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Seed Storage Practices and Cultivation Techniques: A Survey in Gajuri Rural Municipality, Nepal

Abstract. The production, selection, and storage of the seeds used for cultivation in Nepal are done in two ways: traditional and modern. Conventional ways of storing and reusing seeds depend on indigenous and traditional techniques, whereas modern techniques depend on the different agencies performing scientific agricultural breeding and storage techniques. The study aimed to determine the major varieties and sources of seed used for cultivation, to what extent the cultivated varieties are stored, and whether the stored seeds are cultivated. The study surveyed 171 households by systematic random sampling in the Jarebagaiccha and Milanatar villages of ward 6 in the Gajuri Rural Municipality, Nepal. The study was constructed utilising a literature review and in-depth interviews. The researcher used SPSS version 26 for analysing and illustrating the findings of the 11 cultivated crops, i.e., Rice, Maize, Millet, Wheat, Mustard, Potato, Beans, Black lentil, Cowpea, Soybean, and Rice beans. The findings determined that the majority of the farmers cultivated local varieties of crops by using informal sources of seed and stored the seeds in their own homes. The study further highlighted that only four local varieties (soybean, cowpea, potato, mustard) were acquired from agro-vets by a minority of the farmers. The hybrid varieties that were cultivated had formal sources, and none of the hybrid varieties were stored. The farmers stored nine local varieties using the traditional method of cultivation.

Keywords: agriculture, seed storage, traditional practices, cultivation, survey, Nepal

JEL Classification: Q12, Q16, E23

Introduction

Nepal's economy is driven mainly by agriculture, making it one of its most important industries. Agriculture provides a resilient livelihood by offering diverse income sources, ensuring food security, contributing to local economies, and fostering adaptability to environmental changes. It also plays a vital role in cultural preservation, rural development, global stability, and climate resilience, making it a cornerstone of sustainable livelihoods worldwide. Only 21% of Nepal's land is cultivated, and 65% of the population works in agriculture, which is their main occupation (Joshi et al., 2020). The agriculture industry employs approximately 8 million people, two-thirds of the country's total labour force

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(Gyawali & Khanal, 2021). It provides livelihoods for about 70% of the population and accounts for around 30% of the National GDP (Dhakal, 2022). However, there is insufficient investment even in rice research, even though it is a major crop in Nepal (Pandit et al., 2020). Importantly, such research on the seeds of rice and other crops is imperative for many reasons. Seeds are one of the most essential requirements in the agriculture industry. The quality and availability of seeds are pivotal for achieving resilient livelihoods in agriculture. High-quality seeds are fundamental as they contribute to enhanced crop yields, pest resistance, and high-quality produce (De Falcis et al., 2022; Jones et al., 2018). Conversely, subpar seed quality can lead to crop failures and reduced income, increasing vulnerability to external factors.

Seeds used for sowing and cultivation can be obtained from various seed production sources. These sources can be local (neighbours, family, friends), regional (community seed banks, cooperatives, etc.), national (national seed companies, extension agencies, etc.), or even international (such as a multinational seed company or an international gene bank) (Puskur et al., 2021). More than 90% of cereal seed supply in the local context of Nepalese farming is informal (Paudel et al., 2013).

By 2030, the Sustainable Development Goal (SDG) 2: End hunger, seeks to end hunger, achieve food security, enhance nutrition, and promote sustainable agriculture and food systems. SDG 2.3 aims to double the agricultural productivity and incomes of small-scale food producers by 2030 through secure and equal access to productive resources, among other means. SDG 2.4 calls for implementing resilient agricultural practices that increase productivity and production (UNDP, 2015).

Nepal has legislation in place to address seed quality and availability. The Seeds Act, 2045 (1988) came into force on 26th October 1988 (Nepal Law Commission, 2018). It has undergone several amendments, including the Seeds (First Amendment) Act, 2058 (2002), and the Republic Strengthening and Some Nepal Laws Amendment Act, 2066 (2010) (Nepal Law Commission, 2018). The act established a National Seed Board to formulate and implement seed-related policies and advise the government on seed-related matters. The Seed Act 2010 provides a legal framework for seed production, processing, certification, marketing, import/export, research, and development (Nepal Law Commission, 2018; Gauchan, 2019). The Seed Vision 2013–2025 aims to ensure quality seed availability for farmers through a well-functioning seed sector (SQCC, 2013). It outlines a long-term strategy to enhance seed production and distribution, explicitly improving seed quality and availability (SQCC, 2013). This vision aligns with global goals, particularly SDG 2, by promoting food security and poverty reduction through improved seed systems.

The cultivation of seeds and their storage play direct and indirect roles in achieving these goals. There is demand at the local, regional, national, and worldwide levels for community seed banks and field gene banks that contain seeds and plants with greater genetic diversity and stress tolerance to biotic and abiotic factors (Gautam, 2017). Community seed banks are necessary financial instruments for farmers (Falcis et al., 2022) as they provide economic benefits for the farmers to improve their livelihood (Shrestha et al., 2007).

Thus, the storage mechanisms of seeds are essential. If the seeds' storage management is not done appropriately, it leads to storage losses. Storage losses are fairly high (up to 10%) for several crops (Paneru et al., 2018). Nepali farmers mostly use traditional storage

methods (Subedi et al., 2009). However, conventional methods are not sufficient to prevent storage loss and traditional methods are inefficient for protecting seeds from insects (Kandel et al., 2021).

Despite the significance of understanding farmers' practices in seed cultivation, storage, and utilisation in the Gajuri Rural Municipality, there remains a notable gap in the existing literature. Some studies have examined seed management and agricultural practices in rural settings. For example, the study of Joshi et al. (2011) examined using improved seed varieties to improve productivity. Likewise, Kandel et al. (2021) detailed the challenges in the Bagmati province of Nepal, such as insects in seed storage, and suggested improved storage methods. Similarly, Sharma and Tiwari (2020) suggested improved storage methods, such as metal bins, to preserve bins. However, few studies have specifically focused on the practices of farmers in the Gajuri Rural Municipality regarding seed cultivation, storage, and utilisation. This research emphasises the practices of the farmers of the Gajuri Rural Municipality in the cultivation and storage of seeds and their sources for plantation. This study aimed to determine the major seed varieties and sources farmers use for cultivation, the extent to which the cultivated varieties are stored, and whether or not the stored seeds are used for cultivation in the study area.

Methodology

Study Area, Population, and Sample

The area of study was the Gajuri Rural Municipality of Dhading. There are eight wards in this rural municipality with a total area of 138.88 sq. km. (Government of Nepal, 2021). Out of these eight wards, Ward 6 was chosen for the study, as it provides a critical conduit for transportation logistics within the agricultural landscape. The total population of the Gajuri Rural Municipality is 27,074, whereas the population of Ward No. 6 is 4,565 (MOFALD, 2021). The probability sampling technique was intended to be used in this study. Here, the researchers chose systematic random sampling, and households were selected systematically. According to CBS 2012, there are 300 households in the villages of Jarebagaichha and Milantar. The sample size was calculated from the population (300) by applying the sampling formula of Yamane (1967).

$$N_0 = \frac{N}{1 + N \times \alpha^2}$$

Where:
N_0 = Sample size;
N = Total population = 300;
α = Level of significance = 0.05.

Then, the interval of the selection of the house would be the total number of households divided by the sample taken, i.e., 300/171, which is approximately 2. Therefore, the researcher chose respondents from every second house. After the sample was determined, a questionnaire was prepared with the help of an expert and supervisor in the English language and later translated into Nepali for the convenience of the respondent. The questionnaire was piloted among 17 farmers, approximately 10% of the total sample. The survey took 5–8 minutes for each participant and was completed in 15 days. The received data was coded using SPSS software version 26.

Results and Findings

Males aged 56 and older made up the most significant proportion of the respondents within the study population, whereas the females were aged 26–35, which illustrates that the total number of female respondents was more than that of the males.

Table 1. Age and Gender of the Respondents

Serial Number	Age Range	Gender		Total
		Male	Female	
1	20–25	4 (2.3%)	6 (3.5%)	10 (5.8%)
2	26–35	18 (10.5%)	27 (15.38%)	45 (26.3%)
3	36–45	13 (7.6%)	23 (13.5%)	36 (21.1%)
4	46–55	17 (9.9%)	17 (9.9%)	34 (19.9%)
5	56–above	29 (17.0%)	17 (9.9%)	46 (26.9%)
	Total	81 (47.4%)	90 (52.6%)	171 (100%)

Source: Own calculation.

The demographic data were analysed, revealing the ethnic composition of the surveyed population. The majority of the respondents were Brahmins and Chhetri (62.6%). They make up more than 50% of the total respondents. There was also significant representation from the Janajati (25.1%) and Dalit (11.7%) communities, alongside a small fraction of 'others' (0.6%).

Table 2. Ethnicity of the respondents

S.N	Ethnicity	Frequency	Percent
1	Brahmin, Chhetri	107	62.6
2	Janajati	43	25.1
3	Dalit	20	11.7
4	Others	1	0.6
	Total	171	100.0

Source: Own calculation.

All the respondents' primary source of income was agriculture, with a secondary source of income being reported by 136 (79.5%), and 14 (8.2%) reported having a tertiary source of income.

Table 3. Occupations and Source of Income of the Respondents

S.N	Source of Income	Primary Source		Secondary Source		Tertiary Source	
		N	%	N	%	N	%
1	Agriculture	171	100%				
2	Job			39	22.8		
3	Business			9	5.3	1	0.6
4	Remittance			22	12.9	2	1.2
5	Wages			27	15.8	5	2.9
6	Others			39	22.8	6	3.5
	Total	171	100%	136	79.5	14	8.2

Source: Own calculation.

All the respondents had their own land and a few respondents had rented, 'Adhiya' land (the farmer pays half of the harvest from the rented land as payment for using the land) along with their own land.

Table 4. Types of Land of the Respondents

S.N	Types of Land (N=171	N	%
1	Own	171	100.0
2	Own and Rented	3	1.8
3	Own and Adhiya	11	6.4
4	Own, Rented and Adhiya	2	1.2

Source: Own Calculation.

Eleven crops were cultivated by the farmers, among which maize was the most cultivated crop (N=166, 97.1%). Out of the 11 crops, local varieties of 10 were cultivated except the wheat variety. Of them, they chose to produce the local variety of cowpea, making it a highly cultivated local variety. Maize was the preferred hybrid crop, and it was grown by 93 farmers (56.02%).

Table 5. Cultivation Status of the Crops

		Cultivation		Variety		
S.N	Crops		Total cultivated	Local	Hybrid	Both (Hybrid + Local)
		N	N (%)	N (%)	N (%)	N (%)
1	Rice	171	105 (61.4%)	20 (19.04%)	13 (12.38%)	72 (68.57%)
2	Maize	171	166 (97.1%)	40 (24.09%)	93 (56.02%)	33 (19.87%)
3	Millet	171	111 (64.9%)	111 (100%)	-	-
4	Wheat	171	13 (7.6%)	-	13 (100%)	-
5	Mustard	171	102 (59.6%)	102 (100%)	-	-
6	Potato	171	101 (59.1%)	95 (94.05%)	6 (5.9%)	-
7	Black lentil	171	102 (59.6%)	102 (100%)	-	-
8	Cowpea	171	112 (65.5%)	112 (100%)	-	-
9	Soybean	171	78 (45.6%)	78 (100%)	-	-
10	Beans	171	21 (12.3%)	21 (100%)	-	-
11	Rice beans	171	32 (18.7%)	32 (100%)	-	-

Source: Own calculation.

The source of all the hybrid varieties of seeds was an agro-vet. The home was the primary source of seed for the crop millet, where out of 171 respondents, 111 were millet cultivators, and out of 111 cultivators, 99% of millet cultivators' seed source was their own home, and 1% of farmers' source of seed was their neighbour. Among the local varieties, beans were shared in the neighbourhood in the highest number (90.47%).

Table 6. Varieties of seed by their source

S.N	Crops	Seeds from							
		Home		Neighbours		Agro-vet		Others	
		N	%	N	%	N	%	N	%
1	Rice	20	100	-	-	-	-	-	-
		-	-	-	-	13	100	-	-
		72	100	-	-	72	100	-	-
2	Maize	31	77.5	9	22.5	-	-	-	-
		-	-	-	-	93	100	-	-
		33	100	-	-	33	100	-	-
3	Millet	110	99	1	1	-	-	-	-
		-	-	-	-	-	-	-	-
4	Wheat	-	-	-	-	-	-	-	-
		-	-	-	-	-	-	13	100
5	Mustard	38	37.62	15	14.85	48	47.52	-	-
		-	-	-	-	-	-	-	-
6	Potato	-	-	-	-	95	100	-	-
		-	-	-	-	6	100	-	-
7	Black lentil	100	98	2	2	-	-	-	-
		-	-	-	-	-	-	-	-
8	Cowpea	92	82.14	7	6.25	13	11.60	-	-
		-	-	-	-	-	-	-	-
9	Soybean	67	85.89	4	5.12	7	8.9	-	-
		-	-	-	-	-	-	-	-
10	Beans	2	9.5	19	90.47	-	-	-	-
		-	-	-	-	-	-	-	-
11	Rice beans	32	100	-	-	-	-	-	-
		-	-	-	-	-	-	-	-

Source: Own calculation.

Out of 11 cultivated crops and their local varieties, nine local types were stored using a primitive method. 100% of local rice, maize, millet, and black lentil cultivators stored the seed using primitive methods. The farmers stored none of the hybrid varieties.

Table 7. Varieties of seed by source

S.N	Crop	Method of Storage			
		Primitive		Modern	
		N	%	N	%
1	Rice	92	100	0	0
2	Maize	73	100	0	0
3	Millet	111	100	0	0
4	Wheat	0	0	0	0
5	Mustard	98	96.05	0	0
6	Potato	0	0	0	0
7	Black lentil	102	100	0	0
8	Cowpea	98	87.5	0	0
9	Soybean	72	92.30	0	0
10	Beans	2	9.5	0	0
11	Rice beans	32	100	0	0

Source: Own calculation.

Only nine crops of local varieties were stored for cultivation. The local varieties of millet, black lentil, cowpea, soybean, beans, and rice beans were stored and cultivated. Likewise, not all the farmers checked the quality of all seeds before cultivation. Soybean was the crop whose quality was checked in the highest amount (88.46%).

Table 8. Cultivation after Storage and Quality Check

S.N	Crop	Quality check of stored seed		Cultivation after Storage	
		N	%	N	%
1	Rice	81	88.04	90	97.82
2	Maize	58	79.45	68	93.15
3	Millet	85	76.57	111	100.00
4	Mustard	79	80.61	97	98.97
5	Black lentil	90	88.23	102	100.00
6	Cowpea	72	73.46	98	100.00
7	Soybean	69	88.46	78	100.00
8	Beans	2	100.00	2	100.00
9	Rice beans	2	6.25	32	100.00

Source: Own calculation.

The participation of female respondents was more than that of male respondents by 5.2%. According to a preliminary report of the Central Bureau of Statistics (CBS, 2022), the ratio of females (51.04%) is greater than that of males (48.96%) in Nepal. The majority of the respondents belonged to the Brahmin and Chhetri communities. All the respondents had their own land and used it for farming and shelter. Some respondents (1.8%) also rented land for farming, and Adhiya (1.2%) was also taken for farming.

All the respondents were engaged in farming, and agriculture was the main occupation in that area, making it the primary source of income. Out of 171 respondents, 137 respondents had a secondary source of income, and 14 respondents had a tertiary source of income apart from agriculture. According to Maharjan et al. (2013), farmers spend less on low-productivity subsistence crop farming and livestock when remittances are relatively large and instead favour the non-farm sector or use remittances more for leisure and consumer items.

There were 11 crops: rice, maize, millet, wheat, mustard, potato, black lentil, cowpea, soybean, beans, and rice beans. Maize was cultivated by the highest number (N=166, 97.1%) of respondents, and wheat was cultivated by the lowest (N=13, 7.6%). The second most cultivated crop was cowpea (N=105, 61.4%).

Farmers cultivated local, hybrid, and both (local & hybrid) varieties of rice and maize. Wheat was the only crop whose hybrid variety was cultivated. Millet and cowpea were the highly cultivated local varieties. The farmers produced only the local varieties of millet, mustard, black lentil, cowpea, soybean, beans, and rice beans. Nearly 96% of farmers used unauthorised sources, including harvest, to obtain rice seeds (Gauchan et al., 2014; MoAD, 2015).

The farmers used local and hybrid seed varieties for cultivation, and the seeds were acquired from informal (home, neighbourhood) and formal (agro-vet) seed sources. In this research, cultivating local varieties is more likely to be from informal and, at a minimum, formal sources. In support of this, McGuire & Sperling (2016) stated that a study conducted in Africa on 9,660 observations of 40 crops showed that farmers acquired 90.2% of their seed from informal sources. Almost 82% of farmers rotate their seeds at regular intervals for cultivation, acquired from the formal and informal sectors (Baniya et al., 2005). Another study on rice and millet showed that the Kaski, Bara, and Ghanpokhara used informal sources of seed supply, including their own, neighbours, and relatives, and Switzerland used only formal seed supply to cultivate rice and millet (Wyss et al., 2016). The most cultivated hybrid crop in the research area was maize, and of the cultivated hybrid seed source for 93 (100%) was an agro-vet (formal seed supply). The study was conducted in Chitwan, Dadeldhura, Dang, Khotang, Lalitpur, and Sindupalchwok; overall, the formal seed for maize makes up 75%, and informal seed makes up around 25% (Gairhe et al., 2021).

Out of 11 cultivated floras, nine local varieties were stored using the primitive method; the potato was the only crop that was not stored using any of the methods. The respondents also reported not having any community seed banks in the area. The local varieties of millet, black lentil, cowpea, soybean, beans, and rice beans were stored and cultivated. According to the data, the stored varieties are used for cultivation, and their quality was checked using unscientific and traditional methods.

Farmers are utilising the seeds they have on their own farms and storing some for future cultivation. However, the quality of these stored seeds varies, as there is no application of scientific methods to assess their quality. It is essential to combine the farmers' traditional knowledge with scientific techniques to improve seed storage, ensure better cultivation outcomes, and ensure seed security.

The agricultural community in the Gajuri Rural Municipality predominantly relies on traditional seed storage methods, indicating a strong adherence to age-old practices. While rooted in local wisdom, this reliance raises concerns about a potential compromise in the

quality and viability of stored seeds. The absence of modern techniques for assessing seed quality suggests a critical gap in the preservation process, impacting the long-term agricultural sustainability of the region.

A notable absence in the region is the lack of community seed banks. These communal repositories play a pivotal role in collective conservation efforts. Their non-existence represents a significant gap in safeguarding agricultural biodiversity and seed security. Community seed banks could serve as vital centres for preserving indigenous crop varieties, ensuring genetic diversity, and providing a safety net against crop failures. Particularly for crops such as potatoes, which were not stored traditionally, and crops like maize, which were stored, the establishment of community seed banks becomes paramount. These banks could actively promote seed diversity and provide a strategic resource for farmers, contributing to sustainable agricultural practices in the community.

The stored seeds lacked quality assessment through scientific methods, indicating the need to integrate traditional wisdom with modern agricultural techniques. Scientific evaluation methods could ensure the viability and quality of stored seeds, enhancing overall agricultural productivity. The study underscores the importance of ensuring seed security. Combining local knowledge with scientific advancements enhances seed quality and contributes to long-term agricultural sustainability and resilience against environmental challenges.

Implications of the Study

The findings of this study present a robust foundation for future research endeavours, particularly within the unique context of the Gajuri Rural Municipality. The implications outlined below provide a roadmap for scholars, policymakers, and practitioners seeking to deepen their understanding of seed cultivation, storage, and conservation practices in similar rural settings. This data can be used to inform farmers of the source and variety of seeds they are cultivating and the techniques they use for storage. Such awareness will help the farmers choose the seed for cultivation wisely to improve the yield. Additionally, understanding where to improve and what kind of seed is beneficial for them and seeking suggestions from the experts can be done by the farmers. Likewise, the findings from this research will help entrepreneurs understand the cultivation status and behaviour of the farmers so that they can produce seeds that meet the farmers' requirements. Similarly, this research has explored the sources used by the farmers in acquiring seeds, along with the cultivation and storage status. For instance, policymakers can make provisions for the preservation and quality control of seeds that are being used. Likewise, the local government can help the farmers by establishing a community seed bank to preserve the varieties. The community seed bank can be established by merging the scientific method with the traditional method that the farmers are now using in the area. Finally, this research provides a robust foundation for further studies, contributing substantially to preserving crop diversity, enhancing agricultural productivity, and formulating farmer-oriented policies. By addressing these critical areas of inquiry, researchers can profoundly impact the agricultural landscape in the Gajuri Rural Municipality and similar agrarian regions, fostering holistic and enduring advancements in agriculture.

Conclusions

This study covered the major cultivated crops, their varieties, sources, the status of storage, and cultivation after storage in the study area. The gaps in genotype, name of varieties, total cost for cultivation, harvesting after cultivation, etc., are essential to be examined further. Another important aspect indicated by this study is the need to conduct more research using social science perspectives. Although there are studies on seeds, fundamental research indicating the status of cultivation and storage is rare. Notably, the farmers need to know the type, the importance of the varieties, seed conservation, seed security, and their rights.

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