration proposal of Schedule D includes information on distinguishing features, morphological and agronomic traits, and the cultural, nutritional, commercial, or medicinal value of the variety. A required seed sample must be submitted to the National Genebank for accessions, where the sample and supporting documents are reviewed

and assigned an accession number (NGRC) upon approval. The completed proposal, along with the required supporting documents including a recommendation letter from the concerned research station, extension office, or agriculture section of the Rural Municipality, Municipality, or Ward, as well as the registration certificate of the farmers' group and a copy of the group president's citizenship certificate is then submitted to the Secretariat of the National Seed Board. The evaluation of the variety registration proposal begins with its presentation to the Technical Sub-Committee, followed by the Variety Approval, Release and Registration Sub-Committee (VARRSC). These committees have the authority to approve, recommend revisions to, or reject the registration proposal. Subsequently, the National Seed Board (NSB) reviews the proposal recommended by VARRSC and may approve or reject it. Approved native varieties are subsequently published in the Nepal Gazette (Fig. 2).

Progress of farmers' native varieties registration in Nepal

The registration of farmers' native varieties in Nepal has advanced significantly in recent years under the "Relaxed Provision" (Schedule D) of the Seed Regulation (2013), which facilitates the formal recognition of locally evolved genetic resources. Between 2021 and 2024, a total of 24 farmers' varieties representing 10 different crops were registered through the National Seed Board. The registered crops included common bean, proso millet, foxtail millet, amaranth, finger millet, rice, soybean, cucumber, broad-leaf mustard, and chili. Rice accounted for the majority of the registered varieties, with 13 varieties, followed by broad-leaf mustard and common bean, with two varieties each. The remaining seven crops were each represented by a single registered variety. These registrations, proposed by community seed banks, farmers' cooperatives, and local organizations, reflect the growing institutional engagement of farming communities in varietal conservation and seed governance. These varieties originate from diverse agroecological zones and administrative regions—spanning from the lowland Terai (up to 500 m above sea level (masl)) to the high hills (up to 3,500 masl)—and were registered through local institutions across 16 districts of Nepal (Table 3, Fig. 3). A total of six varieties were

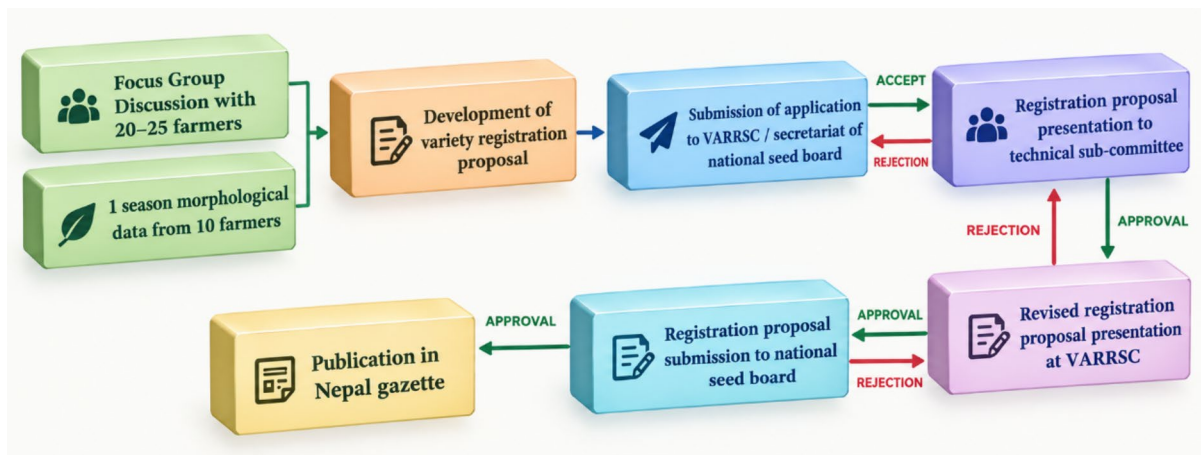


Fig. 2 Procedure for the registration of farmers' native varieties in Nepal (Source: Authors)

registered in 2021, followed by five varieties in each of 2022 and 2023. The highest number of registrations was recorded in 2024, with a total of eight varieties registered. This progress demonstrates Nepal's growing commitment to documenting and protecting farmers' genetic resources while bridging the gap between informal and formal seed systems. The initiative recognizes farmers' contributions to agrobiodiversity conservation and promotes the integration of traditional seed management practices into national agricultural policies. To date, no variety submissions have been rejected; however, varietal duplication and insufficient supporting data may pose potential challenges to the acceptance of future submissions.

Source seed of registered varieties is maintained by the farmers themselves or by community-based institutions such as community seed banks, farmers' groups and cooperatives. Farmers, producer groups, or organizations interested in accessing these varieties can obtain seeds by directly contacting the respective local institutions responsible for seed maintenance and multiplication. At present, seed exchange and distribution are primarily governed through community-level agreements, and seed prices are generally determined through mutual understanding depending on crop type, seed availability, and varietal demand. Unlike more formalized access systems in countries such as India and several European Union member states, where registered farmers' varieties are linked with plant variety protection and benefit-sharing mechanisms, Nepal's system remains largely

community-driven and decentralized. Nevertheless, the current approach has contributed positively to strengthening local seed systems, improving access to locally adapted genetic resources, and promoting on-farm conservation and sustainable utilization of native crop diversity through farmer-led seed networks and community seed enterprises.

Farmers' variety registration: linking seed systems with livelihood improvement

Bringing farmers' varieties into the formal seed system is important not only for seed systems development but also for improving farmers' livelihoods, market access, and long-term sustainability of native genetic resources. Under informal seed systems, farmers' varieties are often exchanged locally without formal recognition, quality assurance, branding, or market linkage, which limits their commercialization potential and economic value. In contrast, formal registration enables farmers and producer organizations to legally produce, label, market, and distribute seeds through recognized seed channels, thereby increasing market opportunities, consumer trust, and potential income generation. Formal inclusion into seed systems also facilitates institutional support for seed multiplication, varietal maintenance, quality control, and value-chain development. From the perspective of farmers and producer groups, conservation of agrobiodiversity becomes more meaningful when

Table 3 Progress in the registration and official recognition of farmers' native varieties under Nepal's seed regulatory framework. Source: SQCC 2025

S.N	Crop	Variety	Accession number	Registration category	Proposed by	Registered year (AD)	Recommended domain
1	Common bean (<i>Phaseolus vulgaris</i> L.)	Khairo Ghiu Simi	NGRC08500	Schedule D	Himchuli multi-purpose cooperative, Dolakha	2021	Dolakha and nearby districts
2	Common bean (<i>Phaseolus vulgaris</i> L.)	Panhelo Simi	NGRC08503	Schedule D	Himchuli multi-purpose cooperative, Dolakha	2021	Dolakha and nearby districts
3	Proso millet (<i>Panicum miliaceum</i> L.)	Dudhe Chino	NGRC07346	Schedule D	Karpunaath agriculture cooperative, Humla	2021	1500–2000 masl of Humla & nearby districts
4	Foxtail millet (<i>Setaria italica</i> L.)	Bariyo Kaguno	NGRC07945	Schedule D	Ghanpokhara Krishi sahakari sanstha limited, Lamjung	2021	800–1500 masl of Lamjung & nearby districts
5	Amaranthus (<i>Amaranthus caudatus</i> L.)	Lal Marshe	NGRC06843	Schedule D	Dhauligadh Krishi sahakari sanstha limited, Jumla	2021	1500–2000 masl of Jumla, Humla and nearby districts
6	Finger millet (<i>Eleusine coracana</i> (L.)	Rato Kodo	NGRC05113	Schedule D	Dhauligadh Krishi sahakari sanstha limited, Jumla	2021	2000–3500 masl of Jumla & nearby districts
7	Rice (<i>Oryza sativa</i> L.)	Bayarni	NGRC06666	Schedule D	Jaiwik srot samraxyen abhiyan, Kaski	2022	Mid-hill (between 800–1000 masl)
8	Rice (<i>Oryza sativa</i> L.)	Panhele	NGRC06667	Schedule D	Jaiwik srot samraxyen abhiyan, Kaski	2022	Mid-hill (between 800–1000 masl)
9	Rice (<i>Oryza sativa</i> L.)	Ekle	NGRC06664	Schedule D	Jaiwik srot samraxyen abhiyan, Kaski	2022	Mid-hill (between 800–1000 masl)
10	Rice (<i>Oryza sativa</i> L.)	Rato Anadi	NGRC06668	Schedule D	Jaiwik srot samraxyen abhiyan, Kaski	2022	Mid-hill (between 800–1000 masl)
11	Rice (<i>Oryza sativa</i> L.)	Kalo Jhinuwa	NGRC06665	Schedule D	Jaiwik srot samraxyen abhiyan, Kaski	2022	Mid-hill (between 800–1000 masl)
12	Rice (<i>Oryza sativa</i> L.)	Ghiupuri	NGRC09455	Schedule D	Jaiwik bibhidhata krishi sahakari sanstha limited, Bardiya	2023	Upto 500 masl
13	Rice (<i>Oryza sativa</i> L.)	Dalle Masino	NGRC09493	Schedule D	Jaiwik bibhidhata krishi sahakari sanstha limited, Tanahun	2023	450–800 masl
14	Rice (<i>Oryza sativa</i> L.)	Kanak Jeera	NGRC08889	Schedule D	Krishi bikash tatha krishak samrakshan samiti, Nawalpur	2023	Upto 500 masl

Table 3 (continued)

S.N	Crop	Variety	Accession number	Registration category	Proposed by	Registered year (AD)	Recommended domain
15	Rice (<i>Oryza sativa</i> L.)	Tilki	NGRC06636	Schedule D	Jaiwik bibidhata krishi sahakari sanstha limited, Dang	2023	500–900 masl
16	Soybean (<i>Glycine max</i> (L.) Merr.)	Nepale Bhat-mas	NGRC09474	Schedule D	Tamaphok krishi jaibik bibidhata sanrakshan tatha bikash samiti, Sankhu-wasabha	2023	1400–1800 masl of mid-hill and high hill
17	Cucumber (<i>Cucumis sativus</i> L.)	Madale Kankro	NGRC09585	Schedule D	Annapurna community seed bank, Kaski	2024	Kaski, Parbat, Myagdi, Baglung and nearby district
18	Rice (<i>Oryza sativa</i> L.)	Kalopatle	NGRC10248	Schedule D	Annapurna community seed bank, Kaski	2024	1400–1700 masl of Gandaki province
19	Rice (<i>Oryza sativa</i> L.)	Joroyal Basmati	NGRC10567	Schedule D	Ganteswor community seed bank, Doti	2024	Upto 900–1200 masl of mid hill of Sudurpaschim province
20	Rice (<i>Oryza sativa</i> L.)	Lal Anadi	NGRC10566	Schedule D	Anmol Krishi sahakari sastha Ltd., Kanchanpur	2024	Upto 300 masl of Sudurpaschim province
21	Rice (<i>Oryza sativa</i> L.)	Hariyo Kauchin	NGRC10320	Schedule D	Pingdanda community seed bank, Sindhupalchowk	2024	1100–1600 masl of Bagmati province
22	Broad leaf mustard (<i>Brassica juncea</i> (L.) Czern & Coss.)	Jimpakha Raayo	NGRC09608	Schedule D	Juneli mahila krishak samuha, Okhaldhunga	2024	1000–2000 masl of Okhaldhunga district and nearby area
23	Broad leaf mustard (<i>Brassica juncea</i> (L.) Czern & Coss.)	Kalo Bhaji	NGRC10085	Schedule D	Rara community seed bank, Mugu	2024	1400–2900 masl of high hill of Karnali province
24	Chilly (<i>Capsicum frutescens</i> L.)	Tistung Akabare Khursani	NGRC09922	Schedule D	Sana kisan sahakari sanstha Ltd, Makawanpur	2024	1200–2300 masl of mid-hill

linked with tangible socio-economic benefits such as premium market prices, niche product development, climate resilience, household food and nutritional security, and strengthened local seed enterprises. Many native varieties possess unique traits including superior taste, aroma, nutritional quality, adaptation to marginal environments, and tolerance to biotic and abiotic stresses, making them valuable under

changing climatic conditions and low-input farming systems. Sustainable utilization of native crop varieties through formal seed systems therefore supports the concept of “conservation through use,” where continued cultivation, seed exchange, and commercialization help maintain genetic diversity in farmers’ fields while simultaneously generating livelihood benefits. Practical experiences from community seed

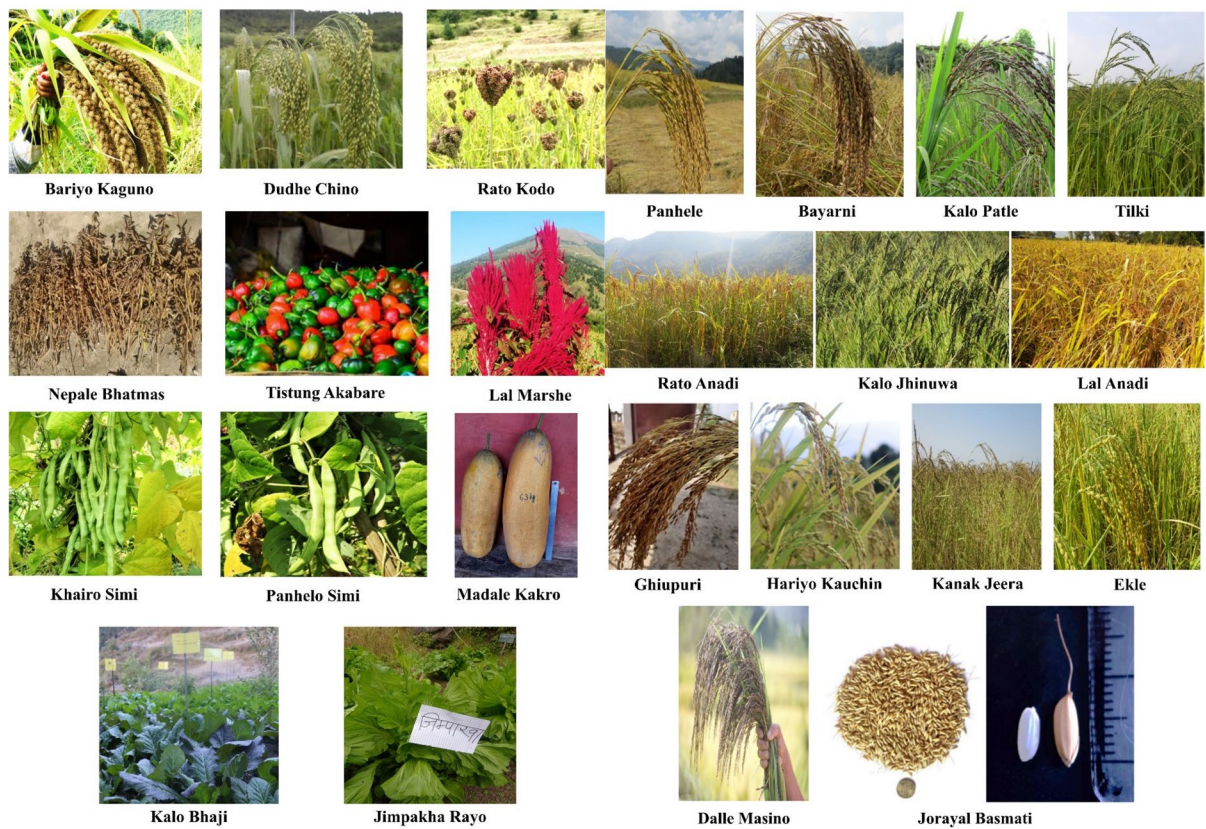


Fig. 3 Registered farmers' native varieties in Nepal, highlighting the locally conserved genetic resources formally recognized under the national seed regulatory system

banks and farmers' variety registration initiatives in Nepal demonstrate that formal recognition of native varieties can enhance farmers' motivation to conserve local genetic resources by transforming traditional varieties from subsistence crops into economically and culturally valuable agricultural assets (Joshi et al. 2026; Shrestha et al. 2013).

Farmers and farmer groups produced source seed under the established seed quality assurance system, which was subsequently distributed across the recommended production domains. This process strengthened the local seed value chain by enhancing the availability and accessibility of quality seeds, thereby facilitating the early dissemination and adoption of registered farmer varieties (Almekinders and Louwaars 2002; FAO 2021). Beyond improving seed supply, community-based source seed production created direct livelihood benefits, as participating farmer groups generated additional income through the commercial sale of

source seed. Source seed production and marketing of the two registered varieties—Bariyo Kaguno and Dalle Masino—have shown a continuous increasing trend (Fig. 4). This finding is consistent with previous studies reporting that decentralized seed production and marketing can strengthen local seed systems, support the on-farm conservation of genetic resources, and generate livelihood opportunities for farming communities (FAO 2019; Sperling et al. 2013). Thus, linking farmers' variety registration with decentralized seed production and marketing can provide a mechanism for simultaneously supporting seed system resilience, genetic resource conservation, and rural livelihoods.

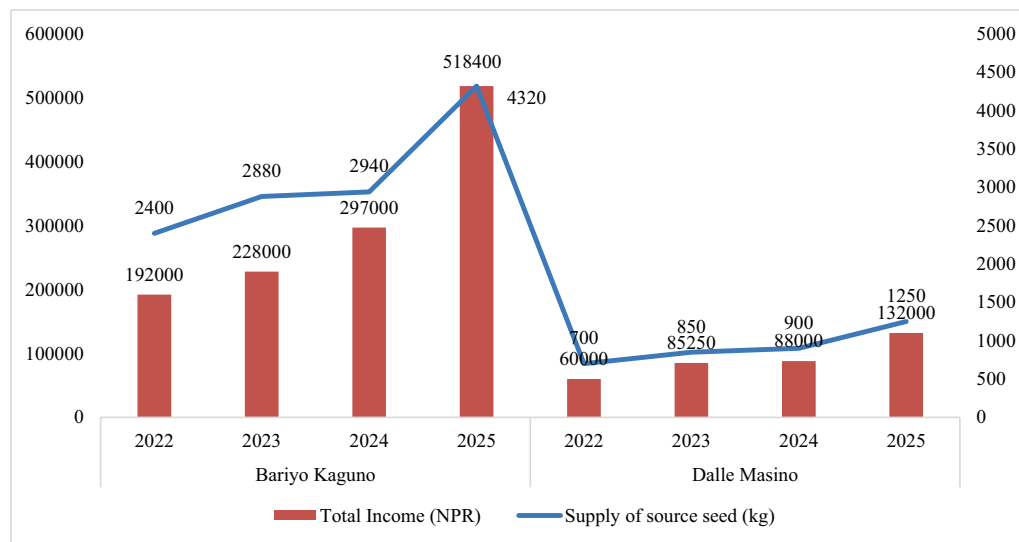


Fig. 4 Source seed production and marketing trends of selected registered farmers' native varieties (Source:LI-BIRD 2026)

Policy gaps for registration of farmer's native varieties in Nepal

During the initial years of schedule D implementation, several technical and institutional limitations were identified. Its provisions did not adequately address non-orthodox seeds, forage crops, and vegetatively propagated species, highlighting the need for regulatory revision or alternative registration categories. However, the amended Seed Regulation (2024) has addressed this gap by establishing a clearer framework with separate categories for the registration of these crops. Cases of exotic fruit varieties, such as litchi, mango, and kiwi, being registered under Schedule D further contradict its intended purpose of protecting native and farmers' varieties. In addition, eligibility for registration remains restricted to farmer groups or cooperatives, excluding individual farmers. Another emerging issue is varietal duplication, where the same variety is known by different names in different regions. To address this, DNA fingerprinting and molecular characterization could support accurate identification, with SQCC, in collaboration with NARC and CGIAR institutions, updating the phenotypic and genotypic databases of registered varieties. Given the traditional and dynamic nature of these varieties, farmers themselves should be recognized and supported as primary custodians of varietal maintenance through their indigenous knowledge

and practices. Clear seed quality control and source seed maintenance guidelines for Schedule D varieties should therefore be developed and disseminated by SQCC in consultation with farmers' organizations, private sector actors, and relevant governmental and non-governmental institutions. Despite these challenges, the future prospects for farmers' variety registration and maintenance in Nepal remain highly promising due to increasing national and international recognition of agrobiodiversity conservation, farmers' rights, climate-smart agriculture, and community-based seed systems (De Jonge et al. 2024; FAO 2019, 2021; Gauchan et al. 2020; Sthapit et al. 2012).

Implementation gaps for registration of farmer's native varieties in Nepal

Although Schedule D of the Seed Regulation 2013 (Annex 5 in the Seed Regulation 2024) was introduced to facilitate the registration of farmers' varieties, its implementation has faced several challenges. Awareness of its relaxed provisions remains limited among key stakeholders, while weakening community-based seed systems, inadequate incentives, and limited technical capacity among farmers, local communities, technicians, and researchers further constrain its effective implementation (Gauchan and Shrestha 2020). Farming communities and

community-based organizations also lack sufficient orientation on registration procedures, limiting their active participation. In some review and defense seminars, technical members have raised concerns related to molecular and advanced technologies, despite these being beyond the intended scope of Schedule D. In addition, the registration process is often lengthy and costly, discouraging small-scale farmers. Misunderstanding of the uniformity criteria by some members of the varietal release and registration sub-committee has also created hesitation, as farmers' varieties naturally possess intra-varietal diversity. Furthermore, the conventional emphasis on yield as the primary criterion for varietal registration often overlooks important attributes such as nutritional value, cultural significance, and geographical adaptation, thereby undermining agrobiodiversity conservation.

Recommendation for strengthening of farmers' native varieties registration system in Nepal

The recommendations have been reorganized into immediate-, medium-, and long-term priorities as follows:

Immediate priorities

The immediate priority should be to strengthen the implementation of Schedule D through clearer technical guidelines, harmonized procedures, and improved coordination among relevant institutions. Awareness programmes, participatory capacity-building, and technical support should also be expanded for farmers, cooperatives, community seed banks, local governments, and other relevant stakeholders to facilitate the registration, maintenance, and sustainable use of farmers' native varieties across diverse agroecological regions.

Medium-term priorities

In the medium term, Nepal should strengthen linkages among farmers, research institutions, government agencies, private seed enterprises, NGOs, and international organizations to establish a more inclusive and decentralized registration and seed management system. Digital documentation and database systems, community-based seed quality assurance

mechanisms, and appropriate approaches for molecular characterization and geographical indication (GI) tagging should be developed and progressively integrated to improve varietal documentation, traceability, authenticity, and conservation planning.

Long-term priorities

In the long term, Nepal should develop appropriate access and benefit-sharing mechanisms aligned with the principles of the Nagoya Protocol to promote the fair and equitable sharing of benefits arising from the use of native genetic resources (Gauchan et al. 2018; Kamau and Winter 2013; Morgera et al. 2015). These mechanisms, together with strengthened institutional collaboration and sustainable financing, could support long-term conservation through sustainable use, enhance local livelihood opportunities, and safeguard Nepal's agricultural genetic diversity for future generations.

Leveraging the Nagoya protocol for benefit-sharing in farmers' varieties in Nepal

Although Nepal has drafted an Access and Benefit Sharing (ABS) Bill, it has not yet been formally approved and implemented. Consequently, the country currently lacks a comprehensive legal framework for royalty distribution and equitable benefit-sharing arising from the registration, utilization, and commercialization of farmers' varieties. This policy gap limits the formal recognition and compensation of farming communities that have conserved, selected, and maintained native crop genetic resources over generations.

Nevertheless, Nepal is a Party to the Nagoya Protocol, which provides an internationally recognized framework for fair and equitable sharing of benefits derived from the utilization of genetic resources and associated traditional knowledge (CBD 2011). The Nagoya Protocol emphasizes key principles such as prior informed consent (PIC), mutually agreed terms (MAT), and equitable benefit-sharing between providers and users of genetic resources (Morgera et al. 2015). These provisions are highly relevant in the context of farmers' variety registration in Nepal, where local farming communities play a central role

in the conservation, evolution, and sustainable management of native agrobiodiversity.

Integration of Nagoya Protocol principles into Nepal's farmers' variety registration system could provide a strong policy and legal foundation for establishing transparent and inclusive benefit-sharing mechanisms. Such mechanisms could ensure both monetary and non-monetary benefits to farmers and farmer groups when registered native varieties are utilized in plant breeding, research, seed production, commercialization, or value-chain development (De Jonge et al. 2024; Gauchan et al. 2018; Salazar et al. 2007). Potential benefits may include royalty-sharing, community development support, technology transfer, capacity building, participatory breeding programs, market incentives, and formal recognition of farmers' custodianship of genetic resources.

Furthermore, linking farmers' variety registration with national ABS mechanisms would strengthen farmers' rights, encourage on-farm conservation through sustainable utilization, and promote the long-term conservation of agricultural genetic diversity. It would also support Nepal's commitments under the Convention on Biological Diversity by ensuring that farming communities receive fair recognition and equitable benefits from the use of their conserved and locally adapted genetic resources.

Conclusion and way forward

This study summarizes the existing policy provisions for registering farmers' varieties, identifies key gaps and challenges during the registration process, and highlights the need for stakeholder awareness and sensitization to integrate these novel genotypes into the formal seed system. It specifically outlines policy provisions, process, gaps and future prospects for farmers' native variety registration in Nepal. The effort of bringing farmer's varieties into the registration process will support improving food and nutritional security and strengthen livelihoods and enhance the resilience of farming systems to climate change and other challenges. Despite the significant progress in registering farmers' varieties in Nepal, there are still numerous policy-level gaps and challenges that need to be addressed. During the entire cycle of production, maintenance, and registration of farmers' varieties, there is an immediate need of a

clear source seed maintenance guideline alongside a coordinated and holistic approach involving collaboration among farmers, government agencies, private sectors, NGOs, and other stakeholders. In addition, creation of incentive mechanisms for farmers, plant breeders and private sectors are crucial to conserve and promote farmers' native varieties for strengthening farmers' seed systems and ensuring food and nutrition security of people in Nepal.

Acknowledgements The authors would like to thank all farmers and organizations that we have collaborated and interacted for developing this registration system.

Author contributions All authors contributed to the study conception and design. The first draft of the manuscript was written by Pradip Thapa and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Funding Authors would like to express sincere gratitude to the Nepal Agricultural Research Council for their funding for this research.

Data availability No datasets were generated or analysed during the current study.

Declarations

Conflict of interest The authors have declared that no conflict of interest exist.

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