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Challenges in Adopting Productive Landscaping Approaches in Indian Cities

H Rallapalli¹, SV Sreepada² and J Gorle³

¹ School of Planning and Architecture, Vijayawada

² School of Architecture, GITAM (Deemed to be University), Visakhapatnam

³ CEPT University, Ahmedabad

E-mail: hemasree.gsa@gmail.com

Abstract. The United Nations has projected that over two-thirds of the world's population will be living in cities by 2050. With the desire to reach the goals of higher economic growth, Indian cities are facing rapid urbanization leading to high density living and decreasing green spaces threatening the living conditions of the urban areas. These conditions drastically changed in the recent past with the increase in temperatures and vehicular pollutants depleting the natural systems in the cities. The scarcity of the natural resources such as water, fresh air and green spaces at one hand and the rapidly depleting resources at the other hand, the process of sustainable development and creating urban green infrastructure is becoming a challenging task for Indian cities. The major factors influencing the urban environment such as climate, water resources and air quality and other multi folded issues can be addressed through setting up of green infrastructure at various scales. The recent trend in the changing perspectives of landscape planning in Indian cities and addressing the loss of natural infrastructure in the cities has to be balanced by creating adaptable built environment with green infrastructure such as urban farms, urban forests and community farms in urban spaces as part of existing and evolving city fabric. The challenge is that such green infrastructure solutions are failing to find their way into practical form. The study focuses on analysing the parameters to incorporate sustainable green infrastructure models, challenges and strengths in adopting successful models into the city fabric. A study of various existing models at different scales from cities of Bangalore, Hyderabad and Visakhapatnam are discussed to give insights into the adaptability aspects of the model with reference to their respective urban context.

Key Words: Productive Landscaping, Green Infrastructure, Urban Agriculture, Indian Cities

1. Introduction

According to United Nation World population prospects, the current global population is 7.7 billion, and in most parts of the world, the current urban population is increasing three times faster than the rural population. People migrate to urban areas with the hope of a better living, considering relatively better infrastructural facilities, and higher per capita income. As cities grow, urban areas expand geographically, characterized by impervious surfaces like roads, pavements and buildings. At present, the unplanned and rapidly urbanizing Indian cities are facing serious problems like - increase in pollution levels, inequitable distribution of natural resources, traffic congestion, spreading of slums, unemployment, increased reliance on fossil fuels, uncontrolled outgrowth and sprawl in periphery etc. [1]. Many cities are at a risk of becoming "disaster traps", through the direct effects of sea level rise, floods, hurricanes, increased temperatures due to Urban Heat Island effect or through severe food supply problems etc. Rapid urbanization in India is accompanied by a rapid increase in urban poverty and urban food insecurity which is further worsened by food inflation leaving a lot of underprivileged urban population with no or low-quality food.



To overcome these challenges, Urban agriculture can be a part of a solution where the urban residents can produce food using resources such as organic waste for compost and waste water for irrigation and serve the produce to the local markets. Urban agriculture can be practiced on private land such as terraces or backyards of residences, on public lands such as parks, conservation areas, along the roads, streams and railway lines and on semi-public land such as schoolyards and grounds of educational and health facilities. The practice of urban agriculture promotes economic development through food production, builds social capital, community well-being and civic engagement. Community gardens, farms in city blocks, vertical farms based on hydroponics or aeroponics and aquaculture are some smart urban agriculture models.

Urban agriculture can be a sustainable strategy to reduce urban poverty, food insecurity and enhance urban environmental management. It contributes to poverty alleviation, social inclusion of the poor, women empowerment, productive use of vacant plots and reuse of urban waste. Consumers, especially the urban poor, will be able to enjoy the access to fresh produce at better prices. Urban growers can sell directly by avoiding intermediaries and spend less time on transport, packaging and storage. Further, urban agriculture can create employment opportunities for disadvantaged groups. The importance of urban agriculture is also being recognized by various organizations such as the United Nations-Habitat and FAO (Food and Agriculture Organization) etc.

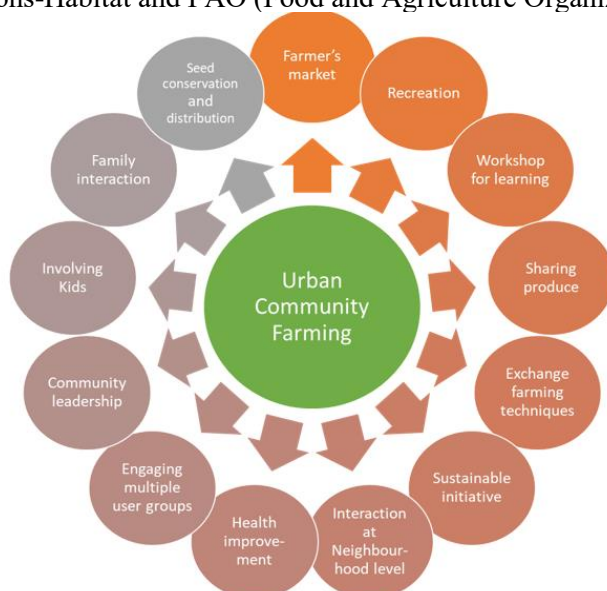


Figure 1: Advantages and possible networking through urban farming

Similar to most developing nations, India is also facing problems of urbanization with current urban population 377-million that is expected to grow by another 300 million by 2050 [2]. Yet, agricultural land is rapidly shrinking in urban areas, leaving city dwellers increasingly reliant on rural farmers for meeting their sustenance requirements. Transported across long distances and handled by several middlemen, the price of rural produce shoots up by the time it actually reaches urban consumers. The prices of perishables in particular, such as those of vegetables and fruits, could easily be twice the production cost, or even more. Added to that is the problem of spoilage. According to the UN's Food and Agriculture Organization (FAO), in developing countries, 10-30% of produce is spoiled during transit [3]. As the government of India envisions creation of 100 smart cities in the coming years, green infrastructure assumes all the more importance of which Urban Agriculture is a major factor. India's agricultural policy needs to focus on urban agriculture. A few Initiatives such as composting and vermiculture, horticultural activities and terrace farming are being witnessed in small pockets in Indian cities, including Kolkata, Chennai, Delhi, Mumbai, Bangalore and Hyderabad. In this paper, we examine how urban agriculture is being practiced in various such Indian cities and what

are the challenges that the cities are facing and suggest a few guidelines as steps to take this forward for a wider implementation.

2. Study Methodology

The primary objective of the study is to understand the parameters to incorporate sustainable green infrastructure solutions and the challenges in incorporating urban agriculture. To study and get an overview of the existing challenges and strengths in adopting various models at different scales in Indian cities, case studies from Bangalore, Hyderabad, Visakhapatnam are analysed with the reference with their urban context.

Many Indian urban farmers have carried out successful trials in growing fruits and vegetables under most constrained urban conditions (lack of space, water, soil, pollution etc). They have become the pioneers and teach by example their methods to grow maximum yield from minimum space available. However, there are failed examples too that can guide the study in developing better strategies. An investigation of the existing urban farming activities is done from literature, case studies and personal interviews to understand the existing practices, successful practices and challenges in three Indian cities - Bangalore, Hyderabad and Visakhapatnam. By doing a comparative analysis, opportunities and challenges were identified that could give a direction based on which few recommendations are suggested for wider adoption of urban farming in India.

3. Case Studies

3.1. The Bangalore Case

Bangalore (now known as Bengaluru) is the capital of the state of Karnataka, in southern India. It is positioned at 12.97°N 77.56°E, covers an area of 1741 km² with a population of over 9.6 million (2011 census), and an estimated population density of approximately 4,300 people per square kilometer. (Bose 2011). It has a moderate climate. Once known as the “Garden City” of India, the city has experienced immense economic growth over the past two decades, mostly attributed to the Information Technology (IT) sector, and is now known as the “Silicon Valley of India.”. With the city's development for accommodating the huge number of people coming to the city, Bangalore's farmlands and green spaces are disappearing at an astonishing rate, with more high rises and commercial developments being put in their place.

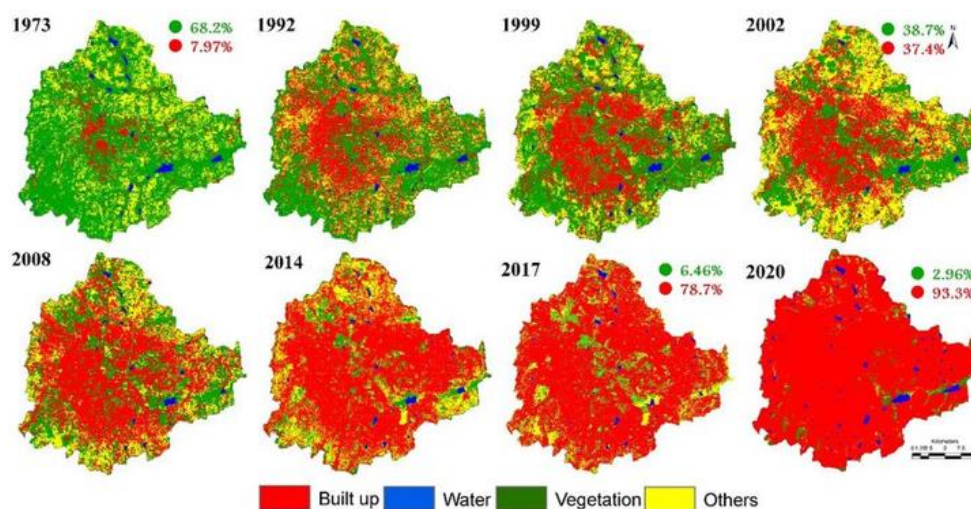


Figure 2: Land use dynamics in Bangalore [4]

According to the state government's Department of Agriculture, as Bangalore was witnessing its IT boom and burgeoning growth, the area covered by vegetable crops in the district decreased from 0.1 million hectares in 2000 to a mere 0.04 million hectares by 2015. As a result, vegetable production went down 72%, from 0.29 million tons to 0.08 million tons during the same period [4]. Urbanization in Bangalore city consumed the peri-urban areas that were once used for agriculture for development of IT parks. Many lakes in and around Bangalore are polluted with both industrial waste and untreated residential sewage. Using this water for irrigation is leading to the pollutants finding their way into the food. Though there are several challenges to urban and peri-urban agriculture in Bangalore due to shortage of land and access to clean water for irrigation, there are certain initiatives taken by the city dwellers for practicing urban agriculture.

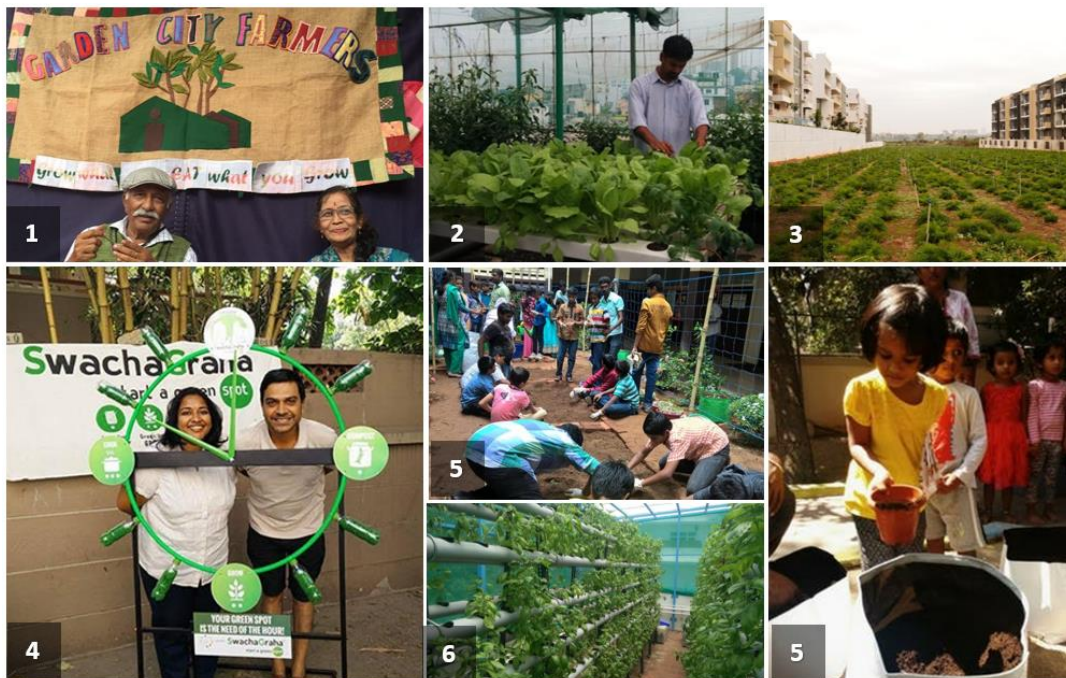


Figure 3: Urban Agriculture activities in Bangalore (1) Garden City Farmers with a slogan 'Grow what you eat, eat what you grow' (2) An IT professional turned urban farmer (3) A farm fringed by new apartment buildings in Varthur, Bangalore (4) Active citizens who propagate efficient solid waste management (5) Kids learning community farming (6) Bangalore citizen practicing vertical farming.

In Bangalore city, there are several organizations such as Organic Terrace Gardeners, Garden City Farmers that are self-support groups for small scale urban farming. They focus on educating and promoting organic terrace and home gardening by conducting trainings and workshops, connecting practitioners and resources, and promoting awareness of urban food growing through seminars with the guiding principle "Grow What You Eat, and Eat What You Grow". There are specific organic stores like Sahaja Samruddha, Annadana, Nitya Jaivika, Namdari etc that support urban farms by selling organic fertilizers, seeds and products. In the private sector, there are a number of firms making inroads in the fields of vermiculture and composting. Terra Firma Biotechnologies is a Bangalore-based company involved in the manufacturing and sale of compost using organic and agricultural wastes. Varanashi Research Foundation in Adyanadkha, taps agro-industrial wastes such as coir pith, saw dust, rice mill waste, coffee husk, areca husk and leaf sheaths to make compost. The concept of zero budget natural farming, which is neither chemical-loaded nor organic with its reliance on manure, is swiftly catching up. It is being adopted by urban gardeners and small-scale farmers in and around Bangalore. They believe that nature provides its own pest control mechanism and no additions are required to grow or nurture plants.

There are a few community farms such as Navadarshanam in Bangalore in which group farming is done by people living in a community, that are working towards Urban Agriculture. There are several other non-profit agencies, public or private enterprises working towards urban horticulture that play an important role in the fostering of fruit and vegetable cultivation in cities and their immediate hinterlands. AGRITECH was established by the Centre for Technology Development (Bangalore) in 1989 and has been involved in a variety of research activities that helped in Urban Farming. The Indian Institute of Horticultural Research (IIHR) in Bangalore provides advanced training, consulting services and is a repository of advanced technology and knowledge in horticulture. NGOs like ECONET that aim at sensitizing the public to the increasingly dangerous trend of consuming chemically grown food. In Bangalore, the work of Agriculture Man Ecology (AME), with the support of the Netherlands administered by ETC Netherlands, is actively promoting organic farming and "Low External Input Sustainable Agriculture" (LEISA) in conjunction with 30 NGOs in the states of Karnataka, Andhra Pradesh and Tamil Nadu. Companies like Square foot in Bangalore provide clients with raw materials, gardening support and technical knowhow on farming.

3.2. The Hyderabad Case

Hyderabad is endowed with composite climate, with maximum temperature of 40°C and lowest temperature of 13°C and spread over an area of 625 sq.km. with average rainfall of 89 cm. According to the State Horticulture department, out of 625 sq.km of the Greater Hyderabad Municipal Corporation (GHMC) area, nearly 60 sq.km has the potential for urban farming. Though the availability of open spaces for urban agriculture is limited, most buildings have terraces that are vacant or generally not used. The roof tops constitute to an area of approximately 60,000 Sqm. If 50% of area is converted into roof top gardens most of the food needs of the residents could be met. According to GHMC, out of the 22 Lakh houses and apartments that are there in the city, 40,000 households are engaged in rooftop urban farming which translates to less than an acre sq.km area [5]. This shows that there is still a lot of untapped potential to the City.

Horticulture department in City of Hyderabad is actively training residents in Urban agriculture and giving the assistance in roof top cultivation. As a part of urban farming initiative, horticulture department was giving subsidy kit that involve stallion round beds, red earth, farmyard manures, 14 bags and are provided with guidance for installation and maintenance. Occasional visits to the farms and monitoring of the practices is the key for the success of this model. GHMC and horticulture department together are trying to create awareness among people of the city through regular newspaper articles, organizing workshops and training programs. They are identifying resources persons and assisting them in hand holding the program.

Co-living and farming communities like Organo in Hyderabad are an example of how people are coming together with common ideologies and working on urban agriculture. It is spread across 35-acres in the lush green bio-conservation zone of Hyderabad is for those who respect nature's ways and want to lead a life of self-reliance through a completely sustainable organic way of living. It has been designed as a holistic farm, where farming is practiced at various levels. It features community farming, personal farming, nursery, animal husbandry, forest plantation, medicinal plantation, aqua farming, api culture etc. Apart from a 16.5-acres community farm dedicated to various fruits and vegetables, every resident has open spaces in their own farm plot to indulge in their choice of vegetables and fruits. Together, all these greatly benefit the residents in leading a sustainable and healthy lifestyle.



Figure 4: Urban Agriculture activities in Hyderabad [6]. (1) Couple in Hyderabad use the hydroponic technique to grow exotic salads leaves, vegetables and flowers (2) Co-housing facility and Community farming in Organo. (3) A resident posing with his rooftop farm which he started with the kit that the horticulture department sold at a subsidized amount. (4) Awareness and training program to city dwellers (5) professionals by the weekday and community farmers by the weekend (6) Homecrop's modular vegetable gardens on rooftops [7].

On the other hand, farming is still being practiced by some traditional farmers in tiny pockets within the city and the outskirts. In Hyderabad, approximately 250 households live around the banks of Musi river and use this river water for farming their 100 ha of land [8]. They however also are having problem with the yield pertaining to the pollution of the land, water and air. Farmers along the Musi river in Hyderabad use the polluted river water for irrigation, which has led to higher rates of skin disease, infections and dysentery. High air pollution levels also affect crop yields, sometimes forcing farmers to stop producing some crops or shift to new ones. In this scenario, farmers find agriculture unfeasible and prefer to sell their land to developers. In Hyderabad, farmers in urban areas have shifted from the production of paddy to fodder grass production as the river water that is used for irrigation gradually became more polluted. That being said there are also a few examples, where a land that is marked as barren land and waste land has been converted to lush green farm by an Organic Farmer in the outskirts of the city. Today, with natural organic farming, this farmer grows several crops on his 17-acre land without the use of any pesticide or insecticides, just by natural farming, water management techniques and mixed cropping. International Crops Research Institute for the Semi-arid Tropics (ICRISAT), is a research station that offers an insight into the integration of agricultural sciences and research-for-development activities across the whole value chain, through to the agribusiness center, watershed management and crop production field experiments [9].

3.3. The Visakhapatnam Case

Visakhapatnam, commonly known as Vizag, is a port city on the east coast of Bay of Bengal in southern India. Spanning across an area of around 682 square kilometres, it houses a population of about 20.35 lakhs (~2 million) (Census 2011). The city, which supports several major industrial sectors, such as information technology (IBM, Wipro, etc.), manufacturing (Hindustan Zinc, Vizag Steel Plant, etc.), and the fishing and sea trade, contributes around \$26 billion toward India's gross domestic product (GDP). Visakhapatnam is one of the cities that is being developed as a smart city under the 100 smart cities mission of Government of India.

There is a small but active group of urban farmers in the city of Visakhapatnam who have been practicing urban farming in vacant plots, roof tops etc. and helping in educating the city dwellers by demonstrating how urban farming can be done in the spaces available to them. A Non-government

organization (NGO) named Rythumitra Foundation, is an active part of this group that aims at educating the city dwellers on how to do farming in their premises in a sustainable way using zero budget natural farming techniques. This NGO developed a model roof top kitchen garden, a farm on vacant plot and a food park in a semi urban area which they use to conduct workshops and awareness sessions on a weekly basis reaching out to more and more citizens. The organization also educates city dwellers about nutrition, healthy eating and treating diseases through herbal plants with a motto 'Eat food as medicine, otherwise you have to eat medicine as food'. They engage with schools and colleges to educate students on farming and healthy eating and encourage institutions to develop urban farms in their premises. Another NGO, Citizen encourage and guide the city dwellers in developing their own farms and also train them in activities like composting on a household level and community level. These spaces help in creating a dialogue, encourage community engagement and empowerment as well as introduce city-dwellers to fresh, safe, healthy home grown produce.



Figure 5: Photographs of the farms and events from the current Urban Farming activities in Visakhapatnam. (1) Roof top farm demos (2) Workshop conducted by an NGO on Waste segregation and composting (3) Child watering his rooftop farm (4) Organic/Natural Food farmer's Market (5) Pictures of the urban farm produce shared by the city farmers in their social network.

These NGOs helps various farmers and gardeners in urban and peri-urban areas of Visakhapatnam in selling their produce through specific stores and arrange local farmers markets over the weekends in public spaces. The organic farmers market has been attracting many city dwellers and encouraging them to shift to natural food and food products and motivating them to start their own kitchen garden. The group uses the web and social media for a wider outreach by sharing pictures of the farming activities and demonstrations videos. The network on the social media provides a platform for marketing and sharing details of events related to Urban farms. This kind of a motivated group with a strong support system is a great advantage for the city to adopt urban farming on a large scale.

A community named Kuraakula live on the suburbs of Visakhapatnam growing leafy greens and vegetables in the open plots available to them and sell them in the local market. The whole family of this community work on the farm activities. Men and women in farm activities, youngsters of the community in harvesting the produce and elderly in sorting and packing vegetables and leafy greens in bunches. This case showcases a successful community level farming at neighborhood level.

4. Discussion on the Case studies

It is evident from the study that there are many good practices and approaches for urban farming from all the three cases which are majorly citizen driven in Bangalore and Visakhapatnam case and municipal body driven in Hyderabad case. All the three cities studied have different contexts since Bangalore is a developed city and has almost reached its saturation point in development, which makes Urban Agriculture crucial part of its survival. Hyderabad is also developing at a fast pace with some scope for adoption and improvement in existing infrastructure. Visakhapatnam on the other hand has a lot of scope for becoming an ideal city if planned ahead. Though practices are similar to each other in all the three cities, there is a distinctive variation in the procedures followed, range of activities, spread and the support system they have. Observations from all the three cases largely constitute individual and periodic successes rather than a systematic, sustained development of urban agriculture.

Table 1: Comparative analysis from all three cities studied

	Bangalore	Hyderabad	Visakhapatnam
Context			
Geographical Location	12.97°N 77.56°E	17.366° N 78.476° E	17.6868° N, 83.2185° E
Description	Commercial IT hub	Fastest growing metropolitan	Coastal city, Port city
Climatic Region	Tropical savanna climate	Tropical wet and dry climate/semi-arid	Tropical wet and dry climate
Climate Data: Temperature	Annual mean temperature is 25 °C Maximum temperature is 41.0 °C	Annual mean temperature is 26.6 °C Maximum temperature is 40.0 °C	Annual mean temperature is 24.7 °C Maximum temperature 42.0 °C
Climate Data: Mean Precipitation	986.8 mm	828.5 mm	1,118.8 mm
Climate Data: Humidity	63%	56%	52%
Population	84,25,970 (CENSUS,2011)	68,09,970 (CENSUS,2011)	20,35,922 (CENSUS,2011)
Total Land Cover	709 km ²	650 km ²	681 km ²
Available Urban Green Cover	6.46%	1.7%	N/A (Data from authentic source was not available)
Major Urban Water Sources	Kaveri River (100Kms Away) Arkavathy River	Osman Sagar, Himayath Nagar, Singanoor, Manjeera, Akkampally, Sripada Yellampally (Godavari)	Yeleru/Godavari, Raiwada, Thatipudi, and Meghadri Gedda
Existing Urban Farming Practices			
Government Initiatives	None in Bangalore Urban Area. Vision to maintain greenbelt around the city	The Department of Horticulture Government of Telangana introduced the scheme “Vegetable Growing in Urban Areas” under Rashtriya Krishi Vikas Yojana (RKVY) for the year 2012-13	No specific resources allocated from Government side. However, development of parks is encouraged under PPP (Public Private Partnership) mode.
Individual farming activities	Micro-farming on balconies, roof-top terraces, gardens and window sills, Vacant plots near their property	Micro-farming on balconies, roof-top terraces, gardens and window sills	Micro-farming on balconies, roof-top terraces, gardens and window sills
Community farming activities	Vacant plots, community living, institutional level and Peri-urban areas	Vacant Plots, institutional level, community living areas, along the rivers and Peri-urban area	Vacant Plots, and peri-urban area

Drivers in existing Urban Farming practices			
Land availability	Low	Low	Medium
Access to water for irrigation	Rainwater, polluted lakes, treated urban sewage water	Rainwater, polluted rivers and lakes, municipal water	Rainwater, ground water, municipal water, water streams
Infrastructure facilities	Good but stressed due to higher density of population.	Good	Now being developed under smartcity mission
Urban agriculture Policies	None	None	None
Government support	Low for urban agriculture. Mostly supports rural agriculture	Medium for urban agriculture	Low for urban agriculture
Presence of local support system	High (NGOs, stores, seed banks, market)	Medium (NGOs and Stores), Universities	Medium (NGOs, local gardeners)
Availability of Manpower	Some farmer families and citizens	Small-and medium scale farmers and citizens	Some farmer families and citizens
Citizen Motivation and Participation	High	Medium	High
Market availability	High - Urban Farmer's market, Organic stores, Restaurants seeking organic food supply	Medium - Organic stores, occasional farmer's markets by NGOs	Low - Occasional Urban Farmers Market by NGOs, few stores
Forces that support or hinder wider adoption of Urban Agriculture			
Driving forces	Labour availability, employment needs, local support system, citizen motivation, market availability	Farmers availability, employment needs, government initiatives, citizen motivation, market availability	Local support system, Farmers availability, employment needs, citizen motivation, Land availability, access to safe water for irrigation
Hindering forces	Land availability, access to safe water for irrigation, lack of government support or policies supporting urban agriculture	Land availability, access to safe water for irrigation, lack of policies supporting urban agriculture	Lack of government support or policies supporting urban agriculture, low market availability
Recommendations to promote wider adoption of Urban Agriculture	Effective zoning of land for Urban farming, Policies encouraging urban agriculture, De-centralised sewage water treatment made available for irrigation, connect farmers with vacant plots for leasing, micro-farming in and around built environment. Vertical farming where space is constraint. Set-up laboratories to test soil and water quality.	Effective zoning of land for Urban farming, Policies encouraging urban agriculture, De-centralised sewage water treatment made available for irrigation, connect farmers with vacant plots for leasing, micro-farming in and around built environment. Set up laboratories to test soil and water quality. Encourage citizen participation through public-private partnership	Encourage citizen participation through public-private partnership. Set-up outlets for buying farming equipment and organic fertilizers and set-up outlets for selling their produce. Effective zoning of land for Urban farming, Policies encouraging urban agriculture.

A major problem that urban Indian farmers face is the drying up of their wells leaving only polluted water for them to access. Some cities do have facilities to treat a part of their wastewater; but even then, the treated water is released into already contaminated water bodies. Directly using this polluted water for irrigating crops certainly affects the health of both farmers and consumers. This problem could be dealt with by de-centralising sewage treatment by locally treating the sewage and also reusing and recycling the water. Creating buffer spaces near the water bodies that can filter the contaminants from entering into them and can reduce the pollution to a certain extent. Technologies like constructed wetlands, soil-scape filter, green bridge, bioremediation can help protect and treat the natural waterbodies in the cities. Untreated wastewater may be used for growing trees, shrubs, crops for industrial use and other non-edible plants.

Another challenge observed is that over the last two to three decades, agricultural land in the peri-urban areas have been increasingly converted for other use, and the surviving farmers are struggling to deal with the pollution of their water sources, losses from farming and pressure to sell their land. One way forward is protecting the land and water resources and institutionalizing and incentivizing urban agriculture for traditional farmers in urban areas. Urban agriculture can be promoted through land zoning for agriculture in city master plans, taxing of vacant plots and stopping speculative buying and conversion of agricultural land, by providing resources to poor farmers like free soil and water testing labs, and incentivizing housing societies that take up horticulture. Urban agriculture policies should consider a combination of social, economic and environmental aspects. Due to the multi-dimensional nature of urban agriculture, policy development and action planning for it should involve multiple stakeholders from sectors such as agriculture, health, waste management and community development. Making an inventory of the available vacant open land within the city by community mapping or GIS-based data and by analyzing its suitability for agriculture will be a good starting point for enhancing access to land for urban farming. Giving short- or medium-term leases to organized groups of urban producers can also help. Clearly earmarking zones and avoiding unscientific intervention where only urban agriculture suited to local conditions and resource availability is practiced can reduce possible health and environmental risks. Policies should create the right framework conditions for reinforcing the practice of urban agriculture as a sustainability tool.

5. Conclusion

Unplanned urbanization has led to serious problems in Indian cities. Urban Agriculture can be a solution by contributing to the development of sustainable and resilient cities that are inclusive, food-secure, productive and healthy. From this study it is evident that though there are challenges there are many factors that are favorable for the success of Urban Agriculture in India. Detailed survey of the existing infrastructure, knowledge and motivation among citizens, study of existing land-use and policies needs be done for wider adoption of Urban farming in various Indian cities.

References

- [1] Ramachandra TV & Aithal, Bharath H & Sreejith K, 2015. "GHG footprint of major cities in India," Renewable and Sustainable Energy Reviews, Elsevier, vol. 44(C), pages 473-495.
- [2] UN-Habitat, 2016. World Cities Report: Urbanization and Development: Emerging Futures, p. 7;
- [3] FAO, 2013. Food Wastage Footprint: Impacts on Natural Resources (Summary Report). 1-63.
- [4] Bharath H Aithal, Vinay S and Ramachandra T V, 2013. Modeling and Simulation of Urbanisation in Greater Bangalore, India, Proc. of National Spatial Data Infrastructure 2013 conference, IIT Bombay, November 29-30, 2013, pp 34-50
- [5] "Urban Farming in Hyderabad." Accessed February 1, 2019. <http://horticulture.tg.nic.in/UFarming/UFarming.html>.
- [6] Style L. 2019. *Growing salad sans soil*. [online] The Hindu. Available at: <https://www.thehindu.com/life-and-style/food/hydroponics-simply-fresh-farming-sachin-and-shwetha-darbarwar-hyderabad/article19502552.ece> [Accessed 11 Feb. 2019].
- [7] Dey S. 2019. How a Cuban Organic Farming Revolution Spurred This Engineer to Make Farmers out of City Dwellers. [online] The Better India. Available at:
- [8] Buechler S, and Devi G 2002 Livelihoods and Wastewater Irrigated Agriculture along the Musi River in Hyderabad City, Andhra Pradesh, India [Editorial]. [Http://www.ruaf.org/](http://www.ruaf.org/). (Accessed on 10 August, 2017, from <http://www.ruaf.org/livelihoods-and-wastewater-irrigated-agriculture-alongmusi-river-hyderabad-city-andhra-pradesh>).
- [9] Icrisat.org. 2019. Facilities and services – ICRISAT. [online] Available at: <https://www.icrisat.org/research-facilities/> [Accessed 2 Feb. 2019].