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**POTATO PRODUCTION: CULTIVATION PRACTICES,  
LIMITATIONS, AND OPPORTUNITIES FOR IMPROVEMENT IN  
CHAPARHAR, NANGARHAR, AFGHANISTAN**

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**ABSTRACT**

Potato cultivation plays an important role in the agricultural economy of Chaparhar district, Nangarhar Province, Afghanistan, where the crop is grown in both spring and autumn seasons. Despite its importance, farmers possess limited knowledge of cultivar characteristics and typically distinguish tubers only by skin color, commonly referred to as red or white varieties. Field observations and farmer interviews conducted during the 2024 and 2025 cropping seasons revealed that red-skinned potatoes were preferred due to higher market prices, although yields remained modest, with each plant producing an average of 3 to 4 tubers. Approximately 2.40 t ha<sup>-1</sup> of seed tuber produced 11.35 t ha<sup>-1</sup> of marketable output. Harvesting, sorting, and packaging were conducted manually at the farm level, with produced potatoes transported to urban markets such as Kabul, Ghazni, and Bamyan. Key constraints identified included poor seed quality, limited access to certified planting materials, water scarcity, pest and disease pressures, inadequate pest diagnosis, postharvest losses, and weak extension services. Despite these challenges, potato farming remains a critical livelihood source for smallholders. This study employed a mixed-methods approach, integrating field surveys, farmer interviews, and literature review to assess existing cultivation practices, identify gaps, and recommend feasible interventions. Findings highlight seed system improvement, efficient irrigation, integrated pest management, enhanced storage, and knowledge dissemination as major opportunities to improve productivity, reduce losses, and strengthen market linkages in the region.

**Keywords:** *Market, Potato farming, Postharvest, Smallholders.*

**INTRODUCTION**

Afghanistan has a predominantly arid and semi-arid climate with low and variable rainfall, and is among the world's most climate-vulnerable countries (Sayed Ahmad et al., 2024). The authors stated that the average annual temperatures have increased by 1.8 °C in recent decades, with a projection of increasing by 6-7 °C in 2100. Meanwhile, average annual precipitation has declined; this decrease in rainfall is

causing more frequent and severe droughts in the country (Raoufi et al., 2024a). For major cereals such as wheat and barley, each additional degree Celsius can reduce their yields by 271 kg ha<sup>-1</sup> and 221 kg ha<sup>-1</sup>, respectively (Sarwary et al., 2023).

In Afghanistan, within this fragile setting, marked by problems such as drought, political issues, and poverty, potato (*Solanum tuberosum* L.) has emerged as the country's third most important food crop after wheat and rice (Honaryar, 2020). Bamyan, Wardak, Kabul, and Badakhshan have traditionally dominated national potato output, but Nangarhar's warmer lowlands have recently expanded their production due to favorable early-season marketing opportunities (Honaryar, 2020). Mishra et al. (2024) stated that national potato production is expected to reach approximately 860,000-937,000 t by 2030 on about 69,500 ha. Radmand et al. (2024) stated that yields of up to 30 t ha<sup>-1</sup> can be achieved under good farming conditions; however, average farm level yields often remain much lower, typically ranging between 15-25 t ha<sup>-1</sup>. This yield gap is largely attributed to suboptimal seed quality, imbalanced fertilization, pest pressure, and inadequate postharvest infrastructure. Potato waste during planting, harvesting, transportation, and storage can exceed 20%, particularly in regions lacking proper agronomic and postharvest practices (Mohammadi et al., 2023). This may significantly reduce farmers' income and food availability. Addressing these inefficiencies is critical for improving nutritional outcomes, income diversification, and resilience to climate related shocks.

Despite these challenges, there is limited localized research on the potato production system in Chaparhar district of Nangarhar Province. Farmers in this region commonly rely on traditional practices, face limited extension support, and experience both yield and postharvest losses. Moreover, due to low market prices at the time of harvest, many farmers are reluctant to invest in improved cultivation practices, which further limits productivity and profitability. Understanding the current state of potato cultivation and its limitations in this area is crucial for developing context specific interventions. This study aims to evaluate existing cultivation practices, identify production and postharvest limitations, and explore opportunities for improving potato yield and quality in Chaparhar, Nangarhar, Afghanistan.

## **MATERIALS AND METHODS**

### **Study Area, Climate, and Soil Characteristics**

The study was conducted in Chaparhar district, Nangarhar Province in Afghanistan. The region has hot, dry summers and cool winters, with annual rainfall ranges between 90-200 mm, while average monthly temperature drops below 10 °C in December and January, and exceed 30 °C from July to September (ICARDA, 2002). In this region, soils are typically sandy loam to loam in texture, alkaline, moderately calcareous, and low in nitrogen and organic carbon (Masunaga et al., 2014).

### **Field Survey and Observation**

During 2024 and 2025, two potato cropping seasons, winter (October-January) and spring (March-June) were observed. Forty farmers were randomly selected and

interviewed using a semi-structured questionnaire covering seed sources, inputs, irrigation, pests, yields, and marketing. Cultivation practices were observed and documented.

**Secondary Data and Analysis**

Due to the limited availability of published data on potato agronomy, seed systems, and pest management specific to Afghanistan, relevant information was gathered from studies conducted in comparable agro-climatic regions. Quantitative data (seed rate, spacing, yield) were summarized using descriptive statistics in Microsoft Excel. Qualitative responses were grouped into themes such as water scarcity, pest pressure, and postharvest handling.

**RESULTS AND DISCUSSION**

**Land Preparation and Planting**

In Chaparhar district, potato land preparation involved deep ploughing ( $\approx 25$  cm), weed removal, ridge or furrow beds formation, and incorporation of well-rotted animal manure composted for about a year (Table 1). Before planting, seed tubers were stored in a cool, dark place for sprouting, cut into 3 or 4 pieces, depending on buds (eyes), and then planted manually at a depth of 10 cm, with inter-row and intra-row spacing of 40–50 cm and 15–20 cm, respectively. The mean seed rate was 2.40 t ha<sup>-1</sup> for both red and white potato varieties. Plant spacing plays a critical role in optimizing potato yield. The results from Chaparhar align with recent agronomic studies. Dhakal et al. (2019) reported that optimal spacing (30 × 20 cm in triple rows) significantly improved marketable yields, while Yayeh et al. (2025) found that 50 × 15 cm spacing gave the highest yields in Ethiopia, supporting the intra-row distances used locally. The use of medium-sized tubers cut into 3–4 pieces is consistent with Marpaung et al. (2023), who showed that medium and large tuber sizes enhanced plant growth and yield. Similarly, Dua et al. (2008) emphasized that seed size and spacing directly affect tuber number and grade. Soil preparation practices in Chaparhar, including deep ploughing and manure incorporation, also reflect the findings of Liashchenko et al. (2024), who noted that proper spacing helps maintain soil moisture and structure for tuber development. The effectiveness of manual planting at 10 cm depth is further supported by Mandal et al. (2018), who highlighted the role of correct depth and spacing in improving water use efficiency and yield.

**Table 1.** Summary of Agronomic Practices in Chaparhar District and Comparison with Literature

Practice	Observation in Chaparhar	Comparable Study or Recommendation
Seed rate (t ha <sup>-1</sup> )	2.40	Within optimal range (Dhakal et al., 2019)
Planting spacing	40–50 cm × 15–20 cm	50 × 15 cm gave highest yield (Yayeh et al., 2025)
Planting method	Manual planting at ~10 cm depth	Enhanced water efficiency (Mandal et al., 2018)
Seed tuber type	Medium-sized tubers cut into 3–4 pieces	Improves canopy and yield (Marpaung et al., 2023)
Organic input	Composted animal manure	Maintains soil health (Xing et al., 2025)
Fertilizer use	Unmeasured, based on farmer experience	Need for dose training (Safi et al., 2025)

### **Irrigation and Weed Management**

Furrow irrigation was the predominant method, with irrigation frequency adjusted to the potato crop's needs, reflecting broader trends in Afghanistan, where traditional surface irrigation methods were still widely used. At the same time, the adoption of modern systems, such as drip or sprinkler irrigation, remained limited due to financial and educational barriers. Climate change has further intensified water challenges, with increased evapotranspiration and rising crop water requirements predicted in the coming decades (Rahmani & Abid, 2024; Raoufi et al., 2024b). Additionally, our observations revealed that many farmers rely on groundwater extraction using solar-powered pumps. While this method improves access to water, it also risks depleting underground reserves if not managed sustainably. To address this, more efficient use of available surface water sources such as rivers and lakes should be prioritized through improved storage, delivery systems, and regulated water use. These strategies are essential to reduce dependence on groundwater and ensure long-term agricultural sustainability. Weed management was carried out manually 2–3 times per season, once during land preparation and twice during vegetative growth, reflecting the limited access to herbicides and mechanized tools

### **Fertilization and Soil Amendments**

Soil management began with initial irrigation followed by ploughing, after which farmers applied well-rotted animal manure and ploughed again to incorporate it. Chemical fertilizers, mainly Diammonium Phosphate (DAP, N:P<sub>2</sub>O<sub>5</sub> 18:46), and to a lesser extent Nitrophos (N:P 22:20) and Russian-manufactured fertilizers, were applied twice (at planting and flowering stages) during the season. During the flowering stage, a 10 cm trench was dug near the rows for hand-applied fertilizer, followed by immediate irrigation. This practice aligns with Safi et al. (2025), who reported that subsurface fertilizer application reduces nitrogen losses and enhances nitrogen use efficiency. The combination of organic manure and reduced chemical fertilizer rates has been shown to maintain yields and improve soil health (Xing et al., 2025). In the study area, farmers estimate fertilizer amounts based on experience, highlighting the need for integrated nutrient management and farmer education on optimal dosing.

### **Pest and Disease Management**

In this study, wireworms, the larvae of click beetles, were identified as the most damaging pest affecting tuber quality. However, the potato tuber moth affected foliage. Although the Colorado potato beetle was not dominant in Chaparhar, research by Falahzadah et al. (2022) in Bamiyan, has shown that insecticides like cypermethrin significantly reduced Colorado beetle populations and improved yield. Many pests and diseases in the study area remain unidentified due to the lack of diagnostic work, and farmers often select pesticides based on peer or dealer advice, with limited extension support, resulting in inconsistent control. These findings reflect broader challenges in potato protection, where reliance on pesticides raises

sustainability concerns (Vilvert et al., 2022) and highlight the need for improved pest identification, farmer education, and integrated pest management strategies

### **Crop Growth and Phenology**

In the spring season, red potatoes were typically planted in early March and white potatoes in April, while in the winter, both varieties were grown around October. Plants developed a bushy growth habit, reaching approximately 30 cm in height. Flowering began 35–40 days after planting, with purple or white blossoms depending on the variety. This timing aligns with Joshi et al. (2016), who reported that root development peaks during the first six weeks after planting. The observed stages also correspond to the BBCH scale updates by Kacheyo et al. (2021), offering a standardized view of potato development. Planting date and environmental stress strongly affect growth. Egorov et al. (2024) showed that earlier planting improves height and yield in early-ripening varieties. Drought and heat, common in the region, can reduce tuber size and increase tuber abortion, though growth may resume after stress relief (Musse et al., 2024; Van Harsselaar et al., 2021). Growth stimulants like silicon-based biostimulants have also been shown to improve biomass and yield under water deficit conditions (Wadas, 2021). These findings support the phenological trends and challenges observed in the study area.

### **Harvesting, Yields, and Postharvest Handling**

In spring season, red potatoes were typically harvested in June, while white potatoes were harvested in July. The plants were dug manually using spades or hoes to extract the tubers. The harvested potatoes were weighed and packed into 7-kg plastic bags, which had holes for better ventilation. During this stage, farmers manually removed damaged, rotten, or undersized tubers and packaged only the marketable yield. On average, farmers harvested 11.35 tons per hectare for both red and white potatoes. Approximately up to 10% of the crop was discarded due to undersized or damaged tubers. Mechanical injury during harvesting, especially when using hoes or spades, was relatively high (Table 2). For winter crops, harvesting usually began in January with same cultivation practices. The postharvest handling practices observed in Chaparhar face similar challenges reported globally. Farmers often rely on manual digging with hoes, leading to significant **mechanical injuries**, and discard approximately **10% of the crop** due to damage or undersized tubers. This aligns with findings by Yadav & Singh (2021), who noted up to **12% harvest losses** and **15.6% during sorting**. Similarly, Yimenu et al. (2024) observed that **harvest and storage contribute most** to the overall **15–46% losses**. Inadequate storage and packaging further exacerbate losses, consistent with Nofriati et al. (2021), who found a **31% improvement need** in postharvest stages under GHP protocols. Additionally, postharvest diseases such as dry rot and soft rot, as discussed by Liu et al. (2020), represent a latent threat to quality and marketability. These findings underscore the need for improved harvesting tools, ventilated packaging, farmer training, and disease management during storage to reduce postharvest losses and improve overall yield quality.

Table 2. Postharvest Loss Estimates in Chaparhar Compared to Other Studies

Stage of Loss	Chaparhar Estimate (%)	Other Reports (%)	Source
Harvesting	~10	12.0	Yadav & Singh (2021)
Sorting	Qualitative discard	15.6	Yadav & Singh (2021)
Storage	Unmeasured but noted	20.1	Yimenu et al. (2024)
Total loss range	-	15–46	Yimenu et al. (2024)
Postharvest quality gaps	Not formally evaluated	31%	GHP Nofriati et al. (2021)
Disease threats	Mentioned (e.g., dry rot)	Fungal decay & mycotoxins	Liu et al. (2020)

### Farmer Knowledge and Decision Making

Most farmers rely on informal advice and have limited access to formal training. They prioritize inputs like seed quality, water, and affordable fertilizer because of their limited resources. Since they often don't earn much money at harvest, they are reluctant to invest in high-tech methods or spend more on inputs. As a result, they tend to trust practical demonstration plots more than just formal research recommendations. Key constraints and their recommended interventions are outlined in Table 3, offering a roadmap for improving potato productivity in Chaparhar

Table 3. Summary of Key Constraints and Improvement Opportunities in Chaparhar Potato Production

Constraint	Observed Situation in Chaparhar	Recommended Intervention
Poor seed quality	Use of informal red/white seed with unknown origin	Establish certified seed supply systems and on-farm seed selection
Unmeasured fertilizer application	Based on farmer experience, often imprecise	Promote training on fertilizer rates and integrated nutrient management
Pest and disease mismanagement	Pesticide selection based on peer/dealer advice	Improve diagnostics, IPM training, and advisory support
Water scarcity and inefficiency	Reliance on furrow irrigation and solar pumps	Encourage drip/sprinkler trials, community storage, water regulation
Postharvest losses	~10% tuber loss due to damage, poor packaging	Introduce improved tools, ventilated crates, and storage training
Limited farmer knowledge	Reliance on informal advice, no formal training	Use demonstration plots, farmer field schools, participatory extension

## CONCLUSION

Potato production in Chaparhar district of Nangarhar is primarily based on traditional practices, with limited access to standardized input management or extension services. Manual land preparation using composted animal manure, hand-cut seed tubers, and furrow irrigation is widespread. Despite resource limitations, average marketable yields of 11.35 t ha<sup>-1</sup> were achieved, though up to 10% of the crop was lost due to damage or undersizing. Fertilizer application was unmeasured and based on experience, and pest management relied heavily on informal advice, particularly against wireworms. Farmers prioritize affordable inputs due to limited profitability, and trust in practical demonstrations over formal research indicates a need for on-site, participatory extension approaches to improve productivity and sustainability.

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