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Rooftop Farming: Emerging Establishment of Environmental Sustainability: A Study from the Smart City of Bhubaneswar, India.

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Abstract

In present practice and challenge for the urban people to produce food from their own roof, balcony, terrace. Rooftop agriculture promotes long run urban environmental sustainability. Rooftop farming plays a significant role in pandemic. Main objective of this study is environmental sustainability on rooftop farming. The Soilless culture hydroponics, organic farming and aeroponics, Tissue culture, Media culture cultivates rooftop farming. How to conserve endangered plants in rooftop farming? How to benefit from practices on rooftop gardens in micro-culture methods? How to reuse household waste in rooftop farming? How to check air pollution through rooftop farming? How to reduce excess use of pesticide and chemical fertilizers and its effects on the environment, Flora and fauna? The data is collected from door to door meet and open field survey of rooftop gardeners, Stakeholders, participants, researchers, Technicians, educators and local gardeners and non-gardeners. Open handed semi structured questionnaires form participants. The primary data are collected directly from urban people who are involved and not involved in rooftop gardens. The field experiment for preparation of soilless culture media, compost by recycling of vegetable peels, Bio-fertilizers. The result is gathered by different practitioner's opportunities, methods, constraints and findings. The urban has also realized that to combat increased air pollution in urban environments. The green cover of plants needs to be increased. The plants are known to escape the ill effect of air pollutants besides providing an insulating effect

of temperature. The rooftop gardens offer and adopt these challenging circumstances. The rooftop garden has the following opportunities that are easy to cultivate a fearless environment. The growth of urban population and change of consumer's perception of the rooftop garden play an important role for economic as well as ecological benefits. Rooftops garden thus ages in cooling effect the down area interesting singly these gardens help midrates noise as a wall. The combination of plants and social absorption reflect and deflate sound waves and provide a building with considerable noise reduction. Vertical gardening to gardening of the risers balconies or window sills, hydroponics, aeroponics, gardening in self watering buckets bags sacks, creates, boxes, pots, gruels, gardening edible gardens act are all different inactivates taken to alleviate hunger and multinational problems, recent innovation in urban technology promote space and waste management. Environmental pollution happened due to rapid urbanization and industrialization of urban areas. The benefits of rooftop gardens are environmental benefits, providing a conventional green roof, making roof cooling systems and water management systems. In some cases availability of responses will not compensate for the effects of harsher climates and water scarcity. Increases in the intensity of conflicts between agriculture and the natural environment may also limit the extent to which adaptation is possible. This necessitates appropriate framing practices which minimize pollution of the surrounding environment. All levels of people can cultivate on the rooftop. Conservation of endangered plants, nursery, control of environmental pollution, ecosystem service, these are the important opportunities of rooftop farming. A wide variety of new approaches have been developed for effective and urban methods of urban waste utilization in vegetable cultivation and adoption of appropriate water management systems Including use of water from urban liquid wastes. Rooftop farming lung runs strategies of urban sustainability.

Keywords-: Bio-fertilizer, Environmental sustainability, Organic farming, Rooftop Farming, Water management, Waste management.

Introduction

Today on this planet the life of urban areas suffers this Urban and peri-urban cultivation can be defined as agriculture that occurred within the surrounding blunderings of cities throughout the world and includes products from crop and livestock agriculture. It also includes production as well as ecological service. Increasing urbanization has brought holders of rural population to cities causing increase in fresh food product and sub basement increase in prices of consumables, Ackerman (2011). There is also an increase in concerns about the detrimental effect of residual pesticides on fresh fruits and vegetables. Urban areas have necessitated the effect by city dwellers to create facilities to grow vegetables in their homes. Colon, Martizen and Gabarrel (2010) The low water preparation and use of proper growth media use of garden tools choice of lighter grows-bags soil less cultivation. The kitchen wastes and household garbage converted to bio-compost for growing plants, Allen (2003). Household solid waste management is one of the serious problems of urban areas.

Study Area

Bhubaneswar [20.27^0N 85.84^0 E] is a smart city of Odisha, country India. It is a smart city and also called as temple city and capital of state odisha due to the India declared smart city the smart farming is growing on the rooftop farming is one of the interesting cultivation in Bhubaneswar city of India. Bhubaneswar is a densely populated city of India. It contains a large space of roof and the people of Bhubaneswar are very much interested in cultivating rooftop, terrace and balcony farming. We chose Bhubaneswar as a research area because rooftop farming plays an important role in food security and environmental sustainability in Bhubaneswar.

Materials and Methods

The research is done on the basis of survey and data collected from urban people who cultivate rooftop gardens in Bhubaneswar. Research method of this article is on the basis of a survey, by the following practitioner in Bhubaneswar. The survey report and questionnaire have provided following information. The primary data collected from the doorstep of a practitioner and the secondary data collected from Internet, Association, journal, urban people, researcher, Scientists. The data is collected in two ways: primary data collected directly from door to door meet and field survey of rooftop gardeners in different localities of Bhubaneswar. The survey report was collected through questionnaires and observations. It has provided the following primary information. The primary data collected from the doorstep of practitioners. Exclusive data collected by direct interviews of gardeners and non-gardeners. How to cultivate organic farming. How to prepare organic compost using household garbage. What are the constraints of rooftop gardens? How to manage used water in irrigation in rooftop gardens. How to perception of the traditional methods of cultivation. The needs of selection of containers and seeds. Output of vegetable and vegetable garbage from kitchen daily wise and others. All data are collected from structured and semi structured questionnaires with participants. The secondary data collected from the Internet, Association, journal, urban people, researcher, Scientists. The rooftop garden has the following opportunity that are easy to cultivate, fearless and security environment, less water scarcity, use of dewed water, rain water and pipe water organic way of technical cultivation, Dublling (2011) labourless cultivation, more diversified cultivation in small area, Soilless cultivation, container garden, obtain fresh food, Suraj, Manohar et.al.(2019) Collection of secondary data is online (virtual) mode due to covid-19 pandemic. Shakeholder Maheshwar Khilar and Arunika Mohapatra,at sahid nagar, Bhubaneswar, He is preparing organic liquid media using on roofto gardens. Its local name Amrut ras. Practitioner named Kenee Mohapatra, Amar puri plot no-245 lewis road Bhubaneswar-751014, She make compost from kitchen bio-waste. Practitioner named Pritidhara Samantaray and his husband Dilip Samantaray, Gajpati nagar, Bhubaneswer-751015.He cultivate vegetable, around 40 types of vegetables are cultivated within his rooftop garden in containers. Water management is performed on the rooftop farming. Radhamohan Samantaray and Mamuni Samantray, Nayapali, Bhubaneswar. He cultivates and makes a Rooftop nursery

Methods

This method of study both experimental field study and survey. The temperature is measured by digital thermometer in daily wise in maximum temperature during days and analyzed. The requirement of material for composting raw materials vegetable peels and biodegradable substances from home. The secondary substrates can be used for composting such as cow dung, Molasses, cow urine, leaves etc. equipment used for preparation of compost are normal soil, cow dung, containers which are made of plastic, mud, cements and concrete. Mixture of bio-waste with soil from the kitchen is put in the contenders for 15 days to 30 days, Bendt and Barthel (2013). Supply of water interval of time as per required. Proper aeration is facilitated for it. This is the traditional technique compost preparation. This compost is used and recycles of house hold and gardens waste. The Proper water management for the rooftop gardens which is done by the dripping system, piping and direct spray by machines, and water delivery pipe and by hand in jugs.[Figure-1]. Reduce temperature from building by cultivation of plants on the rooftop gardens, Farrency, Morales et.al.(2011). Fresh air is obtained from rooftop farming. The ecological balance in urban areas the cultivation on the rooftop. Rooftops are hubs of meeting plants of ornamental flowers, medicinal plants, vegetables and domestic animals, Berger (2013). They have the most economical value. Temperature recorded from 10 rooftop gardens by the observation at the same time by the participant and record. Solid waste is sorted and measured daily wise from 10 kitchens and the rooftop gardens, Badmi, Roman (2015) Water supply on rooftop garden by hand pipe spray and dripping systems.

Result and Discussion

Urban rooftop vegetable farming in an intensively managed, market- based system. Environmental pollution happened due to rapid urbanization and industrialization of urban areas. The benefits of rooftop gardens are environmental benefits provided by conventional green roofs, making roof cooling systems and water management system, Audsley (1997). In some cases availability responses will not compensate for the effects of harsher climates and water scarcity. Without adequate moisture solid waste management, framing becomes economically impractical since the major aim of urban vegetable production system is to grow vegetables round the year, Specht, Siebert et.al.(2014). Increases in the intensity of conflicts between agriculture and the natural environment may also limit the extent to which adaptation is possible .this necessitates appropriate framing practices which minimize pollution of the surrounding environment, Despommier (2011). Water is used in homes in various ways and water is the life of all the Water is lifted from ground to roof of the building. This lifted water is mainly used on rooftop gardens washing, cooking, bathing and drinking are in proper management. Open survey, experiment and record of data of 10 identical homes bearing rooftop agriculture for daily utilization of water. The result shows 30% water is used for bathing,17% on rooftop gardens,21%washing,13% cooking,9% drinking. 27% of lifted water is used on rooftop farming. This water is the major source of water. Apart from that the storm water is also used on the rooftop. Rain water conservation

and utilization is one of the significant roles of rooftop gardens. The liquid media are also used in Rooftop farming for better results. In future the recycling of water planning will be adopted and it may be used on rooftop farming.[Figure-1]. Water supply on rooftop farming is directly on hand by jugs, pans, bottles, pipe, spray, dripping systems and a canal made of concrete. As per survey results 45% of water used by hands,24%,23%,12% and only 7% water irrigated by canals, spray, pipes, drip systems respectively, [Figure-2]. The maximum of 45% water is used by traditional methods of water irrigation due to the container gardens, Angiill, Farriency, et.al. (2012). The pipe was fixed and movable on the rooftop garden. The canal systems of water supply on rooftop farming made by cement concrete as per direction of plots, beds, grow bags, poly bags. Dripping systems of irrigation are more expensive, fixed and maintainable but less waste of water. Minimum amount of water is expended in rooftop farming as compared to field cultivation and minimizes the waste water. [Figure-3]. Solid waste management is another appropriate concept of rooftop farming. It has an effect on the urban economy. Recycling of the solid waste (household garbage) to produce compost and reused it on rooftop farms. On field survey, every day's urban homes are output of enormous solid waste from kitchens and rooftop farms of urban homes. These wastes are put in the compost bins to produce compost, Van Den Berg, et. al.(2010). These methods reduce the urban garbage in door steps and use it to rooftop gardens. The survey carried out of different ten rooftop farming of different localities of Bhubaneswar. Output of daily waste are recorded from kitchens such as vegetables peel, food waste, rotted vegetable, rotted fruit, other waste from home cardboard, cloth, paper all these waste are burnt and use of ass directly into the rooftop farming. On the other hand it may be added to the compost and peat and then used on rooftop farms, Yuen, Wong (2005). The waste obtained from rooftop farms include. Green leaves, dry leaves, flowers, fruits, stems, unused soil. [Table-1]. The analysis of waste produced from collected data of 10 homes having rooftop gardens (H_1-H_{10}).all the home output biodegradable wastes. Rooftop farming is organic farming which uses bio-compost, compost, Bio-fertilizer and soilless media culture. The data is collected from the practitioner for four successive years during research years 2018, 2019, 2020, 2021. Organic compost uses 22%, 29%, 35%, 42%. Chemical fertilizers use 45%, 36%, 27%, 13%. Bio-fertilizers use 23%, 38%, 46%, 69%. Soilless media use 12%, 19%, 24%, 27% in respective years. The bio related manure is gradually increasing every year but the chemical fertilizer is decreasing. Some RTGs are purely organic due to use of compost-bio-fertilizers-soilless culture media (coco peat, media culture etc).The bio-fertilizers are used more in rooftop farming because these are available in market in low price. Organic compost is time taken and lengthy processes are quite difficult .Soil less media culture is very much used in aroponics, hydroponics and container garden. [Figure-4]. According to the data collected by interviewer participants, the implementation of application of solid waste management and use of organic fertilizer on rooftop farming is increasing from the years 2018,2019,2020,2021 are 32%,44%,63%and 68% respectively.[Figure-5] Cooling effect on rooftop farming: the temperature decreases from the building by rooftop farming. In the survey, the temperature of normal buildings is reduced every month and rooftop garden bearing buildings. Record of data will be in [Table-2]. The total maximum temperature in 10 gardens in every month is recorded 264.8 to 265.6The average temperature in rooftop

gardens per month 26.48.The temperature different from normal and average temperature of 10 rooftop farms is 3.32^{o}c. Yearly reductions of temperature on 10 rooftop farms are 4.17/year. Mean difference of temperature in a year reduces to -3.43083^{o}c. The negative sign means the decrease in the temperature of rooftop farms buildings due to the transpiration, evaporation, water contained in plant, holards, echards, chesard, irrigated water so the temperature is decreased and the humidity increases on the buildings. The effect of temperature is depending upon the size, type of rooftop gardens and amount of water used on Rooftop farms. Temperature is one of the constants of environmental sustainability.

Conclusion

A wide variety of new approaches have been developed that will combine well to produce the more productive, sustainable agriculture of the future. The main thrust areas are the safe vegetable production technology, effective and safe methods of urban methods of urban waste utilization. The vegetable cultivation need water management systems. It is proof that rooftop farming is one of the safeguard urban cultivation in covid-19. Rooftop garden will help to eradicate Covid -19. Indoor food production of lung runs strategies of food security and urban sustainability. In mega cities of the world people are adopting smart farming in terms of rooftop farming. In covid-19 rooftop farming is very effective to sustain the environment. All levels of people can cultivate on the rooftop such as balcony garden, terrace garden. The vegetables, fruits, flowers, medicinal plants, Orchids and even ornamental plants can be cultivated from roof to garden. Conservation of endangered plants, nursery, control of environmental pollution, ecosystem service, these are the important opportunities of rooftop farming. In future roof tops are growing tremendously in urban areas to protest against any pandemic diseases best referenced as covid-19 pandemic. The rooftop garden is given remarkable opportunity. It produces fresh organic food and environmental sustainability through household biological solid waste management. It produces bio-compost and uses it on rooftop farms on the same building which produce qualitative and quantitative food. The production of compost on the rooftop reduces the economic value of the family. In both ways food production and waste management along with rooftop farming helped to clean the environment. Cooling effect is fully dependent upon the rooftop gardens and buildings. Rooftop farming emits temperature from the building.3^{0}c to 4^{0}c decreased by rooftop garden daily in the building. The rooftop farming need proper manage of water. Now new technology is applied and recycling of wastewater and reuse of this water on the rooftop farming. The organic fertilizer is used on rooftop farming from management and produces compost and vermiculite from household garbage. Rooftop garden is totally organic farming. Eventually rooftop farming is an emerging effect on environmental sustainability in urban locality.

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Table-1: Bio-composting on the rooftop farming

FROM HOMES	SI/ No	Bio-west in Grams	H_1	H_2	H_3	H_4	H_5	H_6	H_7	H_8	H_9	H_{10}	Total/ H_{10x}	Average
	1	Vegetable peels	544	602	732	806	823	917	609	578	467	653	6731	673.1
	2	Food wastes	364	455	286	541	632	712	485	456	357	496	4784	478.4
	3	Rotted vegetable	688	716	564	657	486	522	836	692	304	582	6047	604.7
	4	Rotted fruits	434	542	579	611	598	743	923	468	577	648	6123	612.3
	5	Cards board	205	395	463	735	945	484	565	986	459	330	5567	556.7
	6	Paper	596	453	695	345	659	605	870	756	452	585	6016	601.6
	7	Cloth	765	458	356	768	462	796	964	940	893	679	7081	708.1
FROM GARDENS	8	Leaf	859	867	578	782	699	864	965	458	685	961	7718	771.8
	9	Flower	799	380	458	375	467	355	653	549	546	436	5018	501.8
	10	stems	2147	3246	2149	3443	6348	2431	4564	4589	3453	3675	36045	3604.5
	11	Fruit	345	236	569	354	334	586	436	432	548	513	4353	435.3

Table -1:Survey of Solid waste management: ingredients waste output from home for bio-composting on roof top, Daily wise output of house hold garbage and converted into compost on rooftop for reuse on rooftop garden.H_1-7,657Gms, H_2-8,350Gms,H_3-7,429Gms,H_4-9,417, H_5-12,453Gms, H_6-9,015Gms,H_7-11,870Gms, H_8-10,904Gms, H_9-8,741Gms,H_{10}-9,558

Table-2: Cooling Effect on the rooftop farming

Months	Normal (T_B)	RTG 1	RTG 2	RTG 3	RTG 4	RTG 5	RTG 6	RTG 7	RTG 8	RTG 9	RTG 10	Total RTG (1-10)	Average RTG_{AV}	Different T_B-RTG_{AV}	Mean different
January	29.8	27.4	26.8	27.2	28.3	25.4	26.9	24.6	25.6	27.3	25.3	264.8	26.48	-3.32	
February	32.2	30.4	31.2	28.5	28.9	29.2	27.3	28.4	30.6	29.7	29.1	293.3	29.33	-2.87	
March	35.8	32.5	34.7	31.6	33.4	31.8	30.4	32.5	33.8	34.2	31.3	326.2	32.62	-3.18	
April	37.6	34.2	35.8	32.3	34.6	29.9	30.1	34.8	32.7	34.5	30.2	329.1	32.91	-4.69	
May	39.9	36.5	37.8	34.2	36.7	34.4	36.9	35.8	34.8	36.3	35.7	359.1	35.91	-3.99	
June	36.4	33.6	33.2	36.5	32.8	33.7	35.1	31.6	33.4	34.7	32.6	337.2	33.72	-2.68	
July	31.3	29.6	29.8	28.4	27.9	28.5	27.3	26.8	29.7	28.6	29.8	286.4	28.64	-2.66	-3.43083
August	32.2	27.5	26.8	29.2	26.4	26.9	25.6	28.7	29.3	28.9	28.4	277.7	27.77	-4.43	
September	34.6	31.7	32.4	33.8	32.1	31.6	32.4	30.2	31.8	29.5	29.7	315.2	31.52	-3.08	
October	33.7	30.2	31.6	29.7	31.7	29.6	28.4	27.8	28.9	27.3	26.5	291.7	29.17	-4.53	
November	30.9	27.5	28.6	26.8	27.1	26.3	28.5	26.2	27.8	26.9	25.3	271	27.1	-3.8	
December	28.5	27.2	26.7	26.9	27.3	25.7	26.9	27.4	25.6	27.1	24.8	265.6	26.56	-1.94	
														-41.17	

Table-2: Survey of cooling effect on the rooftop gardens are recorded 10 sampling on rooftop gardens (RTGs) in celcious (C^0) scale in different zones of Bhubaneswar city. Average high temperature of different months.

Use of compost on rooftop farming and watering

Figure-1: Use of compost and watering on the rooftop garden

Water is used in rooftop farming

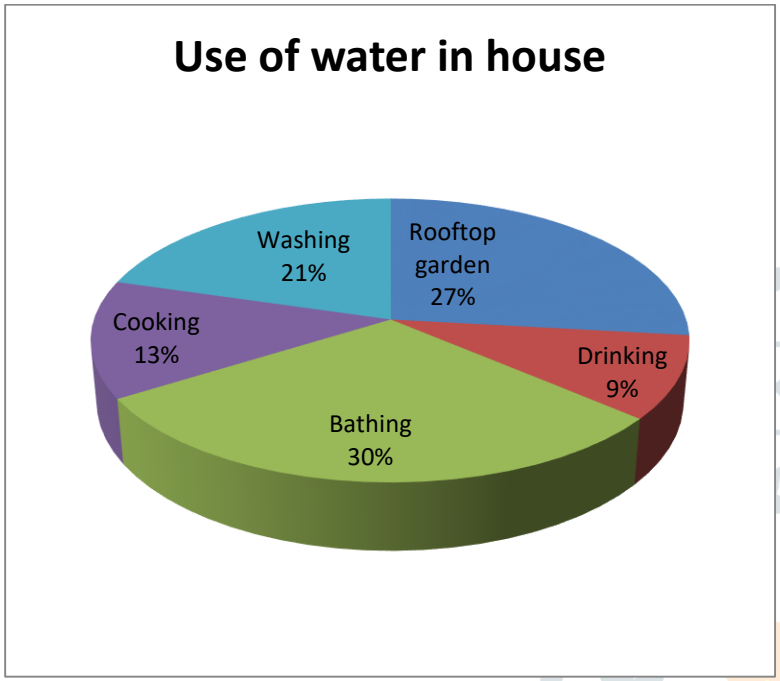

Figure- 2: Lifted water is used in rooftop garden

Irrigation on the Rooftop farming

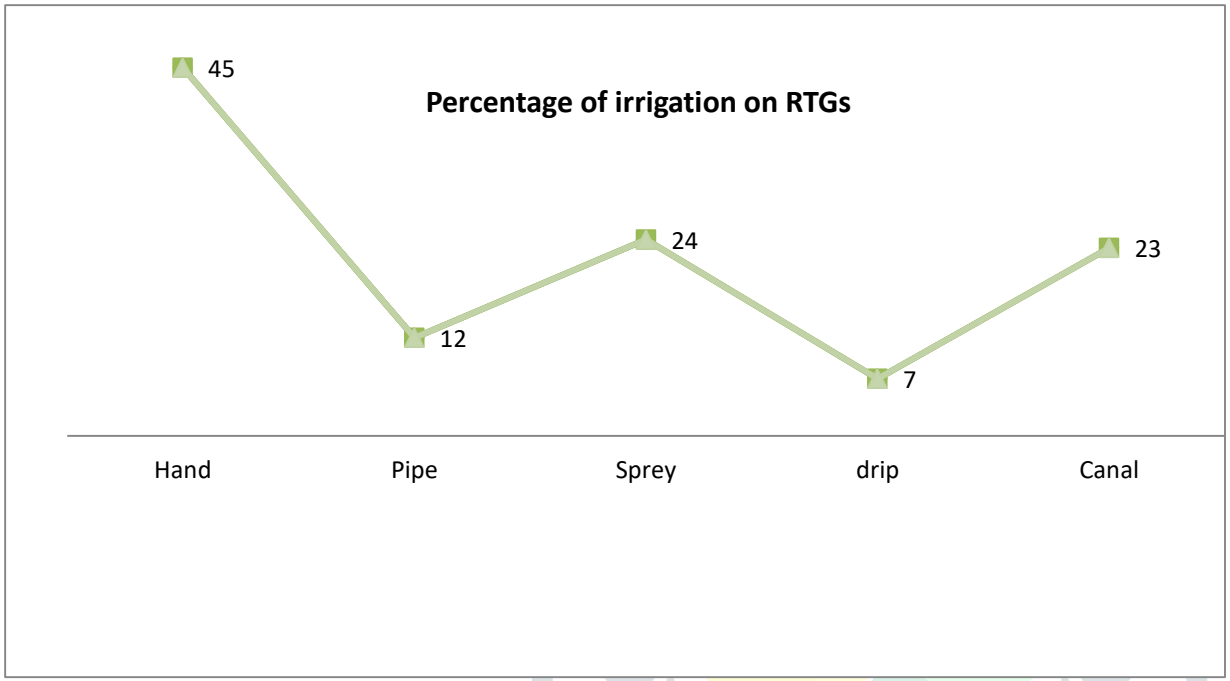

Figure- 3: Survey on irrigation facilities in rooftop garden in Bhubaneswar.

Use of organic fertilizers

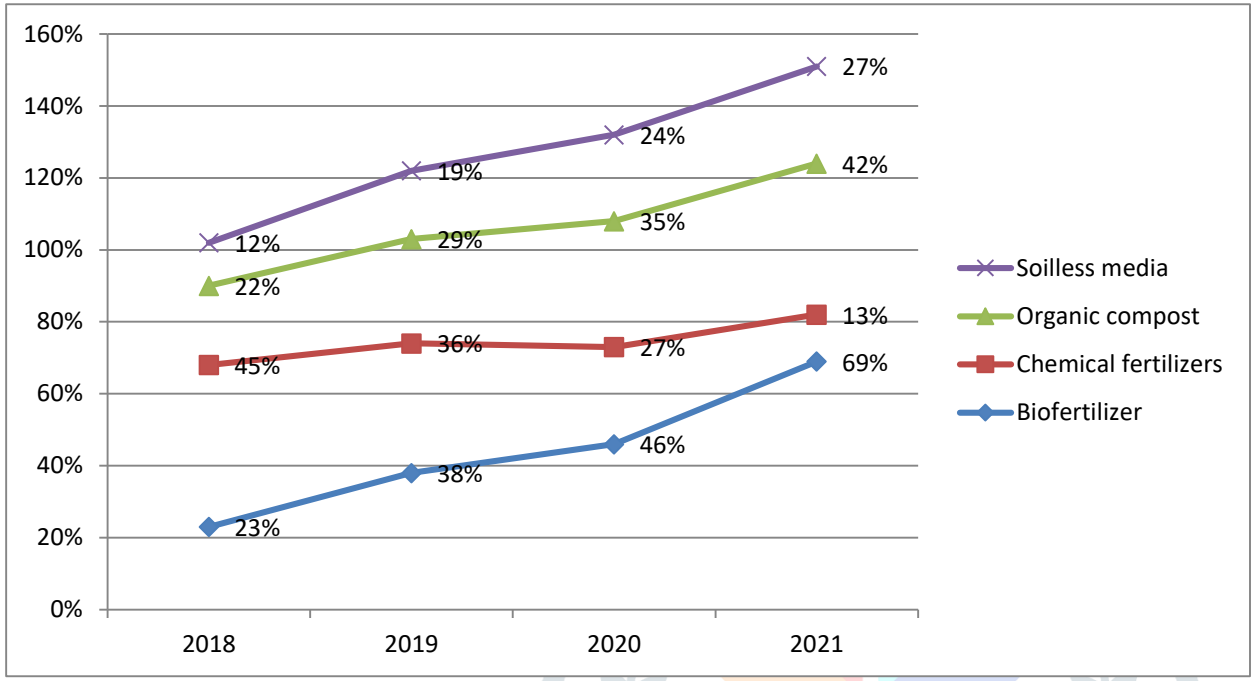

Figure-4: The uses of organic fertilizer increasing on rooftop gardens in Bhubaneswar.

Bio-waste management

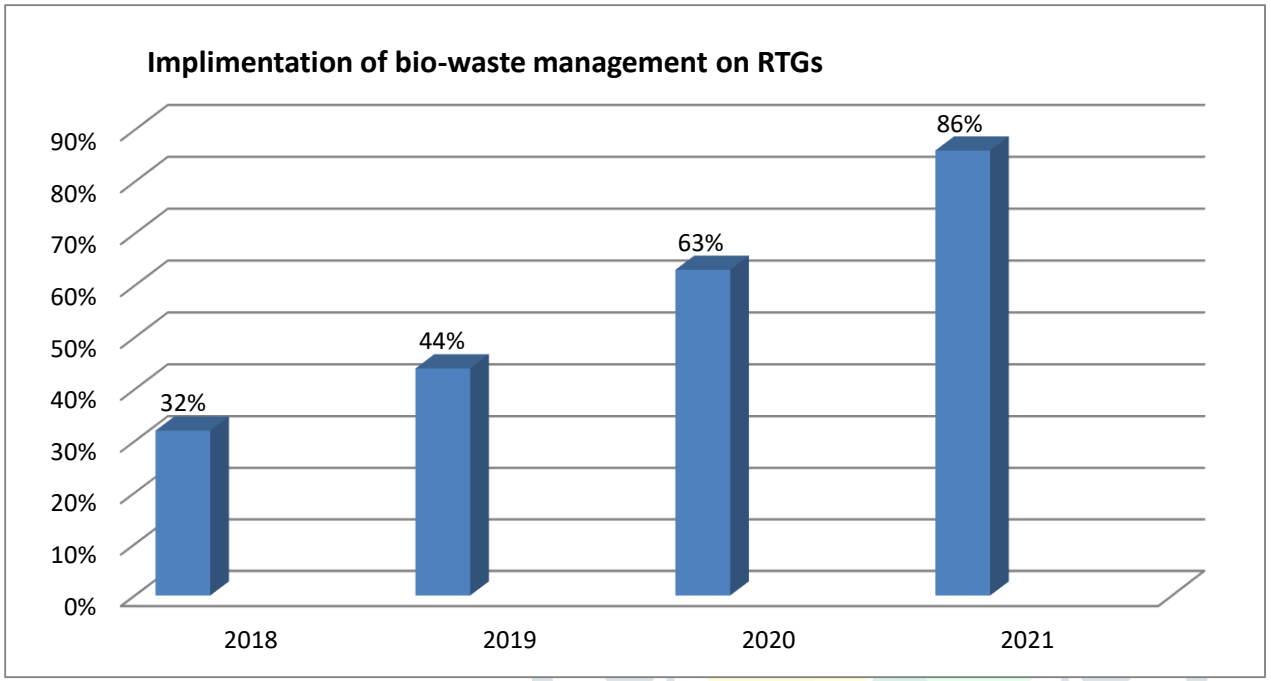

Figure-5: Survey of implement for solid bio-waste management on rooftop gardens in Bhuban eswar.