ISSN (Online): 2455-3662
EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal
Volume: 8| Issue: 11| November 2022|| Journal DOI: 10.36713/epra2013 || SJIF Impact Factor 2022: 8.205 || ISI Value: 1.188

HI-TECH VEGETABLE FARMING IN KERALA: BETWEEN PROSPECTS AND CHALLENGES

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Article DOI: https://doi.org/10.36713/epra11730
DOI No: 10.36713/epra11730

ABSTRACT

As a consumer-based economy, Kerala must rely on imports for a large portion of its food supply. The state frequently looks to its neighbouring states, Karnataka and Tamil Nadu, to meet its vegetable needs. However, chemical pesticide residue was found on most of the imported vegetables from these states. In 2009–10, the state began implementing high-tech vegetable farming in order to produce safe-to-eat products and to overcome various hurdles of conventional vegetable cultivation. In its early stages, the venture was wildly successful, rapidly expanding to all regions. By the following year, 2013-2014, growth in the number of newly established farms had slowed. The main reasons for the failure of the endeavour were the presence of pests and plant diseases, the decreased price of the products, the lack of sufficient support from the government, and the decrease in output caused by the accumulation of moss and dust on the roofing sheets.

KEY WORDS: ***High-tech farming, Vegetable Cultivation, Greenhouses, Polyhouses***

1. INTRODUCTION

Vegetables were first grown in the fertile soil close to early settlements. The ever-increasing human population necessitated novel approaches to vegetable cultivation, which were eventually developed in order to meet the resulting enormous demand. Though there are other methods, the most common is still growing crops in an open field with soil. In addition, urban agriculture has led to the development of container gardening to compensate for the lack of fertile soil in pots and polybags. Protected greenhouse (GH) or polyhouse vegetable farming has become increasingly popular in recent years around the world. When compared to open fields, vegetable production was greatly boosted by the GHs (Sanwal et al., 2004). Over 115 countries now use the GH method of vegetable cultivation (Sabir & Singh, 2013). Despite its initial use in 1980, it has never been put to any practical purpose outside of research laboratories in India. Later, in 2012–13, the technology was used on 58,000 hectares across 30 states and union territories. Chhattisgarh, Gujarat, Maharashtra, Madhya Pradesh, and Uttar Pradesh are among the leading states adopting this method of farming (Saravayya et al., 2014). Kerala has recently decided to implement a GH system, especially for vegetable cultivation, due to a lack of arable land and the prevalence of small land holdings (98% of holdings). Farmers were compelled to invest in GHs for vegetable farming due to the state's unique characteristics, including high input costs and a shortage of water and labour (Franco et al., 2018).

But the other unique aspects of the state necessitated the use of the GH system in vegetable cultivation. It is estimated that the state spends around Rs. 1500 crore annually on vegetable imports from its neighbouring states. In 2012, the state only produced 22% of the needed vegetables (Verma, 2016). The state's goal was to increase vegetable production from 2016's 6.5 lakh tonnes to 9.5 lakh tonnes by 2018 (The New Indian Express, April 7, 2018). The average daily consumption of vegetables by Keralites is less than the recommended dose by the Indian Council of Medical Research (The Hindu, February 08, 2010). Even with imports, each person in the state could get about 290 grams of vegetables every day. This was less than the 400 grams per day that the World Health Organization recommends (except for potatoes and other starchy tubers).

Open-field vegetable cultivation is not feasible on a large scale in the state due to the long duration of the rains (typically between June and November). As a result, the cost of vegetables goes up during the wetter months and down during the warmer summer months. Revenue for farmers was consistently low because of the cobweb phenomenon, or the

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inverse relationship between changes in output and changes in price. The only viable solution to the production and consumption issues is the greenhouse cultivation of vegetables. This article explores the potential and difficulties of growing vegetables using high-tech methods that shield crops from pests and severe weather.

2. RESEARCH PROBLEM

Vegetables are among the many necessities that the state of Kerala, a consumer market to the west of the Western Ghats, must import. The prolonged monsoon showers make it impossible to grow vegetables in open fields year-round. What's more, most of the imported vegetables from the neighbouring states had chemical pesticide residue. As a result, people are hesitant to consume enough vegetables to meet their nutritional needs. There are two major issues with vegetable production and consumption in the state. The first is that Kerala's unusual climate makes it impossible to grow vegetables year-round. The second is that people are not eating enough vegetables because they are concerned about possible chemical pesticide residues on imported vegetables. Therefore, experts have suggested greenhouse cultivation for protected vegetable growing, which simultaneously lessens the need for the use of harmful chemical pesticides and allows for year-round vegetable production. Greenhouse vegetable cultivation is common in many parts of the world and India, and in 2009-10, the state of Kerala introduced and promoted this method among farmers. After initially gaining traction, the method has since plateaued and begun to decline. Therefore, it's important to figure out what makes the state unique and what opportunities and challenges that brings for growing high-tech vegetable cultivation in greenhouses.

3. OBJECTIVES OF THE STUDY

1. To identify the factors which support greenhouse vegetable cultivation in the state of Kerala
2. To analyse the growth pattern of greenhouse vegetable cultivation in the state of Kerala.
3. To analyse the factors which create hurdles in the trajectory of greenhouse vegetable cultivation in the state of Kerala.

4. METHODOLOGY

The research in this article draws from a variety of sources, both primary and secondary. The secondary sources used to compile this analysis were written by a wide range of authors. The bulk of the primary information came from state agricultural departments. Inferences were drawn using tables, percentages, and ratios. Inferences were also drawn from a qualitative and descriptive analysis of greenhouse vegetable growers' experiences.

5. ANALYSIS AND DISCUSSION

Corresponding to the three objectives of this study the discussion is divided into three such as prospects, growth, and challenges of greenhouse vegetable farming in the state.

Prospects of GH vegetable cultivation

5.1. Deficiency in the production of vegetables: Government-owned vegetable procurement agency Kerala Horticultural Products Development Corporation (Horticorp.) estimates that the state requires about 30 lakh tonnes of vegetables annually. However, even with this, Kerala is still only able to meet 40% of its needs with its own agricultural output. Other 60% comes from nearby states (Suchithra, 2015). Vegetable self-sufficiency and year-round access to fresh, high-quality produce are two benefits that could accrue from a state's efforts to encourage vegetable farming and establish an effective marketing infrastructure. A major barrier to the commercialized production of vegetables in the state is the small and uneconomical holding size. Due to population concentration and consequent land use constraints, there is little room for further development. Implementing intensive and scientific farming practices that maximize output per acre could help alleviate the situation. Both are achievable because of the technological advancements in farming made possible by GHs. More can be produced per acre of land and harvesting can occur throughout the year with this method. As a result, growing vegetables in Kerala is best accomplished through the GH method.

5.2. Higher level of chemical pesticide residue in imported vegetables: As mentioned earlier Kerala state imports around 60 percent of its required vegetables from neighbouring states such as Tamil Nadu and Karnataka. According to a report published by the Kerala Agriculture University (KAU), between July 2019 and September 2019, pesticide residues were found in 15.67 percent of samples collected from the market. Out of 531 samples collected at random from various markets in the state, 83 contained pesticides. In another study, pesticide residues were found in 14.99 percent of vegetables and 29.16 percent of fruits ("Pesticide Residue in Fruits and Veggies Coming Down," 2020). Without the growing awareness of pesticides and fertilizers, the import of vegetables from Tamil Nadu would have continued uninterrupted with minimal testing of chemicals. Numerous studies have linked pesticides to the growing incidence of cancer and other diseases in Kerala. Dr. VP Gangadharan, a renowned oncologist, said high levels of pesticide residues can cause cancer in two ways. One is the direct effect that leads to gastrointestinal cancer. Second, the indirect effect of disrupting hormone levels on breast and cervical cancer in women. "Every third woman who comes in for cancer treatment has breast cancer," he said (Sanandakumar & Krishnakumar, 2015). The government of Kerala had sent a formal letter to the government of Tamil Nadu mentioning that the vegetables purchased from the state contain three to five times more pesticide residues than the permissible limit. A team of Kerala Food Security officials recently visited farms in nine districts of Tamil Nadu. This was in the backdrop of a campaign launched by the state against the sale of vegetables with high pesticide content imported from neighbouring states (Suchitra, 2015). However, 99 percent of the vegetables grown by Kerala farmers are safe to consume because they don't contain any harmful chemicals, according to findings based on tests done on samples taken from farmers'

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fields in several districts during the first half of 2014 (Mathew, 2015). Hi-tech farming under the protection of greenhouses insulates against pest attacks up to a greater extent. Consequently, the need for the application of chemical pesticides on crops was very rare. Even though its application is unavoidable in the early stage of plant growth, one can avoid it in the fruit-plucking stage. Therefore, most of the vegetable crops cultivated in greenhouses are "safe to eat" and fetch higher prices. Thus, GHs are helpful in ensuring farmers a regular income and safe food for consumers throughout the year.

5.3 Hard climate and fluctuation in production: The major rainy season in Kerala is the southwestern monsoon, which starts at the end of May or early June. There will be bursts of torrential rain in the next few months. Lying on the windward side of the Western Ghats, Kerala receives ample rainfall as it is the first state to be struck by the monsoon winds. Kerala's monsoons lead to almost 85 percent of the rainfall obtained in Kerala (*Kerala Climate*, n.d.). Subsequently, the northeast monsoon starts in October. This unique climate of approximately 6-month showers hinders open-field cultivation of vegetables throughout the year.

The total area under vegetable cultivation during 2018-19 was 41,809.11 hectares. It accounts for 4.42 percent of all food cropland. The total vegetable area decreased by 9.82 percent in 2018-19 when compared to the previous year (*Agricultural Statistics 2018-2019, 2020*). Except during periods of heavy rain, most of the vegetables consumed by Keralites in their daily dishes, such as drumstick, amaranth, bitter gourd, snake gourd, okra, brinjal, green chilly, bottle gourd, little gourd (Koval), ash gourd, pumpkin, cucumber, and cowpea, can be grown in the state. Though during the rainy season, vegetable cultivation was not rare in the state, it was not sufficient to meet the requirements of the people. Therefore, heavy imports were necessary to meet the demand. Consequently, vegetable prices usually shoot up during the rainy season. However, the implementation of the hi-tech system to cultivate vegetables solves the issue because it makes possible the cultivation of vegetables even during the rainy season in the protected environment of greenhouses. The mentioned three points indicate the necessity to adopt hi-tech farming methods in the vegetable production sector of Kerala. Similarly, the success of countries like Israel, which is facing adverse conditions in the world, in this activity also paved the way for the state of Kerala to test this technology. As a result, the state stepped into the sector in 2009-10 by launching a few initiatives in the Thrissur district.

6. GROWTH OF HI-TECH VEGETABLE FARMING IN KERALA

As mentioned, high-tech vegetable cultivation was started commercially in the Thrissur district by establishing 4 units in the year 2009–10 and then 6 more units in the following year. Gradually, it spread to other districts and reached its peak of growth in 2013-14 when it covered all districts of the state. Its growth structure is given in table 1. Although its growth was very slow in the early years, it accelerated in 2011-12 and reached its peak in 2013-14. But in subsequent years, there was a decline in the number of new ventures. This declining trend continued till the year 2016-17 and showed a revival in the following year. However, that growth was not sustained in subsequent years, and only 5 new ventures were started in the years 2019–20. According to the State Horticulture Mission (SHM), the agency to promote greenhouse or polyhouse farming in the state, there were 890 units that received subsidies for the establishment of hi-tech farms in the state. However, of those, 837 were individually identified. Idukki was the leading district with 112 farms, followed by Wayanad (107) and Ernakulam (97). Pathanamthitta has the fewest greenhouse vegetable farms (27) in Kerala, followed by Kasargode (30) and Kollam (32).

Table 1: Growth of hi-tech vegetable farms in Kerala since 2009-10

Sl no	Year	Number of units	Growth rate
1	2009-10	4	--
2	2010-11	6	50
3	2011-12	33	450
4	2012-13	129	290.91
5	2013-14	237	83.73
6	2014-15	176	-25.74
7	2015-16	86	-51.14
8	2016-17	37	-56.98
9	2017-18	84	127.03
10	2018-19	40	-52.39
11	2019-20	5	-87.5
	TOTAL	837	

Source: Various agricultural offices in the state

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Table 2 illustrates how greenhouses of various sizes are distributed in different districts. Medium-sized farms (200 to 500 sq. m) were the most visible in the state (55.2%), followed by small farms (25.4%). Greenhouses of all sizes can be found everywhere except in Palakkad and Pathanamthitta districts. There were no small greenhouses in these two districts. Large farms were located mostly in the Thiruvananthapuram district (33) followed by Wayanad (28) and Idukki (20). Medium-sized farms were mainly concentrated in Ernakulam, Idukki, and Thrissur districts, while small farms were in Wayanad, Idukki, and Thiruvananthapuram districts. Figure 1 shows the pattern of rising and falling in the number of various-sized greenhouse farms in the state. From this, it can be seen that the number of farms of all sizes increased and decreased almost uniformly during the period between 2009–10 and 2019–20.

Table 2: **Districts and size of greenhouse vegetable farms in Kerala**

		Size category			
Sl NO	**District**	**Large Farms (Above 500 sq. m)**	**Medium Farms (200 - 499 sq. m)**	**Small Farms (Below 200 sq. m)**	**Grand Total**
1	Alappuzha	11	15	9	35
2	Ernakulam	11	72	14	97
3	Idukki	20	64	28	112
4	Kannur	19	16	6	41
5	Kasargode	3	10	18	31
6	Kollam	8	22	1	31
7	Kottayam	6	25	16	47
8	Kozhikode	7	26	15	48
9	Malappuram	12	32	17	61
10	Palakkad	8	32	0	40
11	Pathanamthitta	2	25	0	27
12	Thiruvananthapuram	33	30	26	89
13	Thrissur	4	48	19	71
14	Wayanad	28	45	34	107
	Total	172	462	203	837
	Proportion	20.55	55.20	24.25	100.00

Source: Various agricultural offices in the state
Source: Various agricultural offices in the state

In the state, greenhouse vegetable cultivation began with a small number of farms but has since expanded rapidly. Nonetheless, only a small number of units have been initiated in the past few years, despite the substantial subsidy that is available. With this information in hand, it's easy to see why people would be wary of getting involved with this activity. This is likely attributable to the sector's low profitability, farmers' inability to handle the complexities of farming, or difficulties in marketing the product in comparison to open-field crops. Anyway, let's take a look at the most significant obstacles to growing greenhouse vegetables in the state.

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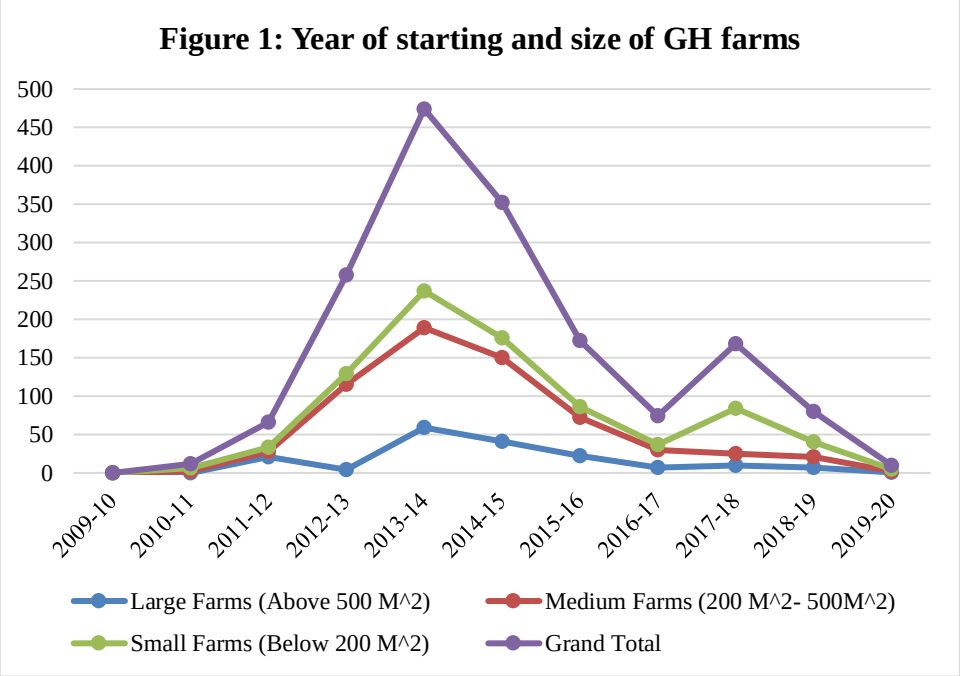

Source: Various agricultural offices in the state

7. CHALLENGES OF HI-TECH VEGETABLE FARMING IN KERALA

Although greenhouse vegetable cultivation has been proven to be feasible in Kerala, the sector is now facing many challenges. As a result of these challenges, the number of new start-ups in the state has been declining significantly since 2013-14. The following section analyses the prominent challenges faced by the GH vegetable farming sector in the state.

7.1 High cost of production: There are two types of costs commonly incurred for vegetable cultivation under GHs: the initial cost of construction and the recurring cost of cultivation. According to Greer L. and Steve Diver (2000), a commercial GH with a size of 30 ft. x 100 ft. with complete heating, cooling, and ventilation systems will cost between $10,000 to $30,000 to construct and equip. A low-cost GH of the same size can be constructed for as little as $500 to $1,500. Besides the initial construction cost, labour and energy are the two largest greenhouse expenses. Rs. 2,36,000 is required as a non-land capital investment for a 500 sq. m polyhouse. The average annual variable cost was Rs. For tomato cultivation, the cost was an average of Rs. 12,494 and the equivalent of capsicum was Rs. 16,334 (Murthy et al.,2009). Nalin Kumar estimated the cost of an approximately 400 sq. m polyhouse in Kerala in 2016. The total cost was Rs. 104485, which he divided into variable expenses of Rs. 69,760 and fixed expenses of Rs. 34725 (Kumar, 2018). Compared to open-field cultivation, greenhouse practice was more expensive. Therefore, despite high cash subsidies, a greater number of farmers are reluctant to switch to GH cultivation. It can be assumed that this is the main reason for the recent waning of this activity in the state.

7.2 Lack of regular market and low price for the product: The market potential of the product and remunerative prices are essential for the survival of any enterprise. However, as greenhouse farming is expensive and complex, it is important to ensure a secure market and higher prices for the produce. The requirement for pesticide application in GH is less than that of the open field, so it is reasonable to demand higher prices for the product. But because consumers can't tell the difference between GH products and other products, they only look at the price and prefer to buy cheap products that were sprayed with poisonous pesticides in open fields. A farmer from Thiruvananthapuram opined that the prices of most of the vegetables usually grown under GHs are not remunerative and, therefore, the farmers cannot sustain this farming practice. One of the main reasons why GH farmers often do not have easy access to the market is that they are not able to make their products available to the vendors regularly. This is due to the inadequacy of the farming methods the farmers follow. The entire part of a greenhouse is cultivated at the same time and then all of it is harvested at the same time. This leads to a situation where they do not have the product to market until the harvest of one season is over and the harvest of the next season begins. Consequently, vegetable merchants are reluctant to buy from them as they are not able to supply the products regularly. But, Mr. Joshi Joseph of Kattipara, Kozhikode, and Mr. Anil Kumar of Alappuzha, who followed the staggered planting method, succeeded in overcoming this crisis. If this method is followed by other farmers also, they will be able to supply continuously and can find a better market for their crops.

7.3 Insect attack and plant diseases: Many people believe that the GHs can shield crops from natural disasters, pests, and diseases. Successful implementations of the GH system in countries like the Netherlands, Israel, Spain, etc., have demonstrated this to be the case. However, farmers in Kerala report a different reality. The prevalence of plant diseases is

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exacerbated by the state's extreme temperature swings and high humidity, both of which farmers must contend with. Mr. Anilkumar claims that the saw tooth structure commonly used by farmers in Kerala leads to significant temperature swings in and out of greenhouses (GHs), whereas the gable-type structure is optimal because it minimizes such swings. While this is happening, pest infestations are increasing at an alarming rate. For various reasons, farmers must use pesticides. This significantly reduces the allure of GH farming.

7.4 Lack of timely support from experts and officials: Greenhouse farming is a highly technological method, so farmers need to be well-versed in it. However, in the implementation phase, having access to timely technical guidance is essential. Unfortunately, many regions have not provided farmers with any technical assistance beyond the mandate of the subsidy. This meant that the farmers' problems took longer to solve than necessary. In a conversation, Mr. Arish Babu, a GH farmer from Thrissur, revealed his bitter experience. In the first year he planted tomatoes, they flourished and grew well until they touched the roof. But, none of the tomato flowers survived long enough to develop into fruit before they withered and fell. The crop that year was a total loss, and he tried to get an explanation from the agricultural officers. He tried growing bananas there the next year, but they didn't do well either. The following year, he tried his hand at growing ginger there, and that was a huge success as well. It resulted in a substantial sum of money. The following year, however, was not as fruitful, and yields were significantly lower. Now his greenhouse is full of low-priced Robusta bananas he grew himself. Greenhouse farming has not only failed to turn a profit but has also led to a loss of investment funds. From a social cost and subsidy perspective, GH was a huge loss for this farmer. Further. he specified that the lack of technical support from the officials was the main reason for his loss.

7.5 Disposal of expired covering sheets and consumables: Disposal of polythene sheets, tags, ropes, and covers used for greenhouses after use is a major challenge for farmers. Roofing and side covering sheets last for a few years only. High rainfall and humidity in Kerala further reduce their duration compared to other regions. In addition, there were plastic tags, ropes, and covers used for each crop in recurrence. Farmers do not have any suitable strategy for the effective disposal of these materials at present. Dumping the sheets at the boundaries of the field or using them for mulching in the open field was a common practice among farmers. Burning tags, ropes, and covers were also not uncommon. All these methods are definitely a threat to the survival of the soil and nature. These shall be disposed of with the help of local self-governing bodies. In addition, tags, ropes, and covers must be made of eco-friendly materials like coir, paper, etc. Furthermore, the quality of the sheets used for roofing and side coverings must be improved.

7.6 Moss and Dust Clogging on Roofing Sheet: As mentioned earlier, the roofing sheets of greenhouses in Kerala have a short lifespan compared to other areas. The main reason for this was prolonged rainfall. Due to continuous rainfall, the sheet was covered with moss, and as a result, the proper penetration of sunlight was obstructed. This causes the production capacity to decrease significantly after the first few years. But greenhouses were not built in such a way that the moss could be easily cleaned properly. There are two ways to fix it, one is to remove the moss with the help of tools including a water jet, brushes, etc., and the other is to change the sheet. Either way, it requires high monetary costs. Mr. Hashim, a high-tech farmer from Aluva, estimates that cleaning the roofing sheet of a 400 sq. m greenhouse cost him around Rs 35,000.

8. CONCLUSION

Kerala is a state with great potential for hi-tech vegetable cultivation as the scope of conventional cultivation of vegetables in the open field has numerous constraints. Hi-tech cultivation of vegetables started in the state in the year 2009-10 in the Thrissur district. Subsequently, this system of cultivation extended to all districts of the state. Then, the sector made great progress until the year 2013–14. Then the sector experienced a declining trend in establishing new farms. The high cost of production, lack of regular market and low price of the product, infestation and plant diseases, lack of timely support from governmental agencies, lack of suitable strategy for the disposal of nonbiodegradable waste materials, and moss and dust clogging on roofing sheets were the prominent challenges of this endeavour in the state.

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Volume: 8| Issue: 11| November 2022|| Journal DOI: 10.36713/epra2013 || SJIF Impact Factor 2022: 8.205 || ISI Value: 1.188

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