

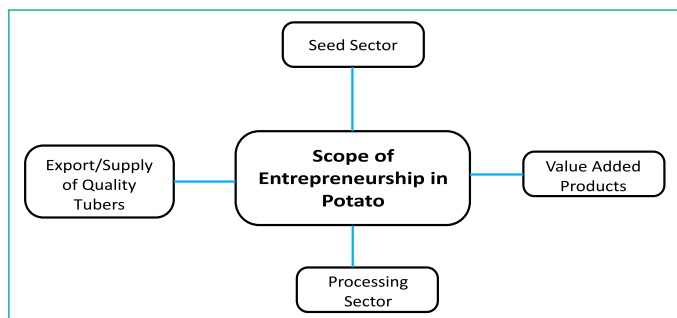
Bioentrepreneurship avenues and opportunities in potato

The ICAR-Central Potato Research Institute has been instrumental in development of ~70 native potato varieties and has also contributed to popularize potato cultivation as well as utilization under various agro-climatic regions in the country. Following these scientific advances, India has emerged as the world's second-largest potato producer, accounting for around 12% of the crop's total production. The potato industry is contributing significantly to the growth of entrepreneurship, particularly in the processing and seed industries. The potato crop has enormous potential to improve the country's food and nutritional security. Since the beginning of the last decade, the Institute has taken a proactive role in promoting intellectual property rights and licensing institute's technologies to young people and other individuals working in the seed and processing industries. Commercialization of institute's technologies is critical to fostering an entrepreneurial culture in the country.

A COUNTRY'S development depends on the effective and efficient use of its various available resources. Globalization, economic liberalization, and rising urbanization are changing consumer preferences. To address this situation, the emphasis is on assisting farmers in increasing their competitiveness, going to produce for a specific market, and seeking new market opportunities that would provide higher levels of income. Agriculture is the backbone of the Indian economy, and more than 58% of the Indian population works in agriculture. Agriculture and related industries are the country's largest enterprises, and an enterprise can only survive if it grows consistently. Potatoes are one of the third most important food crop in the world. Potatoes contribute significantly to the Indian agricultural economy. Potato's current share of agricultural growth domestic product (GDP) per unit area of cultivable land is approximately 3.7 times (2.86% agricultural GDP from 1.32% cultivable area) higher than rice (18.25% GDP from 31.19% cultivable area) and 5.4 times higher than wheat (8.22% GDP from 20.56% cultivable area), which are the country's two main food crops. India is the world's second-largest producer of potatoes, but it does not even rank among the top ten processing nations. Its global contribution to processing is negligible. India has nine major potato-producing states viz. Punjab, Uttar Pradesh, West Bengal, Haryana, Gujarat, Andhra Pradesh, Assam, Bihar, and Madhya Pradesh. Potatoes play an important role in Indian cuisine and are one of the most popular flavourings in majority of dishes. Along with cereals, potatoes make a significant contribution to the nation's food security.

Entrepreneurship is commonly defined as starting one's own business while also being able to identify profitable opportunities that come along the way. An entrepreneur is an innovator or developer who sees and grabs opportunities, transforms them into commercial concepts (goods or services that can be sold), adds value via hard work and expertise, takes on the risks associated with a fiercely competitive industry, and recognizes gains or losses. Successful entrepreneurship in the agricultural sector requires qualities such as decision-making ability, resourcefulness, personability, adaptability, persuasiveness, and a strong desire to grow the business. ICAR-CPRI is moving forward with its vision of advancing professional competency for pursuing excellence in research and development along with entrepreneurship development in the potato and related sectors with ethical values to meet regional and national needs. Institute is also providing specialized services to farmers and entrepreneurs for a decent livelihood and earning.

In many states in the nation, ICAR-CPRI technologies related to the production of mini-tubers using the aeroponics system, processing varieties, and value-added products which are managed and transferred by institute technology management unit (ITMU) have greatly expanded, strengthening the confidence of farmers and entrepreneurs. These technologies are helping to promote potato productivity, production, and the development of entrepreneurship. The potato industry offers numerous opportunities for entrepreneurship development, such as producing healthy mini-tubers or seed, exporting healthy planting material and processing raw material



Components for entrepreneurship in potato sector

to other countries, developing value-added products and processing sectors, and so on.

Development of entrepreneurship in the potato seed sector

The Central Potato Research Institute has developed approximately seventy varieties that are suitable for India's diverse range of agro-ecologies. The majority of the country's potato area—more than 94% of it is covered up with potato varieties developed by ICAR-CPRI. Furthermore, a few of them have become more well-known in various other countries. The production of virus-free seed from potatoes, a crop that is vegetatively propagated, has long been troublesome. Production of mini-tubers from tissue-cultured plants is restricted to 5–7 tubers per plant in the conventional method; these tubers are irregular in size and frequently suffered with diseases that are transmitted by the soil. This method requires a large area covered with insect-proof netting, which raises the cost of production per mini-tuber to somewhere around ₹ 5–6. Therefore, in order to meet India's and other countries' enormous seed potato requirements, it is extremely important that more mini-tubers be produced per unit time per plant at a lower cost of production. Despite a five-fold increase in total seed potato production over the previous 50 years, the overall productivity is low (24.5 q/ha), primarily due to farmers' lack of access to high-quality planting material of suitable, high-yielding varieties. Viral and seed-borne diseases are carried down to the successive generation through the vegetative mode of propagation. Aphids and whiteflies, basically two subtropical insect vectors, are known to transmit viruses. These conditions render potatoes unsuitable for seed production, requiring their substitute. The production of seeds is limited to areas and meteorological conditions that are free from soil-borne diseases and have a low population of vectors; these conditions are found mainly in the winter months in Northwestern India. The circulation of seed from strictly limited seed production areas to potato-producing regions located in the country is restricted. The potato seed is a semi-perishable, bulky tuber, and the transportation cost and cold storage incorporates to the seed's total cost. Therefore, institute has developed an aeroponic system technology to develop disease free minitubers to cater the seed demand in the country. Aeroponic system technology is the process of raising plants without using soil or any other aggregate media under nutrient rich air-mist environment. The basic idea is to spray roots with a

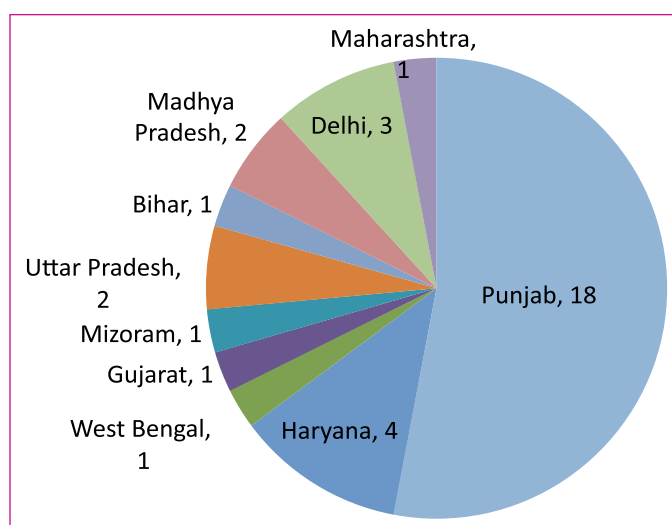


Potato mini-tubers grown using an aeroponics system technology

nutrient-rich solution on a regular basis to grow plants in a closed environment. When compared to cultivation under net-house conditions, this technology has the advantage of producing seven to ten times more mini-tubers from *in vitro* plantlets.

Aeroponics mini-tuber productions are carried out indoors in a net house, which helps to prevent soil exposure and a lot of soil-borne pathogens. Mini-tubers of the desired size can be collected, and multiple pickings are made possible by this technology. Water and nutrients were efficiently governed during the mini-tuber production process. A minimum amount of land is required to install an aeroponics facility. The development of high-quality potato seed production has been linked directly to the strengthening of the potato seed chain through the use of aeroponics system technology.

ICAR-CPRI has licensed or transferred this technology to 28 entrepreneurs involved in mini-tuber production and 6 entrepreneurs involved in the fabrication of aeroponics units in ten different states across the



State-wise licensing of aeroponics system technology for potatoes mini-tubers production

country. These states include Haryana, Punjab, Madhya Pradesh, Bihar, Uttar Pradesh, Mizoram, Gujarat, New Delhi, West Bengal, and Maharashtra. In the other states of the country, there is a huge opportunity for entrepreneurs to produce high-quality mini-tubers for the purpose of seed. All licensees have established aeroponics facilities and benefited directly from ICAR-CPRI technologies. They are producing high-quality planting materials (mini-tubers) after licensing CPRI Aeroponics technology.

Photoautotrophic micro-propagation (PAM) and apical-rooted cutting (ARC) technology developed by CPRI are also gaining recognition and popularity among farmers seeking to become entrepreneurs. The photoautotrophic micropropagation (PAM) technology outlined here has been standardized for rapid multiplication as well as hardening of potato microplants. The technology is a replacement for the tissue culture technique, which is currently used to rapidly multiply high-quality planting material. PAM technology is simple and cost-effective, and it can be performed by semi-skilled personnel with minimal equipment. It produces highly vigorous plants that can be transplanted directly into an external environment without the need for hardening to produce tubers, which can then be multiplied as seeds. These technologies are an alternative to aeroponics for producing high-quality planting material in potato crops, and they have the potential to boost enhanced entrepreneurship and the establishment of viable ventures. An entrepreneur has successfully obtained a license for PAM technology from ICAR-CPRI, Shimla.

Impact of plant tissue culture on entrepreneurship development

Tissue culture is a new and indispensable technology that has addressed some serious issues in agriculture and plant-based industries. Plant tissue culture has numerous applications in the horticulture sector, including potato crops. Meristem culture helps to eliminate potato viruses. It falls under the category of plant tissue culture and has a large potential for commercial venture or entrepreneurship by providing professional services to those involved in potato farming and related industries. Some of its advantages and scope include regeneration of whole plants from a range of cultured tissues (roots, leaves, tubers, stems) and from single cells; rapid and mass production of plants. Due to wider scope as well as applicability in horticultural sector has made it possible to meet the ever-increasing demand for plants in commercial space; producing plants with desirable characters; producing disease-free plants; producing plants during their non-favourable growth season; conservation of endangered or extremely endangered species. Tissue culture technology expands potato breeding programs in a variety of ways. Some tissue culture techniques can be used to improve the efficiency of breeding programs. The combination of tissue culture and traditional breeding methods opens up the possibility of developing new, effective breeding strategies. Potatoes are susceptible to a variety of viral diseases, resulting in a gradual decline in vigour and yield. Meristem culture is an established method for eliminating viruses and producing disease-free plants.

Culturing potatoes with axillary shoots is an easy way to grow shoots and keep them alive through sub-culturing for tissue culture processes. They are also an important means of preserving genetic stocks. Potato plants can be regenerated by cultivating organs such as anthers or by using cultured explants of the leaf, stem, rachis, and tuber. Anther and ovary cultures are appropriate for haploid production. Background of genotype, planting at the appropriate developmental stage (uninucleate microspores, i.e., flower buds 4-6 mm in length), and pretreatment (e.g., incubation of flower buds at 6°C for 48 hours) always have an impact on potato anther culture. Plant tissue culture offers alternative methods of propagation through *in vitro* techniques that enable the production and multiplication of material with high sanity. CPRI produces approximately 3187 metric tonnes of nucleus and breeder seed, with 70% propagated using the conventional seed plot technique and 30% via the advanced tissue culture technique. Keeping this in mind, plant tissue culture has enough potential in the potato crop to develop into a successful entrepreneurship.

Entrepreneurship in potato processing sector

The operational definition of entrepreneurial behaviour among entrepreneurs is the resultant combination of eleven elements: individual creativity, self-assurance, achievement motivation, leadership aptitude, capacity for making decisions, risk orientation, market orientation, scientific orientation, economic motivation, and awareness of value-addition in services. Urbanization and population growth rates are rising, and so is the amount of potatoes consumed, particularly when they are processed into chips and crisps. Potato chips and snack pellets, dehydrated products, frozen products, and other products make up the different segments of the global potato market. With a market value of USD 31.2 billion in 2020, potato chips continue to be the most popular snack food in the world. From 2020 to 2026, they are projected to grow at compound annual growth rate (CAGR) of 6.4%. The increased demand for French fries served in restaurants and fast food establishments is driving the rapid growth of the frozen potato market. French fries hold a dominant market share of approximately 40% of the global frozen potato market, valued at USD 21.8 billion in 2020 (IMARC 2021). Because dehydrated potato flakes are easier to handle, have a longer shelf-life, and are available throughout the year, the market for them is likewise expanding significantly. These instant potatoes have great thickening qualities and taste just like fresh potatoes. Flakes lead the global dehydrated potato market with 36.5% of the market share, followed by dices, shreds, value-added products, and potato powder. The processing of potatoes is a major contributor to the food security of the world. The Indian potato processing industry has grown significantly as a result of growing urbanization and consumers' preference for quick, ready-to-eat foods, especially French fries, which are among the best-selling foods. India is the world's largest producer of potatoes, but only 7% of the crop is processed (in contrast to over 80% in industrialized nations). There may be room for further growth in the Indian potato processing industry



Potato semolina



Gluten free potato cookies



Potato flour



Potato muffins



Potato French fries



Potato chips

Value-added products developed from potatoes

given current global trends in shifting food consumption habits. India is producing more than 53 million tonnes of potatoes, ranking second only to China with a global production of 371 million metric tonnes. Additionally, India offers opportunities for the expansion of processed potato products, as the country's economic boom is expected to generate a strong demand for easy-to-eat snack foods.

The majority of the crop grown in India is grown for tables and seeds; processing is still in its infancy. Therefore, there is a lot of room for investment in India's potato processing sectors. Over the past 15 years, there has been a significant expansion in both the dehydrated potato flake and frozen French fry industries in India. The percentage of potatoes processed was only 3-4% in 2010, but with the establishment of additional processing facilities, the amount of potatoes processed has nearly doubled to 7-8%. One way to boost the entrepreneurial spirit and involvement of housewives from the smallest social sphere—the household—is to conduct a potato chip training program. This can empower potential housewives with plenty of free time and encourage women's independence. The practice of making potato chips can help housewives develop their skills, and it is anticipated that the training and exposure to this material will increase their understanding as well as spirit of entrepreneurship.

Export scope for potatoes and their products

India exported approximately 10,000 metric tonnes of dehydrated potato flakes to Malaysia, Indonesia, Thailand, the Philippines, and Vietnam in 2019. During the last decade, India's fresh potato exports increased dramatically. India entered the market in 1987 and is now Asia's third-largest exporter of fresh potatoes (table and

processing), trailing Iran, China, and Pakistan. Exports of fresh potatoes from India increased from 0.1 million metric tonnes in 2010 to 0.42 million metric tonnes in 2019 (FAOSTAT 2019), representing a 14% annual growth rate worth 76.6 million USD. There is a huge scope for export of potato mini-tubers for seed and value-added products related to potatoes.

SUMMARY

Despite the positive outcome, potato growers demonstrated a medium to high degree of entrepreneurial behaviour. Therefore, in order to encourage entrepreneurial behaviour among potato growers, it is necessary to improve specific knowledge and the adoption of value-added practices. CPRI, Shimla is also actively involved for the commercialization of innovative technologies related to potato industry. Licensing of the potatoes technologies by the ITMU unit of the institute is really helpful for establishment of new ventures to become the successful entrepreneurs in potato sector. In the ever-evolving world of today, the development of critical skill sets and the growth of entrepreneurship are increasingly important. In the seed industry, new opportunities can be made available to the jobless youth who are interested in ensuring the supply of high-quality mini-tubers or potato seed. In order for India to achieve its goal of becoming self-sufficient in food production and nutrition, potato processing may be crucial. In the upcoming decades, it will be profitable to expand the potato-based industry in India.

For further interaction, please write to:

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