For Restricted Circulation

Occasional Paper
No.10-1216

FUTURE OF URBAN AGRICULTURE IN INDIA

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December-2016

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Abstract

Cities in India are beset with many problems which make urban life increasingly difficult with every passing day. Scarcity of water or mismanagement of water supply, inadequate waste water treatment and municipal solid waste management leading to the spread of vector borne diseases and pollution of its soil and water bodies, creation of heat islands and increasing poverty are some of them. With 50% of the Indian population expected to live in cities by 2050 and change in climate predicted for the future, these problems are bound to increase manifold in the days to come.

The percentage of the urban population growing their own food is miniscule. Food and nutritional insecurity is often considered a rural phenomenon. However, the truth is that the food and nutritional security of urban dwellers is compromised by many factors including non-availability of food, price fluctuations and poverty. There is considerable undernourishment and deficiency of calorie intake in India's urban areas. Urban agriculture or peri-urban agriculture (hereafter referred to as Urban Agriculture or UA) can not only provide nutritional security but also help find sustainable solutions to the growing challenge of wastewater and solid waste management in addition to helping alleviate poverty.

Many cities around the world have adopted pro Urban Agriculture policies and promoted it with varying degrees of success. In India, Urban Agriculture is not a priority at the moment at the institutional level. A majority of the urban dwellers also do not realise the need for producing their own food. The conditions presently existing in most Indian cities are not favourable for the easy adoption of UA. There is a serious problem of economic incentives. Non-availability of land and astronomically high land prices are major concerns. Scarcity of water for irrigation is a significant constraint, even as there is a huge quantum of waste water generated by cities, which can be treated and reused. The paper argues that UA has to be institutionalized for it to make a significant contribution to urban food security and income generation through incentive structures. The paper suggests the following legal and institutional interventions and market instruments for promotion of UA : 1] 'zoning' of land for urban agriculture in urban development master plans; 2] promotion of urban land market, through enabling laws; 3] imposing tax for vacant plots; 4] technology extension services through soil and water testing laboratories; 5] volumetric water pricing by urban water utilities; 6] tax incentives for housing societies which take up UA; and, 7] subsidies for precision farming systems.

1 Introduction

With food prices rising and with increasing incidence of extreme climatic events, the Food and Agricultural Organization of the United Nations (FAO) has identified urban and peri-urban agriculture as a farming system that can contribute to domestic food & nutritional security and jobs, and improving urban ecology and sanitation, thereby achieving poverty alleviation, food security and sustainable urban development. The FAO defines urban and peri-urban agriculture as an industry located within (intra-urban) or on the fringe (peri-urban) of a town, a city or a metropolis, which grows and raises, processes and distributes a diversity of agriculture products, using largely human, land and water resources, products and services found in and around that urban area.As India is projected to add 400 million people to its urban population by 2050, it is very important for the country to address this issue earnestly to stay ahead of the huge challenge of meeting the nutritional security and sanitation needs of the urban dwellers. At the aggregate level, access to land and water can play a critical role in reducing urban poverty and improving food and nutritional security through urban and peri-urban agriculture, especially gardening of fruits, flowers and vegetables. There is a growing market for these products in cities particularly for organic produce with increasing buying power and nutritional awareness among the residents.

At the micro level however, those who have land in their dwelling premises may not have the time and interest or motivation to undertake farming while those who are willing or are in need of work may not have the basic factors of production for the same. So there is a need to connect the two groups, through appropriate institutions. In heavily populated cities, where availability of land is a constraint even at the aggregate level, a different approach may be needed to overcome the scarcity of urban space for urban agriculture including developing technologies for vertical farming. In Singapore, Sky Greens, a business venture of entrepreneur Jack Ng produces in its low carbon, hydraulic driven vertical farm, one ton of vegetables every other day and is five to ten times more productive than a regular farm. Chicago's 'Farmed Here' uses hydroponics systems to produce greens in an abandoned warehouse and provides employment to more than 200 locals.

The problems related to real estate development in India also have a bearing on the availability of usable land for urban agriculture. There is a huge investment in plots and apartments, which remain un-used. A sizeable percentage of this investment is black money. In cities like Singapore where vacant land tax laws are stringent there is more effective utilization of urban land.

While many large cities are already under water stress, urban agriculture would increase the demand on the already stressed resource base. Hence, new sources of water need to be found. In most cities and towns in India the management of waste water and solid

waste is far from satisfactory. Most water bodies in the cities are polluted with untreated and partially treated sewage. Municipal waste including biological waste ends up in the soil and water bodies. An assessment by Water Aid says that about 80% of India's surface water is polluted. According to the Census of India 2011 only 32.7 percent of urban households are connected to a sewerage system. The remaining depend on in situ systems of disposal and it is unclear how the waste is further disposed.

But, if effectively planned, there can be a win-win situation for those who are interested in urban agriculture and municipal water utilities. The biodegradable waste can be effectively used as fertilizer for the small scale urban farms after composting while the waste water can be treated to such levels that it can be used for irrigating these farms. The possibility of using bio swales for the treatment of grey water can also be explored.

The objective of this paper is to analyse the urban agriculture scenario in India, identify the prevailing problems and constraints and suggest a way forward based on a nuanced understanding of the factors that make urban agriculture successful. The cities where UA has been very successful were studied to understand the factors that contribute to the success. An attempt is made to identify the factors that help sustain UA and the problems that hinder it, in different Indian cities where there is considerable urban agricultural activity. The future institutional and policy support needs for promoting urban agriculture were examined along with the existing institutional support for farming in cities.

2 Need for Urban Agriculture in India

The urban population in India which stands at 377 million is expected to grow by 404 million by 2050 (World Urbanisation Prospects, 2014). The nutritional requirements of this increased urban population have to be met. Also, with growing affluence and increasing nutritional awareness among the city dwellers about nutrition, there will be increased demand for vegetables, fruits, eggs, meat, dairy products and even flowers. The direct consumption of food grains has decreased while the demand for food products higher up in the food chain, especially processed food, has gone up in recent years.

On the other hand, about 65.5 million people live in urban slums and sprawls which lead to intra generational nutritional inequality. As pointed out by the "Report on the state of food security in urban India" by the M. S. Swaminathan research foundation the situation in urban areas is often overlooked during discussions on food and nutrition security. There is considerable food and nutritional insecurity in the urban areas the situation being worse in smaller towns. Especially vulnerable are women and children; about 50% of the women are anaemic, and undernourishment resulting in severe energy deficiency is rampant among women (MSSRF, 2010).

People living in urban areas have much less control over the supply and quality of the food they consume as compared to the rural population. The food prices, especially those of vegetables, fruits and pulses, which heavily influence the quantum of their intake, are often subject to huge fluctuations due to many factors ranging from the vagaries of the monsoon to spread of diseases to the changes in price of crude oil in the international

market and to the changes in policies governing import and export of agricultural commodities. They also have no control over the use of pesticides and other chemicals used in producing the food, which has serious implications for nutritional value and safety of the food consumed. Instances where farmers grow organic food for their own consumption and insecticide laden produce for sale have been reported. By the time it reaches the urban consumer the food will not be fresh and maybe refrigerated or artificially ripened. Use of chemicals to increase shelf life of the produce is also prevalent. The prevalence of cancer in India is expected to increase from an estimated 3.9 million in 2015 to an estimated 7.1 million people by 2020 (Ernst and Young LLP, 2015).

Urban agriculture will go a long way in addressing these concerns to a great extent. It can provide fresh produce to city dwellers without the need for resource intensive transportation, refrigeration and storage facilities, by reducing the time and distance from farm to fork. Being labour intensive it will also provide jobs and can become a source of income and thus contribute to poverty alleviation. Urban farming has been found to be particularly helpful for poor women in urban and peri urban areas as it provides a means for meeting their families' nutritional needs and getting some income as they work near their homes, simultaneously taking care of their families. UA has a significant role in urban environmental management as it can combat urban heat island effects and function as an urban lung in addition to providing visual appeal. The Food and Agricultural Organization has long since recognized Urban Agriculture as a key element in food security strategies. However formal recognition of UA and its integration into the urban planning process is necessary for it to be successful.

In India urban agriculture is being carried out in many cities including Mumbai, Delhi, Kolkata, Bengaluru and Chennai under the leadership of government, private agencies or even individuals. An important factor that needs to be mentioned in this context is the use of treated or untreated waste water for agriculture. In cities like Delhi, Hyderabad, Chennai and Ahmedabad direct and indirect use of waste water in urban and peri-urban agriculture is widespread. While the use of untreated waste water for irrigation is not allowed for public health reasons it is being used in many places for want of access to fresh water. It is also proven that yields are higher with the use of untreated domestic waste water for irrigation owing to the presence of nitrates. There are recent initiatives to sell treated waste water to farmers in Delhi, Noida, Hyderabad and Chennai. Treated sewage is sold in Chennai and there is increasing demand for the same. The Noida authority uses treated waste water for irrigating some green belts and have plans to undertake tertiary treatment to treat waste water to potable standards. In Hyderabad farmers lift domestic effluent from the Musi River for irrigation purposes. The use of waste water in urban agriculture not only reduces demand for fresh water but also helps close the loop in urban water management, provided the wastewater is treated to safe standards for preventing environmental pollution. Organic waste from the city can be composted and used in urban agriculture with the added advantage of reducing waste that is dumped on land. FAO reports that extensive farming in Havana led to the near elimination of local refuse dumps for household waste.

There is also great interest in organic farming in many quarters. However the scale of the UA efforts has not been sufficient to make a substantial difference to food and nutritional security in the urban areas. There is need to undertake planning towards achieving this goal. Crucial to this is the research based knowledge about the set of conditions under which urban agriculture becomes viable.

3 Urban Agriculture in India and Other Parts of the World

One example which is always quoted while discussing initiatives on urban agriculture is the success story of Havana, Cuba. After the Cuban communist party came to power in 1960 and till 1989, Cuba was importing most of its food, devoting most of its agricultural land to the cultivation of sugarcane. Soviet Union paid premium price for the sugar imported from Cuba in the form of food, petroleum, machinery and other goods supplied to Cuba in return. But the fall of the Soviet Union in 1989 led to severe food shortages in Cuba and with no access to food, petroleum, machinery and fertilisers Cuba had to quickly transform itself from an import dependant nation to a food self- sufficient nation. The main reason for the success of the world's first co-ordinated urban agricultural programme other than the fact that it was a necessity at that time was the complete support provided by the government with favourable policies and institutions playing a pivotal role in spearheading the urban agricultural revolution.

President Fidel Castro proclaimed that no piece of land should be left uncultivated. Even on the lawn of the Ministry of Agriculture (MOA), crops were planted. The newly formed Urban Agriculture Department worked with the Poder Popular or Legislative Council to change city laws to suit urban agriculture. The urban agriculture programme worked by integrating access to land, providing extension services, undertaking research and technology development and providing marketing schemes and selling points for the produce. The self-supply (autoconsumo) plan, initiated in the late 1980s, was expanded to increase local food self-sufficiency and reduce the need for transport, refrigeration, storage and other resource-demanding activities. In September 1993, the Cuban Government issued Law No. 142, breaking up the majority of large state farms into Basic Units of Production (Unidades Básicas de Producción Cooperative (UBPCs) and the ban on farmers' markets was lifted. This helped to make the collective of workers and their families self-sufficient, connect income directly to the degree of productivity and increase autonomy of governance (Novo and Murphy, 1998) By the year 2000, urban agriculture had become an activity covering 12% of the area of Havana involving more than 22000 urban and peri-urban producers, and resulting in a near elimination of refuse dumps for household waste. By then, UA accounted for more than 60% of the country's vegetable production and provided 117000 direct and 26000 indirect jobs (FAO, 2008).

FAO (2008) discusses several urban agricultural projects from different parts of Asia, Africa and Latin America. Roof gardens in Cairo, solar green houses in El Alto, Bolivia, micro gardens in the slum areas of Bogota and Medellin in Columbia, Edible Landscape Project in Kampala, Uganda and Backyard Agricultural Programme of Mexico are some of them. In India, the Hubli-Dharwad Municipal Corporation practices UA and small livestock

farming in the urban areas and livestock, vegetable and sewage based farming in the peri urban areas (FAO, 2008).

Urban agriculture has not been very popular in India. The rural areas have traditionally provided food for the country's population. There were also resource constraints in pursuing urban farming in a systematic way. However, with more and more people migrating to urban areas it is predicted that India will add 404 million people to its urban population by 2050 (UN, 2014). This would take away a large amount of water resources from rural areas to meet the urban needs, competing with agricultural demand in the rural areas. It is therefore important that the wastewater generated in urban areas is reused in an environmentally sustainable manner to meet part of the food demand in urban areas, which in turn can also reduce the pressure on scarce water resources. Increasing the contribution of UA in India would ensure food and nutritional security for the rapidly growing urban population in addition to providing jobs. As pointed out by FAO (2001), Urban and Peri Urban Agriculture helps in closing energy loops and transforming waste into biodiversity. In recent years there has been some interest in urban agriculture in some cities in India.

Mumbai is a city which has little open space that can be used for urban farming. Mumbai also is home to one of the largest slums in the world. But it is also a city where there is a lot happening in the UA scene. Citizens of Mumbai are becoming innovative and are transforming terraces, balconies and common areas into vegetable gardens. Organisations like City Farming, Earthoholics, Fresh& Local, Urban Leaves, etc are helping people to grow their own food. The Indian Railway has leased its land along railway tracks to farmers to prevent encroachment and to keep the land clean and useful. A waste dump in Mumbai's Ambedkar Nagar slum is now a community garden. It is another matter that many of these farmers who have no access to good water use drainage water for farming leading to complaints that the vegetables contain harmful levels of heavy metals and other chemicals.

Though Pune has some gardens on terraces and empty parking areas, the Pune city corporation's City Farming Project started in 2008, where citizens were encouraged to grow vegetables and other crops on allocated land, was not a success (Times of India, 2012). Nagpur is another city where people are into organic farming on terraces and small plots but at an informal level. Slum dwellers in Cuttack have taken to organic farming and even sell the surplus produce to local markets. In Delhi there is extensive farming happening on the banks of river Yamuna as the flood waters make it very fertile though the farmers have no legal sanction to farm there.

In Hyderabad, farmers along the Musi River use water from the river for urban farming which except during heavy rains consists of the waste water let into it from houses, apartments and commercial buildings as it flows through the city. Though the government did not support the use of partially treated waste water for irrigation, farmers have continued to do so due to the absence of an alternate source of water. Para grass, rice and vegetables are grown though only 1-2 % of the vegetables contributed to the market. With the introduction of more sewage treatment plants the quality of water

has improved and the farmers have year round access to water. However significantly higher morbidity rates have been observed among the farmers using waste water with skin problems, nematode infections and waterborne diseases like dysentery being reported(IWMI, 2013).Measures to minimise risks while at the same time providing access to waste water for irrigation is what is required.

In Chennai too roof top farming is becoming popular. The Government of Tamil Nadu introduced a "Do-it-Yourself" kit under the Urban Horticulture Development Scheme in 2014 to enable city dwellers to grow vegetables on open terraces of individual houses and apartment buildings. First introduced to Chennai, the kit is now available in Madurai also. At present the subsidised kits which contain the basic materials needed to start a garden (except soil) are priced at Rs 500 and there is no limit on the number of units one can purchase. There has been a lot of interest to purchase the kits but we do not know if the scheme has been successful in increasing the access to nutrition among the poorer people or in reducing their monthly food expenses. While the Chennai Metropolitan Water supply and Sewerage Board popularly known as Metro Water says on its website that it sells 36MLD of secondary treated sewage and 5 MLD of untreated sewage to industries this is only a small quantity considering the amount of sewage generated in the city. Another disturbing fact is that during the drought of 2003 Metro Water bought from farmers the rights to pump water from 164 bore wells and from another 44 in 2004. A majority of these farmers prefer selling the water as it fetches them more money than farming on their small holdings (Down to Earth, 2004).

The department of horticulture in Karnataka provides support for horticultural activities and the Horticultural Producers' Co-operative Marketing and Processing Society Ltd. or HOPCOMS was established with the principal objective of establishing a proper system for the marketing of fruits and vegetables covering the five districts of Bengaluru Urban, Bengaluru Rural, Kolar, Ramanagara and Chikkaballapura. HOPCOMS obtains horticultural produce directly from its members. It uses an indent system that puts a ceiling on the quantity procured with the result that it favours small scale farmers who make up 77% of those who supply to HOPCOMS (Kolady, Krishnamoorthy, & Narayanan, 2007).

According to an exploratory study from the IWMI-Tata Water Policy Programme published in 2012, there is considerable use of waste water in urban and peri-urban irrigation in Gujarat. Small scale farmers prefer to irrigate their crops with waste water as it is cheaper, more readily available and provides nutrients to the crops too. However application of waste water poses a health risk to the farmers and is not suited to micro irrigation techniques. Soil quality may also be affected due to application of waste water. The amount and quality of nutrients as well as presence of pathogens in the waste water need to be ascertained before use in agriculture.

The Kolkata Municipal Corporation has no sewage treatment plant. The 3800 hectares of wet land on its eastern fringe are used for biological treatment of waste water. Agricultural labourers use aquatic plants and sunlight to treat the waste water and also use strips of land in the low lying area to compost the organic waste from the city. The

treated water is used for pisciculture in 3500 hectares and vegetables are grown in 350 acres.26000 urban poor work in this venture (Gupta and Gangopadhyay, 2013)

Kerala is a continuous ribbon of settlement with no demarcation between urban and rural settlements. Urbanisation is happening at a fast pace and Kerala is expected to become an all urban state in the near future (Sharma, 2004).Kerala's rice deficit, which was 50 to 55 % from the early fifties to the mid-seventies, is more than 85% now. This has resulted from a consistent reduction of the area under rice cultivation and an increasing population even though at a slow rate (Kannan, 2000). Over the years Kerala shifted its focus to more remunerative and less labour intensive cash crops such as rubber, coconut and banana eventually becoming dependent on import from Tamil Nadu and Karnataka even for vegetables. There has been growing awareness about the health risks associated with pesticide infused food in Kerala. This coupled with the fact that sample tests conducted in laboratories of Kerala revealed high chemical residues in fruits and vegetables supplied from other states has generated a great interest in organic farming in the state. While the production of grains and pulses is limited by agro-climatic conditions fruits and vegetables can be produced in the state itself. Kerala's water situation is also much better than that of many other states. Individuals as well as self-help groups have started cultivating on rooftops, balconies and backyards. The government of Kerala initiated a Vegetable Development Project to augment vegetable production in the state and the collective farming projects implemented by the government of Kerala's poverty alleviation programme Kudumbashree brought considerable fallow land back under cultivation financially empowering thousands of women in the process. The production of vegetables in Kerala increased from 8.25 lakh ton in 2011-12, to 13.55 lakh ton in 2014-15 and is expected to increase substantially in the next three years (Kerala State Planning Board, 2015).

Thus it can be seen that there is potential and interest for urban farming across India including the use of treated wastewater for irrigation and the use of organic waste in the production of fertilizer.

4 Problems in Urban Agriculture and possible solutions

We have talked about the need for urban farming in India and the ways it can contribute to the economy and poverty alleviation in the section "Need for Urban Agriculture in India". However urban farming is not without problems. Success of urban farming depends on how well the issues regarding land, water and environmental pollution are addressed.

The main issue with urban agriculture is the availability of land for cultivation. In fast growing large cities where there is no more free space available, setting aside land for agricultural use is not feasible. Even where some free land is available the price can be so high that it is not possible for people to acquire the land for farming purposes. A study done on the effectiveness of the green belt as an urban growth boundary in Bengaluru found that there was no significant reduction in prices of land within and outside the city limits. Successive master plans have absorbed illegal and unplanned revenue layouts, i.e.,

private layouts that are culled out from agricultural land and converted for non-agricultural uses, into the city, often illegally and without necessary approvals, ever since 1972 (Venkataraman, 2013).

On the outskirts of many cities agricultural land is either converted for commercial purposes or bought and left fallow in anticipation of a price rise. Price of farmland has increased three to hundred fold in different parts of India. The Economic Times reported in 2013 that an acre of farmland in Vadicherla in Mehaboobnagar district of present day Telangana which is not near any big city and which cost Rs 25000 in 2003 rose to Rs 12 lakh by 2012. The increase was 100 fold in villages next to Vijayawada. We found that the price at which the owners are willing to sell an acre of farmland 30 km from the Hyderabad airport is as high as Rs 3 crore and that for farmland 75 km from the airport is Rs 10 lakh per acre. Around 98 million out of total 120 million farm holdings in India belong to small and marginal farmers. Consumption expenditure of marginal and small farmers exceeds their estimated income by a substantial margin and therefore there is a high level of poverty among small farmers (Dev, 2012). The high price their land would fetch on selling compared to the meagre amount they make from farming makes them sell the land and exit agriculture. In the process, the area under agriculture reduces. In many instances farmers have become labourers and farmland has become unaffordable to farmers in peri urban areas and even in villages. Some of them have sold their land to builders and live off rental income from apartments constructed on their land. Hence, it is not possible to buy agricultural land in peri urban areas and undertake farming as a profitable venture. Even the farmers who continue with agriculture and the new entrants would rather go in for high value cash crops than staples. This is where the government can step in to ensure that some land is set aside for farming purposes wherever feasible. Steps should be taken to stop speculative buying and illegal conversion of agricultural land. Strong enforcement of planning norms in the urban and peri urban areas is needed to prevent illegal conversion of agricultural land. It can also impose tax on vacant plots and houses to prevent unproductive use of land.

Setting up schemes for leasing vacant plots for cultivation and encouraging the use of roof tops and backyards of houses and apartments as well as premises of schools and other institutions for farming are some of the ways space can be found for urban farming. Homeowners with space in their backyards or rooftops where they want to farm but are unable to do so themselves must be connected with people willing to grow food there for a fee. For example in Canada the 'Sharing Backyards' project connects homeowners who have a yard with people who want to grow food but do not own any land (source: Radio Canada).

Large water requirement for crop production is another major hurdle for urban agriculture. Cities in India are struggling to meet the fresh water requirements of its residents for human needs. In many cities the utilities are able to provide only a fraction of the water requirements of its residents. The balance is met through wells drilled in the owners' own premises or purchased from private tanker water suppliers who charge a large sum of money. Indiscriminate use of ground water for farming will lead to falling water tables thereby undermining the water security of the city. A majority of Indian

cities are not located in water abundant regions. Due to encroachment of tanks and ponds and diversions of water most tanks and ponds in these cities have already dried up. Others are heavily polluted with waste and sewage and hence unusable. In many urban areas around the world including humid regions aquifers are getting depleted as pumping takes place within small geographical areas creating "cones of depression"(Mukherjee, Shah, and Kumar, 2010). For example, according to the Central Ground Water Board, India (2011), groundwater development in and around the Ahmedabad – Gandhinagar urban area has reached a critical stage while in Bengaluru ground water is being pumped at a rate higher than the recharge rate with improper management of sewage causing nitrate pollution in the ground water as well. Using grey water and treated waste water for irrigation, a manifold increase in water productivity in agriculture as well as using lower quality water unfit for drinking for farming are the solutions to this problem. Farmers in Chennai have already been buying treated waste water and farmers along the Musi River in Hyderabad use the water from the river which is mostly effluent let into it by apartments, houses and industries. Given that 80% of the fresh water supplied ends up as waste water, treating the waste water to a level that makes it reusable for crop production, but will not cause health hazards to the farmers and consumers, will help close the loop in urban water management. Israel uses saline water and recycled sewage water for agriculture and has been conducting research on varieties and species of plants that are salt-tolerant and resistant to soil pathogens and on using grafted vegetable plants wherein a susceptible scion is grafted onto a resistant root stock. For example, cultivars resistant to Fusariumoxysporumf.spvasinfectum race 3 (FOV3), which posed a threat to Pima cotton (Gossypiumbarbadense L), were developed which are superior in yield and quality compared to the susceptible ones, even in non-infested soil (Fishler et al., 2007). Watermelons and cucumbers are grafted onto different root stocks to prevent damage by soil borne diseases (Cohen et al., 2007).

Improper and excessive use of pesticides and fertilisers in farming can pollute the soil and water in urban areas. Organic farming is the answer to this problem. The state of Sikkim has been declared fully organic in 2016. Mizoram too is expected to become a fully organic state soon while Orissa is taking to organic farming in a big way.[1]The National Centre for Organic Farming under the ministry of agriculture operates through six regional centres. The Ministry has announced in February 2016 the setting up of the National Organic Farming Research Institute (NOFRI) at Gangtok, Sikkim. Another point to be mentioned is that organic farming is more successful where there are a larger proportion of small scale farmers taking to it, as large scale farmers are not willing in

[1]The Chief Minister of Sikkim announced in the state legislative assembly in 2003 that he was declaring Sikkim to be an “Organic State” meaning the use of chemical fertilizers and pesticides will be gradually phased out. By the end of 2015 Sikkim had converted its 75000 hectares of agricultural land into organic farmlands with no use of chemical fertilizers, pesticides or GMOs and all Sikkim’s farms were certified organic by an independent certifying body. On January 18th 2016, Sikkim was declared completely organic. Mizoram passed the Mizoram Organic Farming Act, 2004 on July 12, 2004. Import and use of chemical inputs in agriculture in Mizoram is very less now and it is expected that Mizoram too will become fully organic in a couple of years. Only organic farming is practiced in large areas of Orissa and there is tremendous scope for organic cultivation in the state. The state has the largest area of organic certified farms of 26,300 hectares in India and its share in the global organic exports is expected to be 2.5% by 2017.

most cases to switch to organic farming. Though organic farming produces food with minimum harm to the ecosystem, animals and humans, critics have always argued that the yield from organic farming is considerably less than that from conventional farming. Though this difference has been shown to be much less than it is believed to be and is highly contextual (Seufert et al., 2012), it is very difficult to convince large scale farmers to shift to organic farming. Also they have been using chemical fertilisers and insecticides for far too long; also doing mono cropping, to switch to organic farming easily. It will also take a few years for the soil in such farms to be detoxified and the products from the farms to be certified organic. This makes it easier to push for organic farming in urban areas.

Levels of pollution in cities are higher than in rural areas in the soil, water and air. Emissions from factories and automobiles lead to the presence of heavy metals and other toxic chemicals in water, soil and air while untreated and partially treated sewage lead to the presence of pathogens. This exposes the people who work in the urban farms and to a lesser extent the consumers of the produce to health risks. Suitable checks and precautions need to be exercised to prevent diseases triggered or produced by these pollutants.

In earlier days, houses used to have kitchen gardens and fruit trees which at least catered partially to the needs of the family. These days most houses and apartments in cities do not have much free space around them. Even houses and housing societies that have some cultivable land undertake landscaping that involves non edible vegetation that emphasizes on beauty rather than utility. Builders, housing societies and individual owners must be encouraged and given technical support to include edible plants and fruit trees as part of their landscaping. Tax incentives can also be given to housing colonies and apartments to undertake landscaping that includes fruit trees, vegetables, herbs, etc.

5 Factors Contributing to Success of Urban Farming

The reasons why people engage in urban agriculture are varied. For the urban poor it is a means of getting vegetables and fruits which otherwise are beyond their reach and also making a living selling the produce. For others it is a way to deal with the fluctuating prices of vegetables, to consume fresh produce that has not been refrigerated or transported over long distances or to ensure that the food they eat is organic or pesticide free. Then there are some urban farmers for whom horticulture is a hobby.

Urban agriculture has been undertaken in cities with diverse socio economic conditions and having varying degrees of institutional support with different levels of success. While necessity was the factor that made UA successful in Havana the inability to procure pesticide free vegetables was what led the people of Kerala to take to organic farming. In a very densely populated city like Mumbai citizens are using innovative methods to have access to fresh produce. Farming in the slums of Cuttack, along the railway track in Mumbai and on the banks of the Yamuna in Delhi and Musi in Hyderabad helps the poor to meet their nutritional requirements and earn some money too in the process. The Pune City Farming Project initiated by the Pune Municipal Corporation did not take off

and interest in kitchen gardens has been slow to catch on. In Kerala where production of organic vegetables has increased and expected to grow further, about 60% of the 33,310 households in Thiruvananthapuram who were given grow bags, seeds, plants and instructions by the State Horticulture Mission continued with rooftop farming (Down To Earth, 2015). Residents of Hyderabad can avail a subsidy for rooftop farming but the practice is not widespread.

In many cities the poor urban farmers are fighting against odds to sustain their farming activities, relying on waste water like along the Musi River in Hyderabad or farming without legal sanction as on the banks of the Yamuna in Delhi. However, in cities like Chennai, Hyderabad and Pune there is institutional support but the number of residents taking up rooftop farming is less. The reasons can be varied including lack of space as in an apartment, lack of time or interest or lack of water. For example in a city like Bengaluru, many apartments buy water supplied through tankers for their daily needs. In the same cities where there is not much interest for roof top farming there are the urban poor who farm in the fringes of the city, Hyderabad and Chennai being examples. The farmers along Musi may be selling their produce at local markets thereby obviating the need for apartment dwellers to produce their own on their terraces.

It can be seen that urban agriculture is most successful when there is a need for and an interest in pursuing farming among a large section of the inhabitants of a city and there is institutional support for it. Institutional support is crucial for the farmers to get access to necessary resources. UA became extensively practiced in Havana because food availability declined by as much as 60% and residents had to produce their own food. More and more people started cultivating vegetables on their roof tops in Kerala because that was the only way they could ensure that the vegetables they ate were free from pesticides. In Mumbai farming on terraces and balconies helps recycle kitchen waste and provides fresh organic fruits and vegetables. In all cities there are poor people for whom urban farming is a means to feed the family and a source of income.

6 The Way Forward

Looking at the various cities in India where Urban Agriculture is popular it can be seen that there are no regional trends or pattern with regard to the practice of UA. Before undertaking UA in any city a preliminary survey regarding the need and interest for it among the residents has to be conducted. Once a strong interest has been identified the availability of resources including the need to set up waste water treatment facilities, composting facilities, etc has to be looked into. Identifying the sections of residents who are seriously interested in farming and providing them with support will ensure the success of the project. Availability of resources namely land, water for irrigation and support services including garden supplies , expert advice and microcredit are the prerequisites for success in urban agriculture.

In Cultivating Sustainable Cities: A Comparative Study of Urban Agriculture in Mumbai, India and New York City, USA, Satterlee (2015)observes that the urban farming communities in New York and Mumbai felt that they were not able to reach out truly to

the communities in need. In Mumbai the farmers felt they could concentrate either on food security or environmentalism but not both. While the predominantly upper middleclass not for profit farmer could concentrate on the quality of the produce without worrying about food security or income, the farmers along the railway line used drainage water, pesticides and fertilizer so that they can grow maximum food in minimum time. Different socio economic groups also had varying degrees of access to resources for urban farming. According to Satterlee (2015), governmental programs surrounding urban agriculture act as equalizers distributing necessary resources to communities that would not otherwise have access to them and that the absence of such programmes in Mumbai leaves a large gap between low-income farmers along the railway line and their more wealthy counterparts on community gardens, with regard to resources. In fact if residents who have access to and have the money to pay for more potable water decide to use it for agriculture they may be depriving other residents of water to satisfy even their basic needs. This is where institutional support and checks on urban agriculture become important.

As pointed out earlier, the availability of land and water are the factors that are critical to the success of urban agriculture in a city. The government can take steps to allot land for community gardens and introduce measures to free up empty plots for lease for urban farming and make them available for landless farmers. The optimum utilization of land in a city cannot be effective without help from the authorities. Projects that bring together people who own land or have spacious backyards with people willing to work on them are needed. Landowners fearful of losing their land rights let their land lie fallow rather than allow informal cultivation by landless farmers. There should be proper legal framework to lease or rent farmland. In an around cities agricultural land is being indiscriminately converted into non- agricultural land sometimes illegally without the permission of the revenue department. Proper zoning laws for cities with legal protection for areas earmarked for urban agriculture is necessary.

Most cities in India are struggling to provide water to its citizens. In many cities the city water supply does not reach a large percentage of residents who rely on ground water either from their premises or brought in water tankers from other parts of the city or suburbs. While almost 80% of the water used by urban dwellers ends up as waste water, cities do not have the facilities to treat the waste water and reuse it. In most cases only a part of the waste water is treated and the untreated and partially treated sewage enters the rivers and lakes in the cities polluting them and making them unfit for use for any purpose. Thus on the one hand there is a huge demand for fresh water and on the other there is a large amount of waste water which ends up polluting fresh water and also the soil.

The problem with sewage treatment plants is that they are expensive to set up and run and need space too. In most cases due to space constraints it is not possible to locate them in such places as would facilitate the productive use of the treated water. There is urgent need to find ways of treating the waste water in order to close the loop and also to meet the cities' water demands. While it may not be possible to use the treated water for domestic consumption it can be used to advantage in urban agriculture. If free of

pathogens, heavy metals and toxic chemicals the water with some nutrients left in it is beneficial for growing crops. Considering the amount of space and money needed to set up large scale centralized sewage treatment plants, the possibilities for setting up small decentralized sewage treatment plants need to be explored and the necessary laws passed for implementing the same. Grey water can be used without much treatment for irrigation. This will also help reduce the load on sewage treatment plants. The Centre for Science and Environment has reviewed and documented select case studies that present innovative, sustainable and affordable ways of treating the sewage locally including reuse/recycle. It is mandatory for building sites over a particular area to have their own sewage treatment plants in some cities like Bengaluru. Finding ways of treating all the sewage from the city and reusing the waste water including for urban farming will help address the demand for water as well as food in the urban areas. Micro irrigation techniques can also be used to reduce the water demand for urban agriculture.

Once land and water are available, projects to convert bio degradable waste from the city into compost for use as fertilizer, making available good quality seeds and organic insecticides, providing the necessary knowhow and expert advice as well as provision for microcredit will lead to the success of urban agriculture. India is presently the second largest producer of fruits and vegetables in the world according to the National Horticulture Mission launched in 2005-06 as a centrally sponsored scheme for the promotion of the horticulture sector through area based regionally differentiated strategies. In 2014-15 this scheme was made part of the Mission for Integrated Development of Horticulture or MIDH and is implemented by the State Horticulture Missions in selected districts of 18 states and 4 centrally administered territories. During 2005-06 to 2014-15, area coverage under the NHM has increased from 1.03 lakh hectares to 25 lakh hectares (MIDH, 2016). The MIDH provides assistance to farmers for a whole range of farming activities like production of plant material, setting up gardens including micro irrigation, setting up precision farms, creation of water resources, organic farming and certification, etc. Thus India already has an institutional framework for the promotion of horticulture in addition to the agriculture department. This has to be extended to provide special attention to cities to increase their share in agriculture/horticultural production.

Unplanned urbanization has led to serious problems in India. For example T.V Ramachandra of the Centre for Ecological Sciences, Indian Institute of Science, Bangalore cautions that the unrealistic concentrated developmental activities in Bengaluru would make the region GHG-rich, water-scarce, non-resilient and unliveable, depriving the city-dwellers of clean air, water and environment. There has been a tenfold increase in paved area, 88% reduction in vegetation, 79% decline in wetlands, high increase in air pollution, huge increase in city traffic and steep decline in the depth of the water table from 1973 to 2016 (Ramachandra and Aithal, 2016). The condition is similar in most major cities in India. There is an urgent need to reverse this trend to prevent our cities whose population is increasing day by day from becoming dysfunctional.

Urban planning policies in India have traditionally focused on development of infrastructure and land. It has mainly been concerned with constructing buildings and

roads without incorporating the concepts of social justice or environmental sustainability with the result that our cities have become centres of urban poverty and environmental degradation. Our urban planning policies should take a holistic approach towards our cities. Steps towards recycling solid waste and waste water, reducing pollution and increasing the green cover with an emphasis on urban food production in our cities will help make our cities more sustainable.

7 Conclusion

With increasing urbanisation of India's population it is essential that importance is given to urban agriculture to improve food and nutritional security. At least partial self-sufficiency in food will protect the urban poor from the uncertainties in food availability brought about by climate variability, price fluctuations, changes in oil price and the like. At present our cities are faced with problems of water shortages, inadequate systems to manage municipal waste and waste water, air, and water and land pollution and urban poverty. These problems will only get intensified as the urban population increases. Changes in weather patterns like floods and droughts will add to these woes. The Food and Agricultural Organisation has emphasised the role of Urban Agriculture in achieving real efficiencies by making productive use of underutilized resources and intensified agricultural practices (FAO, 2001).

In addition to institutional support, there is a need to incentivise farming in urban areas to make it attractive to the urban citizens. With this in mind we have developed a matrix of measures and mechanisms (see Table 1). The type of measures for creating incentives fall under legal; institutional; policy; technology and information and awareness. A survey of the literature and organizations and government agencies in this area makes it clear that there is no dearth of information or institutional support with regard to farming in India. From the detailed research and guidelines provided by the FAO to the extensive institutional framework in India in the agricultural and horticultural sector and the numerous NGOs who are active in this field there are many factors that are favourable for the success of UA in India. The available information and infrastructure have to be streamlined towards making UA a viable proposition in India. It is also necessary to weed out inefficiencies and corrupt practices as is seen in the speculative trading in land and illegal conversion of agricultural land for other purposes and polluting our water bodies with untreated sewage. Once this is done we foresee a very positive future for urban agriculture in the country.

Table 1: Measures and Mechanisms for Incentivizing Urban Agriculture in India

Type of Measures	**Incentive Mechanisms**					**Expected Outcomes**
Legal	Include UA as part of poverty alleviation programmes	Incorporate UA in city plans and identify areas where farming can be practised. Form Joint Liability Groups (JLG) to make credit available	Identify urban and peri-urban areas where specific animal husbandry projects can be undertaken	Enact laws that would help landless women obtain credit and access to land for farming activities. Include women in the JLGs	Increase tax on vacant plots, houses and apartments to optimize land use in cities. Provide tax incentives for housing societies to undertake UA activities	Productive use of urban land. Effective zoning of land for UA
Institutional	Land pooling: Set up procedures to connect land owners to potential farmers and to rent/lease land. Introduce concepts like 'share your backyard and 'Rent a field. Provide Subsidies for protected and precision farms, and vertical farms	Lease land along railway lines, under power lines, premises of government buildings and other vacant government land for farming by JLGs or other community groups	Set up outlets for organic fertilisers, pesticides, garden tools, grow bags, Soil, gardening tools, good quality seeds, etc. Make the procedure for organic certification easier	Make available treated water from sewage treatment plants for farming, for a price	Provide composters for apartments and housing communities at competitive or subsidized prices. Introduce the concept of exchanging biodegradable waste for compost or vegetables or exchanging compost for vegetables	Gainful employment in the UA sector. Increased income and nutrition in urban areas
Policy	Encourage setting up of protected farms and precision farms including vertical farms where space is a	Encourage export of fruits, vegetables and flowers where conditions are favourable Increase	Encourage participation by private sector through Public Private	Metering & pricing of water: to ensure optimum use of water. Introduce	Use the space allotted for landfills for farming or composting	Increased investment in UA. Recycling of wastewater and solid waste

	constraint. Establish a favourable climate for the setting up of agribusiness companies	cultivation of exotic fruits for which there is a growing market and are presently being imported	Participation projects which is supported by the government of India under the Rashtriya Krishi Vikas Yojana	separation of grey water to use for irrigation after biological treatment.		
Technology	Set up laboratories where urban farmers can get waste water/ grey water tested for toxins or pathogens and soil for nutrient deficiency and toxicity	Set up decentralized sewage treatment plants, wherever economically viable, and make available the treated water for farming	Provide facilities for technicians to visit the premises to solve any problem faced in farming	Provide training in farming and related activities		Greater productive use of treated wastewater. Preventing exposure of farmers and consumers to toxins and soil or water borne pathogens.
Information and awareness	Publish pamphlets to spread awareness and for information dissemination	Provide facilities where information can be obtained over phone or email	Connect labourers skilled in horticulture with home owners who want help with farming on their terraces or backyards	Create awareness about the harmful effects of using untreated grey water and sewage water for agriculture and about on- and off-site based safety measures to be undertaken where treatment is not adequate		Improved knowledge and awareness among urban farmers

References

Amerasinghe, P., Bhardwaj, R.M., Scott, C., Jella, K. and Marshall, F. (2013). *Urban Wastewater and Agricultural Reuse Challenges in India*. Research Report 147. Colombo, Sri Lanka: International Water Management Institute.

Baud, Isa., Post, J. and Furedy, C., eds. (2004). *Solid waste management and recycling: actors, partnerships and policies in Hyderabad, India and Nairobi, Kenya*. Dordrecht: Kluwer Academic Publishers.

Birkby, J. (2016). Vertical Farming. *National Center for Appropriate Technology, Butte, Montana*, [Online]. Available at: https [Accessed 5 Dec. 2016].

Central Ground Water Board. (2011).*Ground Water Scenario in Major Cities of India*. New Delhi: Central Ground Water Board.

Central Pollution Control Board. (2009).*Status of Water Supply, Wastewater Generation and Treatment in Class-I Cities and Class-II Towns of India*. New Delhi: Central Pollution Control Board.

Centre for Science and Environment, Decentralised/Sustainable Wastewater Treatment Technologies, *Centre for Science and Technology*, [Online]. Available at: http://www.cseindia.org/node/3798[Accessed 5 Dec. 2016].

Cohen, R., Burger, Y., Horev, C. and Koren, A. (2007). Introducing grafted cucurbits to modern agriculture: the Israeli experience. *Plant Disease*, 91(8), pp. 916-923.

Dev, Mahendra.S (2012*). Small Farmers in India: Challenges and Opportunities*. Mumbai: Indira Gandhi Institute of Development Research.

Drechsel,P., Keraita, B., Cofie, Olufunke, O and Nikiema, Josiane. (2015). Productive and safe use of urban organic wastes and wastewater in urban food production systems in low-income countries. In: RUAF Foundation and International Water Management Institute, ed., *Cities and Agriculture: Developing Resilient Urban Food Systems,* 1st ed. Oxon and New York:Routledge, pp. 162-191.

Ernst and Young. (2015). *Call for Action: Expanding cancer care in India.*Kolkata: Ernst and Young LLP.

Fishler, Gad. , Fishler, Ram. , Katan, Jaacov and Noy, Boaz. (2007)**.**Simultaneous breeding of extra-long staple cotton for Fusarium and Alternaria resistance, yield and fiber quality: length, strength, perimeter and maturity. *World Cotton Research Conference.*[Online]. Available at:https://wcrc.confex.com/wcrc/2007/techprogram/P1248.HTM[Accessed 5 Dec. 2016].

Food and Agricultural Organisation.(2008).*Urban Agriculture for Sustainable Poverty Alleviation and Food Security*. Position Paper. Rome: FAO.

Food and Agricultural Organisation. (2001).*Urban and Peri Urban Agriculture - A briefing guide for the Successful Implementation of Urban and Peri-urban Agriculture in Developing Countries and Countries of Transition*, SPFS/DOC/27.8,Revision 2, Handbook Series- Volume III.Rome: FAO.

Food and Agricultural Organisation. (2010).*The wealth of waste*: *the economics of wastewater use in agriculture*, Water Reports -35. Rome: FAO.

Food and Agricultural Organisation. (2012).*On-farm practices for the safe use of wastewater in urban and peri-urban horticulture: A training handbook for farmer field schools*. Rome: FAO.

Food and Agricultural Organisation. *Defining the peri-urban: rural-urban linkages and institutional connections*. Corporate Document Repository, [Online]. Available at: http://www.fao.org/docrep/003/x8050t/x8050t02.htm[Accessed 5 Dec. 2016].

Gupta, Rahul and Gangopadhyay, S. G. (2013*).*Urban Food Security through Urban Agriculture and Waste Recycling: Some Lessons for India.*Vikalpa - Volume 38. No 3. July – Sept2013,* pp. 13-22.

Hingorani, P. (2011). The economics of municipal sewage water recycling and reuse in India. In: Infrastructure Development Finance Company, ed., *India Infrastructure Report 2011 Water: Policy and Performance for Sustainable Development,* 1st ed. New Delhi: Oxford University Press, pp. 312-324.

Hofstedt, Charlotta (2005) *Wastewater use in Agriculture in Andhra Pradesh, India: An evaluation of irrigation water quality in reference to associated health risks*,UPTEC W05 029, Examensarbete 20 p, Maj 2005, Uppsala: Swedish University of Agricultural Sciences.

Jadhav, R. (2012). Urban Agriculture Idea Brings Farms to High-Rises.*Times of India*, [online]. Available at:http://timesofindia.indiatimes.com/city/pune/Urban-agriculture-idea-brings-farms-to-high-rises/articleshow/13145685.cms [Accessed 5 Dec. 2016].

Krishnagopal, G.V and Simmons, R.W.*Urban and Peri Urban Agriculture: Towards Better Understanding of Low Income Producer Organizations Hyderabad – City Case Study*, RUAF Foundation.

Kamyotra, J.S and Bhardwaj, R.M.(2011).Municipal Wastewater Management in India: In: Infrastructure Development Finance Company, ed., *India Infrastructure Report 2011 Water: Policy and Performance for Sustainable Development,* 1st ed. New Delhi: Oxford University Press, pp.299-311.

Kannan, K.P. (2000*). Food Security in a Regional Perspective: A view from 'Food Deficit' Kerala*, Working paper No.304.Thiruvananthapuram:Centre for Development Studies.

Kolady, Deepthi.Krishnamoorthy, Sujana and Narayanan, Sudha. (Cornell University). (2007). *India: Marketing cooperatives in a new retail context: A case study of HOPCOMS*, www.regoverningmarkets.org

Liebe, Jens and Ardakanian, Reza., eds. (2013). *Proceedings of the UN-Water project on the Safe Use of Wastewater in Agriculture*. Bonn: UN.

Ministry of Agriculture.(2012).*Framework for Supporting Public Private Partnership for Integrated Agricultural Development under Rashtriya Krishi Vikas Yojan.*New Delhi: Ministry of Agriculture.
Mission for Integrated Development of Horticulture. (2014).*Operational Guidelines*. Horticulture Division. New Delhi: Department of Agriculture &Cooperation.

M.S Swaminathan Research Foundation. (2010). *Report on the State of Food Insecurity in Urban India*. Chennai: MSSRF.

Mukherjee, S., Shah, Z. and Kumar, M. D. (2009). *Sustaining Urban Water Supplies in India: Increasing Role of Large Reservoirs*. Springer Science+Business Media. [Online].Available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1536443[Accessed 5 Dec. 2016].

National Institute of Urban Affairs. (2015*). Urban Solid Waste Management in Indian Cities*. New Delhi: National Institute of Urban Affairs.

National Horticulture Board. (2015). *Schemes of National Horticulture Board: Operational Guidelines*. New Delhi: Ministry of Agriculture.

National Horticulture Board. (2015).*Horticultural Statistics at a Glance 2015*.New Delhi: Ministry of Agriculture.

Novo, Mario. Gonzalez and Murphy, Catherine. (2000).*Urban Agriculture in the City of Havana: A popular Response to a Crisis, International Knowledge Network* [Online]. *Available at:* http://www.iknnetwork.de/lib/exe/fetch.php/themen/ernaehrung/urban_agriculture.pdf [Accessed 5 Dec. 2016].

Palrecha, A., Kapoor, D., and Malladi, T. (2012).*Wastewater Irrigation in Gujarat: an Exploratory Study*, Research Highlight -30, Anand, Gujarat: IWMI – TATA Water Policy Program.

Planning Board, Government of Kerala. *Economic Review 2015*. [Online]. Available at: http://spb.kerala.gov.in/images/er/er15/Chapter2/chapter02.html. [Accessed 5 Dec. 2016].
Ponisio et al. (2014*). Diversification practices reduce organic to conventional yield gap.* The Royal Society Publishing. [Online]. Available at: http://rspb.royalsocietypublishing.org/content/282/1799/20141396.[Accessed 5 Dec. 2016].

Radio Canada, *Sharing backyards: a popular Canadian innovation in urban farming*. [Online]. Available at: http://www.rcinet.ca/en/2013/06/21/sharing-backyards-a-popular-canadian-innovation-in-urban-farming/. [Accessed 5 Dec. 2016].

Rajsekhar, M. (2013). Great Rural Land Rush: 3 – 100 Fold Increase in Farm Land Prices May Not Bode Well, The Economic Times. [Online]. Available at: http://economictimes.indiatimes.com/news/economy/agriculture/great-rural-land-rush-3-to-100-fold-rise-in-farm-land-prices-may-not-bode-well/articleshow/25607513.cms[Accessed 5 Dec. 2016].

Ramachandra, T.V., and Aithal, B.H. (2016).Bengaluru's Reality: towards Unliveable Status with Unplanned Urban Trajectory*. Current Science Volume 110 Number 12, 25 June 2016,* pp. 2207-2208.

Raschid-Sally, L. and Jayakody, P. (2008).*Drivers and Characteristics of Wastewater Agriculture in Developing Countries: Results from a Global Assessment*. Research Report 127, Colombo: International Water Management Institute.

Redwood, Mark. (2004).*Waste Water Use in Urban Agriculture: Assessing Current Research and Options for National and Local Governments*. Ottawa: International Development Research Centre.

Seufert, V., Ramankutty, N., and Foley, J.A. (2012).Comparing the yields of organic and conventional agriculture. *Nature, Volume 485, 10 May 2012*, pp. 229-232.

Salari, M., Panjehkeh, N., Nasirpoor, Z. and Abkhoo, J. (2012). Screening of Cucumismelo L. Cultivars from Iran for Resistance against Soil-Borne Fungal Pathogens. *Journal of Plant Pathology &Microbiology*. [Online]. Available at: https://www.omicsonline.org,[Accessed 5 Dec. 2016].

Satterlee, K. (2015).*Cultivating Sustainable Cities: A Comparative Study of Urban Agriculture in Mumbai, India and New York City, USA*. Digital Commons @ Connecticut College [Online]. Available at: http://digitalcommons.conncoll.edu/cgi/viewcontent.cgi?article=1012&context=envirohp [Accessed 5 Dec. 2016].

Scott, C.A; Faruqui, N.I and Raschid-Sally. (2004).Waste Water Use in Irrigated Agriculture: Management Challenges in Developing Countries. In: CAB International with IWMI and IDRC, ed.*Waste Water Use in Irrigated Agriculture, Coordinating the Livelihood and Environmental Realities.*pp.1-10.Available at: http://www.ircwash.org/sites/default/files/Scott-2004-Wastewater.pdf**.** [Accessed 5 Dec. 2016].

Sharma, Rajendra Kumar. (2004).*Urban Sociology*. New Delhi: Atlantic Publishers and Distributers.

Smit J, Nasr J and Ratta, A*. (2001). Urban Agriculture Food, Jobs and Sustainable Cities* [Online].Available at: http://www.jacsmit.com/. [Accessed 5 Dec. 2016].

Smit, J and Nasr, J. (1992).urban agriculture for sustainable cities*:* Using Wastes and Idle Land and Water Bodies as Resources*. Environment and Urbanization, Vol. 4, No. 2, October 1992*, pp 141-152.

Srinivasan, R.K., Kozhisseri, Deepa. (2004). Emergency*. Down to Earth, 31 Dec. 2004*, pp.23-38*.*

Venkataraman, Madalasa. (2013). *Analyzing Urban Growth Boundary Effects in the City of Bengaluru*, Working Paper No.464. Bengaluru: Indian Institute of Management.

WaterAid. (2016).*an Assessment of the Faecal Sludge Management Policies and Programmes at the National and Select State Levels*, Report. New Delhi: WaterAid.

Yasmeen, Gisele. (2001).*Urban Agriculture in India: A Survey of Expertise, Capacities and Recent Experience*. Cities Feeding People Series - Report 32.New Delhi: International Development Research Centre, South Asia Regional Office.

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