

# Status and Issues of Pre- Basic Seed (PBS) and True Potato Seed (TPS) Production in Potato Crop Development Center, Nigale, Sindhupalchok

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## Abstract

Potato (*Solanum tuberosum* L.) is a critical crop for food security and income generation in Nepal, ranking fifth in cultivation area and fourth in production. Despite its agro-economic significance, productivity remains constrained by the limited availability of quality seeds. This paper explores two advanced seed production technologies - **Pre-Basic Seed (PBS)** through tissue culture and **True Potato Seed (TPS)** via hybridization. **PBS production** involves meristem culture under sterile laboratory conditions, virus testing (DAS-ELISA), and mini-tuber production in aphid-proof screen houses. PBS seeds, graded by weight (A: >5g, B: 1–5g, C: <1g), enhance yield by 49.8% but face challenges like high infrastructure costs, skilled manpower shortages, and inconsistent demand. **TPS technology**, an alternative to costly seed tubers, relies on hybrid progeny HPS 7/67) and offers advantages such as disease resistance and suitability for remote areas. However, TPS adoption is hindered by labor intensity, genetic variability, and climate sensitivity. Nepal's institutional framework NPRP, PCDC-Nigale) and private labs produce 990,000 PBS tubers annually, yet supply falls short of the national demand. TPS production, though limited (9.5-32 kg/year), shows promise for resource-constrained farmers. Key recommendations include strengthening tissue culture infrastructure, scaling up certified seed programs, fostering public-private partnerships, and promoting climate-resilient TPS hybrids. These strategies aim to bridge the seed deficit, boost productivity, and support sustainable potato farming in Nepal.

**Keywords:** Hybridization, Potato, Pre-basic seed, Tissue culture, True potato seed

## Introduction

Potato (*Solanum tuberosum* L.) is one of the most important crops in Nepal, playing a vital role in both food security and income generation. In the Terai and mid-hill regions, it is widely consumed as a vegetable, while in the high-hill areas; it serves as a major staple food crop. Among the major food crops rice, maize, wheat, and millet, potato ranks fifth in terms of area coverage, fourth in total production, and first in productivity (MoALD, 2022/23) Potato cultivation is particularly well-suited for smallholder farmers due to its short growing period (3–4 months), high nutritional value, and relatively low water requirements. It also fits well into various cropping systems and is a key ingredient in almost all vegetable-based diets across Nepal. In addition to its importance at the household level, potato holds significant commercial and industrial value. It serves as a raw material for potato-based processing industries, adding further economic potential through value addition and employment generation.

The country has witnessed significant growth in potato production over the years, with the area under cultivation expanding from approximately 198,256 hectares to about 203,812 hectares and the productivity is approximately 17.11 ton per hectare in recent years (MoALD, 2022/23). In the year 2022/23, Nepal produced around 3.41 million metric tons of potatoes, reflecting an increase in both production and cultivated area due to adoption of new technology and the use of improve potato varieties. The productivity of potato is still lower than neighboring countries as we as its production potential. There are several factors which are responsible for lower production of potato among them loss of pbs seed cycle, insufficient supply of source seed and use of informal source for potato seed are most important factors (Potato seed system in Nepal by S.Gairhe, 2021).

In the fiscal year 2022/23, Nepal saw a significant expansion in potato cultivation, with the total area increasing to approximately 203,812 hectares (MoALD, 2022/23). Given the standard seed rate of 2.5 tons per hectare, the estimated national seed potato requirement stands at around 509,530 metric tons. This substantial demand highlights the critical importance of a reliable and sustainable seed supply system. Despite the increasing area under cultivation and improved yields through new technologies and better varieties, seed availability-particularly quality seed-remains a major bottleneck. Addressing this gap is essential for enhancing productivity, ensuring food security, and improving the livelihoods of smallholder farmers who depend on potato as a key crop.

The availability of quality potato seed is one of the most critical factors influencing potato productivity in Nepal. High-quality seed ensures healthy plant growth, better resistance to diseases, and higher yields, which are essential for both household food security and commercial farming. Poor seed quality, often resulting from the use of informal seeds, leads to lower yields, increased vulnerability to pests and diseases, and reduced income for farmers. Therefore, strengthening the potato seed system through advanced technologies like Pre-Basic Seed (PBS) and True Potato Seed (TPS) production is vital for improving productivity, supporting smallholder farmers, and ensuring the sustainable growth of Nepal's potato sector.

## **Institutional Framework for Potato Seed Production in Nepal**

To address the seed quality issue, Nepal has established two major governmental institutions for potato seed production and distribution:

National Potato Research Program (NPRP), Khumaltar – operating under the Nepal Agricultural Research Council (NARC), focuses on varietal development, breeder seed production, and research on potato agronomy and seed health.

Potato Crop Development Center, Nigale, under the Department of Agriculture (DoA) – responsible for the multiplication and distribution of certified seed potatoes to regional and local extension offices and farmers.

In addition to these, private sector organizations and cooperatives have increasingly participated in the production and multiplication of quality seed potatoes, especially at the pre-basic and basic seed levels. Despite these efforts, the current supply is not sufficient to meet the growing demand, especially with the expansion of commercial farming.

For production and distribution of quality potato seed, there are mainly two governmental organizations which are National Potato Research Program (NPRP), Khumaltar, under Nepal Agriculture Research Council and Potato Crop Development Center, Nigale under Department of Agriculture and various private entities are responsible for producing pre-basic seeds; however, the current output remains insufficient to meet the growing demand for quality seed potatoes. The importance of quality potato seeds cannot be overstated. High-quality seeds are critical for ensuring robust plant health and maximizing yield. Poor seed quality can lead to suboptimal plant stands, increased vulnerability to pests and diseases, and ultimately lower yields. For quality seed potato production there are mainly two methods. One is Pre basic Seed (PBS) production through tissue culture and second is true potato seed (TPS) production through hybridization.

## **Methods of Quality Seed Production**

There are two primary methods used for producing quality seed potato in Potato Crop Development Center, Nigale, Nepal:

1. Pre-Basic Seed (PBS) Production via tissue culture
2. True Potato Seed (TPS) production through hybridization.

### **1. Potato Pre-Basic Seeds (PBS)**

Virus and disease free In-vitro plantlets are produced using tissue culture technology and these In-vitro plantlets are transferred into the Aphids/insects proof screen/glass house and 1-25 gram of small potato Mini tubers are produced called (PBS) Pre-Basic seeds. Double antibody sandwich - enzyme linked immuno-sorbant assay is used to test six major potato viruses, namely PLRV, PVS, PVX, PVY, PVA and PVM. PBS was produced for the first time in Nepal during 1989/90 at NPRP, Khumaltar. As per the study of NPRP, Khumaltar the productivity of potato has been increased by 49.8% due to utilization of pre-basic seed potatoes.

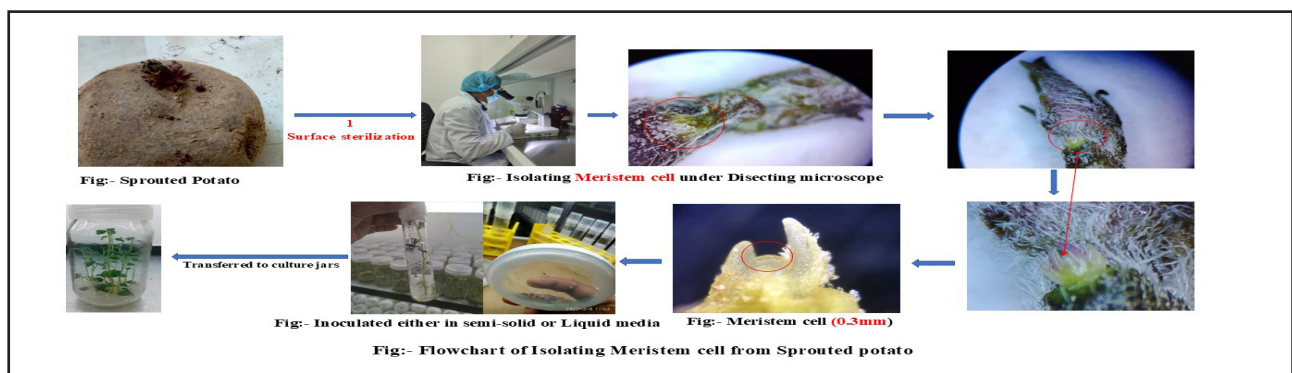
In the process of potato pre-basic seed production there are two important steps, first step is conducted inside the tissue culture laboratory and the second step is conducted inside insect proof screen house.

#### **1.1 Inside tissue culture laboratory**

In-vitro cultivation of plantlets and its parts on nutrient medium under aseptic artificial environmental condition is called plant tissue culture. It allows the production of large number of genetically identical plants from single mother stock. Inside tissue culture laboratory following steps are followed to produce virus free potato in-vitro plantlets.

- Firstly, potato tubers are kept in semi dark room/area at 25-30 °C for 2-3 weeks and let them sprout.
- When the potato tubers are sprouted the fresh sprouts from potato tubers are taken and they are surface sterilized with tap water for 7-10 minutes and washed with mixed solution of detergent and Tween-twenty for 15 minutes and again they are washed with distilled water with continuous shaking for 10 minutes.

- Then sprouts are taken into Laminar Air Flow (LAF) and they are washed with 70% ethanol for 30 second and then with 2% sodium hypochlorite solution for 5-7 minutes.
- Then finally sprouts are washed with double distilled water for 3 times 5 minutes each.
- Then with the help of dissecting microscope, sterilized forceps and scalpel 0.2-0.3 mm size of meristem cell is isolated and inoculated in either liquid MS media or semi-solid MS media prepared with 0.25mg/l GA3 (Gibberellic acid) hormone.
- And these media containing meristem cells are incubated in sterilized incubation room in which room temperature is 23±2°C, light intensity of 3500 lux and photoperiod of 16 hours' light and 8 hours' dark.
- After 45-60 days' whole plant with 6-8 node, leaves and roots is developed.
- This whole plant is sub-cultured in fresh MS-media containing 0.15m/l GA3 through single nodal cutting method.
- Then virus testing is done using DAS-ELISA method to diagnose six different types of viruses i.e. PLRV, PVA, PVX, PVM, PVS, PVY.
- When the plants are found virus free they are considered as mother plant and as per Seed Quality Control Centre (SQCC) PBS seed certification policy, NPRP, Khumaltar is responsible to produced mother plant and these mother plants are given to SQCC certified tissue cultured laboratory for the multiplication and PBS production. Then these mother plants are multiplied (sub-culture) using single nodal cutting technique inside tissue cultured laboratory.
- Once the sub-culture is done after about 25-30 days' plantlets are transferred into screen house.



Source: PCDC, Nigale

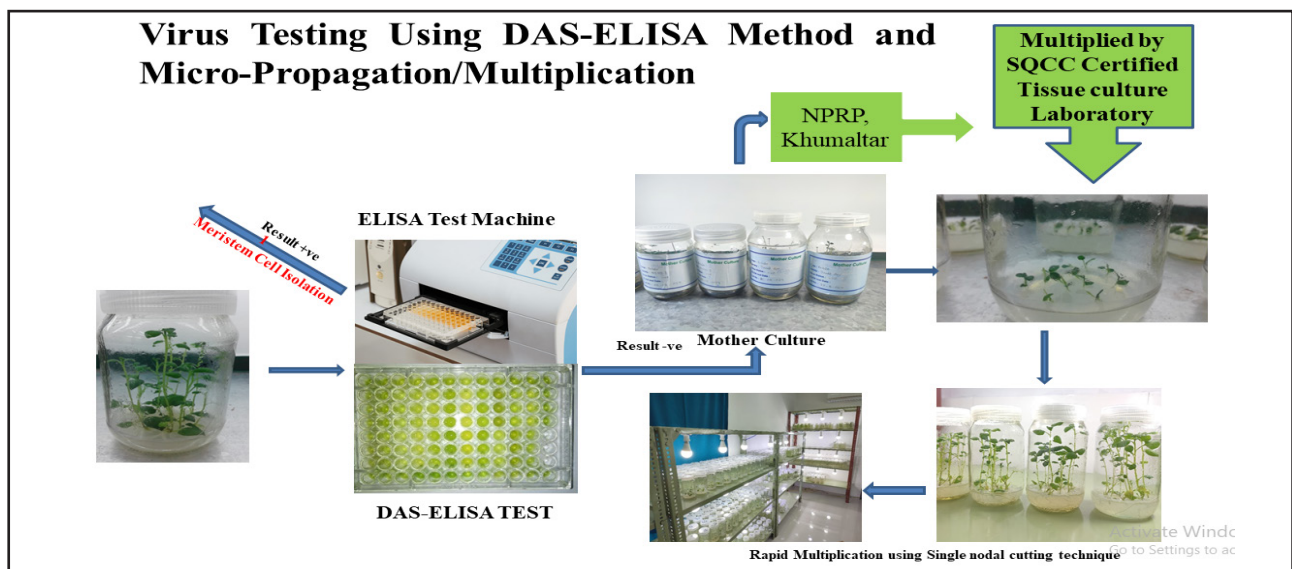


Fig: Virus testing and Rapid Multiplication using Single nodal cutting technique

## 1.2 Inside aphid proof screen/glass house

Before transferring of in-vitro plants in the bed of screen house we should prepare the bed (sand and soil mixture of 75:25 ratios) and sterilized the bed. To sterilize the soil bed we can use either formalin or Silvox.

- Before soil treatment chemical fertilizer i.e. N: P: K with dose of 200:200:120 kg per ha is mixed in the soil and irrigated with UV treated water, and nitrogen should be used in at least 2 split doses.
- 25-30 days old in-vitro plants are taken into the screen house and they are kept for 3-4 days for acclimatization, during these 3-4 days we should prepare and sterilize the soil bed.
- If we use formalin for soil treatment then formalin (6-10% of formaldehyde) is used, whole soil bed is treated with formalin and covered with plastic for 2-3 weeks. But use of formalin for soil treatment is risky for the person who regularly work in screen house as formalin is health hazardous chemical and can cause cancer in long run.
- Now days instead of formalin Silvox (Nano silver hydrogen peroxide) is being used for soil treatment, and Silvox is safe to use for human health and we don't need to wait for 2-3 weeks as we can plant in-vitro plants after 12 hours of soil treatment by Silvox. Normally Silvox dose at 35ml/3ltr/m<sup>2</sup> of water is applied uniformly over soil bed and it doesn't require plastic covering, after 12 hours we can transfer the in-vitro plants in the bed.
- After 3-4 days of acclimatization, we start planting of In-vitro plants
- Before planting roots of these in-vitro plants are treated with 1-2 % of fungicide (Bavistin) for few seconds.
- The distance between plant to plant should be 10cm and the distance between row to row should be 25cm.
- After planting, irrigation is done with UV treated water and 1-2% Bavistin (fungicide) is sprayed over the plants
- Regular irrigation and monitoring should be done for plants.
- Normally after 3-4 months of planting of In-vitro plants PBS is ready to harvest.
- Irrigation should be stopped 15-20 days before harvesting.
- Haulm pulling is done 7-10 days before harvesting.
- Finally, after harvesting Grading is done on the basis of its weight

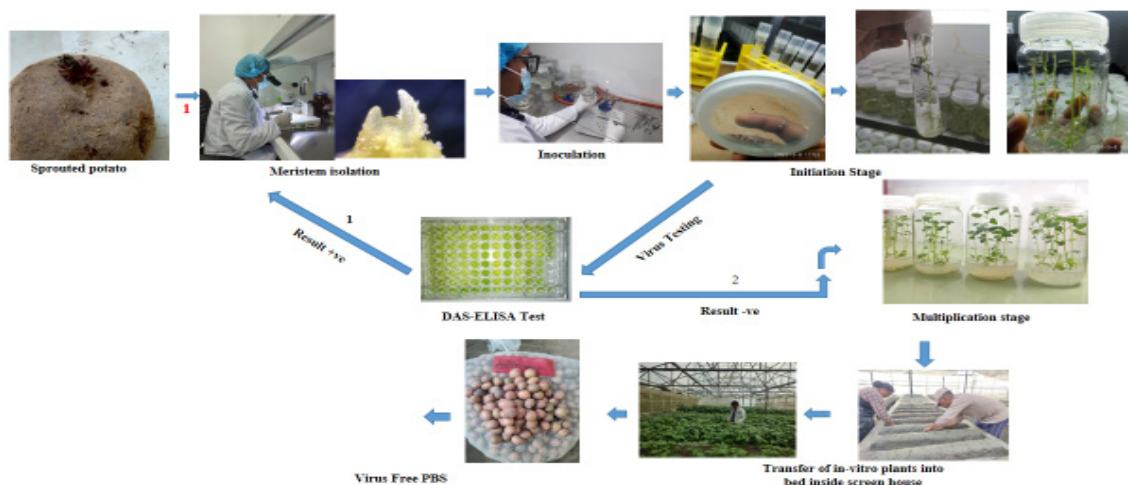


Fig: Flowchart of Virus free Potato PBS Production

Source: PCDC, Nigale

### 1.3 PBS seed grading



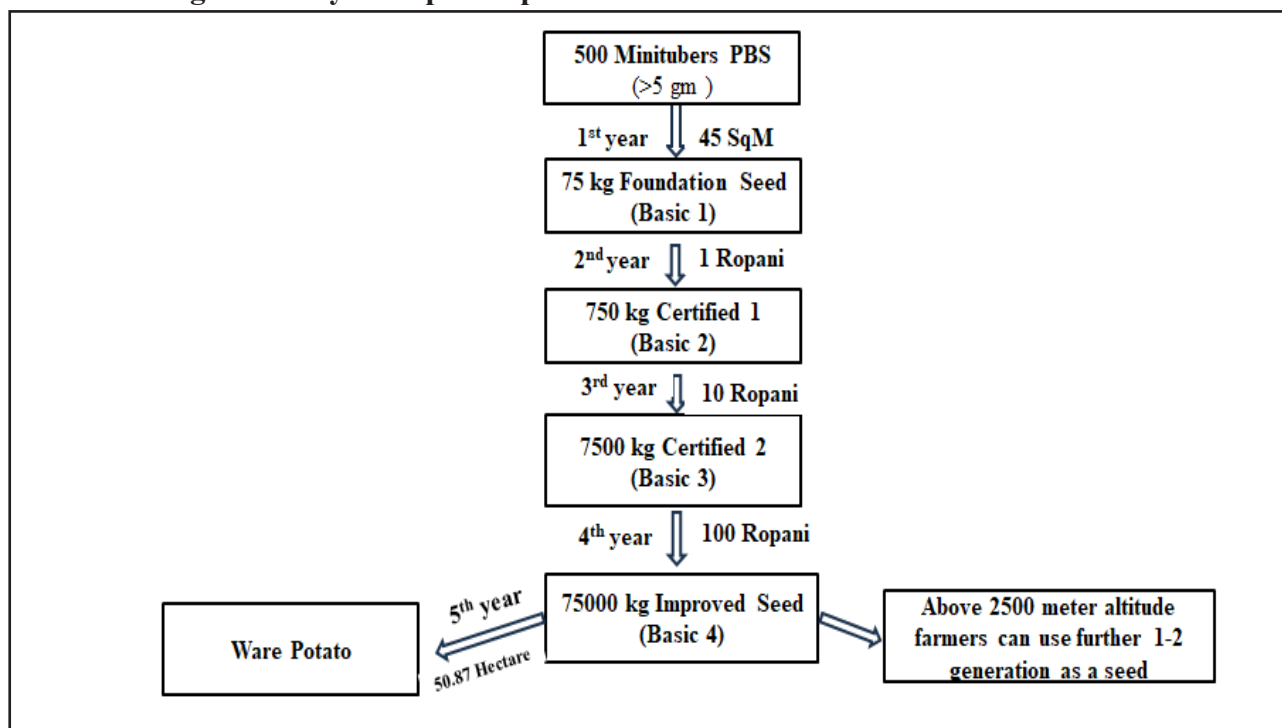
Fig: Virus free PBS tuber

Source: PCDC, Nigale

S.N.	Wt. of PBS Seed	Planting Distance	Area covered by 500 PBS Seed tuber
1.	>5 gm (up to 20 gm) (A grade)	60×15 cm	45 Sq.m

2.	1-5 gm (B grade)	60×7 cm	25 Sq.m
3.	Up to 1 gm (C grade)	60×5 cm	15 Sq.m

#### 1.4 Planning of seed cycle of potato pre-basic seed



Source: PCDC, Nigale

#### 1.5 PBS production, demand and Supply of as per fiscal year 2080/081

S.N.	Certified PBS Producer	Annual Production as Per 2080 B.S.	Annual Demand and Supply	Remarks
1.	National Potato Research Program (NARC), Khumaltar	1.50 Lakh Tuber	Around 80% are sold	20% is used for Basic seed production Untimely and Demand/order of Seeds Variety is changeable every year.
2.	Potato Crop Development Centre, Nigale, Sindhupalchok	95 Thousand Tuber	Around 90% are sold Demand is higher than Production	10% is used for Basic Seed Production
3.	Ficus Biotech Pvt.Ltd, Budanilkantha, Kathmandu	1 .00 Lakh Tuber	Around 60% are sold	40% is used for Basic Seed Production
4.	Shree Ram Niketan Biotech Pvt.Ltd, Godavari	3 .00 Lakh Tuber	Around 75% are sold	25% is used for Basic Seed Production. Untimely and Demand/order of Seeds variety is changeable every year.
5.	Khaddyenna Tatha Biu Aalu, Alaichi Tatha Falful Nursery Uddhyog, Kushadevi	1.50 Lakh Tuber	Around 20% are sold	80% is used for Basic Seed Production

6.	Kushal Agriculture Research and Development centre, Bardiya	1.50 Lakh Tuber	80% are sold	20% is used for Basic Seed Production
7.	Apex Biotech and agri-forestry Research centre Pvt.Ltd, Jhapa	45 Thousand Tuber	50% are sold	50% is used for Basic Seed Production
	Total PBS Production	9.90 Lakh Tuber		

Source: Annual reports of PCDC 2080-081 BS

### 1.6 Data of pre-basic seed production in different fiscal year at PCDC

S.N.	Fiscal Year	Number of In-vitro Jars	Pre-basic Seed (No. of tuber)
1.	2080/081	6500	95,240
2.	2079/080	4220	56,850
3.	2078/079	1800	45,000
4.	2077/078	60	28,180
5.	2076/077	0	12,500

Source: Annual reports of PCDC

## 2. Seed production technology of True Potato Seed (TPS)

In Nepal, the traditional method of using seed tubers is common but costly and prone to diseases. TPS technology was introduced to overcome these challenges and improve productivity in remote areas where access to quality seed tubers is limited. True potato seeds, or “botanical potato seed” differentiates from “seed potatoes”, which are genetically identical clones produced in large numbers by planting pieces of a potato stem or tuber or through tissue culture.

### 2.1 Parent lines for planting

Conventional varieties in the mid-hill region in Nepal have been found to be vulnerable to foggy weather, cold waves and late blight disease. Hence, farmers have been producing potatoes from TPS seeds from hybrid potato varieties, like HPS 7/67 and HPS 1/13, obtaining yields of about 35 tons per ha.



Fig: TPS Berry and Seed

Source: PCDC, Nigale

Any successful true potato seed program must guarantee a reliable supply. Fortunately, TPS can be produced following steps similar to those used to produce many other vegetable crops.

### 2.2 Pollination or crossing of parent line

Pollination can occur either naturally, or under controlled conditions. If plants are left in the field to set fruits naturally, much of the seed will result from self-pollination

The proportion of out-crossing that occurs is caused primarily by insects. The resulting TPS is termed “open pollinated seed” as only the female parent is known. Seed also can be produced from controlled pollination done by hand. In this case, the TPS is termed “hybrid progeny”. With controlled pollination, pollen from the male parent is placed on the stigma of the flower. This can be done in the field or in the greenhouse under controlled conditions.

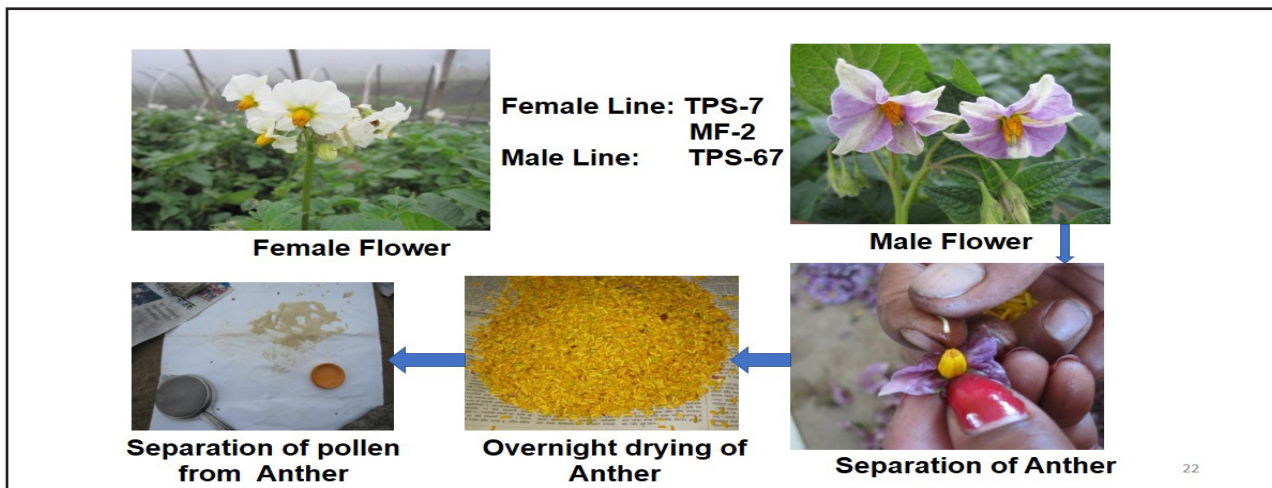


Fig: True Potato Seed (TPS) Production Steps

Source: PCDC, Nigale

### 2.3 Berry harvest

A few days after pollination, berries will start to develop on the plants. In about 40 days, these berries will be ready for harvesting. Under field conditions, a flowering plant will produce an average of 20 berries. When berries are mature, they are harvested and kept at room temperature until they are soft enough to easily extract the seed. The number of TPS per berry can range from 50 to 500, though the average usually is about 200. One gram contains approximately 1000-1500 TPS.

### 2.4 TPS Seed storage

TPS extracted from the berries is then dried at room temperature in low relative humidity. When kept at room temperature, seed can remain viable for several months up to approximately two years. At 4° C, TPS can be stored for several years without losing germinability. In both cases, however, low relative humidity during storage is essential. TPS also has a longer dormancy period than tubers. Although it lasts from four to nine months, it can be broken by a simple treatment with Gibberellic acid.

#### TPS Production Con..

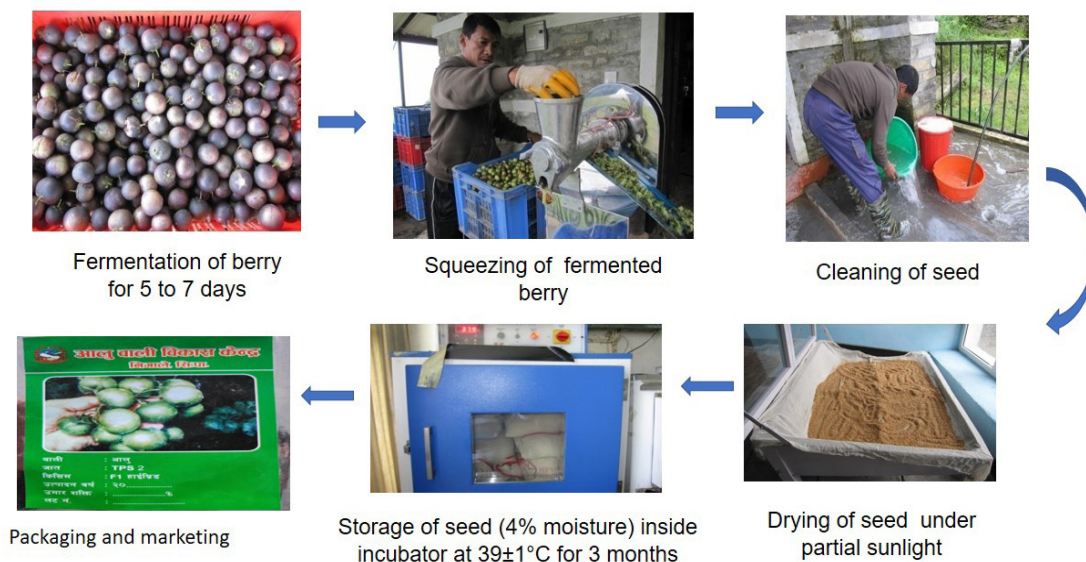


Fig: Berry harvest, seed processing and storage

Source: PCDC, Nigale

### 2.5 TPS Seedling tuber production through TPS Seed

The first generation of tubers produced from seedlings grown from TPS is referred to as “seedling tubers”. This production method combines the advantages of TPC with those of planting seed tubers.

- Depending upon environmental conditions, seedling tubers will grow in densely sown ground beds or in rows in the field.

- When properly managed, a nursery bed will yield as many as 800 clean seedling tubers per square meter. Seedling tubers can be used to increase seed tuber quality, Furthermore, tubers can be multiplied to produce additional potatoes for consumption. In production seedling tuber can be grown by:

**2.5.1 Seed sowing**

Field sowing TPS has potential in areas with mild temperatures, where rainfall is light and evenly distributed during the first five to six weeks after sowing. This permits good germination and seedling establishment in the field. Sowing directly to the furrow often produces inconsistent results. There are ways to facilitate field sowing, such as the use of pelleted seed, fluid drilling and the “plug mix” methods. With “plug mix”, seed is pre-germinated in a prepared soil mix and sown. Under favorable conditions, good plant emergence from direct sowing of TPS can be achieved.

**TPS to seedling tuber production**

- HCL 10-11% (3:1 water and HCL)
- NAOCL (10:1 water and NAOCL)

Cleaning of seed

5 gm seed=25-30m.square area

Seedling tuber 100-120 kg

TPS nursery (P/P and L/L distance 5×25cm)

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**Figure:** Seed sowing and seedling tuber harvesting

Source: PCDC, Nigale

**2.5.2 Transplanting seedlings to the field**

Transplanting TPS seedlings to the field has several advantages over direct sowing. First, plants are in the field less time, freeing the land for other uses. Weed competition is also reduced and agronomic practices are simplified.

- TPS can be sown in trays or ground beds in a nursery. In warm climates, use of shade in nurseries for 15 to 20 days after sowing helps achieve more uniform emergence and vigorous seedling growth.
- Seedling emergence normally occurs between eight to ten days after sowing. Seedlings are thinned a week to ten days after emergence.
- Approximately 35 days after sowing, the seedlings are ready for transplanting.
- To reduce shock at transplanting due to adverse conditions, seedlings can be transplanted with soil-covered roots using containers such as compost cubes, banana leaf cups, or thin, plastic trays.
- This system has promising applications, especially in areas where vegetation production by transplanting is a common practice.
- When adequate management practices are followed, adapted progenies can yield more than 30 tons per hectare.

**2.5.3 Harvesting and storage**

**2.6 TPS Production trend in PCDC over 5 Years**

Data of True Potato Seed (TPS) Production in Different Fiscal Year at PCDC

S.N.	Fiscal Year	TPS Seeds (kg)
1.	2080/081	19.50
2.	2079/080	32.00
3.	2078/079	9.80
4.	2077/078	8.30
5.	2076/077	9.50

Source: Annual reports of PCDC, 2081-082 BS

True Potato Seed (TPS) is utilized in both the Terai and hill regions of Nepal. However, its adoption is significantly higher in the Terai, particularly in the eastern districts such as Jhapa, Morang, and Sunsari, as well as in the western Terai districts including Bardiya, Dang, Rupandehi, and Nawalparasi. The favorable climatic conditions, better access to irrigation, cold storage facility and established seed networks in these areas have contributed to the greater popularity and success of TPS technology in the Terai compared to the hill regions.

## Key Challenges in Pre-Basic Seed Potato and True Potato Seed Production in Nepal

Pre-basic seed production, primarily carried out through tissue culture and greenhouse multiplication, is essential for supplying clean and disease-free planting material. However, several constraints limit its effectiveness in Nepal:

### a) Limited Infrastructure and Facilities

- Inadequate number of well-equipped tissue culture labs, screen houses, and controlled-environment greenhouses.
- Poor maintenance and outdated equipment reduce efficiency and seed quality.

### b) Skilled Manpower Shortage

- Limited availability of trained personnel in tissue culture, greenhouse management, and seed health monitoring.
- High turnover of skilled staff in government labs and lack of training programs.

### c) High Initial Investment

- Infrastructure setup and maintenance costs are high, making it less feasible for small or private operators without financial support.

### d) Quality Control and Certification Gaps

- Weak enforcement of quality assurance and certification protocols for pre-basic and basic seed production.
- Lack of standardized monitoring systems and seed traceability.

### e) Limited Public-Private Collaboration

Weak coordination between government agencies and private sector stakeholders involved in seed multiplication and dissemination.

With increasing demand for potatoes and the need for sustainable farming practices, TPS technology has great potential to enhance potato production in Nepal. Efforts to improve farmer training, develop climate-resilient TPS varieties, and integrate TPS into mainstream farming systems can contribute significantly to food security and rural livelihoods.

## Recommendations to Overcome Challenges

### 1. Strengthen infrastructure and facilities

Upgrade Existing Laboratories and Screen Houses: Invest in modernizing tissue culture labs, screen houses, and greenhouses with reliable power and water supply to ensure consistent and high-quality PBS and TPS production.

### 2. Build technical and human resource capacity

Training Programs: Organize regular training for technical staff of three levels of government on tissue culture, disease indexing, greenhouse management, and TPS hybridization techniques.

### 3. Enhance quality assurance and certification

Strengthen Seed Certification: Enforce strict quality control and certification protocols for PBS and TPS to ensure only disease-free, high-quality seeds.

### 4. Promote research and innovation

Develop Climate-Resilient Varieties: Support research on TPS hybrids lines that are tolerant to local climatic stresses and diseases and farmers' choice.

### 5. Strengthen public-private partnerships

Collaborate with Private Sector: Encourage private biotech labs and seed companies to participate in PBS production.

### 6. Increase farmer awareness and adoption

Establish model farms and demonstration plots to showcase the benefits of PBS and TPS technologies. Extension Services: Strengthen agricultural extension programs to educate farmers on the advantages, handling, and management of PBS and TPS.

## 7. Ensure policy and financial support

Subsidies and Grants: Provide targeted subsidies for infrastructure development, input costs, and certification fees for PBS and TPS production.

Seed Policy Reform: Update national seed policies to prioritize PBS and TPS in the formal seed system and ensure sustained government support.

## 8. Maintain seed cycle and parent line

Preserve Parent Lines: Regularly rejuvenate and maintain parental lines for TPS and PBS to prevent genetic degeneration.

Seed Cycle Management: Implement a strong seed cycle plan to ensure timely multiplication and supply of quality seeds.

## 9. Promoting community-level seed production: A sustainable way forward

Community-level seed production is a vital component for strengthening Nepal's potato seed system. The large-scale multiplication and dissemination of quality seed to farmers across the country can be effectively achieved through active community participation.

- Strengthen infrastructure for tissue culture and screen house seed production.
- Enhance training programs for technicians and farmers. capacity building program
- Develop and enforce robust seed certification and traceability systems.
- Promote research on locally adapted TPS hybrids with uniform tuber traits.
- Facilitate public-private partnerships to scale up quality seed production and distribution.
- Seed cycle maintain of all providence, federal and local governments

## Conclusion

The Potato Crop Development Center, Nigale, and other organizations are working to produce and supply better seeds, but current efforts are not enough to meet the country's needs. To solve these problems, it is important to improve infrastructure, train more people, compulsory seed certification and seed cycle maintain, support community seed production. The government and private sector should work together to make sure farmers can easily access quality seed. By focusing on these areas, Nepal can boost potato production, help farmers earn more, and strengthen food security for the whole country.

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