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Revolution in Potato Farming: Smarter Ways to Multiply Seed

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Potato (*Solanum tuberosum* L., 2n = 4x = 48), a major staple crop globally, ranks fourth in human consumption and plays a vital role in India's food security and rural economy. With India achieving a record 60.18 million tonnes of production in 2024–25, the need for quality seed potatoes has intensified. Traditional propagation methods using bulky seed tubers pose challenges such as low multiplication rates, high costs and disease transmission. To address these issues, advanced propagation techniques such as tissue culture, micropropagation, micro- and mini-tuber production, aeroponics, aerohydroponics, apical rooted cuttings and synthetic seed technology have been developed. These innovations enable rapid multiplication of disease-free, uniform planting material, reduce storage and transport issues and enhance productivity and profitability for farmers. Supported by government schemes like MIDH and RKVY and promoted by institutions such as ICAR-CPRI and IARI, these technologies are transforming seed production systems and contributing significantly to the upliftment of small and marginal farmers across the country.

Introduction

Potato (*Solanum tuberosum* L., 2n = 4x = 48), a member of the Solanaceae family, is one of the most important and widely grown food crops across the world. It ranks fourth in terms of human consumption, after rice, wheat and maize. In India, potatoes are not only a daily part of meals but also a major source of income for millions of farmers. The crop is known for its short duration, high yield and adaptability to different climates, making it suitable for both plains and hilly regions. Globally, potato production in 2023–24 reached about 383 million tonnes on nearly 16.8 million hectares, with an average productivity of 22.8 tonnes per hectare. India stood as the second-largest producer, with a record production of 60.18 million tonnes in the 2024–25 season, grown over 2.2 million hectares achieving an average yield of approximately 27 tonnes per hectare, which is above the global average. These figures highlight the crop's growing importance in food and economic security.

Challenges in Conventional Propagation

Traditionally, potatoes are propagated using seed tubers for planting. While this method is simple, it has several drawbacks, seed tubers are bulky, costly to store and transport and often carry diseases such as bacterial wilt and viruses. Also, the multiplication rate is low, requiring a large quantity of seed to cover even small areas. To solve these problems and meet the rising demand, scientists and agricultural experts have developed modern propagation techniques such as True Potato Seed (TPS), tissue culture, mini-tuber production, aeroponic systems and Apical Rooted Cuttings (ARC). These techniques allow farmers to access healthy, disease-free and high-quality planting material at a faster rate and lower cost. With the changing climate and growing food needs, these advancements in propagation are helping farmers improve productivity, reduce losses and increase profits.

Traditional methods

Seed plot technique: Introduced in the 1950s by Dr. Pushkar Nath, the seed plot technique was designed to reduce disease incidence by growing potato crops during periods of low aphid activity. It emphasizes the use of disease-free sprouted tubers, strict field hygiene, early planting and timely dehaulming. When followed rigorously, this technique produces high-quality seed potatoes with minimal virus contamination.

The Seed Plot Technique (SPT) is a scientifically developed method for producing healthy, virus-free seed potatoes in plains with low aphid populations. It involves selecting disease-free, certified seed tubers and planting them in well-prepared fields during the last week of October to the first week of November to escape peak aphid activity. Proper spacing, irrigation and nutrient management are maintained and seed tubers are treated with fungicides before planting. A crucial step is regular roguing, where diseased and off-type plants are removed starting 30 days after planting and repeated every 10–15 days. Haulm cutting is done around 70–80 days after planting, just before the aphid population exceeds 20 per 100 compound leaves, to prevent virus transmission. Tubers are harvested 10–15 days after haulm removal, then graded (preferably 30–60 mm size) and stored in cold conditions (2–4°C) for future seed use. This technique ensures high-quality seed production at a lower cost and improves the seed replacement rate.

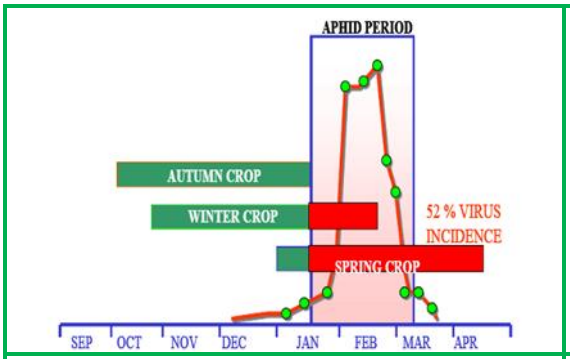

Fig. 1: Aphid infestation in Indian plans


Fig. 2: Plants raised through seed plot technique

True potato seed: TPS involves cultivating potatoes from botanical seeds rather than vegetative tubers. Introduced by Dr. Ramanujan, this approach requires as little as 100–120 grams of seed per hectare and significantly reduces transportation and storage costs. However, TPS plants may vary genetically, exhibit dormancy and have longer crop maturity periods. These challenges have limited its widespread adoption despite its economic and storage advantages.


Fig. 3: Procedure of collecting TPS

Advances in potato seed production

Tissue culture-based system: Tissue culture is a modern biotechnology tool where small parts of the potato plant, especially the shoot tip or meristem, are grown in sterile laboratory conditions. This technique ensures that the plantlets are disease-free, genetically uniform and healthy. It is especially useful for eliminating viruses and other pathogens that spread through traditional tubers.


Fig. 4: Tissue cultured plant

Micropropagation: Micropropagation is a part of tissue culture focused on mass multiplication. Single nodes or shoot tips from elite potato plants are placed on a culture medium to encourage multiple shoot formation. These shoots are separated and re-cultured every 3–4 weeks, enabling exponential multiplication. After

rooting is achieved in a suitable medium with rooting hormones, the plantlets are gradually exposed to external conditions through hardening. This technique is ideal for generating thousands of healthy plants from a single parent in a short time.

Fig. 5: Shoot formation from initial sprout explant

Micro-tuber production from micro-plants: Micro-tubers are tiny potato tubers (3–10 g) produced in vitro from tissue culture plantlets. Under controlled conditions, nodal explants or mini shoots are grown in dark or low-light conditions on a high-sucrose MS medium to promote tuberization. The temperature is maintained around 18–20°C and the growth chambers simulate conditions that induce tuber formation. Once the micro-tubers reach a desirable size, they are harvested, stored at low temperatures (4°C) and used either directly for planting or for further multiplication in protected structures.

Fig. 6: Micro-tuber production from micro-plants

Mini tuber production: Mini-tubers are small, high-quality seed potatoes weighing around 8–15 grams, typically produced in insect-proof greenhouses or net houses. Plantlets derived from tissue culture are transplanted into sterile soil media within these protected environments. Proper fertigation, pest management and temperature control are maintained. After about 60–90 days, the plants form mini-tubers, which are harvested, graded and stored. These mini-tubers can either be planted directly in the field or used for further multiplication.

Aeroponics system: In aeroponics, potato plants are grown without soil. Tissue culture plantlets are fixed in net pots such that their roots hang in the air inside a chamber. Nutrient-rich solutions are sprayed onto the roots using fine mist nozzles at regular intervals. This setup ensures maximum aeration and nutrient absorption. Environmental conditions such as temperature, humidity and light are precisely regulated. After 10–12 weeks, the roots develop a large number of healthy mini-tubers, which are harvested and stored. Aeroponics allows for high multiplication rates and minimal disease contamination.

Fig. 7: Potato plants grown under aeroponic system

Aerohydroponics: Aerohydroponics combines the benefits of aeroponics and hydroponics. In this system, the roots of the potato plants are partly submerged in a nutrient solution and partly exposed to nutrient mist and oxygen. This dual environment promotes vigorous root growth and enhanced tuber development. Like aeroponics, aerohydroponics also takes place in a controlled environment with strict regulation of nutrient composition, pH and light. It has

proven to produce a higher number of mini-tubers per plant and is gaining popularity in early-generation seed production.

Fig. 8: Aerohydroponic system

Apical rooted cuttings: ARC involves cutting the apical (top) shoots of in vitro-grown potato plants and placing them in rooting media such as cocopeat or soil trays. These cuttings are kept in a humid and shaded nursery environment until roots develop. After successful rooting and hardening, they are transplanted to open fields or protected structures. This method is simple, cost-effective and suitable for decentralized seed production. A single rooted cutting can produce up to 8–10 seed tubers, making it ideal for small and marginal farmers.

Fig. 9: Procedure to produce apical rooted cutting

Synthetic seed technology: Synthetic seed technology involves encapsulating shoot tips or micro-tubers in a gel-like substance such as sodium alginate to form bead-like synthetic seeds. These beads protect the propagule and allow for easier handling, storage and transport. The encapsulated material can be stored at low temperatures and later planted directly into sterile media or protected nurseries. Upon sowing, these synthetic seeds germinate and grow like regular seedlings. This technology is particularly useful for long-distance distribution and automation in planting operations.

Fig. 10: Synthetic seed treatment

Impact on Farmer Livelihoods

The adoption of these propagation technologies has enhanced seed quality, yield stability and economic returns for farmers. By minimizing disease risks and input costs, farmers can better plan crop cycles and secure higher market prices. These innovations especially benefit small and marginal farmers by reducing dependence on expensive commercial seed sources.

Policy and Institutional Support

The Government of India, through schemes like the Mission for Integrated Development of Horticulture (MIDH), Rashtriya Krishi Vikas Yojana (RKVY) and State Horticulture Missions, provides financial and technical support for seed production infrastructure, especially for protected cultivation and mini-tuber production. Institutions like ICAR–Central Potato Research Institute (CPRI), Indian Agricultural Research Institute (IARI) and various State Agricultural Universities (SAUs) are playing a crucial role in developing and disseminating these technologies. Farmer training programs, model demonstration farms and subsidies for protected nurseries are making these advances more accessible at the grassroots level.

Conclusion

Modern propagation methods are revolutionizing potato farming by making high-quality planting materials more affordable and accessible. Tissue culture, mini-tubers, aeroponics and synthetic seed systems are improving productivity, reducing losses and enhancing sustainability. With continued government backing and farmer education, these technologies can help India achieve self-reliance in seed potato production and empower rural communities economically.

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