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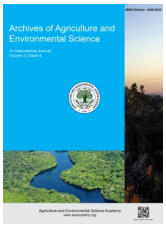

REVIEW ARTICLE

Potatoes for prosperity: Enhancing food security, livelihoods, and climate resilience in Nepal

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ABSTRACT

Potatoes have played a vital role in shaping Nepal's agricultural economy and food system for many years. It is cultivated across diverse altitudes and climatic zones, and make a substantial contribution to household nutrition, rural livelihoods, and national food security. Focusing on the growing challenges of climate change, population growth, and rising food demand, the potato's short cultivation period, high yield, and adaptability position it as a key component of Nepal's strategy for sustainable agriculture. This review examines the current state of potato cultivation in Nepal, focusing on its socioeconomic impact, production trends, major challenges, research achievements, and future outlook. It emphasizes the importance of sustainable farming practices, varietal improvement, efficient seed systems, and supportive policies to strengthen the crop's role in achieving national food security. Recent advancements in potato research and development offer promising solutions to address Nepal's ongoing food security challenges. The findings of this study are useful for potato researchers, producers, and policy makers for sustainability in potato production in Nepal.

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INTRODUCTION

Potato (*Solanum tuberosum* L.) is the fifth most-produced major crop in the world, after sugarcane, wheat, rice, and maize, and is one of the most important cash and food crops in Nepal. It is grown in more than 150 nations and is an essential source of food security, revenue, and calories. An estimated 17.4 million hectares of potato land were under cultivation worldwide as of 2022, and 376 million metric tons of potatoes were produced overall (FAO, 2023a). Although yield levels differ significantly between countries and production systems, the average global productivity is roughly 21.6 tons per hectare. With China as the top producer, producing over 94 million metric tons, or nearly 25% of the world's total production, Asia makes up the largest portion of the world's potato production (FAO, 2023a). Because of its ability to adapt to a variety of agroclimatic zones, potatoes are a strategically important crop for improving food and nutritional security. Breeding climate-resilient, disease-resistant cultivars and enhancing storage and processing facilities have been the main focus of research projects in response to the growing demand worldwide (Devaux *et al*., 2021).

In Nepal, it is utilized as a major vegetable in the terai and mid-hills and also used as a staple food in the high hills. Potatoes are grown under diversified climatic conditions, at an altitude ranging from 70 to 4500 m above sea level in different seasons, and harvested accordingly at different times, almost throughout the year. In Nepal, potatoes are grown in two main seasons: during winter under short-day conditions in the Terai and during summer under long-day conditions in the hills and mountains. In addition to these, potatoes are also cultivated at other times of the year in areas where irrigation and other growing conditions are favorable, such as monsoon planting in the dry high hills and autumn planting in the Kathmandu Valley and surrounding areas. Natural resources and agriculture are under unprecedented strain due to the world's expanding population and rising food demand. The world's population does not receive enough nutrient-dense food in an environmentally sustainable manner from today's food systems (Wu *et al*., 2018). 1.2 billion people are

overweight or obese, and 821 million people are undernourished. Environmental resources are under unsustainable strain as a result of food production, processing, and waste. A population of 9.7 billion people worldwide is expected to consume 70% more food by 2050 than they do now (FAO *et al*., 2018). A significant overhaul of the global food system is necessary to feed this growing population in a sustainable and nutrient-dense manner, one that minimizes the current environmental impact while supporting farmers' livelihoods and offering customers wholesome products (Foley *et al*., 2011). A significant obstacle is to increase food production with the same or less resources. Potatoes are a staple crop that improves the food security and livelihood of impoverished farmers (Devaux, 2014; Timsina *et al*., 2013). Potatoes are a major source of income for farmers and contribute significantly to food security. Food security in Nepal is an urgent concern, considering the country's difficult topography, fragmented landholdings, and vulnerability to climate-related threats.

Food insecurity is more common in Nepal's mostly rural, low-productivity, and remote areas, where rain-fed subsistence farming is more common (Chemjong & KC, 2020). The MoH (2017) reports that the percentage of people who are extremely food insecure is 9% in urban areas and 12% in rural regions. If we compare the prevalence of food insecurity in the mountain, hilly, and terai zones, we find that the former appears to have higher rates than the latter, at 14% and 9%, respectively. Among many essential crops, the potato has emerged as a critical food and cash crop for farmers in both the hills and the plains. The potato, a high-yielding, nutrient-rich crop that thrives in various agro-ecological zones, has become an increasingly important component of Nepal's food and nutrition plans. This analysis seeks to highlight the significance of potatoes as a sustainable food security solution, as well as the major accomplishments in Nepal's potato research and development sector and the paths to realizing their full potential.

METHODOLOGY

Secondary sources of information were used in the study. A thorough desk study was done for the potato literature collection. For this study's compilation, pertinent journal and proceedings papers, annual reports, and books were consulted and carefully examined.

POTATOES' PLACE IN NEPALESE AGRICULTURE

Scenario of area, production and productivity

About 211,505 hectares of potato land are planted in Nepal, and 3,521,794 tons are produced overall, with an average productivity of 16.65 tons per hectare (MoALD, 2025). The Eastern Hills, Central and Western mid-hills, and isolated Terai regions are important growing regions. Out of the total cultivated area under potato, about 18 percent is in the high hills and mountains, 42 percent in the mid-hills, and 40 percent in the Terai. In many ecological regions, potatoes are a desirable crop due to their capacity to adapt to varying climatic conditions. 6.55% of agriculture's gross domestic product (AGDP) comes from potatoes (MoALD, 2025). The nation's per capita consumption of potatoes is still 86 kg (FAOSTAT, 2023). As a result of improved cultivars and better agronomic practices, yields per hectare have been increasing steadily. Figure 1 shows the area, production, and productivity of potatoes during the past ten years, which amply illustrates the situation or trend of potatoes in Nepal. However, the main cause of Nepal's low potato production and productivity is the lack of timely, reasonably priced, and sufficient supply of high-quality basic seed. For many years, farmers have been utilizing degraded seed tubers without replacing them (Subedi *et al*., 2023). By using scientific technology, potato yield can be raised, ensuring food security (Manjunath *et al*., 2013).

Nutritional and economic significance

Nutritional value

Carbohydrates, fiber, potassium, vitamin C, and antioxidants are all abundant in potatoes. Potatoes are a significant source of calories, particularly in high-altitude areas where cereal production is limited. They also contribute to dietary diversification and efforts to combat malnutrition. Their role is especially important for children and women in undernourished households that lack dietary diversity. The potato is a cost-effective source of digestible carbohydrates (starch) that delivers rapid energy and plays a significant role in the diets of Nepal's hill agro-ecosystems (FAO, 2023b).

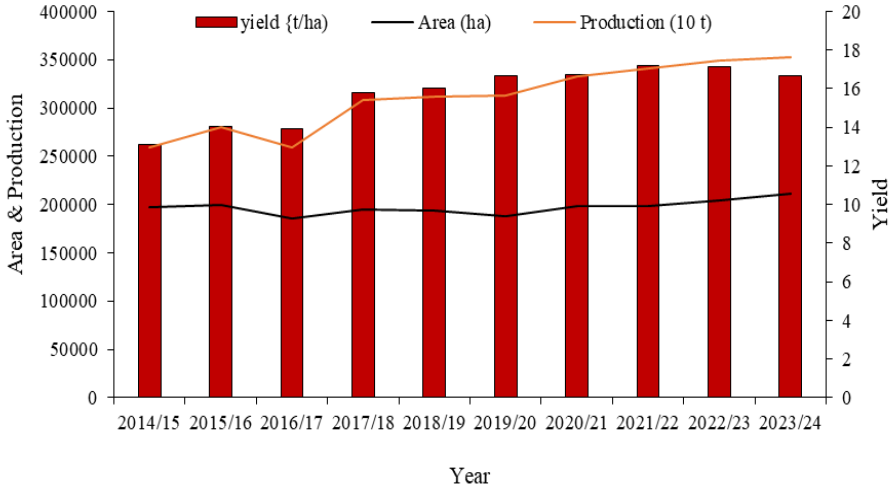

Figure 1. *Area, production and yield of potato during last decade in Nepal (MoALD, 2025).*

Income and employment

In addition to being a significant source of income through local and regional markets, potato growing offers thousands of rural households' seasonal employment. Surpluses are either exported to nearby nations, especially India, or sold domestically. In Nepal, potatoes serve as a subsistence staple, particularly in the hills and highlands, as well as a commercial crop that enhances smallholder earnings; research and development, along with seed initiatives, have demonstrated favorable economic results (Timsina *et al*., 2013). Studies from Nepali hill districts reveal that potato production significantly benefits smallholder farmers by providing a reliable source of cash income through the sale of tubers and seeds (Timsina *et al*., 2019).

Sustainability and climate resilience

Climate adaptability

The potato is a climate-resilient crop due to its tolerance for marginal sites and its comparatively short growth season. It is particularly important in mountainous areas with limited land holdings and highly variable climates. According to research, Nepalese farmers have benefited from improved potato varieties developed through participatory breeding, including those supported by the International Potato Center (CIP), in adjusting to climate stresses like unpredictable rainfall and shorter growing seasons (Gairhe *et al*., 2018). In Nepal, potatoes play a significant role in household food security and seasonal dietary diversity due to their high yields per unit area, ability to be grown in marginal hill soils, and short growing seasons (CIP, 2019b).

Soil health and crop rotation

Potatoes support soil health and sustainable land use by being a part of crop rotation systems that also include cereals and legumes. Concerns over long-term sustainability are being raised, meanwhile, by the excessive use of agrochemicals and monoculture methods in some areas.

POTATO AND FOOD SECURITY IN NEPAL

Particularly in the mid-hill and Himalayan areas of Nepal, potatoes play a vital role in enhancing livelihoods and ensuring food security. They are an essential crop for smallholder farmers due to their high productivity and adaptability to a variety of agro-ecological zones. Food security refers to the availability, access, and utilization of nutritious food for all people at all times. The potato is essential for maintaining dietary sufficiency in Nepal, where approximately 25% of the population experiences food insecurity (WFP, 2022). This is especially true in high-altitude areas where other staple crops are difficult to grow. In high-hill and mountainous regions such as Mustang, Dolpa, and Jumla, the potato is often the primary staple food, surpassing cereals in both cultivated area and importance. Due to the harsh climate and short growing season, high-altitude potato varieties are cultivated for local trade and food self-sufficiency. These communities store potatoes for use during the snow-bound months and rely on them as a year-round food source. Potatoes offer a dependable alternative in the mid-hills, where grain crops frequently suffer due to irregular rainfall and rugged terrain. During periods of food scarcity, they provide substantial nutritional and caloric value and mature rapidly when cultivated on terrace -based systems. Potatoes are especially important in marginal areas where rice cultivation is impractical. In the Terai, they are widely produced as a winter crop and as an off-season crop in peri-urban regions, owing to easier access to land and generally superior irrigation systems. Both rural and urban customers find it to be a calorie-dense staple that is essential to household diets, particularly during the lean time between rice and wheat harvests. Carbohydrates, fiber, vitamins (especially C and B6), and minerals such as potassium and magnesium are all abundant in potatoes (FAO, 2008). Potatoes contribute to the year-round availability of food at the household level because of their short growing season and high yield per hectare. Furthermore, they provide resilience against seasonal hunger and enhance calorie intake during lean periods, as they are a crop that can be harvested multiple times a year in lower elevations (Pradhanang *et al*., 2015).

In terms of livelihood contribution, growing potatoes in rural regions directly boosts employment and income generation. After rice and maize, potatoes are one of the most important cash crops in Nepal, with over 2 million farmers cultivating them (MoALD, 2021). Potato cultivation constitutes a major source of income for marginalized and smallholder farmers. It generates seasonal employment in planting, harvesting, and marketing, particularly for women and landless laborers. Market participation is increasing, as surplus potatoes are sold in regional and national markets, and exports to Bangladesh and India continue to rise. The development of agro-enterprises including small-scale processing (e.g., starch and chips), storage, transportation, and seed production has made significant contributions to rural economic activity. Furthermore, potato-focused cooperative and contract farming models have enhanced access to markets, credit, and extension services in many regions, thereby enabling rural communities to thrive both economically and socially. More than 200,000 hectares of land, Nepal produced about 3.5 million metric tons of potatoes in 2023-24 (MoALD, 2025). Farmers can earn significant profits from the sale of table and seed potatoes, particularly in high-value markets such as Pokhara and Kathmandu. Furthermore, the potato value chain from cultivation and input supply to harvesting, storage, and marketing creates employment opportunities in rural areas and supports the rural economy (Khatri-Chhetri *et al*., 2010). Potatoes are the primary cash crop in certain regions, particularly in hilly districts such as Dolakha, Rukum, Solukhumbu, Jumla, and Mustang, where they contribute substantially to household incomes.

MAJOR ACHIEVEMENTS OF POTATO RESEARCH IN NEPAL

Variety improvement

The International Potato Center (CIP) is the primary source of potato germplasm. In addition, India, the Netherlands, and

collections of adapted local cultivars constitute the genetic base for varietal improvement. Thirteen potato varieties viz., Kufri Jyoti, Kufri Sindhuri, Janak Dev, Khumal Seto-1, Khumal Rato-2, Desiree, IPY-8, Khumal Laxmi, Khumal Upahar, Khumal Ujwol, Khumal Bikas, Khumal Seto-3, and Khumal Rato-4, have been officially released, while Cardinal, MS 42-3, Rojita, Saggita, Alverstone, and Innovator have been registered for commercial cultivation (Table 1). Most potato varieties released to date are exotic materials that have undergone extensive multi-location adaptive trials. The exception is Khumal Bikas, which was developed by the National Potato Research Program (NPRP) through its own breeding crosses.

With regard to varieties developed using true potato seed (TPS), NPRP maintains parental materials in its tissue culture laboratory and supplies mini-tubers for crossing purposes to the Potao Crop Development Center, Nigale, and the Tropical Horticulture Farm, Sarlahi. Following performance evaluations of multiple TPS families introduced from CIP for yield and late blight tolerance, two hybrid TPS varieties, HPSII/67 (TPS-1) and HPS7/67 (TPS-2), were registered in 2013. Criteria for potato varietal selection based on essential characters are (higher tuber yield, LB resistance, early maturing, good storability, slow degeneration rate, wide adaptability and acceptable cooking quality) and desirable characters (red/purple skin, good uniformity of tuber size & shape, good chipping quality, tolerance to biotic& abiotic stresses).

Diseases management

- Fenamidon 10 % and Mancozeb 50 %WG (Sectin) or Dimethomorph (Acrobat) @ 1.5 g/lit water, four sprays at 9 days intervals, was found effective in controlling late blight. These fungicides could be applied for better management of late blight instead of metalaxyl spray (Sharma, 2014).
- Some PRP lines viz., PRP 017173.48, PRP 446971.117, PRP 017173.101, PRP367072.22, PRP 437274.112 and PRP 317072.8 are found resistant against late blight (LB) disease.
- Seed treatment with 8% Uthane M-45 for 30 minutes and shade drying before planting of tubers controlled powdery scab incidence by 69% followed by 4% Antracol (62%) and seed treatment with 2% bleaching powder along with soil treatment @ 25 Kg a.i. ha^{-1} (57%) at Sharadanagar, Chitwan. Planting of apparently healthy (Powdery-scab free) tubers in severely infested soil reduced disease incidence only 44% (Sharma, 2014).
- Seed tuber treatment with 2% boric acid for 30 minutes, prior to planting controlled the black scurf disease under field conditions. Seed and soil treatment with antagonistic fungus *Trichoderma harzianum* also found effective in controlling this disease (Sharma, 2014).
- In an intercropping experiment of potato with radish, pea, and garlic, late blight severity was less in potato plot intercropped with garlic (Subedi & Rana, 2021).

Post harvest studies

- Potato tubers fumigated with Chlorophenyl Isopropyl Carbamate (CIPC) traded as Oorza @ 40 ml/liter per 1000 kg of potatoes (before storage and 45 days after storage) were effective for inhibition of sprouting and reduction of post-harvest losses up to 120 days of storage in mid-hill and high hill conditions.

Figure 1. Released and registered varities of potato in Nepal (NPRP, 2024).

Varieties	Year	Source	Recommended domain	Remarks
Kufri Sindhuri	1992	India	Terai and Inner Terai	Released
Kufri Jyoti	1992	India	Mid and High hills	Released
Desire	1992	Netherland	Terai-High hills	Released
Khumal Seto 1	1998	CIP	Mid and High hills	Released
Khumal Rato 2	1998	CIP	Terai and Inner Terai	Released
Janak Dev	1998	CIP	Terai- Hills	Released
Khumal Laxmi	2008	CIP	Terai-Hills	Released
IPY 8	2008	CIP	Terai and Inner Terai	Released
Khumal Upahar	2013	CIP	Terai-Hills	Released
Khumal Ujwal	2013	CIP	Terai-Hills	Released
Khumal Bikas	2018	NPRP	Mid and High Hills	Released
Cardinal	2019	Netherland	Terai-High Hills	Registered
Rosita	2019	Switzerland	High Hills	Registered
MS 42-3	2019	CIP	Terai and Mid Hills	Registered
TPS 1	2013	CIP	Terai-Hills	Registered
TPS 2	2013	CIP	Terai-Hills	Registered
Khumal Rato - 4	2023	CIP	Mid and High hills	Released
Khumal Seto -3	2023	CIP	Terai and Mid hills	Released
Sagitta	2024	Netherland	Terai and Mid hills	Registered
Alverstone	2024	Netherland	Terai and Mid hills	Registered
Innovator	2024	Netherland	Terai and Mid hills	Registered

- Potato genotypes such as CIP 393073.179 (a clone with high vitamin C, iron, and zinc content, high yield, red color) were superior for long storage life in ordinary room conditions for 3 months, followed by Techno 304351.109.
- Local variety Panauti Golo and a released variety Khumal Upahar exhibited fewer postharvest losses than the widely used registered variety MS 42-3 during 80 days of storage under farmers' storage conditions (Upadhyay *et al*., 2020).
- Application of Bojho powder at 2 gm/kg was effective for reducing infestation of potato tuber moth (PTM) for 45 days. Cage (net) + Bojho was the most effective treatment for this objective. Thus, Bojho rhizome dust could be one of the potential botanicals that, along with caging, can be adopted to protect potatoes against PTM. Modified rack (rack covered with net) storage structures were identified as the most effective seed potato storage structure compared to open floor, sand, and biochar storage (Subedi & Rana, 2021).

Technology and variety for processing

- NPRP under NARC developed chips making technology.
- Multilocational varietal trials showed that genotypes CIP 394611.11 (12.7 t/ha), PRP296667.3 (12.4 t/ha), CIP 385499.11 (12.4 t/ha), CIP 392025.7 (21.6 t/ha) and CIP392025.7 (18.8 t/ha) were promising genotypes.
- Potato varieties Khumal Bikas, Khumal Upahar, Khumal Ujwal and Khumal Rato-4 were found good for chips making.
- The varieties registered for French fries in 2024 are Sagitta, Alverstone, and Innovator.

TPS (True Potato Seed) technologies

- Two-hybrid True Potato Seed varieties, viz., TPS 1 & TPS 2 have been registered (NPRP, 2014).
- True potato seed is less expensive than seed tubers. In addition to having a higher yield and greater resilience to pests and diseases, hybrid seeds are more viable. It is comparatively cheap to deliver true seed in remote locations, and storage facilities are not needed (Bhattarai *et al*., 2014).
- Technologies for seedling tuber production in nursery beds and production through transplanting in the main field were developed and recommended.
- The first-generation of TPS viz., seedling tuber (F1C1), is recommended to use as hybrid seed; further generations are technically not recommended as seed because of their hybrid nature. If segregation of plant types is accepted, one more generation can be grown for ware potato production without losing tuber yield.

Production technologies

- Before planting, make the sprouts green and bold, using diffused light in well-ventilated room conditions, and plant such sprouted seeds without cutting.
- A blanket recommendation of nutrients 100:100:60 Kg N, P2O5, and K2O/ha in addition to 20 tons of compost or FYM/ha recommended. However, it could be changed depending on the available nutrients and soil fertility conditions.
- Seed tuber treatment and three times foliar spray of Asuro (*Justicia adhatoda*) and EM mixed suspension at 10-day interval have been found effective for increasing yield.
- The screen house was more cost-effective than the glass house for sustainable pre-basic seed production under Kathmandu Valley conditions.
- Black plastic and paddy straw mulching increased yield under less irrigated and moisture- stressed condition.
- Tuber size ranging 25 to 50 g in weight is economically apropriate, but a larger size could be used for production. The use of cut seed tubers is strictly prohibited for seed production purposes because of the high chance of transmitting tuber-borne diseases.
- Weed management through intercultural operations and earthing-up two times are most important to cover the newly developed tubers, which helps to minimize greening of tubers, late blight infection, and PTM infestation.
- Pre-emergence application of herbicide 'Metribuzin' @ 0.75 -1.0 kg ai in 500-600 liters of water recommended for effective weed control in potatoes under mid-hill conditions.
- Instead of the furrow flooding irrigation system, drip irrigation and black plastic mulch were found economical for soil moisture conservation and weed control.
- Pests & Diseases must be economically managed through using IPM and IDM technologies.

Germplasm maintenance, PBS production and virus cleaning

- More than 150 potato genotypes conserved in-vitro at the tissue culture laboratory of NPRP, NARC.
- All released and registered varieties, local germplasm like Jumli local, Surkhet local, Kaalo Aalu, and Tharu local have been maintained in vitro in the tissue culture laboratory, cleaned against six potato viruses, and produced PBS for further multiplication to provide quality seed to the concerned potato-growing area.
- To eliminate potato viruses from the potato germplasms, a DAS-ELISA test was done for the local and released potato varieties maintained in the tissue culture laboratory. Under this, regular virus testing and meristem culture were done for local germplasm as well as recommended varieties for disease-free mini-tuber (PBS) production (NPRP, 2022).

RESEARCH, EXTENSION, AND POLICY GAPS

Potato research in Nepal is primarily led by the Nepal Agricultural Research Council (NARC), with the National Potato

Research Program (NPRP), based in Khumaltar, Lalitpur, serving as the principal coordinating body. NPRP, in collaboration with international partners such as the International Potato Center (CIP), focuses on varietal improvement, seed system development, integrated disease and pest management, and climate-resilient agricultural practices. Over the years, several improved potato varieties have been released for different agro-ecological zones. Current research efforts are also focused on developing early-maturing, heat-tolerant, and disease-resistant varieties to address climate challenges and enhance productivity. However, the linkage between research and on-farm application remains weak. Extension services in Nepal, administered by the Department of Agriculture (DoA), face significant limitations in outreach, institutional capacity, and resource availability. Technology dissemination largely depends on local Agriculture Knowledge Centers (AKCs), cooperatives, and non-governmental organizations (NGOs), which often lack adequate coordination with research institutions. Increased investment in extension services, farmer training, and rural infrastructure is essential. Strengthening public–private partnerships and empowering cooperatives can enhance market access and promote the diffusion of agricultural innovations. The informal nature of existing seed systems and limited access to certified seed tubers hinder the adoption of improved technologies. Strengthening collaboration among research institutions, extension services, private seed producers, and farmer cooperatives is essential to bridge the gap between technological innovation and its adoption at the grassroots level.

OPPORTUNITIES

Nepal offers several opportunities for potato production due to the country's varied agro-ecological zones, growing demand, and increasing interest in commercialization. Opportunities exist to support community seed systems for disease-free seed production, expand cold storage facilities, and promote potato processing industries (Subedi *et al*., 2016). Furthermore, potatoes can have a greater impact on food and nutrition security if they are incorporated into nutrition-sensitive farming practices. A list of the main prospects for potato farming in Nepal is provided below:

Agro-ecological suitability

Due to its varied terrain, including the Terai plains, mid-hills, and high mountains, Nepal is able to cultivate potatoes year-round. Depending on altitude, the crop grows best in spring, summer, and fall; however, it can thrive in a range of climatic conditions. With staggered planting and harvest windows, potatoes can be grown almost year-round across Nepal, from the Terai plains to heights of about 4,000 meters (Dhakal & KC, 2019; Sharma, 1999).

High domestic demand

After rice, potatoes rank as the second most important staple in terms of consumption. There is a growing demand for potatoes and processed potato products due to growing urbanization and dietary diversity (FAO, 2020).

Export potential

India and China, two of the biggest potato-producing and consuming nations in the world, are adjacent to Nepal. Cross-border export is possible with appropriate post-harvest management and quality control, particularly for organic or off-season potatoes (MoALD, 2022).

Scope for mechanization and modern farming

Although traditional potato cultivation still predominates in Nepal, productivity can be significantly improved through mechanization, enhanced irrigation infrastructure, and improved storage facilities. The adoption of Integrated Pest Management (IPM) and the distribution of virus free seed potatoes, produced by both the government and private tissue culture companies which increased yields by 71%, are transformative strategies for sustainable intensification (Sakha *et al*., 2014).

Seed potato production opportunities

Nepal faces a shortage of high-quality seed potatoes. Establishing local seed production systems can improve yields and reduce reliance on imports, particularly in the highlands, where conditions are optimal for disease-free seed production (CIP, 2018).

Public and private sector support

The Prime Minister's Agriculture Modernization Project (PMAMP) and other government and non-governmental organizations are encouraging the commercialization of potato production by providing infrastructure support, training, and subsidies (PMAMP, 2021).

CHALLENGES

Notwithstanding its significance, Nepal's potato production suffers following challenges:

- **Seed quality and supply:** Lack of quality seed tubers and formal seed systems remains a major constraint. Most farmers rely on informal sources. Informal seed certification, production and poor distribution system
- **Pest and disease pressure:** Potato tuber moth, red ant, leaf minor fly, late blight, scab, bacterial wilt, and viruses are prevalent threats.
- There is a lack of high-yielding potato varieties that are suitable for diverse climatic conditions and have an extra-short maturity period of 70 to 90 days.
- Inadequate potato varieties suitable for processing qualities.
- **Post-harvest losses:** Inadequate and poor storage facilities and market linkages result in significant post-harvest losses.
- Wider gap in seed production and demand.

- Drought and degrading soil fertility
- Poor irrigation facilities.
- **Market volatility:** Limited access to organized markets and price variations has an impact on profitability.
- Lack of coordination/linkage among production, marketing, and processing.
- Slow dissemination of generated technologies
- Inadequate technology for farm mechanization.
- Open border and weaker plant quarantine systems of Nepal.
- Less incentives to encourage farmers and intermediaries.
- Reducing these limitations can improve food and economic security and greatly increase productivity.

STRATEGIES TO STRENGTHEN THE ROLE OF POTATOES IN FOOD SECURITY

Improved varietal development

Developing potato cultivars that are high-yielding, disease-resistant, and climate-resilient can greatly increase production. Breeding techniques for a range of agro-ecological zones are constantly being developed by research organizations such as the International Potato Center (CIP) (CIP, 2021). Invest in disease and drought tolerance breeding programs.

Promotion of climate-resilient varieties

Distributing early-maturing, disease-resistant potato varieties like Cardinal, 'Khumal Seto-1' and 'Janak Dev' can help lessen the effects of climate variability, particularly in the mid-hills and high-hills (NARC, 2020).

Strengthening seed potato supply chains

For smallholder farmers, establishing decentralized, community-based seed production and distribution systems enhances their access to high-quality planting materials, boosting yields and food availability (CIP, 2019a). This requires increasing the production of disease-free pre-basic seed (PBS) potatoes using high-tech facilities like hydroponic/aeroponics labs.

Improved post-harvest management

Focus must be placed on reducing post-harvest losses and diversifying processed products. Investing in rural cold storage facilities, value-added processing, and transportation infrastructure helps minimize post-harvest losses and maintain a consistent potato supply throughout the year, thereby addressing seasonal food shortages (ADB, 2013).

Enhancing extension services and training

Enhancing farmers' skills through training programs led by the government and NGOs in improved cultivation practices, integrated pest management (IPM), and soil fertility improvement promotes sustainable increases in productivity (MoALD, 2021).

Market access and value chain development

Improving market access by strengthening farmer cooperatives, expanding digital platforms, and developing infrastructure can enhance farmers' incomes and ensure a steady supply of potatoes in both urban and rural areas (Gildemacher *et al*., 2009). Additionally, promoting cooperative marketing, improving rural road connectivity, and leveraging digital tools boosts farmers' negotiating power, stabilizes prices, and ensures better access to affordable potatoes in remote areas (USAID, 2020).

Sustainable farming practices

Promoting the use of integrated pest management (IPM), enhancing soil fertility, and adopting water-efficient irrigation techniques supports environmentally sustainable and productive potato cultivation (Kharal *et al*., 2018).

Policy support and research investment

Governmental support through subsidies, extension services, and investment in agricultural research is essential to strengthen the potato sector's role in national food security plans (MoALD, 2021).

Conclusion

Potatoes have enormous potential to contribute to Nepal's goal of achieving sustainable food security. From the Terai to the high hills, the potato is more than just a vegetable; it is a strategic crop for food security, nutrition, and poverty reduction. By supporting food availability, nutritional adequacy, and economic opportunities, it strengthens the livelihoods of millions of Nepalese, especially in remote and marginalized communities. Enhancing its production, storage, and value chain integration will be key to leveraging its full potential in national food security planning. With appropriate policy support, technology dissemination, and market linkages, potatoes can serve as a pillar of Nepal's resilient agricultural system in the 21st century. Advancements in potato research and development can significantly enhance Nepal's food security strategies and address food security concerns.

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