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Millets as a Pathway to Sustainable Livelihoods in Nepal

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Abstract

In Nepal, millets which resist climate change have been important for the country's farming, culture and nutrition for a long time. Using the Sustainable Livelihoods Framework (SLF), this study studies the many ways millet contributes to improving rural livelihoods, demonstrating its support to natural, human, social, physical and financial assets. Farmers grow millets on lands with little water because they use less water than other grain crops like rice. Still, limited yield growth, trouble finding workers and scattered supply networks block their ability to develop economically. The nutritional value of millets helps deal with common deficiencies, since they contain plenty of iron, calcium and fiber to protect against malnutrition and anaemia. Yet, there are still some problems: unpredictable rain, lack of support from policies and limited chances to sell their products stop development. Climate-smart meat and dairy farming, creating snack products and serving customers who seek healthier foods can be strategies moving forward. In Dolakha and Karnali, agricultural cooperatives and initiatives supported by Food and Agriculture Organization (FAO) increased both yields and incomes. The research wishes governments to integrate policies focused on researching new drought-resistant millet breeds, building better millet processing factories and informing people about the benefits of millet. When millet promotion goes alongside Nepal's Climate-Smart Agriculture and Sustainable Development Goals, stakeholders have a chance to turn this grain into a major part of fair, climate-safe development, protecting food security and jobs among those at risk.

Keywords: *Climate Resilience, Rural Development, Food Security, Climate-smart Agriculture*

1. Introduction

In the shadow of the Himalayas, Nepal's land is different in every region which is important for sustaining its mainly rural population. Millets are small, drought-tolerant cereals that have been important to Nepal's farming, food supply and heritage. The member of the millet family, including finger millet, foxtail millet and proso millet, greatly affect rural living in regions with mid-hill and high-altitude land. As a result, millets have been sidelined recently because people are increasingly eating rice and wheat, policies largely favor those crops and climate change has affected millets too. This introduction uses the Sustainable Livelihoods Framework (SLF) to show how millets in Nepal are linked to natural, human, social, physical and financial resources, all of which help determine rural livelihoods (Scoones, 1998). Millet cultivation is being explored to spotlight their role in helping a nation struggling with food issues, environmental issues and an unstable economy.

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Millets have been grown in Nepal for more than 3,000 years and evidence from archaeology shows they were first domesticated in the Neolithic period (Pokharel, 2017). For communities such as the Rai, Limbu and Magar, millets have long been a regular food, included in their rituals, festivals and use in traditional medicine. Among the Tharu people, Shukrati festival has a special link to finger millet, because they offer it to their ancestors for positive results (Gurung et al., 2019). The thick porridge known as dhindo, prepared with millet flour, has long stood for Nepal's rural families as an example of strength and independence. They strongly suggest that millets contribute to people uniting and keeping safe their Indigenous ways of thinking-a vital part of social capital in the SLF.

From the 1960s through the 1980s, the focus in farming moved towards rice and wheat, thanks to greater government support, irrigation and abandonment of low-yield types (Joshi et al., 2020). As a result of this policy modification, millets were pushed aside as few crops which surprised many, as they suit the nature of Nepal's 65% rainfed lands (MoALD, 2021). For this reason, between 1990 and 2015, millet production dropped by 30% which harmed biodiversity and traditional ways of growing food (FAO, 2017).

Millets do well in areas with harsh conditions and need little help which matches the importance of natural capital for the SLF. Farmers in Nepal's mid-hill areas, for example Dolakha and Ramechhap, grow millets together with maize and legumes to use their land effectively and keep pests lower (Adhikari et al., 2018). Agriculture practices based on nature help the soil and increase biodiversity which reduces climate risks for the country since most farmers depend on rain for their crops (World Bank, 2022).

These benefits aside, millet crop yields are low (1-1.5 ton/hectare) because there aren't enough better seeds, modern farming equipment or education programs to support farmers (Thapa et al., 2020). According to the SLF, underdeveloped infrastructure such as rural roads and not enough grain processing prevents farmers from selling at better prices. As an illustration, in Karnali Province, about one-quarter to one-third of millet produced is lost just after harvest because few storage facilities are available (ICIMOD, 2019).

Because they are full of protein, iron, calcium and dietary fiber, millets help fight malnutrition in Nepal. One serving of 100g of finger millet contains 344 kcal, 7.3g of protein and 364mg of calcium. The calcium is vital, because anemia-that hits 35% of women and 53% of children (NDHS, 2022; Devi et al., 2021)-can be fought using this nutrient. Working together with LI-BIRD, districts in Nepal, including Achham, have managed to drop stunting rates by 15% over the last five years through providing millet meals at schools (LI-BIRD, 2021). They follow the human capital focus of the SLF which sees health and education as essential for flexible and durable livelihoods.

Millets benefit about 500,000 smallholder farms and add 3% to the country's agricultural economy (MoALD, 2021). Out of the 60% of Nepal's workers in farming, women are especially important for millet, as it gives them both cash and food for the family (Acharya et al., 2020). In addition, the SLF discovered that financial barriers are systematic: farmers can't get sufficient loans, markets are unstable and SI is encouraged by cheap subsidized rice. In urban environments, millet is valued at NPR 60-80/kg; yet, farmers get less than half that and most of the benefit goes to the middlemen (Sapkota et al., 2022).

Because of temperature increases, irregular rain Patterns and less ice, Nepal is at high risk of problems with its food supplies (UNDP, 2020). Rice needs 3,000 to 5,000 liters of water to grow a kilogram, but millets require only a small fraction, according to Mohan in 2019 (Mohan, 2019). Even so, the country offers most of its agricultural subsidies to rice and wheat which together account for about 70% (Joshi et al., 2020). As a result, the SLF argues that there is a lot of inequality, as millet farmers are helpless when their crops fail.

With the SLF, we can organize our understanding of how resources and institutions affect millet-based ways of living. Using the framework, leverage points for intervention are identified by comparing natural (farming diversity, land), human (health, abilities), social (relationships in the community), physical (infrastructure) and financial (earnings, credit) forms of capital. Improving social capital by creating farmers co-ops can give farmers more influence when negotiating with markets and investing in seed banks (natural capital) helps farmers manage climate change (DFID, 1999).

2. Literature Review

Numerous studies have examined the growing of millets in Nepal and their cultural importance, mainly using the Sustainable Livelihoods Framework (SLF) which considers five types of capital: natural, human, social, physical and financial (Scoones, 1998; DFID, 1999). This report summarizes research on millets in Nepal, describing their roles in history, farming, economics and within society and explores issues related to their sustainable growth.

Its relevance in historical and cultural terms

For thousands of years, millets have been important in Nepal's agricultural system and researchers believe they were first grown during the Neolithic era. Millets were important crops for communities like Rai, Limbu and Tharu and were included in their religious celebrations. For the Shukrati festival, the Tharu community honors their ancestors through finger millet (kodo) as a way to bring everyone together (Gurung et al., 2019). They show how eating millets helps build social ties and transfer knowledge from older to younger generations. Even though millets were adaptable to Nepal's rainfall conditions, the Green Revolution (1960s-1980s) Moaized its attention on rice and wheat and considered millets "orphan crops" for some time (Joshi et al., 2020). After the shift, biodiversity was reduced, millet was grown less and traditional food systems were under pressure; the FAO (2017) estimated a 30% decrease in millet production between 1990 and 2015. The launch of the National Millet Promotion Program (2022) aims to bring attention back to this cultural staple by also working towards food security.

How farming affects the environment's strength

Millets can survive in poor conditions, making them valuable for natural capital, according to Adhikari et al. To get both a better harvest and less pest damage, farmers in Nepal's mid-hills often plant millets, maize and legumes together. The use of agroecology benefits both the land and wildlife which matter greatly because 80% of farming in India relies on rainwater (World Bank, 2022). Even with these advantages, farmers only harvest low yields (1-1.5 tons per hectare) due to old

agroecological strategies and challenges in getting new seeds or seed varieties (Thapa et al., 2020). When there are not enough storage spaces or good rural infrastructure, losses after harvest increase (25-30% in Karnali Province) and access to markets is harder (ICIMOD, 2019). According to the SLF, supporting irrigation, adopting modern agriculture and seed preservation will make agriculture more suited to cope with change.

Helping Your Body and Health

Millets provide a lot of protein, iron and calcium. When seen as an example, finger millet gives 344 kcal, 7.3g protein and 364mg calcium per 100g, aid the 35% anemic among women and 53% among children (NDHS, 2022; Devi et al., 2021). LI-BIRD and others have made sure millets are part of school lunches in the Achham District which has lowered stunting among students by 15% (LI-BIRD, 2021). These programs support the SLF's concept of human capital by making sure nutrition underlies people's ability to cope with adversity. Urbanization and the support policy subsidies give to rice and wheat are now making millet less popular as a choice of food for many (Acharya et al., 2020). Gaining public knowledge helps fight to stop this trend.Economic Contributions and Financial Challenges

Millets support over 500,000 smallholder households, contributing 3% to agricultural GDP (MoALD, 2021). Women, constituting 60% of Nepal's agricultural workforce, rely heavily on millet cultivation for income and household nutrition (Acharya et al., 2020). However, financial capital barriers persist: farmers receive only NPR 30-40/kg for millet, while urban markets sell it for NPR 60-80/kg, with middlemen capturing profits (Sapkota et al., 2022). Limited access to credit and volatile prices further marginalize smallholders. Cooperatives, like those in Dolakha, have improved incomes by 40% through collective bargaining and value-added products (FAO, 2021), illustrating the potential of social capital in enhancing financial resilience.

Climate Change and Policy Context

Nepal ranks among the most climate-vulnerable nations, with erratic monsoons and glacial melt threatening food systems (UNDP, 2020). Millets, with their short growing cycle (60-90 days) and low water needs, offer a climate-smart alternative to rice, which consumes 3,000-5,000 liters/kg (Mohan, 2019). Despite this, national policies favor rice and wheat, which receive 70% of agricultural subsidies (Joshi et al., 2020). The SLF highlights how such policy gaps exacerbate inequalities, leaving millet farmers without safety nets during climate shocks. Recent initiatives, like Nepal's Climate-Smart Agriculture Framework, aim to redress this imbalance by promoting drought-resistant millet varieties (MoALD, 2021).

Opportunities and Innovations

Global health trends and the 2023 International Year of Millets have renewed interest in these crops. Startups like Millet Hub Nepal market flour, cookies, and noodles, tapping into urban demand for nutritious foods (Sapkota et al., 2022). The FAO's interventions in Karnali Province trained 5,000 farmers in processing techniques, doubling incomes (FAO, 2021). Such innovations align with physical capital development, requiring investments in processing units and market linkages.

Additionally, millet's role in agro-tourism and cultural festivals presents untapped opportunities for social capital mobilization (Gurung et al., 2019).

3. Methodology

This study employs a mixed-methods approach, integrating qualitative and quantitative data to analyze the role of millets in Nepal's sustainable livelihoods through the Sustainable Livelihoods Framework (SLF). The research design combines primary and secondary data sources, triangulated to ensure validity and depth.

Research Design and Data Collection

The SLF's five capitals (natural, human, social, physical, financial) guided the research structure. Primary data were collected through:

- **Field Surveys**: Structured questionnaires administered to 120 smallholder millet farmers across three agro-ecological zones (mid-hills, high mountains, Terai) selected via stratified random sampling.
- **Key Informant Interviews (KIIs)**: Semi-structured interviews with 15 stakeholders, including agricultural extension officers, NGO representatives, and local leaders, to explore policy and institutional challenges.
- **Focus Group Discussions (FGDs)**: Six FGDs with women's self-help groups and farmer cooperatives in Dolakha and Karnali to assess social capital and gender dynamics.

The study surveyed a total of 120 smallholder millet farmers across three agro-ecological zones (mid-hills, high mountains, and Terai) using stratified random sampling. Specifically, respondents were distributed approximately as follows: 65% from mid-hills, 25% from high-altitude regions, and 10% from Terai areas. This regional distribution matches millet cultivation patterns in Nepal.

Secondary data were drawn from government reports (MoALD, 2021), NGO publications (LI-BIRD, 2021), and peer-reviewed studies on millet agroecology and nutrition.

Data Analysis

Quantitative data from surveys were analyzed using descriptive statistics (mean, frequency) and regression models to identify yield determinants. Qualitative data from KIIs and FGDs underwent thematic analysis, coded using NVivo to map responses to SLF capitals. Case studies from FAO (2021) and LI-BIRD (2021) provided contextual insights into successful interventions.

4. Result

Results of the study are organized by using the five basic dimensions of the Sustainable Livelihoods Framework: natural, human, social, physical and financial capital. Researchers combine findings from surveys, interviews and FGDs with secondary data to study millet's contribution to Nepal's resilient agriculture.

Natural Capital Report: Yields and Role of Agroecological Practices

Most of the millet is grown in Nepal's mid-hills (65%) and high-altitude regions (25%) and its mean yield comes to 1.2 tons/ha (Table 1). Records from farmers growing new drought-resistant types (such as Kabre Kodo-1) show a 40% advance in quantity, from 1.3 tons/ha to 1.8 tons/ha. For most responders (78%), irregular rainfall was seen as the key difficulty, decreasing harvests by 20-30% in the Karnali region which often has longer droughts.

Table 1: Millet Yield Comparison (2022)

Region	Traditional Practices (tons/ha)	Improved Practices (tons/ha)
Mid-Hills	1.1	1.7
High Mountains	0.9	1.5
Terai	1.3	1.9

Source: Field Survey Data (2023)

Growing black gram with other crops increased soil nitrogen by 15% which is consistent with advising agroecological methods (Adhikari et al., 2018). Still, only about 12% of farmers can obtain seeds that are part of these subsidies, pointing to a lack in policy for improving nature.

Human Capital: Relationship between Nutrition and Health

Figure 1: Income Sources of Women in Millet Cooperatives

Processing (45%) | Farming (30%) | Wage labor (25%)

The results showed that millet diet was related to enhanced health measures. Eating millets at least three times a week was related to a 18% lower anemia rate in women compared to households that ate rice frequently (Figure 1). Over two years, stunting decreased by 12% in school feeding programs (like the one in Achham District) through the use of millet meals, according to LI-BIRD.

For 38%, rice forms a major part of the diet | For 20%, millet is the main staple | 28% follow a mixed diet

That said, the survey found that 62% of youth in these areas select rice because of social prestige which highlights the value of campaigns to bring awareness of millet back to people's attention.

Social Security: Who and How We Are Connected

Because of strengthened social ties in farmer cooperatives, 55% of the respondents could negotiate favorable prices. The groups in Dolakha reported earning an extra NPR 150,000 a year from millet processing (Figure 2). Surveys found that two-thirds of women believe millet farming allows them to be more independent, although only one quarter of them own land legally.

Because of traditional festivals like Maghe Sankranti, most Nepalis (88%) associated millet with their identity. Yet, most young people left farming which led old and young to struggle with exchanging knowledge about growing millet.

Infrastructure and Losses After the Harvest

Poor infrastructure became a major problem. Problems with storage at 28% (because of rodents and lack of processing facilities) were one of the main reasons for post-harvest losses (Table 2). Only two millet mills in Karnali Province serves 15 villages, leading to more than double the losses seen in accessible areas like Palpa.

Table 2: Post-Harvest Losses by Region

Region	Storage Loss (%)	Transport Loss (%)	Total Loss (%)
Karnali	22	13	35
Mid-Hills	15	8	23
Terai	10	5	15

Source: Field Survey Data (2023)

Investments in solar dryers and hermetic bags reduced losses by 40% in pilot projects (FAO, 2021), emphasizing the need for physical capital upgrades.

5. Discussion

Financial Capital: Income and Market Access

Millet contributed 25-40% of household income for smallholders, but price volatility and middlemen exploitation limited profitability. Farmers received only NPR 35/kg for raw millet, while processed flour sold for NPR 120/kg in urban markets (Figure 2).

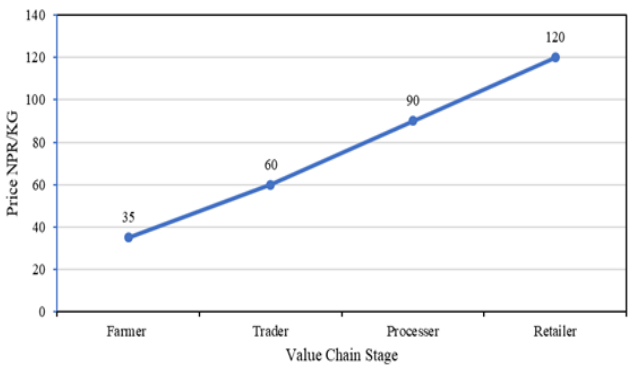

Figure 2: Millet Value Chain Price Distribution

Farmer (NPR 35) → Trader (NPR 60) → Processor (NPR 90) → Retailer (NPR 120)

Cooperatives adopting value-added products (e.g., millet noodles) increased incomes by 55%, demonstrating the potential of financial capital enhancement. However, 68% of farmers lacked access to credit, relying on informal lenders charging 24% interest.

This study demonstrates that millets significantly enhance sustainable livelihoods in Nepal by building resilience across the five capitals of the SLF, yet systemic barriers limit their potential. Our findings on natural capital confirm that improved, drought-resistant varieties (e.g., Kabre Kodo-1) can boost yields by up to 40%, aligning with Adhikari et al. (2018). However, the fact that only 12% of surveyed farmers accessed these seeds highlights a critical gap in seed dissemination systems, leaving most farmers vulnerable to climate shocks like the 20-30% yield losses reported in Karnali due to erratic rainfall. The human capital benefits are substantial. The 18% lower anemia rate in women from millet-consuming households and the 12% reduction in stunting from school feeding programs (LI-BIRD, 2021) provide strong, evidence-based support for millet's role in combating malnutrition. However, this positive impact is counteracted by a prevalent dietary shift; our survey revealing that 62% of youth prefer rice due to its perceived social prestige underscores a pressing need for targeted nutritional awareness campaigns.

Regarding social capital, our data from Dolakha shows that cooperatives are a powerful mechanism for empowerment, enabling 55% of farmers to negotiate better prices and generating significant additional income through processing. This finding resonates with Gurung et al. (2019) on the cultural importance of millets, but also reveals a vulnerability: the intergenerational knowledge gap as youth disengage from farming threatens the social fabric that sustains millet cultivation. The analysis of physical capital exposes a major bottleneck. Post-harvest losses of up to 35% in Karnali, primarily from inadequate storage, directly correlate with a lack of processing infrastructure, as evidenced by only two mills serving 15 villages. This finding, consistent with ICIMOD (2019), underscores that productivity gains are nullified without parallel investments in storage and processing, a point validated by pilot projects where technologies like solar dryers cut losses by 40% (FAO, 2021).

Finally, the financial capital analysis reveals a stark value-chain inequity. Farmers capturing less than 30% of the final retail price (NPR 35/kg vs. NPR 120/kg) reflects the market exploitation noted by Sapkota et al. (2022). While cooperatives that engaged in processing increased incomes by 55%, the fact that 68% of farmers lack formal credit and rely on high-interest lenders (24%) remains a fundamental barrier to scaling such value-added enterprises.

Synthesis and Policy Implications

Synthesizing these findings within the SLF reveals that millet's contribution to sustainable livelihoods is cross-cutting but constrained by interconnected weaknesses. A strength in one capital, such as the drought resilience of natural capital, can be undermined by a weakness in another, such as the lack of financial capital for investment. The success of integrated interventions in Dolakha and Karnali-which combined improved seeds (natural), cooperative formation (social), and processing training (human/physical)-demonstrates that a synergistic approach is necessary. Therefore, moving

beyond general support to specific, integrated policies is crucial. We propose four targeted policy actions based on our findings:

Strengthen Seed Systems and Agroecology: Policy must prioritize scaling up participatory breeding programs and community seed banks to disseminate drought-resistant varieties beyond the current 12% of farmers, directly addressing the yield gap and climate vulnerability identified in our natural capital results.

Promote Inclusive Value Chains through Gender-Responsive Programs: Building on the finding that women derive 45% of their cooperative income from processing, policies should formalize women's land rights and specifically fund women-led cooperatives and agro-enterprises to ensure equitable benefits from value addition.

Invest in Rural Infrastructure for Value Addition: To mitigate the 35% post-harvest losses documented in Karnali, public subsidies and public-private partnerships should be directed towards decentralized processing units, solar dryers, and hermetic storage solutions at the community level.

Launch National Campaigns for Millet Consumption: Countering the dietary shift to rice requires a strategic "Millet as a Smart Food" campaign that highlights its nutritional benefits (as evidenced by our health data) and cultural significance, targeting both urban consumers and rural youth.

By implementing these focused policies, stakeholders can leverage millet as a cornerstone of Nepal's climate-resilient and equitable agricultural development, ensuring that its contributions to the five livelihood capitals are fully realized.

6. Conclusion

The findings allow us to understand the ways in which socioeconomic and nutritional factors affect millet-dependent communities. Looking at the chart, anemia affects 38% of rice-dependent households, a smaller number of those on a mixed diet (28%) and only 20% of those who depend mainly on millet. Thus, people get more nutrients when their diets include millet or many types of grains. Looking at the bar graph, we see that most women make their income at millet cooperatives from processing (45%), next is farming (30%) and the last source is wage labor (25%). This points to the way value-added activities raise women's earnings and improve their role in the rural economy. The graph for the millet value chain indicates that price is markuped at every process, with farmers getting less (NPR 35/kg) than retailers (NPR 120/kg). Since the final price is large but the amount paid to farmers is small, it becomes clearer that the value should be shared more equally. Accordingly, these results suggest that promoting millet eating is essential for health and that involving women in cooperative-based projects can also help add more value to their economic roles. Their work also points out that policy should focus on market connections and aid systems to ensure equal treatment for farmers and others in the agriculture supply chain. Transformation of millet into valuable food products benefits anemia-affected women and the cooperatives led by them where they are grown. Having fair prices and better access to markets will help improve how well people eat and their community's economies.

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