

*Research Article*

A case study of organic protected cultivation at Tirunelveli district of Tamil Nadu, India

Foumy N Rafeeq*

Department of Social Sciences, Agricultural College and Research Institute, Tamil Nadu Agricultural University, Killikulam - 628252 (Tamil Nadu), India

Karthikeyan. C

Department of Social Sciences, Agricultural College and Research Institute, Tamil Nadu Agricultural University, Killikulam - 628252 (Tamil Nadu), India

*Corresponding author. Email: foumy101@gmail.com

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Abstract

Agripreneur is defined as an “entrepreneur whose main business is agriculture or agriculture-related”. The case study was conducted in the Tirunelveli district of Tamil Nadu. A discussion was made with the engineer cum Organic farming who was successful in organic farming for five years. He was practicing vertical gardening, terrace garden, aquaponics, hydroponics and aquaculture in an organic manner under protected cultivation in his farm at Tirunelveli. The need for research was to identify the extraordinary and unique farmer who was leading success in the field of organic farming. The objective of this case study was to bring out and narrate the facts which had been adopted to run the successful model for modern agriculture. The case study approach was made by preparing a semi-structured interview schedule, followed by the field visit, for collecting the data about the profile, skills, work experience, knowledge of the Agripreneur in agriculture and its allied sectors were identified and noted down. Thus, the study had been given a solution to efficiently utilize space and water by means of adopting terrace garden, hydroponics and aquaponics. The focus of the study was to highlight the effectiveness, adaptability and cost for other small farmers.

Keywords: Agripreneur, Terrace gardening, Organic vertical farming, Hydroponics and protected cultivation

INTRODUCTION

Agripreneur is defined as “entrepreneur whose main business is agriculture or agriculture-related” (De Tienne *et al.*, 2004). Entrepreneur or startups is a common term now in our day to day life. A large number of persons who had pursued engineering, agriculture or other bachelor’s degree are instituting their own business, but only a very few were on the path of attaining success or withholding their business after facing all the hardships. Generally, for becoming an entrepreneur, not only idea plays a significant role but also a strong courageous mind, risk bearing ability, confidence and also ability to face all the challenges and get out of those situations in a very easy way without tackling more into it is an important aspect.

There exists very important role of Entrepreneur to sparkle economic development by starting new busi-

nesses, creating jobs and which results in the increasing of gross domestic product (GDP) of the country and key some of the goals to increase the living standards of the people, skill development and community development. Usually, only an entrepreneur can bring new products and services to society and commercialize it. As we all know, agriculture is the backbone of the country and about 15.87 per cent (Ministry of Statistics and Programme Implementation, 2018-2019) of India’s GDP was from agriculture. So, when enterprises started in agriculture and its allied sectors, it can bring significant differences in life aspects.

The case is of an engineer becoming Entrepreneur, was 30 years old. He owned his own family business, so-called S.S. Nataraja Nadar & Co., since 1947, which consisted of hard wares, paints, floor mats, furnishings, and a cement company. He had completed a Bachelor of Engineering in Civil Engineering and passed out in

the year 2011. He was not interested in continuing his family business, so he started working as an assistant engineer in construction works and interior works, mainly in districts like Chennai, Madurai, Coimbatore and Tirunelveli.

Later after 2 years, he went to Kuwait, UAE and worked as a Senior Engineer till 2017. Further, due to family issues, he left Kuwait and came back to India. But he was not happy with what he was doing and started thinking beyond engineering more creative and innovative, making him energetic and peaceful. An engineer took a gap of one year in deciding and discussing his new business venture; thus, one of his childhood friend, an architect, suggested agriculture due to his immense interest in gardening and aquarium. As he was totally confused and worried about his future, the engineer started studying and gathering knowledge about agriculture and its varied aspects. His friend invited him to Bangalore and started learning more about horticulture, agriculture and allied sectors in detail. Nearly about 2 months, he stayed with his friend in the Indian Institute of Horticultural Research, Bangalore.

MATERIALS AND METHODS

A visit was made to the farm of an engineer at Tirunelveli in Tamil Nadu and the area where terrace gardening, hydroponics and aquaponics was carried out. He started a terrace garden in his house terrace in an area of 544 square feet by cultivating 14 kinds of vegetables like tomato, brinjal, bitter gourd, cucumber, squash, and lady's finger etc. and 10 kinds of fruits like banana, passion fruit, cherry, strawberry, kiwi, lemon, lime etc. He also implemented apiculture, where Indian bees (*Apis cera*) and stingless bees (*Meliponini sp.*) were produced. The purpose of apiculture or beekeeping was done only for the sake of pollination. Thus, he grew some alternative flowers like cosmos, daisies, zinnias because it was primarily used for apiculture and pollination, the reason behind introducing honey bees in his garden is that he covered his area using shade net to prevent the entry of insects and other pests such as ants, rats, birds or other creatures.

Further to maintain pollination, he reared honeybees and it is not reared for honey. Terrace garden was implemented in September 2017, but due to bad weather, the entrepreneur was not able to gain enough profit out of it. Later in 2018, he implemented aquaponics and hydroponics, which brought him remarkable changes in his garden.

His main aim was to practice fully organic without using a single drop of chemicals and without any water wastage. Hence he implemented drip irrigation in terrace farming, but it was not as successful as he thought and later, watering was carried out manually. Nearly about

six months, the Entrepreneur was not aware of the proper seasonal changes and sustainability of crops to that particular climatic conditions and varietal differences. Then he started referring to scientific articles, online portals, journals and took guidance from his friends. Later, he concluded and chosen proper variety depending upon the climatic conditions of Tirunelveli district. He utilized native seeds of indigenous varieties only. He adopted organic methods of cultivation without using any chemicals/ pesticides. He followed the principle of recycling waste as resources for integrating various enterprises in his farm. After successfully establishing a terrace garden, the Entrepreneur practised the Balcony garden, Open garden and poly house as well. Later on, in order to practice or try more innovative ideas, he established Hydroponics and Aquaponics along with a terrace garden so that some ideas and practice of engineering can also be experimented with in this new farming.

Hydroponics

The Entrepreneur successfully implemented hydroponics in his terrace garden, where he used soilless media like clay pellets, coco pit and vermin-culture. He grew vegetables like Radish, Tomato, Brinjal, Amaranths, and Spinach etc. The main reason behind introducing hydroponics was that he wanted to retain the soil fertility, which had leached out due to the uncontrolled use of chemical fertilizers and pesticide. He prepared the media to grow the plants by mixing coco-pit, charcoal, neem cake and vermiculture.

He was able to harvest a good yield of 700 kilograms of vegetables from hydroponics. It was attempted in a controlled atmospheric condition. Hence, the plants were free from diseases, insects, pests and some of the crops usually grown in the Tirunelveli belt had been grown and cultured successfully. At present, he utilized the terrace area of 3500 ft² available with his grandparent's houses for practicing the above-mentioned enterprises as follows.

Aquaculture

The Entrepreneur reared edible fish like Tilapia and ornamental fish like Koi. Tilapia was the gift variety native to Japan; he purchased it from the Thoothukudi fishery department and started culturing it on his farm. He grew 50 fishes per tank and had 3 tanks. It was fed with fish pellets by considering the bodyweight of the fishes, i.e., five per cent of the body weight was the amount or quantity of the feed given.

All the fish tanks were connected; usually, three tanks together formed a group. These tanks were connected with the help of tubes. The fish excreta consisted of 14 micronutrients and this nutritious source could be highly useful for plant growth. It was connected in the bottom of the tank, there another tank was connected, due to

the gravitational pull the water and waste were pulled into the other tank, wherein the 2nd tank a filter cotton cloth was dipped. The substrate got clogged with the filter cloth and again, the water further collected or drained into the 3rd tank where the water could filter with the pellets dipped in it.

The bacterial colony would form in the pellets where all the ammonia, both AOB (Ammonia Oxidizing Bacteria) and NOB (Nitrite Oxidizing Bacteria) colony were formed; these manures were then used for the plants and water got circulated back to the 1st tank thus even a single drop of water was not wasted, instead completely circulated and filtered with the help of the motor pump fitted in it. These motors worked for 24 hours and throughout the year. However, to maintain the motor life, the motor would be switched off for 3 hours per day to retain the motor's efficiency and capacity.

Aquaponics

The ornamental fish Koi, specifically Jinli, were colored varieties of Amur carp breed, which was a Japanese variety, kept for decorative purposes in outdoor koi ponds or water gardens were used in aquaponics (Kocher *et al.*, 2008). Koi fishes were bought from the Thoothukudi fishery department. Fifty fishes per group were kept in 3 such groups and reared. The plants like spinach, strawberry, lettuce, amaranthus, celery, mint and coriander were grown in the (Nutrient film Technique)NFT pipes, the water was circulated and filtered each sec and ran throughout the system so that the plants and fishes remained healthy and nourishable. The pellets were fed for the fishes and their excreta could be retained by the plant roots while circulating in the water, and for proper root, anchorage clay pellets were used in cups.

Only green leafy vegetables were advisable to grow in aquaponics. Horticultural crops like strawberry can also be grown. An Entrepreneur cultivated strawberry on an experimental basis and had a profitable yield of 800 kilograms per 3500 square feet area during December 2019.

The plants were kept in small plastic cups where 2 to 3 clay pellets were filled. These were used just for the root anchorage and retention of the plants with the aerated balls. He also cultivated medicinal plants, Ornamental plants and climbers, Succulents and cactus, and vertical gardening. It helped to reduce the carbon footprint of the building by filtering pollutants and carbon dioxide out of the air, which also purifies the quality of air.

Apiculture

As the garden was covered with shaded nets to prevent the external flies and factors, he decided to set up api-

culture or beekeeping of his own in his garden. He preferred Indian bee (*Apis cera sp.*) and stingless bees (*Melliponia sp.*) for pollination and maintaining the ecological balance inside the controlled atmosphere. Honey was not collected from the bees, but new combs, colony and boxes were well maintained.

Vertical garden

Vertical gardening was a special kind of urban gardening suitable to small spaces, particularly decorating the walls and roofs in various styles. This was an alternative method for gardening by expanding the scope of growing plants in a vertical space (Agritech portal, 2016). The construction of vertical gardens was recommended both in interiors and especially in the exterior of buildings. By applying these technologies, any area could be used at its maximum capacity, obtaining aesthetic value and benefits for the environment and human health. Even if the price of constructing and maintaining the vertical gardens was higher than a classical landscape, it was compensated by the environmental benefits, raising the vegetation surfaces, with impact for reducing the pollution effect.

The new modern concepts for landscape development were keen on using any kind of concrete or glass, turning them in real vertical gardens, being possible to overcome the development of the urban areas making a smooth transition for a healthy green urban environment. Green walls were not only spectacularly beautiful but were also helpful in enlivening the ambience. Green walls can absorb heated gas in the air, lower indoor and outdoor temperature, provide healthier indoor air quality and a more beautiful space.

Vertical garden modules is made up of recycled polypropylene material. It had an attractive look, highly durable in nature and could be easily installed. It provided an instant solution for making a garden in residing place. The best plants for vertical gardens were dense, compact and low growing. *Jade plant*, *Sedums*, *Portulaca*, *Asparagus spp.*, *Pileamicrophylla*, *Alternanthera*, *Mentha spp.* *Ficus spp.*, *Chlorophytum*, *Lantana* and all the succulents could also be grown. Usually, weightless media like coco-peat, perlite, sphagnum moss, vermiculite, vermicompost could be used with neutral pH. Watering was done using drip irrigation by connecting tubes around it.

Bonsai cultivation

Bonsai is the art of growing and training a plant to a miniature form having a natural look of old age. It involves the techniques of extreme dwarfing. The optimum size of bonsai must be only 30 to 60 cm in height, but a miniature size of below 25 cm was also preferred. Most commonly, *ficus sp*, *Sapota*, *Manilkhara*, *Tama-*

rind and many shrubs are being used. Under terrace gardening in protected cultivation, Entrepreneur dwarfed 5 *ficus sp*, and it showed a good withstanding capacity and nourishment.

A SWOT analysis was made to find out the strategic planning of the Agripreneur for the farming by fetching out the details about the strength, weakness, opportunity and threat of the Entrepreneur (Table 1).

RESULTS

Agripreneur

After developing all these varied areas, the Entrepreneur commercialized his business. The Entrepreneur had already done about 25 projects for 8 months after successfully gaining out of his new ventures. He was providing technical service in the establishment of terrace gardening and vertical gardening. He charged Rs.150 per square feet of the establishment. According to the customer’s preference, pairs of fish’s costs 50 rupees, plants like vegetables, fruits or ornamentals were chosen. He earned a monthly income of Rs.1,50,000.

He had 3 employers working under him and they were paid 12000 per month; after receiving a contrast, it hardly takes one week time for him to complete his work in starting days, but now the Entrepreneur could set up an area of 500 square feet in a day.

After implementing the set-up, he had provided 8 services free of cost and also he also provided organic

manures and a small honey bee box (preference of the customers). He also used to check ^{PH}, EC and TDS so that he could decide the plant preference according to the soil and water of the particular area. He utilized native seeds of indigenous varieties. He adopted organic methods of cultivation without using any chemicals/ pesticides. He followed the principle of recycling waste as resources for integrating various enterprises in his farm.

The Entrepreneur initially started his business from the profits gained out of his previous job. As the initial investment for aquaponics and hydroponics was high, he sought help from his parents and later could afford the expenses. The cost-benefit ratio for each unit established by the farmer was estimated using the following formula (Jennifer and Andrew 2005).

$$\text{Benefit-Cost ratio} = \frac{\text{PV of Benefits from the Project}}{\text{PV of the Cost of the Project}} \dots\text{Eq.1}$$

Where,

PV_{benefit} is the present value of benefit

PV_{cost} is the present value of cost

Further, the observations on economic aspects are recorded in table 2.

DISCUSSION

The study focuses on terrace farming in organic farming. The fruits and vegetables that grow in such an en-

Table 1. In-depth view of swot analysis of Entrepreneur.

1. Strength	<ul style="list-style-type: none"> • In the beginning, Entrepreneur’s family had no greater interest in his new enterprise. Later, due to his immense determination and interest, his family started supporting him in all ways, which was his greatest strength. • Self-confidence • Though the Entrepreneur faced loss and capability in this new venture, Mr. Chranjeevi Rajan persisted, thus understanding that he had a good risk bearing ability. • Indeed interest and determination • New knowledge-seeking mentality • Punctuality • Entrepreneur had three sincere and dedicated employees working under him. Thus Entrepreneur had a good leadership quality.
2. Weakness	<ul style="list-style-type: none"> • Not aware of the climatic changes • Seasonal problems • Lack of knowledge about the government schemes and policies.
3. Opportunity	<ul style="list-style-type: none"> • Retaining endangered species of plants and insects • Promoting agriculture and allied sectors • Brining greenery even in the urban areas • Providing employment to uneducated and illiterates • Inner happiness • Self-satisfaction
4. Threat	<ul style="list-style-type: none"> • Polluted water for use • A sudden outbreak of disease and spreading rapidly • Maintenance of aquaponics bears a greater risk factor.

vironment have a rich source of vitamins and nutrients when it was watered and taken care of regularly. Just basic knowledge concerning the water cycle and the amount of sunlight that was needed for each plant is enough to generate healthy produce.

As the world population is rapidly growing towards urbanization all over, it resulted in a decrease in land-holding capacity for growing different crops. Due to environmental changes, this was a need to adopt new cultivation techniques to protect the crops from some biotic and abiotic factors. Protected cultivation provided a favourable environment or growing conditions to the plants by providing optimum light, temperature, humidity, carbon dioxide, and circulated air suitable for better plant growth, heavy yield, and good quality fruits. It also ensured plant protection from various biotic and abiotic factors and reduced the crops' gestation period. Organic terrace farms provided nourishing fruits, vegetables, and leafy greens in-house with their flexible ability to be designed in any customizable manner. It probed further into people's personal lives and turned out to be a hobby that was willingly taken up by many as it proved to be a form of relaxation and self-discovery. Also, it was proven to have therapeutic value.

Reddy and Gowda (2014) worked out on experimentation to determine the impact of protected cultivation over flowering, fruit yield, and quality on the Red Lady cultivar of papaya. It was found that early flower initiation and bearing resulted in higher yield of papaya under protected cultivation. Under protected conditions, flowering started in 84.69 days and higher flowers count per plant (48.8%) and greater fruit setting (74.38%) was observed. This earliness in flowering and fruiting resulted in advanced maturity. Thus our Agripreneur was cultivating under the shaded nets and maintained honeybees for pollination inside the house. He observed an extreme change in flowering and fruiting after covered by sheets. Thus under protected cultivation of organic farming, the plants have shown greater yield with good quality inputs.

Thiripurasundari and Divya (2015) reported that organic farming improves the soil chemical properties such as supply and retention of soil nutrients and promotes

favorable chemical reactions, production of clean foods, improves the soil physical condition and properties such as granulation and good tilth, good aeration and easy root penetration, improves water holding capacity in sustaining production system which is largely dependent on on-farm resources. It helped in maintaining environmental health by reducing the level of pollution and ensured optimum utilization of natural resources and conserving them for future generations. In the present study, Entrepreneur had only used indigenous seed varieties and mostly used soilless media for farming so that the depleted soil particles could be retained later.

Prakash *et al.* (2020) has stated that polyhouse cultivation requires a high initial investment to promote cultivation, the government of India has launched a number of programs and schemes, but these are usually limited to a few farmers. This was the same situation for the Entrepreneur as he was unaware of the extent of benefits obtained from the government. Another major issue was the pests and disease control in the protected condition.

SWOT analysis (Table 1) indicated that the main strength of the Entrepreneur was his in-depth knowledge and interest to do agriculture in a very successful manner by taking it into other districts and states as well. But still, he lagged some knowledge about the government policies and schemes, also the extent of welfares that can be accrued from the government side. An entrepreneur could create the opportunity for greenery in the midst of urban life and thereby provide employment to the needy and bring back the extinct species of plants and animals. As the farming was in the town and terrace, the water availability was very low and water was polluted; thus, this happened to a major threat for the Entrepreneur.

Conclusion

Organic farming can play an important role in rural development by reinforcing the penchant for sustainable agriculture and its role in ecosystem conservation. Organic farming can provide quality food without adversely affecting the soil's health and the environment. There

Table 2. Economics of protected organic terrace gardening.

S. No.	Enterprises	Cost in Rs. (per square feet)	Benefit (in Rs. per square feet)	B/C ratio
1.	Vertical gardening	250	400	1.6
2.	Pair of Fishes	30	50	1.6
3.	Terrace Garden	70	150	2.1
4.	Hydroponics	250	700	2.8
5.	Aquaponics	200	550	2.75
6.	Bonsai cultivation	170	350	2

is a need to identify suitable crops/products on a regional basis for organic production with international market demands. The Entrepreneur had established his business in agriculture and gained a good profit out of it. He wanted to expand his commodities from Tirunelveli to other districts of Tamil Nadu and other Indian states and to varied customers. His motto was to promote agriculture and allied sectors, thereby bringing back all the exploited soil and environmental resources. His objective was to go completely organic without using a single drop of chemicals for any diseases or growth-related issues and retaining soil fertility. He had good support from his family even though they opposed in the initial days of implementing his enterprises. He was satisfied and happy with what he was practising. In this study, the Entrepreneur had given the opportunity to state their opinions, and he was able to explain the reasons while interviewing. He saw the social dynamics resulting from the conversation with like-minded farmers in such focus group discussions of qualitative analysis as beneficial to address this study's objectives. Nevertheless, there is a potential for a mixed-method approach, combining focus groups and structured quantitative methods suggested for upcoming studies.

Conflict of interest

The authors declare that they have no conflict of interest.

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