

WHITE PAPER



Potatoes for Prosperity



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1. Delivering on Food, Nutrition and Economic Security Goals

1.1 Global Superfood for a Sustainable Future

Versatility, robustness, nutritional value and being widely accepted in diets justify the importance of potato as the crop of the past, present and future. Historically, potato fed populations throughout the highlands of south America and supported population growth throughout northern Europe. Currently, potato is the third most important food crop globally after rice and wheat. Grown in over 150 countries, potato is a key dietary staple in both developed and developing nations. As the food of the future, potato was the first crop selected for growth trials in space. Like rice and bread, everyone loves potato regardless of their dietary culture or preference.

Across the globe potato delivers on food and nutrition security for populations, and cornerstone of economic development for farmers and those engaged in the value chain. As the most important non-cereal crop in the world and central to addressing the UN's Sustainable Development Goals, the facts are clear that make potato a smart crop for food security. The Food and Agriculture Organization declared potato a key crop to deliver food security with a goal to double global production in 10 years,¹ and in 2024 officially declared the International Day of Potato on May 30, an annually celebrated event. This declaration reflects the fundamental importance of potato for food security with the potential for significant gains in productivity, production and consumption, possibly more so than the world's three top crops rice, wheat or maize.

1.2 Nutritional Powerhouse

Potato is a superfood in plain sight. Low in fat, full of complex carbohydrates, essential amino acids, protein and minerals, with more vitamin C than oranges, more potassium than a banana, more fiber than apple, potato is a pillar of food and nutrition security. A single medium sized potato contains about half the daily adult requirement of vitamin C, as well as significant amounts of iron, potassium and zinc.

Potato also contains substantial amounts of B vitamins and folic acid, and valuable supplies of essential manganese, chromium, selenium and molybdenum trace ele-

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1 FAO (2022) Doubling global potato production in 10 years is possible. <https://www.fao.org/newsroom/detail/doubling-global-potato-production-in-10-years>.

ments. The high vitamin C content enhances non-heme iron absorption,² particularly important in countries where legumes and other plant-based iron make up much of household iron consumption. Potato is a rising star in the plant protein world,³ with the quality of potato protein being greater than most other nonanimal – and even some animal – sources of protein.⁴ Great potential lies in potato protein for the food industry.

2. A Productive and Climate Smart Crop

Not only is potato the smart choice for food, economic and nutrition security, it is among the most climate smart crops. The cumulative reduction in use of water, land and input resources at the scale of potato production undoubtedly out competes resource use of other staples to produce food equivalents.

Unlike other staple crops such as rice or maize, potato matures quickly in 3–4 months providing food and economic security faster, with food available to eat within as little as 2 months. Potato uses resources efficiently, producing more edible dry matter and calories per unit of time, land and water compared to cereals. Having a greater harvest index of 0.75 compared to 0.4 to 0.6 for cereals, a greater portion of all dry matter produced is distributed to edible parts of the potato plant than for cereal crops.⁵ Think of maize, only a small fraction of the plant is consumed as food compared to potato.

Potatoes have lower water demand and greenhouse gas emissions than any other major crop, up to seven times more efficient in water use than cereals- with one

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2 Jongstra R, Mwangi MN, Burgos G et al (2020) Iron Absorption from Iron-Biofortified Sweetpotato is Higher Than Regular Sweetpotato in Malawian Women while Iron Absorption from Regular and Iron-Biofortified Potatoes is High in Peruvian Women. *J Nutr* 150:3094–3102.

3 Potato News Today (2023) Potato protein: A rising star in the plant-based protein revolution. <https://www.potatonewstoday.com/2023/03/16/potato-protein-a-rising-star-in-the-plant-based-protein-revolution/>

4 McGill, C.R., A.C. Kurilich, and J. Davignon. 2013. The role of potatoes and potato components in cardiometabolic health: A review. *Annals of Medicine* 45: 467–473.

Pinckaers P et al (2022) Potato Protein Ingestion Increases Muscle Protein Synthesis Rates at Rest and during Recovery from Exercise in Humans. *Med Sci Sports Exerc* 54:1572–1581.

5 Haverkort A, Struik P (2016) Yield levels of potato crops: Recent achievements and future prospects. *Field Crops Res* 182:76–85.

hectare of potato yielding two to four times the food quantity of grain crops.⁶ Potato produces 5,626 kcal per m³ water, compared to maize, wheat and rice which range from 1,989 to 2,279 kcal per m³ water. Per m³ water, potato produces 150 g of protein per 1 kg dry matter while maize, rice and wheat range from 49 to 77 g/kg.⁷ Not only is water use efficiency critical for farmers in ever changing climates with erratic and lower than average rainfall, selecting potato to devote for using irrigation water makes smart sense.

3. Driving Livelihoods in Diverse Contexts

More than just a staple food, potatoes are a crucial crop for food and nutrition security for populations and economic security for the tens of millions of farmers and those engaged along the value chain. Potatoes thrive in a remarkable range of environments and serve diverse contexts ranging from rural, isolated communities to unimaginable conflict, profiles of farmers and those engaged along the value chain.

3.1 Adapted to a multitude of agro-ecologies

The broad adaptability and robustness of potato enable production from the humid tropics of Comoros and Mauritius island nations in the Indian Ocean to the highlands of sub-Saharan Africa, and the dry deserts of northern Africa. Potatoes are cultivated from the equator to the very far north of Europe and North America and very far south of South America, at elevations from sea level to exceeding 4,000 metres above sea level, and in climates that span from regions of high rainfall to the driest deserts.

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6 Clark M et al (2022) Estimating the environmental impacts of 57,000 food products. Proc Natl Acad Sci USA. 119 (33) e2120584119.

Liu B, Gu W, Yang Y, Lu B, Wang F, Zhang B, Bi J (2021) Promoting potato as staple food can reduce the carbon-land-water impacts of crops in China. Nat Food. 2:570–577.

Potato News Today (2022b) Foods that produce the most and least greenhouse gases: The humble potato is 'the champion'. <https://www.potatonewstoday.com/2022/09/21/foods-that-produce-the-most-and-least-greenhouse-gases-the-humble-potato-is-the-champion/>.

Potato News Today (2024a) Eco-friendly farming: Study finds fresh potato cultivation produces much less greenhouse gas emissions than cereal production. <https://www.potatonewstoday.com/2024/04/15/eco-friendly-farming-study-finds-fresh-potato-cultivation-produces-much-less-greenhouse-gas-emissions-than-cereal-production/>

7 Renault D, Wallender WW (2000) Nutritional water productivity and diets. Agric Water Manag 45:275–296.

Countries with expansive highland regions having moderate temperatures with high rainfall are traditionally associated with potato throughout tropical and sub-tropical Africa, South America and Asia, with production at 1,700 – 2,500+ masl as a rain fed crop. Temperatures during the day normally do not exceed 25–30°C and drop below 18°C during the night, providing the critical environment needed for tuberization.⁸

Cool climates enable ambient-based storage for seed and ware potato, a huge opportunity for farmers and seed growers as can store potato up to several months depending on ambient temperatures while avoiding reliance on electricity or other power source.

In northern Africa, potato is grown as a winter crop during the dry season from November to February. Largely grown in the desert, irrigation water for crops in northern Africa originate from various expansive underground aquifers. The climate of the winter desert provides ideal growing conditions for potato with impeccable solar radiation having unimpeded sunshine from morning to night under moderate temperatures, with nights dropping below 18°C, critical for tuberization. Disease pressure is low with low humidity and no rainfall. Additionally, the sandy soils of the desert do not harbour many soilborne diseases affecting potato.

3.2 Impactful in a multitude of socio-economic contexts

Profitable at small to large scale, especially compared to grain crops, potato has provided solutions to food production in diverse contexts ranging from rural, isolated communities to unimaginable conflict. The versatility of potato means that it can be grown in large fields, at industrial scale, in a small plot of a smallholder farmer, or in a sack at the household level of low-income urban settings or in a refugee/ IDP camp.

Women and marginalised groups, including the frequently mobile, in circumstances where they have limited, or no land can particularly benefit from potato. In Zimbabwe, women have found success and empowerment through growing potatoes. Due to challenges in accessing land, many women grow potatoes in sacks in their household compounds — a method that enables urban women with small plots to maximise yield, contribute to household food security, and generate income for their families.

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8 Demagante AL, VanderZaag P (1988) Potato (*Solanum spp.*) in an isohyperthermic environment II. Response to planting date. *Field Crops Res* 19:153–166.

In Rwanda, potato is king, having the highest per capita consumption rate in Africa of 64 kg/yr. In Kenya, potato is among the big four crops prioritised for development by the government with greater than 800,000 potato farmers. In Ethiopia, it is estimated there are greater than 1 million potato farmers. Countries of MENA and lowland tropical regions where one would not normally associate with potato are prioritising the crop for development for food and economic security such as Comoros, Iraq, Mauritius, Mauritania, Niger and Sudan.

Potato is particularly well positioned to provide affordable and nutritious food for urban and rural low income households. Some highly robust varieties consistently give high yields and are easy to grow with high levels of disease resistance, making small-scale sack farming possible without use of pesticides. Such farming can provide households yearlong with potato and sell excess in their local neighbourhoods or beyond.

4. Closing the Yield Gap to Unleash the Potential of Potato

In large swaths of the potato-growing world, yields are abysmally low, stagnating potato sector development and preventing opportunities to boost food production at scale without expanding land under cultivation. Nigeria has among the lowest global average yields for potato at 3.8 t/ha, creeping up to 7.8 t/ha in Uganda and largely averaging 10 to 12 t/ha across many African countries.⁹

Doubling or tripling these low yields also does not require a proportional increase in inputs, labor, or other resources, making potato an especially attractive crop for scaling up food production. Research demonstrates that adopting improved potato varieties and better agronomic practices—such as proper spacing, hilling, and integrated disease management—can substantially boost yields without a linear rise in fertilizer or water use, highlighting the crop's resource efficiency.⁵

Closing the massive yield gap from 5 to 12 t/ha to approach yields in countries utilizing advanced farming practices relies on improving access to quality seed, knowledge on potato production practices and modern technology.

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9 FAOSTAT (2023) <https://www.fao.org/faostat/en/#home>. Accessed multiple dates during September 2025.

4.1 Limited access to seed main cause of low yields among smallholder farmers

Access to seed-quality seed is the principal challenge to improving yields across the developing world and unlocking the potential of potato. Production of seed potato (referring to the tuber in this narrative) is challenging, given potato is planted at 2 to 2.5 tonnes of seed per hectare and seed is perishable. Box 1 provides an example of the role of seed in improving yields and livelihoods.

With limited supply of actual seed, many farmers source seed from informal sources, such as open food markets selling small ware potato tubers as seed, trading with neighbours and saving seed on farm. This seed is not produced under a quality assurance system, hence often of variable, usually low, quality.

Some farmers multiply seed on farm under some sort of quality assurance mechanism, such as a nursery bed dedicated for seed without history of potato or related crops. Certified seed is produced at a low level in some countries, such as Kenya where certified seed supplies up to 5% of the estimated seed demand. There is limited import of certified seed from Europe.

When available, certified or seed quality seed potato is largely sold farm gate, often meaning farmers have to travel up to 100s of km to access seed. There are no seed distributors or dealers for seed potato given limitations to maintain seed for markets. An input supply business can store a few villages worth of grain seed in their shop, the same capacity sufficient to store only a few tonnes of seed potato or enough seed for a few hectares. Complicated on top of seed volumes, seed potato is perishable requiring cool ambient temperatures or access to cold storage to store seed for some months.

4.2 Seed production systems

Producing seed potato is complicated, going through several stages before commercial seed is available for farmers. Seed is bulky and heavy, planted at 2 t/ha. Perishability poses challenges for storage and marketing. Starting in the laboratory as tissue culture plants – the first step in seed production and how varieties are conserved (mother plants). Tissue culture plants are then planted into a screenhouse to produce minitubers or apical cuttings, which are then transplanted in the field over successive generations to arrive at commercial seed (Fig. 1).

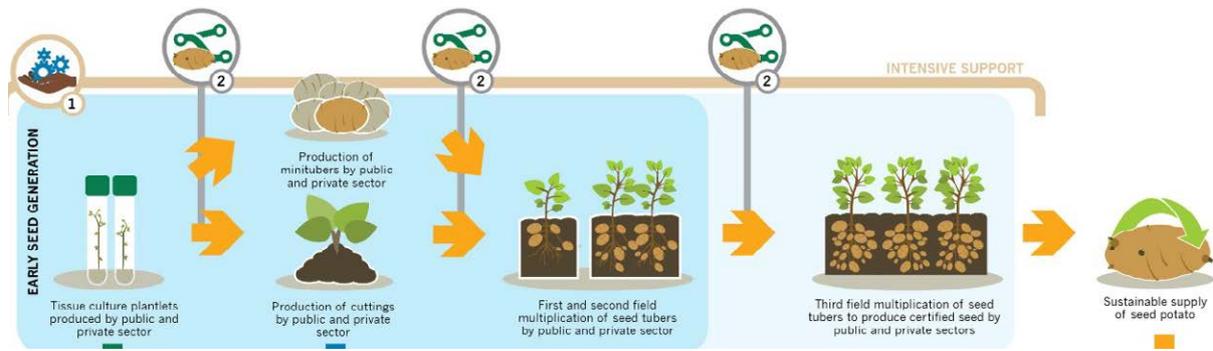


Figure 1. Stages in seed potato production starting from tissue culture in the laboratory to the screen-house to produce minitubers or apical cuttings then to the field for seed bulking over successive generations to become commercial seed. Figure credit: from author's collection of materials developed with the International Potato center.

Early generation seed (EGS) refers to tissue culture, screenhouse and first generation or two of field multiplied seed, often referred to as pre-basic and basic seed, respectively, as highlighted in darker blue in Figure 1. Field multiplication over a further 1 to 3+ generations produces commercial seed that farmers purchase. Often, field multiplication constrains seed systems and prevents seed multiplication from reaching potential quantities.

Seed potato production offers many options and pathways for seed growers where along the production system to engage considering differing stages of seed production and points of sale. The brief from the International Potato Center 'Delivery pathways for different seed potato production systems and scales of production' illustrates the diverse pathways of seed potato production.¹⁰

4.3 Seed certification systems to ensure seed quality

Poor quality seed is largely a result of degeneration from disease, nematodes or pests. An external quality assurance system ensures that a seed lot is of seed quality to prevent yield losses and introduction of diseases and pests into farmers' fields. Seed growers should inherently have rigorous practices to maintain high quality in seed production, most importantly starting with approved starter material and robust agricultural practices.

Normally, seed certification systems provide services to ensure seed meets regulated quality standards. While most countries have formalised seed certification

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10 Wauters, P.; Parker, M. 2023. Delivery pathways for different seed potato production systems and scales of production. International Potato Center <https://hdl.handle.net/10568/129811>

protocols, many lack the resources to support a functioning seed certification system, relying on less formal approaches to seed quality assurance. Other seed quality assurance systems are locally based engaging extension and other agriculture and community members to inspect fields and are often less rigorous. Some informal systems do test soil for high risk diseases to improve rigour of seed quality assurance.

4.4 Ongoing processes to increase seed availability

Most countries in Africa and the developing world supply less than 10% of seed demand with actual seed of any level of quality assurance and limited importation. Current seed demand is high with current market opportunities for farmers. As consumer demand for potato increases, demand for good quality seed with market and consumer demanded characteristics will correspondingly increase.

Normally national agricultural research institutes undertake EGS production, with seed growers multiplying seed in the field. Governments are increasingly prioritizing potato for crop development, which supports national programs to produce EGS. More and more private sector businesses are engaging in seed production, covering all stages of the production system. Large scale growers will often manage screen-house and field multiplication internally to maintain a high level of hygiene. Smaller scale seed growers, ie < 10 ha, normally start with basic seed and multiply over 1 to 3 seasons, depending on access to land.

A system of nurseries to produce apical cuttings can bring highest quality seed to isolated farmers, who otherwise would often have to travel 100+ kilometers to purchase seed from seed growers and eliminates transporting tonnes of seed, which is planted at 2 t/ha (Box 1). Apical cuttings are well suited to rural areas without access to quality assurance systems as they are inherently low risk provided that nursery operators adhere to easy to follow, largely standard quality assurance protocols and farmers to good agricultural practices when producing seed on-farm.¹¹

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11 VanderZaag, P., Xuan Pham, T., Demonteverde, V.E., Kiswa, C., Parker, M., Nyawade, S., Wauters P. and Barekye, A. 2021. Apical Rooted Cuttings Revolutionize Seed Potato Production by Smallholder Farmers in the Tropics [Online First], IntechOpen. Available from: <https://www.intechopen.com/online-first/77334>

Box 1: Seed tech bringing access to quality seed potato transforms livelihoods

Mary on the slope of Mt Kenya shows how access to quality seed potato has transformed her life. Starting with a small seed multiplication nursery planted with apical cuttings in April 2019 produced by her local nursery operator Cecinta as shown in photo on left, she produced her own seed potato for her small farm.

This was the first time she planted seed of such high quality and her potato yields increased 2 to 3-fold. From her potato production plot of less than 0.5 acres, her potato farm grew and prospered. The photo on the right is 2 years later in August 2021 of Mary and Cecinta beside building material she purchased for a new home for the family of her adult child built on land she purchased adjacent to her home as a result of her potato business.



With apical cuttings, seed quality assurance is inherently guaranteed. As starting with tissue culture plants, which are the only true disease-free form of seed, that are propagated in a protected structure (screenhouse or greenhouse) to produce apical cuttings that maintain the disease-free status. Irrigation water should be consistently evaluated for disease and nutrient management, and maintaining good hygiene are standard nursery practices making apical cuttings a low risk for phytosanitary issues.

Apical cuttings are an example of community-based seed production, where seed quality is not compromised. Often the limitation of community-based seed production is seed quality assurance, as either a seed certification system does not function or is inaccessible in terms of distance and/or costs. Without quality assurance, the seed risks to be of variable quality depending on the practices of the seed grower and disease and pest pressures.

True potato seed (TPS), particularly from hybrid potatoes known as hybrid true potato seed (HTPS) is becoming more available. Direct seeding (H)TPS is the true revolution for potato farming to eliminate the burden of planting 2 to 2.5 tonnes of seed tubers per hectare. Currently TPS is another form of EGS. (H)TPS are planted in

a protected structure to produce minitubers for onward field multiplication. Alternatively, when environmental conditions and production systems allow, seedlings can be transplanted in the field prior to maturity to reduce the overall time of seed multiplication. With high multiplication rates of seed (approximately 200 seeds per fruit), seed costs can drastically reduce for farmers as seed tubers are approximately 50% of production costs, and even greater across the developing world. Additionally, TPS eliminates transporting the heavy seed across hundreds of kilometers on land and shipping across major waterways.

Hybrid breeding technology further strong advantage is rapid variety deployment to respond to current demands. The drawback, each hybrid is a new variety requiring farmer and market penetration to replace current varieties, which are often well established and a challenge to replace. Biotechnology tools, such as genetic engineering and CRISPR, allow for the integration of specific traits, such a disease resistance, into existing varieties without altering other traits that make them popular among farmers and markets.

4.5 Good agricultural practices and market access to unlock the potential of potato

While seed is major limiting factor to closing the yield gap, limited knowledge of good agricultural practices for potato prevails among farmers. Many farmers are unaware of benefits of quality seed, consequences of poor quality seed, how to space and hill properly, disease and pest management, and other good crop management practices. Farmers applying good practices is critical to ensure they obtain a full return on investment in seed, otherwise any investment in quality seed would be negated.

Once yields improve, improving farmer integration with market systems will fully unlock the potential of potato. Smallholder farmers often market potato alone, making marketing challenge considering the small-scale plots scattered about the countryside. Supporting farmers to integrate with diverse market approaches will result in a vibrant potato sector:

- membership in an association or cooperative,
- direct marketing in open/roadside markets or to wholesalers or supermarkets,
- contract farming with supermarkets, restaurants, processors.

Emphasising farming as a business and supporting farmers to select the appropriate varieties for the target market and cropping plans to ensure consistent supply of quality potatoes will complete a food systems approach to realizing the potential of potato.

4.6 Viazi as case to support unlocking potential of potato

Viazi channels carbon compensation and social responsibility investments to transition smallholder farmers to more productive and sustainable agricultural practices. Viazi covers the upfront costs of potato farming packages for farmer groups that they otherwise could not afford. Packages include climate-smart inputs (certified seed potato, fertilizer, biofertilizers) and equipment (solar-powered irrigation pumps, drip kits, mechanization, weather stations, etc.), along with training in good agricultural practices.

The returns are significant, impacting yields with increases from 8–12 to 20–30+ t/ha and the accompanying increase in farmers' incomes. Viazi has developed a technology to track delivery and impact of investments. The initial farming resources are funded by Viazi, and farmers become self-sufficient over 2–3 seasons, and will be able to invest in the inputs for the coming seasons and will not need further external funding.

5. A Sustainable Future Rooted in Potato

This narrative provided evidence of the adaptability and versatility of potato that make it is a smart choice for addressing food and economic security challenges, and promoting sustainable agriculture. Potato can be grown in diverse agro-ecologies and production systems. More and more, countries throughout Africa, Asia and MENA are prioritizing potato as a pillar for food security is testament to the potential of this amazing crop. By investing in better seeds, farmer education, and market access, we can help unlock the full potential of the potato.

Acknowledgements

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