

Integrated vertical farming system

an innovative way of efficient utilization of small-land and farm resources in urban areas

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Vertical Farming is an innovative approach to produce good quantities of nutritious and quality fresh food all year round in small area, without relying on skilled labour and favourable weather or high water usage. The Vertical Farm is cheap to construct and safe to operate. If successfully implemented, they offer the promise of urban renewal, sustainable production of a safe and varied food supply. Unemployed youth of urban area can start earning through integrated vertical farms and supply nutritious and fresh food in their locality.

Key words: Farm resources, Integrated Vertical Farming System, Small land

BY 2050, nearly 80% of the earth's population will reside in urban centers. Applying the most conservative estimates to current demographic trends, the human population will increase by about 3 billion people during the interim. Additional land will be needed to grow enough food to feed, if traditional farming practices continue as they are practised now-a-days. At present, throughout the world, over 80% of the land that is suitable for raising crops is in use.

Vertical farming system

Vertical farming is a system of indoor farming which can be practised for producing food in vertically stacked layers, vertically inclined surfaces and/or integrated in other structures. The modern idea of vertical farming uses controlled-environment agriculture technology like utilization of artificial control of light, environmental control (humidity, temperature, gases etc.) and fertigation. Vertical farms come in different shapes and sizes, from simple two-level or wall-mounted systems to large warehouses type. Vertical farming is an innovative

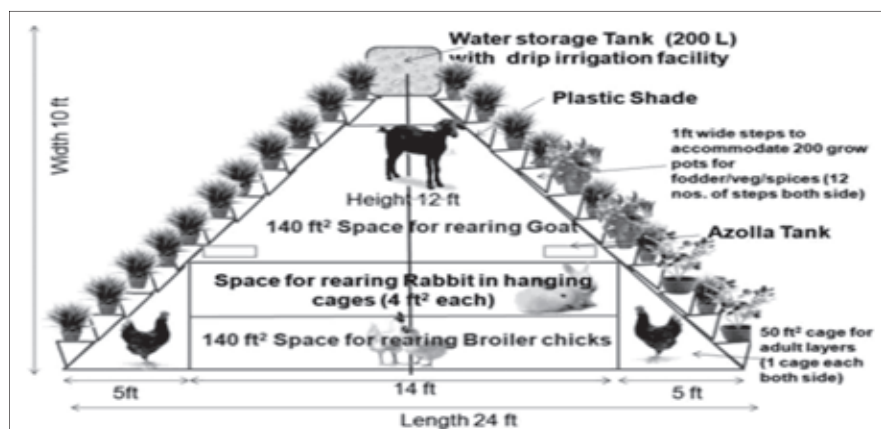


Fig. 1. Lay-out of integrated vertical farming system in Tripura, India

approach to produce good quantities of nutritious and quality fresh food all year round, without relying on skilled-labour, favourable weather, high soil fertility or high water usage. The vertical farm is cheap to construct, safe to operate and offer the promise of urban renewal, sustainable production of a varied food supply (year-round production), and the eventual repair of ecosystems that have been sacrificed for horizontal farming.

Among north-eastern Indian states Tripura is having high population density with high unit cost of land. Farming is becoming a costly venture

and state has to depend on the neighbouring states for meeting food requirements like vegetables, poultry products etc. In urban areas of Tripura, there is little scope of farming due to small-homestead area. To help the youth for income generation in urban areas, a prototype model on 'Vertical Farming System' was developed. The main objectives of system were: (i) subsidiary source of income, (ii) year-round food security and nutritional benefits, and (iii) maximum utilization of available family labour and creation of integrated business enterprise.



Fig. 2. Prototype model on "Vertical Farming System" developed in Tripura, India

Components and layout design

The structure of Integrated Vertical Farming System is triangular in shape with 7.2 m long, 3 m in width and 3.6 m high. The effective area of the structure is about 630 sq ft. with two floors and two galleries (Fig. 1). The ground floor accommodated two cages (50 sq ft each) at both corners wherein 100 layers were reared. The central space (140 sq ft) accommodated 200 bird broiler/layer chicks per batch. Eight goats were kept on the first floor (140 sq ft) area. Twelve rabbits were kept in hanging cages (4 sq ft each) in two rows, in front and back side. Proper drainage facility was provided in both side of structure to collect fodder/feed wastage and livestock excreta with storage facility where it was decomposed and used for manuring the pots.

Three *Azolla* tanks were set up above rabbit cages which were source of nutrient to the goat as well as poultry. Ten benches (30 cm each) was provided on both sides of the structure which accommodated 160 pots for growing small-fodder, vegetables and spices. A water tank of 400 liters capacity was also provided on top of structure for storing water

for animals and poultry and also providing irrigation to each pot through drip irrigation system. The prototype model on 'Vertical Farming System' is shown in Fig 2.

Production value and net income

Animal husbandry has become an important farm activity and provides additional income to throughout the year. As per the design of Integrated Vertical Farming System, 100 numbers of dual purposes (egg and meat both) breed of poultry ('Grampriya'), 200 numbers of growers (coloured broiler), and 12 numbers of rabbits ('Soviet chinchilla') and 8 numbers of goats ('Black Bengal') were integrated in this unit. Dual purpose poultry is very efficient in scavenging rural waste materials require minimum artificial feed and shows better survivability in local conditions. This goat is early-maturing, kidding occurs twice a year, give multiple births (2-3 numbers) and produce excellent quality meat production. Black Bengal goat can effectively survive on shrubs and trees leaves in low fertility lands.

Details of production and income generated under Integrated Vertical

Farming System are presented in Table 1. On an average, about 9,880 eggs and 220 kg of poultry meat were produced from 100 numbers of layers in one year. In case of grower poultry, 320 kg of meat were produced per batch. Altogether about 1,280 kg of poultry meat were produced by growers in 4 batches of one year. All eight female goats produced 28 kids (4 kids/year). Similarly, ten female rabbits produced 140 kits (12 to 14 kits/year). Further, 300 poultry and 8 goats produced about 3,600 kg of goat manures and 2,700 kg of chicken manure in one year. About 80% of manure was sold and only 20% were used for pot culture for growing vegetables and grass fodder.

Profitability of the Integrated Vertical Farming System (IVFS) was calculated covering each aspect viz. goat farming, poultry, and rabbit rearing takes one year. Each of unit is self-sustaining and profitable after 3 months of operation. The economics and farming details is given in Table 1. Integration of all the three components under Integrated Vertical Farming System generated total income of about ₹ 3.15 lakh/year from just 250 sq ft area with an annual expenditure of ₹ 1.30 lakh.

SUMMARY

An integrated approach of rearing animals and poultry along with fodder and daily uses of vegetables and spices gardening was adopted covering an area of 250 sq ft only. The system provides rearing of egg laying poultry, broiler, rabbits and goats. Pot cultures for growing small fodder for rabbits and daily uses of vegetables for household also be integrated. Unemployed youth of urban area can earn up to ₹ 1.85 lakh (net profit) with an annual expenditure of about ₹ 1.30 lakh. The construction cost of IVFS is about ₹ 1.50 lakh which can be recovered within 2 years of operation of Integrated Vertical Farming System.

Table 1. Components of vertical farming system and its economics in Tripura, India

Particulars	Components of Integrated Farming system			
	Goat Black Bengal	Poultry (Grower) Colour Broiler	Poultry (Layer) Grampriya	Rabbit Soviet Chinchilla
Space (ft ²)	14 x 10	14 x 10	50 x 2	12 x 3
Population	8	200	100	12
Duration (days)	365	90	365	365
Number of batches	1	4	1	1
Weight gain (kg/batch)	24	1.6	2.2	2.9
Production cost (₹/batch)	19200	64000	36000	8600
Net Profit (₹/yr)	37200	89600	39800	17800
Benefit : cost ratio	3.12	2.40	2.10	3.06

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