URBAN AGRICULTURE AS AN ESSENTIAL ELEMENT OF SUSTAINABLE INFRASTRUCTURE IN KOCHI CITY

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Abstract: This study explores the possibilities to implement the concept of urban agriculture in buildings of Kochi city. It aims to achieve a sustainable infrastructure that can results in ecological intensification. Predominant studies on urban agriculture focuses on providing design solutions. This paper examines how the practice of urban agriculture can be incorporated into existing buildings to achieve ecological intensification. It describes how cities can be transformed from being only consumers of food into producers of food. In this research, we study and analyze 5 successfully functioning urban farms, some are by individuals, some are by corporates and some are supported by institutions. This research explores innovative models of urban farms which could be used in buildings of Kochi to achieve ecological intensification. The future research potential of the study could provide a design criteria for residential buildings that incorporates urban farming.

Keywords: Ecological footprint, Ecological Intensification, Food Insecurity, Food Miles, Urban Regeneration.

Introduction*: Urban agriculture* is the urban farming or gardening, which occurs within an urban setting. It can be defined as personal and seasonal productive urban landscape that is used for agriculture. Within the urban fabric urban agriculture uses spaces such as residence, utility areas, commercial spaces etc. Features of urban agriculture differs from conventional rural agriculture. In the case of urban agriculture, *space* is the primary aspect. Urban agriculture includes rooftop farming, vertical gardening, facades, fences and boundaries.

The main advantage of urban farming includes the easy access to fresh and nutritious food, water harvesting, water re-use etc. with the help of urban farming one can produce 50-100 times more than regular farming [1]. Most of the urban farms are designed vertically which then allows to grow the products in as many levels as possible on a square foot. Urban farming practice decreases the 'food miles' even compare to the local produce. "Food miles for local produce that is produced from an urban garden or farm can be less than 0.001% the distance to grocery stores or market". On an average the produces travel over 1500 miles from the farm to the customer. In urban farming, the food products travel only 25 miles to the customer [2]. Locally produced food requires less transportation and refrigeration.

The food grown in urban farming is not subjected to flooding and or droughts, ensuring a more consistent, constant food supply, which helps to maintain the *ecological footprint* [1]. The ecological footprint measures the human demand on nature. The ecological footprint can be reduced by increase in urban biodiversity. It helps to prevent food insecurity. Food Insecurity means an economic and social condition of limited or uncertain access to adequate food [2]. Urban farming is seen to have prospective for cities to have food security to a certain degree.

An increase in local urban biodiversity is called as Ecological Intensification, a compensation for an existing loss of biodiversity found in many urban areas farming [1]. Urban agriculture adds to the health and comfort of a community, it strengthens the access to food and thereby enlightening nutrition and finally it improves the ecological conditions that affects the health. Looking into the Social and Cultural

aspect urban agriculture contributes to a community's well-being by improving its aesthetics and solidarity.

Background and Context: "Kerala requires about 15 lakh tonnes of vegetables a year of which only less than half is being produced within the state."- says The Times of India's headlines 23/10/2017. Kochi a metropolitan city having population 6, 01,574 and a density of 6,340/sq.km. The area under Greater Cochin Development Authority (GCDA) encompasses six municipalities and 25 panchayat's covering an area of 632 sq.km [3]. The Kochi city depends on other states for the eatables. The fruits and vegetables are imported from neighbouring states. The increased food miles leads to larger carbon emission. The urban population living and employed in cities has to source their food supply from the market. Therefore 70% of their income has to spend on buying food [4].

The combined issues of population explosion, rapid urbanization and climate change are posing a great threat to food supply. Green revolution has resulted in excessive use of high yield variety produce, fertiliser and pesticides. The practice of urban agriculture can be a potential solution to high public involvement in farming which can develop the values of a society that was developed on the basis of agriculture.This paper examines five case studies, in which the initial processing stage of urban farming practice to final implementation stage are discussed.

Case Study 1: Rooftop Green Terrace – VFPCK, Kakkanad, Kerala: Vegetable and Fruit Promotion Council Kakkanad, is an establishment which is targeting to bring about overall development of fruits and vegetable sector in Kerala. Established in 2001, by the Kerala Horticulture Development Programme (KHDP). VFPCK harvest and supply good quality fruit plants and ornamental plants to the public, in addition to the seeds and vegetable seedlings, grow bags, agricultural publications, flowering plants, fibre, mud products, bio/organic products are available here. The urban population who wants to grow fruits and vegetables on their terrace or in 5 to 10 cents of land approaches VFPCK for their needs. The main aim of VFPCK is to bring out urban agriculture as a part of our day to day life. '*Haritha nagari project'*, at VFPCK aims at promoting organic vegetable cultivation so as to produce farm fresh vegetables in terraces to make each household self-sufficient in vegetable production. The grow bags have been another key attraction for the urban population says Mr Vijayan, worker at VFPCK. The bags with seedling are ideal for terrace farming and growing plants in the limited space. They use grow bags to cultivate cauliflower, tomato, bottle guard, bitter guard etc.

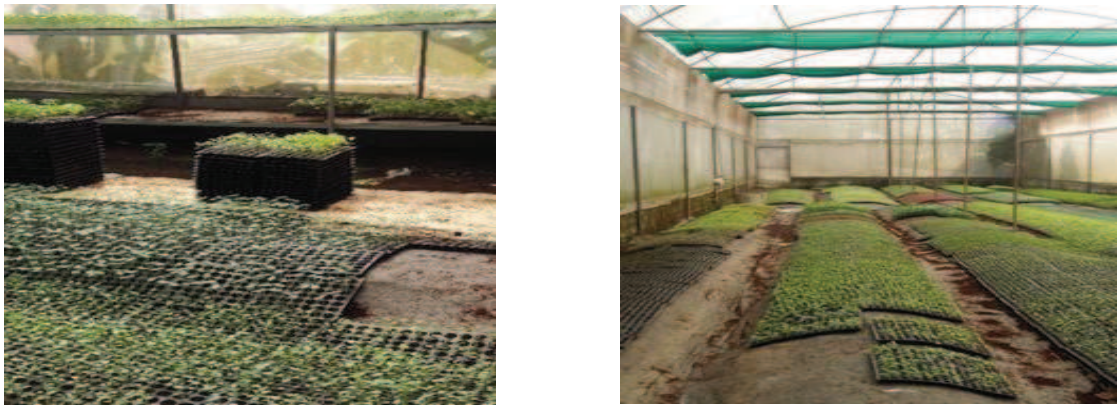

Fig 1: Polyhouse Production Unit - VFPCK

Case Study 2: Networks of Farmers, Kerala – Residential farm of Mr Gopinath at Tripunithura: The residential farm at Tripunithura, Kochi, is installed in the premises of the house that was constructed in 1985. The house is a simple typical residence with rooms only on ground level & open terrace on top. The access to the terrace is at the back of the house, which is next to the kitchen & the kitchen garden. The garden is visible from the road and adds on the elevational appearance of the house. The total site area of the residence is 40ft x 65ft. The terrace floor area consists of 1750 sq.ft. This house is an ordinary wall bearing construction with a flat roof. The crops are grown in reused thermocoal

baskets on the terrace. The arrangement of crops is in an orderly manner in uniform boxes that are placed at 120 cm spacing. The terrace floor is painted with white cement after every harvest to avoid water seepage. He provide the plants with fertilizers through drip irrigation. Daily maintenance is a must for good yield and also the plants should get 4 to 6 hours of sunlight. The plants on top of the roof significantly cuts the heat and enhances the indoor air temperature and quality.

Fig 2: Terrace garden at Mr Gopinath Residence

Case Study 3: Networks of Farmers, Kerala – Office cum Residence Farm of Mr ARS Vadhyar at Ernakulam: The office cum residence that was constructed in 2000 and is in the heart of Kochi. The terrace consists of 3 coconut trees, 35 banana trees, papaya, guava, chickoo, pumpkins, ash gourd, grapes, snake gourd, bitter gourd, okra, drumstick, tomato, and many more vegetables. The terrace is 1500 sq.ft. They uses plastic 'grow bags' which are available at krishi bhavans and also at private outlets. These bags are standardised for ultraviolet rays. So they last for 4- 5 years. The bags come in different sizes, and they are filled with a mixture of top soil, cow dung, and river sand or laterite powder and coir pith. The terrace garden also contains a three-year-old '*pathinettam patta'* coconut tree, which is around 10 feet high. The garden becomes a rich oxygen reserve and also an excellent mode to dispose of kitchen waste. It also reduces the heat within the house since the plants and the greenery form a green canopy.

Fig. 3: ARS Vadhyar, Owner of Yasoram Builders in His Terrace Garden

Case Study 4: Quantitative Analysis – IFSRS, Karamana: The integrated farming system research station works under the Kerala Agriculture University – KAU in Karamana, Trivandrum, in particular has developed a number of farming methods that can be adapted for urban living conditions. About 19 to 20 acres of land, the IFSRS Karamana is working to innovate on integrated farming system which involves the production of rice, fish, poultry, cattle and vegetables. The main aim of IFSRS is to get the maximum yield by farming a small area. Jacob John, Professor and head of the IFSRS, says that in keeping with the rapidly growing demand for organic food and home grown vegetables, the research station is innovating on a variety of food growing models that can be used by everyone from the rural

farmer to urban high-rise residence. He says that one-time-one-crop planting will not serve for effective and smart farming, and he suggests that every farmer should turn into integrated farming. "*The innovation in terrace gardening developed by Jacob himself have turned out to be the most popular. He introduced 7 types of Vertical farming structures for the plantation to be fixed in it. They are Staircase type, Ladder type, Rotating type, Pyramid type, Grow bag type, Roofing type and Wall mounted type*". These terrace gardens also innovatively use water, with sprinkler, drip and stick irrigation systems that are highly eco-friendly. "*A house which is constructed on a 3 cents of land that is about 1300 square feet will get approximately a maximum of around 200 kg vegetables can be produced annually*". The Indian Medical Association recommends a family of four members should consume around 300 – 350 kg of vegetables a year. These vertical farming structures can produce high yields by occupying smaller space. Nearly every bit of free space is used to grow something useful.

Fig 4: IFSRS – Karamana

Case Study 5: Study of Residential Typology – Apartments: The study will be focusing on two typologies of apartments, one is the apartment having proficiency for green and the other does not having the proficiency for green. From the case study we will be able to identify the possibilities of urban farming in these existing buildings to achieve ecological intensification.

Green Clouds Apartments, Veegaland Developers, Kakkanad:

Fig. 5: Typical Floor Plan of the Apartment

Fig.5 shows the available open spaces, which are taken for the calculations. It has a proficiency of green. The apartment consists of 13 floors (B+G+11), each floor has only one flat of 4BHK with the area of 8795 – 9000 sq.ft. Available green space for each flat is 1000 sq.ft.

Tulsi Nest Apartments, Tulsi Developers, Edappally

Fig. 6: Typical Floor Plan of the Apartment

Fig.6 shows available open spaces in plan as well as on building facades. This building does not have proficiency for green, but the balconies, terrace and facades can be utilized. It is 11 storied apartment (B+G+9) consisting of 4 flats on each floor. Each flat is 2 BHK of area 890 – 970 sq.ft. The elevation is designed in the way that it can be used for some kind of connection between the top and bottom floors. Each flats have balcony facility.

Results: From the case study 4 of quantitative analysis, we came into the conclusion that nearly every bit of space can be utilised for urban farming practice. We are implementing calculations into the part 5 of case study that is the study of residential buildings. From the case study 5, we have identified the areas of interest. The result part will give a clear idea of how much space is required to achieve the ecological intensification by the implementation of urban agriculture.
From the study of quantitative analysis, *3 cents of land provides 200 kg of vegetables per year*. That is,
1 cent = 1300 sq.ft = 200 kg vegetables/year.
1 sq.ft = 0.15 kg vegetables/year.

Green clouds apartments, Veegaland builders, Kakkanad:
Total number of floors = B + G + 11 = 13 floors
Around 1000 sq.ft green open space per floor

- For each floor, 1000 sq.ft x 0.15kg = 150 kg/year
- For 11 floors, 1000 sq.ft x 0.15kg x 11 = 1650 kg/ year
- Including the ground floor area(1000 sq.ft) and the terrace space(4000 sq.ft),

1000 + 4000 = 5000 sq.ft x 0.15kg = 750 kg/ year
Grand total, 1650 + 750 = 2400 kg/year.
Family consisting of 4 members should consume 300 – 350 kg of vegetables/ year, 11 families consumes 2400 kg vegetables per year. That is, 2400/11 = 220 kg per family.

The apartment having proficiency for green serves 80% of vegetables for the 11 families. Thus we can conclude that the building with proficiency for green will provide the ecological intensification by providing 80% of the yield.

Tulsi nest apartments, Tulsi developers, Edappally:
Total number of floors = B + G + 9 = 11 floors
Each floor, 4 apartments

Type A – The areas of interests will be garden space, balcony and the corridor space. The 100% of garden space can be used for the urban farming implementation as well as 50% of balcony space and 20% of corridor space.
For Type B, C and D the above spaces are considered as the areas of interests.
Since the apartment consists of cluster of houses, the number of families will be high. For the production of enough food surplus, we need to consider the vertical farming over the outer walls also. The balconies' garden space between the top and bottom floors can make a connection between the families as well as the vertical garden.

- For Type – A,
  50% of balcony space = 50% of 260*180 = 25.188 sq.ft.
  100% of garden space = 240*60 = 15.50 sq.ft.
- For Type – B,
  50% of balcony space = 50% of 260*180 = 25.188 sq.ft.
  100% of garden space = 240*60 = 15.50 sq.ft.
- For Type – C,
  50% of balcony space = 50% of 260*180 = 25.188 sq.ft.
  100% of garden space = 240*60 = 15.50 sq.ft.
- For Type – D,
  50% of balcony space = 50% of 285*180 = 27.60 sq.ft.
  100% of garden space = 450*60 = 29.06 sq.ft
- Corridor space, 150*180 = 29.06 sq.ft
- Total areas of interests of one floor = 207.784 sq.ft
- Total area for 9 floors = 207.784 sq.ft. * 9 = 1870.056 sq.ft
- Terrace area, maximum amount of terrace area is considered as areas of interests.

That is equal to 3000 sq.ft

- Ground floor area with the garden space = 2000 sq.ft.
- Vertical surface area of single elevation = 300*1800*9 = 523.751 sq.ft.
- Vertical surface area of all the four sides = 523.751*4 = 2095.004 sq.ft

Grand total area = 12,488.811 sq.ft
For 1 sq.ft. 0.15 kg vegetables can be produced, therefore 12,488.811 * 0.15 = 1873.32 kg/year

In this case the number of families are higher than the last case study, therefore the percentage amount of vegetables will be lesser as compared to the other case study. But the people can grow vegetables in nearby fields and open spaces thus creating ecological intensification also. 25% of food needs can be served by practicing the urban agriculture methods. From the results, the buildings having provision for green and the building does not having provision for green will maintain the ecological intensification. The architectural innovations for urban agriculture can make higher yield in smaller space available.

Challenges and Opportunities: Surveys and Interviews have been done to determine the challenges and opportunities of the study. A set of questions were prepared for the survey to be done, 15 persons from Ernakulum city, staying in apartments were participated in the survey and interview. All of them where from non-agricultural profession and have a keen interest on the study. The idea of new architectural innovations in urban farming provides a huge opportunity for urban dwellers to produce their needful in their own space.

From the surveys, case studies and interviews done, we can find that the urban farming method is worth and effective. The most important influence of urban farming practice is the quality of space that is generating. We are providing a new better environment and a better condition to live by the implementation of urban farming methods. "Creating safe places" is one of the social impact that we can achieve by the implementation of urban agriculture. It will improve the human relationships and interactions with each other's and the built environment. Thus we can conclude that "Urban agriculture can be an essential element of sustainable infrastructure in Kochi city".

References:

1. Maximum Yield. (2017, November 16). Retrieved from Maximum Yield - Urban Farm: www.maximumyield.com/definition/2183/urban-farm
2. The Future of Food. (2018, November 10). Retrieved from Click and Grow: www.clickandgrow.com/blogs/news/34449092-gmos-have-their-time-and-place-heres-the-when-the-where-and-the-how
3. Ramakrishnan, K. S. (2006, January 06). People's participation in urban governance.
4. Hari Prasad Agarwal and Radha Sinha. "Urban Farming – A Sustainable Model for Indian Cities". International Journal on Emerging Technologies 8. 236 – 242(2017)

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