

## India's untapped potential in hydroponics

*Payal Sachdeva and Akshay Kumar Chaudhry*

*Agriculture has always been the main occupation of people in India, and more than half of population is still employed in agriculture and related industries. However, contribution of the agricultural sector to India's GDP has been steadily declining over the years. The latest developments in technology and research in the field of hydroponics have been addressed in this note to show how it can provide an ideal solution to conventional farming insufficiency, and how Indian farmers can follow its implementation practices to improve their crop yield and income.*

Globally, there is a growing need to increase food production. By 2050, the global population is projected to reach approximately 15 billion people, with 66% of them living in urban areas<sup>1</sup>. Scientists and the general public are pushing towards resource conservation as the supply of fossil fuels and other resources such as water and clean air continues to dwindle. Hydroponics is one method of maximizing the use of available resources for productive agriculture. Thus, hydroponics may represent an important production system in regions characterized by water and land scarcity, and in urban agriculture<sup>2,3</sup>.

After the COVID-19 pandemic, people speak about their new standard, which includes masks and social distancing. It has also helped us reconnect with our families and roots. Growing your own greens, herbs and vegetables at home has become increasingly common. This is a hydroponic farming culture. Hydroponic farming is a modern form of horticulture or plant cultivation that does not include the use of soil. Crops are grown on water in this process, which are rich in important macronutrients like nitrogen, potassium, phosphorus, calcium nitrate and micronutrients like manganese, zinc, etc. The promise that what you do today will not endanger future generations has always been a buzzword used by hydroponics farmers. Clients were enthralled by the hydroponic culture and were interested in learning more about the nutrients, various hydroponic growing systems, plant care and pest management. A 'grow system' controls the balance of nutrition, humidity and temperature, uses less water than soil-based farming and increases yield without chemicals or pesticides. Thus, plants grown hydroponically are healthier and grow faster than those grown in the soil, since nutrients are delivered directly to their roots through water in the form of an aqueous solvent, rather than through the soil<sup>4</sup>.

Following the discovery of hydroponics, research on this technique has advanced rapidly. NASA, USA, has been experimenting with hydroponics for growing plants on long-term space missions in recent years. The programme is known as the 'Controlled Ecological Life Support System' (CELSS), and it has the potential to save astronauts' lives during long-term space missions. In 2007, an Arizona-based company sold approximately 250 million pounds of hydroponically grown tomatoes. Canada currently has hundreds of acres of farms that use hydroponics techniques, including hydroponic greenhouses. So far, they have had success growing peppers, tomatoes and cucumbers. Farmers in Punjab, India, were subjected under contract to grow potatoes, primarily using the technique of hydroponics. These examples are, however, few and far in between. Globally, we are marching ahead in this technology, but India has a lot of catching up to do. According to reports, the India hydroponics market is expected to grow at a compound annual growth rate of 13.53% during the period (2020–2027) (ref. 5).

The benefits of global adaptability are the driving force behind its widespread adoption. For example, compared to traditional farms, this method needs less labour and produces significantly higher yields. It is also possible to have several crop cycles in the same season. Hydroponics uses a fraction of the water used in traditional cropping systems, around 20%. One of the main advantages of hydroponics is that it can be used in a small room. Furthermore, since the ambient temperature is manually regulated, these plants are not affected by the weather outside. In a country like India, where agriculture is heavily dependent on the monsoon, this is a boon. Farmers who can grow crops out of season and provide consumers with more food and nutrition options reap a slew of benefits.

Since this method is not constrained by surface area, it is achieved by stacking plants vertically. Exotic herbs and condiments, for example, make this approach both practical and profitable. The approach is even more profitable in the age of organic farming and a fitness-conscious generation. These methods make farming a financially viable occupation and act as a motivator for not only established farmers, but also aspiring entrepreneurs. The cultivator would benefit not only from increased yields<sup>6</sup>, but also from the ability to tailor nutrient content plant by plant, thereby regulating the amount of produce generated per acre. Nutrients are redirected to the shoot rather than the root in this process, resulting in better quality produce. Since the roots do not take up much room, more crop can be produced in a given surface area than in farm cultivation. Furthermore, since the crops are grown indoors, they are less vulnerable to pest attack. This is particularly important given the frequency of locust attacks on India's west coast. Finally, seeds do not need to make their way through the soil mechanically. This allows for faster maturation and crop development.

While this technology has potential and is gaining popularity, the initial cost of establishing a hydroponics farm is significantly higher than conventional farming. To control the atmosphere and grow plants, one requires at least a building-like structure as well as food-grade plastic trays and tubes. Household kits cost about ₹ 8000, whereas large-scale farming requires a capital investment of ₹ 30–40 lakhs for 1–1.5 acres of land. Plumbing systems and automation, such as sensors, controls, water pumps and lighting all have high costs. There are additional criteria such as consulting fees, costs associated with maintaining ambient temperature, purifying water and producing artificial plant nutrition like nitrogen, potassium, calcium nitrate, phosphorus and other micronutrients like manganese, zinc, etc.

Although small plants such as herbs are easy to grow, heavy fruiting plants need more work and support. This is particularly important because hydroponic plants lack deep roots and are therefore unable to self-sustain. Another major concern is the farming community's lack of knowledge and understanding about all of these problems and technical advances. Technical expertise, to the point of micro-managing temperature and humidity, is needed. A single blip in the ambient temperature will result in significant crop loss. Many farmers are not even aware of hydroponics, let alone how to use it. When we consider that this technology is thriving primarily in the start-up sector of young, urban Indians, the phenomenon becomes even more evident.

The bulk of India's exotic fruits and vegetables is now imported. Although the Central Government is encouraging hydroponics as a viable option, we still have a long way to go before this technology is widely accepted.

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*Payal Sachdeva is in the Chitkara College of Applied Engineering, Chitkara University, Punjab 140 401, India; Akshay Kumar Chaudhry\* is in the Chitkara University Institute of Engineering and Technology, Chitkara University, Punjab 140 401, India. \*e-mail: akshay.chaudhary@chitkara.edu.in*