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HARVESTING GREENS: UNVEILING THE ECONOMICS OF TERRACE GARDENING

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ABSTRACT

Urbanization has led to people concentrate in and around cities which in turn is creating burden on food supplies from rural areas. People in cities usually have less control over the quality and availability of food compared to those living in rural areas. As a result, many city dwellers have started growing their own pesticide-free fruits and vegetables at home, using rooftops to meet their family's needs with little cost. In response to the global food crisis and rising prices, there is a growing focus on improving local food systems through terrace gardening, along with the need for research to assess its economic value and identify the most effective models for various conditions. Therefore, the present study was undertaken to work out the economics of terrace gardening. Data was collected using well-structured schedules through direct interview method. The results revealed that a cost in terrace garden includes initial investment cost and annual maintenance costs. The cost of cultivation of terrace garden under small, medium, large size terrace area were Rs 1627.98, Rs 2067.71, and Rs 2735.39 respectively. Net returns for small, medium, large, and pooled area were Rs 2498.51, Rs 3075.25, Rs 3447.11 and 3061.04 respectively. The returns per rupee expenditure for small, medium, large, and pooled terrace area were worked out to be 2.53, 2.48, 2.26 and 2.45 respectively. The findings from the study suggested that, as the green spaces are shrinking the government should integrate local food production in urban planning to promote more sustainable city development.

Key words: Urbanization, terrace gardening, sustainability, cost of cultivation, gross returns.

Introduction

Urbanization all around the world is an inevitable condition. By 2050, 68 per cent of the world population will live in urban areas. (World Urbanization Prospects, 2018). Cities today cover about 2–3 per cent of the total land area, consume nearly 75 per cent of the world's energy and generate 80 per cent of the CO₂ emissions (UN, 2018). Rapid urbanisation results in a scarcity of facilities like housing, food, water, sewage, and infrastructure, which lowers the quality of life for city dwellers. (Ramachandra, 2012). The UN has set Sustainable Development Goal 11 as its main objective to make cities and human settlements inclusive, safe, resilient, and sustainable, (UN, 2016). Similarly global population is increasing, but the global share of food producers is declining (FAO, 2017). Cities are increasingly

becoming more vulnerable to the effects of climate change. With the increasing population, massive urbanization there is increasing burden on rural agriculture to feed the urban population. To address all these issues, urban agriculture seems to be the probable solution to mitigate the impact on future generations.

Food and Agriculture Organization of the United Nations (FAO) defines urban agriculture as “Growing of plants and rising of animals within and around cities” to provide fresh food, generate employment, recycle waste, and to strengthen cities' resilience to climate change.

The Brundtland Report (1987) defines urban agriculture as one of the strategies for sustainable urban development, emphasizing its use in fresh food production, landscaping, and waste composting.

Table 1: Initial investment cost of establishing terrace garden.

Average size (sq. ft)	524	1012	1630	1018.65
Grow bags	212.00(3.61)	306.42(3.22)	918.75(7.00)	439.71(4.77)
Tubs	103.33(1.76)	211.00(2.24)	265.20(2.02)	190.16(2.06)
Containers from scrap dealers	198.33(3.38)	627.14(6.66)	826.04(6.29)	536.236(5.82)
Stands	295.00(5.03)	216.70(2.30)	503.10(3.83)	320.33(3.47)
Secateurs	44.00(0.75)	73.83(0.78)	77.50(0.59)	64.76(0.70)
Kurpi	50.33(0.85)	93.71(1.00)	153.50(1.16)	95.22(1.03)
Shade net	0(0.00)	311.00(3.34)	935.00(7.12)	367.84(3.40)
Soil	768.33(13.11)	2870.00(30.49)	4195.00(31.95)	2518.87(27.35)
Pots	704.17(12.02)	1232.10(13.09)	1438.50(10.95)	1109.83(12.05)
Rose can	153.00(2.61)	166.00(1.76)	174.00(1.32)	163.35(1.77)
Spraying equipment	198.67(3.40)	250.86(2.66)	267.08(2.03)	237.64(2.58)
Tank /PVC pipes	177.00(3.02)	305.00(3.24)	743.00(5.66)	379.77(4.12)
Materials provided by the government in kit.	2953.4(50.42)	2748.51(29.20)	2630(20.03)	2783.88(30.23)
TOTAL COST	5856.66(100)	9412.4(100)	13125.81(100)	9207.94(100)
COSTS (Rs/Sq. ft)	11.17	9.30	8.05	9.03

Urban agriculture has been practiced for thousands of years, starting around 3500 B.C. in Mesopotamia with small farming plots in cities, the Aztecs developed floating gardens, and in the 16th century, people in Machu Picchu grew vegetables using recycled water. By the 19th century, Germany introduced allotment gardening to provide children with access to nature. The concept of urban farming gained momentum after World War I when European countries struggled with food shortages. During the Great Depression (1929-1939), urban farming provided jobs and food for the unemployed. After World War II, the National Victory Garden Program was launched, and millions of Americans grew food, producing over 9 million pounds of produce.

Starting in the 1970s, the Community Garden Movement gained popularity in the late 1990s; the FAO (Food and Agriculture Organization) was officially tasked

with focusing on urban agriculture. In 2001, the FAO launched the “Food for the Cities” program to tackle the challenges of urbanization and help create sustainable food systems. In 2015, the United Nations included urban agriculture as part of its Sustainable Development Goal (SDG) 11, which aims to build sustainable and resilient cities.

The world’s population reached 8 billion in November 2022, with 56% (4.4 billion people) living in cities. This trend of urbanization is expected to continue, and by 2050, nearly 70% of the global population will live in urban areas. As urban populations grow, especially in developing countries, there is increasing pressure on food supplies in cities. People in urban areas often have less control over the quality and availability of food compared to those in rural areas. In response, many urban dwellers have started growing their own food on rooftops, backyards,

Table 2: Annual maintenance cost of terrace garden. (Rs/household).

Particulars	Small area (100-750 sq. ft)	Medium area (750-1500 sq. ft)	Large area (>1500sq.ft)	Pooled area
Average size (sq. ft)	524	1012	1630	1021
Labour cost	24.3(1.99)	26.10(1.82)	31.20(1.86)	27.00(1.90)
Seeds & saplings	117.00(9.57)	173.00(12.09)	221.80(13.21)	173.55(12.00)
Grow bags	109.50(8.95)	127.20(8.89)	181.23(10.79)	162.05(11.00)
Pots	95.89(7.84)	103.00(7.20)	123.56(7.36)	102.00(7.00)
Organic manures	577.66(47.23)	645.01(45.06)	728.99(43.40)	644.68(44.50)
Organic Pesticides (neem oil, onion garlic sprays etc.)	50.00(4.09)	59.10(4.13)	72.00(4.29)	52.00(3.60)
Ropes	61.30(5.01)	56.85(3.97)	53.60(3.19)	57.00(3.90)
Miscellaneous expenses *	187.33(15.32)	241.17(16.85)	267.20(15.91)	230.33(16.00)
Annual maintenance cost	1222.98(100)	1431.43(100)	1679.54(100)	1448.61(100)
Annual maintenance cost (Rs/ sq. ft)	2.33	1.41	1.03	1.41
Note: Figures in parentheses indicate the percentage. * Miscellaneous expenses include purchase of stacking material, compost bins, pheromone traps, sticky traps, purchases at garden meets, exhibitions etc.				

Table 3: Cost of cultivation of crops under terrace garden (Rs/household).

PARTICULARS	Small	Medium	Large	Pooled
Average size (sq. ft)	524	1012	1630	1021
A. Variable costs				
Labour cost	24.3(1.53)	26.10(1.29)	31.20(1.20)	27.00(1.31)
Seeds & saplings	117.00(7.39)	173.00(8.57)	221.80(8.56)	173.55(8.44)
Organic manures	783.02(49.43)	875.21(43.35)	1033.78(39.91)	908.73(44.17)
Organic pesticides	50.00(3.16)	59.10(2.93)	72.00(2.78)	52.00(2.53)
Ropes	61.30(3.87)	56.85(2.82)	53.60(2.07)	57.00(2.77)
Miscellaneous expenses	187.33(11.82)	241.17(11.95)	267.20(10.32)	230.33(11.20)
Interest on working capital (12 %)	56.8(3.59)	70.22(3.48)	90.14(3.48)	72.39(3.52)
Total (A)	1279.78(80.78)	1501.65(74.37)	1769.68(68.32)	1521.01(73.93)
B. Fixed costs				
Depreciation	235.47(14.86)	399.23(19.77)	629.31(24.30)	412.94(20.07)
Interest on fixed capital (10 %)	68.94(4.35)	118.10(5.85)	191.05(7.38)	123.34(6.00)
Total (B)	304.42(19.21)	517.34(25.62)	820.37(31.67)	536.28(26.06)
Total cost of cultivation (A +B)	1584.20 (100)	2019.00 (100)	2590.06(100)	2057.29(100)
COC (Rs/Sq. ft)	3.02	1.99	1.58	2.01

or vacant land, producing pesticide-free fruits and vegetables to meet their family's needs with minimal investment.

There are various types of urban farming which include, roof top or terrace gardens, backyard or kitchen gardens, hydroponics, vertical gardens, urban beekeeping, small scale animal husbandry, street landscaping, aquaculture, mushroom culture (Bhat and Paschapur, 2020). Unfortunately, indiscriminate use of chemicals and pesticides, the use of improperly treated waste water for the cultivation of vegetables is a bellyache for urban dwellers. Hence, they started growing fruits and vegetables on terraces. The concepts of terrace gardening has emerged as in urban areas.

A Terrace Garden is a garden in which vegetables, fruits, ornamental and medicinal plants are grown on terraces. It reduces the poverty and food insecurity arising from urbanization, at the same time improves the health of urbanites and preserving the environment (FAO, 2016).

During the Covid-19 pandemic, many urban residents faced mental health challenges from being confined to

their homes, leading them to incorporate plants into their living spaces for relaxation. As food insecurity worsened due to disruptions in the supply chain and labor shortages, many people began growing leafy greens and vegetables on their terraces. This shift towards terrace gardening has gained popularity, providing urban dwellers with fresh, chemical-free produce at minimal cost. Therefore, the present study was undertaken to work out the economics of terrace gardening.

Materials and Methods

The study was conducted in Hyderabad, where terrace gardening is widely practiced. The city, divided into six zones, has trained 33,576 households through a government initiative since 2012. Random sampling of 15 households from each zone, totaling 90, was used to represent urban households engaged in terrace gardening. The selected households practicing terrace gardening were classified based on the area under terrace gardening. It was found that the minimum area required for terrace gardening was 100 sq. ft and maximum area of my sample respondents was 1850 sq. ft. Accordingly, the selected households were classified into three categories namely small (100- 750 sq. ft.), medium (750-1500 sq. ft.) and large (>1500 sq. ft.). The required primary data about the cost incurred for establishment and maintenance of terrace garden was collected from the sample households. The details were collected using well-structured and pre-tested schedules through direct interview method.

Concepts and terms used in the study

- Investment cost:** The investment cost in terrace gardening consists of cost of shade nets sheets, tanks, pots, purchase of soil, and other

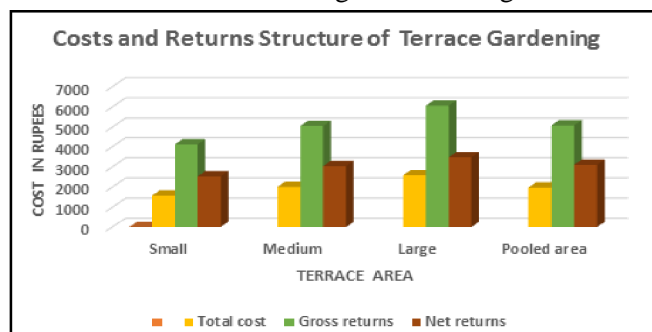
**Fig. 1:** Cost and returns structure of terrace gardening.

Table 4: Yield of the crop.

Type of crops	Yield from 100-750 sq. ft area			Yield from 750-1500 sq. ft area			Yield from > 1500sq.ft area			Pooled area			
Vegetables in Kg	AQ	P	TV	AQ	P	TV	AQ	P	TV	AQ	P	TV	
Tomato	10.65	28.5	303.525	12.78	28.5	364.23	19.53	28.5	556.605	13.62	28.5	388.17	
Cherry tomato	7.71	160	1233.6	9.87	160	1579.2	12.06	160	1929.6	9.6	160	1536	
Brinjal	11.04	31	342.24	15.3	31	474.3	18.03	31	558.93	15.72	31	487.32	
Chillies	4.65	28	130.2	8.16	28	228.48	9.27	28	259.56	7.89	28	220.92	
Capsicum	8.67	34	294.78	10.32	34	350.88	12.18	34	414.12	10.71	34	364.14	
Bhendi	8.73	35	305.55	11.43	35	400.05	12.51	35	437.85	10.95	35	383.25	
Beans	9.66	54	521.64	12.03	54	649.62	15.69	54	847.26	12.63	54	682.02	
Gourds	16.92	38	642.96	18.15	38	689.7	19.41	38	737.58	18.39	38	698.82	
Leafy greens in bundles*													
Curry leaves	21		70	24		80	24		80	24		80	
Spinach	21		52.5	24		60	27		67.5	24		60	
Amaranthus	21		52.5	21		52.5	24		60	21		52.5	
Rosella	18		36	21		42	24		48	21		42	
Ponnaganti	18		36	21		42	24		48	21		42	
Coriander	18		60	21		70	21		70	21		70	
Mint	18		45	24		60	27		67.5	24		60	
Total returns per year (Rs)			4126.49			5142.96			6182.50			5167.14	
Total returns (Rs/sq. ft)			5.87			5.08			3.79			5.06	
AQ: Avg Qty(in Kg); P: Price/kg; TV: T. Value(Rs)													

gardening tools and implements etc., at the time of establishment of garden.

- b. Maintenance cost:** The maintenance cost includes cost of seeds and saplings, FYM, compost, vermicompost, manures and pesticides, labour charges, etc. per annum.
- c. Fixed costs:** Fixed costs include depreciation, interest on fixed capital.
- d. Variable costs:** Variable costs include expenditure on labour, expenditure on inputs such as seeds and saplings, manures, and pesticides etc.
- e. Cost of cultivation:** The total cost of cultivation vegetables in terrace gardening includes annual maintenance costs and fixed costs. Annual maintenance costs include cost of human labour, seeds, etc and fixed costs include depreciation interest on fixed capital, on the initial investment costs. All these costs together arrive at total costs.
- f. Depreciation:** Depreciation for fixed capital items such as gardening tools and implements used in terrace gardening are calculated. Depreciation was computed by diminishing balance method
- g. Interest on working capital:** The interest on working capital was calculated at rate of twelve per cent.

h. Interest on fixed capital: It is calculated at rate of ten per cent per annum on fixed capital.

i. Output and returns: It included physical output and monetary returns obtained from terrace gardening. The physical output realized was multiplied with per unit market price to arrive at the monetary returns. The returns are calculated for every cycle (3 cycles per year) based on the quantity of produce harvested. The returns are estimated with formula

- For vegetables and gourds
= quantity of produce yielded (Kg) × market price of the produce/Kg
- For leafy vegetables
= quantity of produce yielded (bundles)X market price of the Bundles

Market price is the annual average price of each vegetable for twelve months. The returns per cycle are summed together (for whole year) to calculate income generated through terrace gardening annually.

- j. Gross returns:** It is the total produce yielded according to the market price of respective crops.
- k. Net returns:** Net returns are obtained after deducting the total cost of terrace garden from gross returns

Table 5: Returns from the terrace gardening.

Type of crops	Yield from 100-750 sq. ft area			Yield from 750-1500 sq. ft area			Yield from > 1500sq.ft area			Pooled area			
Vegetables in Kg	AQ	P	TV	AQ	P	TV	AQ	P	TV	AQ	P	TV	
Tomato	10.65	28.5	303.525	12.78	28.5	364.23	19.53	28.5	556.605	13.62	28.5	388.17	
Cherry tomato	7.71	160	1233.6	9.87	160	1579.2	12.06	160	1929.6	9.6	160	1536	
Brinjal	11.04	31	342.24	15.3	31	474.3	18.03	31	558.93	15.72	31	487.32	
Chillies	4.65	28	130.2	8.16	28	228.48	9.27	28	259.56	7.89	28	220.92	
Capsicum	8.67	34	294.78	10.32	34	350.88	12.18	34	414.12	10.71	34	364.14	
Bhendi	8.73	35	305.55	11.43	35	400.05	12.51	35	437.85	10.95	35	383.25	
Beans	9.66	54	521.64	12.03	54	649.62	15.69	54	847.26	12.63	54	682.02	
Gourds	16.92	38	642.96	18.15	38	689.7	19.41	38	737.58	18.39	38	698.82	
Leafy greens in bundles*													
Curry leaves	21		70	24		80	24		80	24		80	
Spinach	21		52.5	24		60	27		67.5	24		60	
Amaranthus	21		52.5	21		52.5	24		60	21		52.5	
Rosella	18		36	21		42	24		48	21		42	
Ponnaganti	18		36	21		42	24		48	21		42	
Coriander	18		60	21		70	21		70	21		70	
Mint	18		45	24		60	27		67.5	24		60	
Total returns per year (Rs)			4126.49			5142.96			6182.50			5167.14	
Total returns (Rs/sq. ft)			5.87			5.08			3.79			5.06	
AQ: Avg Qty(in Kg); P: Price/kg; TV: T. Value(Rs)													

Results and Discussion

Initial investment cost of establishing terrace garden

The initial cost of setting up a terrace garden includes expenses for soil, grow bags, tubs, stands, and gardening tools (Table 1). For small gardens (100-750 sq. ft), the average cost per household was Rs 5856.66, for medium gardens (750-1500 sq. ft) it was Rs 9412.4, and for large gardens (over 1500 sq. ft), it was Rs 13125.81. On average, the cost for all households combined was Rs 9207.48. The costs increased with the size of the garden. Initially, households with smaller gardens spent less because they used only the items provided in the training kit, while larger gardens required additional inputs, leading to higher costs. These findings are similar to those of Devi (2017).

In the case of small, medium, large and pooled terrace garden, major cost was incurred for purchase terrace garden kit (50.42 %) from government, purchase of soil (30.49%), purchase of soil (31.91%) and purchase of kit from the government (30.23%) respectively.

Thus, it can be concluded that average cost of kit, soil and pots constituted the major costs and accounted for 75.55 percent, 72.78 per cent and 62.93 percent of total investment cost for small, medium, and large terrace households and same for pooled households found to be 70 per cent of total investment costs.

Annual maintenance cost of terrace garden. (Rs/ household)

Maintenance costs cover expenses for seeds, saplings (for some crops), grow bags, pots, neem cake, seaweed, bone meal, and plant protection chemicals (Table 2). For small gardens, the average maintenance cost per household was Rs 1222.98, for medium gardens it was Rs 1431.43, and for large gardens it was Rs 1679.54. The overall average cost for all households was Rs 1448.61. The maintenance cost increased with the size of the terrace garden. In the case of small, medium, large and pooled terrace garden, major cost was incurred for purchase of manures 36.36 per cent, 32.63 per cent, 31.13 per cent, 32.85 per cent respectively.

Manure and labor make up the largest portion of annual maintenance costs, accounting for 54.83%, 50.57%, and 53.45% of the costs for small, medium, and large terrace gardens, respectively, with a combined average of 52.03% for all households. Many respondents reported a decrease in maintenance costs over time, as they shifted from buying inputs to composting kitchen waste and collecting manure from local sources. With experience, they also learned better practices and found ways to purchase higher-quality inputs at lower prices, further reducing costs.

Cost of cultivation of crops under terrace garden (Rs/household)

The profitability of any business is determined by its

Table 6: Cost and returns structure of terrace gardening.

Particulars	100-750 sq. ft. area	750-1500sq. ft. area	> 1500 sq. ft. area	Pooled
Average size (sq. ft)	524	1012	1630	1021
Total cost	1584.20	2019.00	2590.05	1984.89
Gross returns	4126.49	5142.96	6182.50	5167.14
Net returns	2542.29	3123.96	3592.45	3182.25
Returns per rupee expenditure	2.60	2.54	2.38	2.60

costs and returns, which are typically divided into fixed and variable costs. Fixed costs include depreciation and interest on capital, while variable costs cover expenses like seeds, pots, organic manure, and interest on working capital, with costs calculated for terrace gardens of different sizes. Details regarding cost of cultivation is presented in Table 3.

The average cost of cultivating a terrace garden per household was Rs 1584.20 for small gardens, Rs 2019.00 for medium gardens, Rs 2590.06 for large gardens, and Rs 2057.29 for all households combined. The variable costs for small, medium, and large gardens were Rs 1279.78, Rs 1501.65, and Rs 1769.68, respectively, with a combined variable cost of Rs 1521.01. Variable costs made up a large portion of total costs, ranging from 70% to 81%, depending on garden size. Fixed costs for small, medium, and large gardens were Rs 304.42, Rs 517.34, and Rs 820.37, respectively, with a combined fixed cost of Rs 536.28, which increased as the garden size grew.

In the case of small, medium, large and pooled terrace garden, major cost was incurred for purchase of manures. Variable costs made up the largest portion of total costs and increased as the terrace area grew. Similarly, fixed costs also went up with the size of the terrace. As a result, the overall cost of cultivation increased with a larger terrace area.

Yield of the crops

The yields of various vegetables and leafy greens were calculated per cycle (3 months) and annualized. The highest yields were recorded for crops like tomato (6.51 kg), gourd (6.47 kg), and brinjal (6.01 kg). As the terrace area increases, more number of plants can be accommodated, leading to higher yields. For tomatoes, yields ranged from 3.55 kg in small gardens to 6.51 kg in large gardens, with an average of 4.54 kg in pooled gardens. Brinjal yield ranged from 3.68 kg in small gardens to 6.01 kg in large ones, with an average of 5.24 kg in pooled gardens. Gourd yields ranged from 5.64 kg in small gardens to 6.47 kg in large ones, while bean yields ranged from 3.22 kg in small gardens to 4.49 kg in large ones, with a pooled average of 4.21 kg. Leafy greens yields were similar across gardens, with small gardens producing around 6-7 bundles and large ones 8-9 bundles. These

results align with the findings of Krishnan (2014). The yields presented are averages, so there may be slight variations depending on the gardening practices followed and seasonal changes in temperature.

Returns from the terrace gardening

The prices of vegetables and leafy greens vary depending on the location and market timing. The average market prices for the year were used to calculate the value of the produce. Leafy vegetables are usually sold in bundles, with prices such as Rs 10 for 4 bundles of spinach, amaranths, and mint, Rs 10 for 5 bundles of Rosella, ponnaganti, and Rs 10 for 3 bundles of curry leaves or coriander. The returns from terrace gardening for small, medium, large, and pooled gardens were Rs 4126.49, Rs 5142.96, Rs 6182.50, and Rs 5167.14, respectively. Since the households were growing tomatoes, cherry tomatoes, brinjal, and leafy vegetables year-round, they no longer needed to buy leafy vegetables from the market, as they had enough for their own consumption. With daily access to fresh vegetables from their terrace gardens, respondents were able to save money of Rs 4126.49 from small gardens, Rs 5142.96 from medium, Rs 6182.50 from large, and Rs 5167.14 from pooled gardens.

Cost and returns structure of terrace gardening

The average total cost for terrace gardening was Rs 1584.20 for small, Rs 2019.00 for medium, and Rs 2590.05 for large gardens, with pooled households averaging Rs 1984.89. Gross returns for these households were Rs 4126.49, Rs 5142.96, and Rs 6182.50, respectively, and net returns were Rs 2542.29, Rs 3123.96, and Rs 3592.45, with a return of 2.60, 2.54, and 2.38 per rupee spent for small, medium, and large gardens, respectively, and 2.60 for pooled households. These findings are consistent with those of Naveena and Sahana (2017).

Conclusion

The initial investment costs for small, medium, large, and pooled terrace gardens were Rs 5856.66, Rs 9412.4, Rs 13125.81, and Rs 9207.94, respectively. The annual maintenance costs for these gardens were Rs 1470.25, Rs 1712.68, Rs 2122.28, and Rs 1759.17, respectively. Total costs consist of fixed and variable costs, with

variable costs making up the majority of the expenses. Fixed costs accounted for 18.70%, 25.02%, 29.99%, and 25.46% of the total costs for small, medium, large, and pooled areas, respectively. Meanwhile, variable costs made up 81.30%, 74.98%, 70.01%, and 74.54% of the total costs for small, medium, large, and pooled areas, respectively. Among the variable costs, the highest expenditure was on purchasing manures, which accounted for 32.84%, 27.04%, 24.16%, and 27.44% of the total variable costs for small, medium, large, and pooled areas, respectively.

Depreciation made up the largest portion of fixed costs in small, medium, large, and pooled terrace gardens, accounting for 14.46%, 19.31%, 23.01%, and 19.61%, respectively. The gross returns per year from small, medium, large, and pooled gardens were Rs 4126.49, Rs 5142.96, Rs 6182.50, and Rs 5167.14, respectively. Net returns for the same categories were Rs 2542.29, Rs 3123.96, Rs 3592.45, and Rs 3182.25 per year. Both gross and net returns increased with the size of the terrace area. Returns per rupee spent were 2.60, 2.54, 2.38, and 2.36 for small, medium, large, and pooled areas, respectively.

Declaration

As per international standard or university standard, respondents' written consent has been collected and preserved by the author(s). Authors have declared that no competing interests exist.

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