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Analysis of soilless farming in urban agriculture

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Abstract

World population is increasing at a rapid rate with increase in population there is a challenge to feed this growing population with qualities products. But at same time world agricultural lands are limited and those land are also facing major pollution, salination and drought issues which are not in favor of crop production. This need of food security had given birth to soilless cultivation which farther become popular in urban area and became a part of urban farming. There are several type of soilless farming depending upon the need and type of crop like Hydroponic, Aeroponic, Vertical farming, NFT technology and so on. But most common things between them are their products are superior in term of quality and quantities then soil based crops. By adopting this method we can secure our food supply as well as it also give opportunity of employment. Many cities around the world has already set rooftop farming especially in developed countries. But it gaining rapid popularity in developing countries and it is the future of Agriculture.

Keywords: Soilless farming, urban agriculture, Hydroponics, Sustainable

Introduction

According to United Nation world population is 7.6 billion in 2011 it is expected to reach around 8.6 billion in 2030 and 9.8 billion in 2050 (UN 2011). World's total agricultural land has been increased by 3% in 1958 to 2005 mainly in tropical countries but decrease in 0.19% of agriculture land was recorded between 2005 to 2011 (Foley *et al.* 2011) [12]. Extreme rise in population there is degradation of eco- system, resource scarcity, unequal distribution of food, and many cases of malnutrition. Number of mega cities are increasing rapidly. It is estimated that by 2025 12 to 15 mega cities will be in Asia (Nugent 2000) [21]. For a city to be called as mega city it should have at least 10 million of population or more. To feed this growing population at least 6000 tons of food is required which is mostly imported from other sources out of which most of them are non-trusted source in term of quality standers (Drescher *et al.*). Today cities are the home of 56% of world poor people (Shackleton *et al.* 2009) [32]. According to report till October 2018 820 million people are therw who are suffering from hunger in different parts of world (E.U 2018). So there is a need of urban agriculture revolution to solve food shortage and to tackle malnutrition problem (Dubbeling *et al.* 2001) [6]. Due to today's urban culture cities population are increasing leading in demand of food supply due to poor logistic system and lack of proper fast transportation quality of food get degraded mainly vegetables (Morganti E 2011) [19]. This major quantities and qualitative food problem can be solved by soilless farming in urban area. It is a misconception that plant can only grow in soil but most common medium for plant growth is soil due to its moisture and nutrient carrying capacity as well it can act as a buffer in sudden change in soil ph. (Ellis N.K *et al.*, 1974) [10]. However soil has some limitation in terms of soil borne diseases, unfavorable soil composition, soil pollution, poor water drainage. Moreover soil are not avable in cities if it is then soil may contain pollutants which again is not a good option for plant growth. There are some serious issue in finding space as well as labor to work as both are expansive in cities. (Beibel J.P *et al.* 1960) [10] Hydroponic is a perfect solution for continue supply high quantity as well as ensure good quality food products and it can be practiced within limited space and water (Sardare D.M and Admane V.S). Soilless farming technology mainly focused on two type of Hydroponics and Aeroponic. The word Hydroponic is derived from the Greek word hydro means water and Ponos means labor. In this method a plants are grown in water solution containing nutrients in proper concentration and an inert material is used like Rockwool, sand cockpit for their root growth (Sardare M.D, and Admane S.V 2016) [28].

Soilless culture

Soilless culture can be define as growing of plants in system without soil. In resent past years multiple innovation had took place right from grow bags, net cap, and a variety of specify nutrient solution for specify plants.

These methods of cultivation has been design for the use for soilless farming (Gruda and Tanny 2014) ^[15]. Due to increase in soil erosion and lack of space in urban areas, the importance of soilless culture is likely to become popular in future. Because of light weight, mobility and maintainable In terms of competence soilless cultivation are especially appropriate for urban area. In Hydroponic and Aeroponic system plants are grown in water containing nutrient. These nutrient solution contain exact doses of fertilizers needed for that particular plant (Mok *et al.* 2014) ^[18] during crises of world war I and II vegetables grown throw hydroponic methods were promoted by United States of America as to insure food security. Vegetables were grown by US army as well as by civilians in some islands of Pacific Ocean which were contaminated due to war operation. Their main objective was to obtain self-sufficiency in food production as these island were far from main land and logistics supply were difficult (Savvas and Passam 2002) ^[30]. Aquaponic system is a type hydroponic system in which waste water rich in fish waste containing NH₃ and other sessional nutrients are runs throw hydroponic unit. In this process nutrients are used by plants and ammonia treated water is again flow back to fish tank. By using this process production of horticultural crop and fish is possible simultaneous with same water with proper nutrient cycle. (Savidov *et al.* 2007) ^[29]. Weight of the system is a major factor in installing the system since over weight is difficult in mobilization and difficult to set on rooftop. However light is not required for fish it could be installed in building and water can be supplied by water pumps. At rooftop one greenhouse can be made and a hydroponic system can be installed (Orsini *et al.* 2013) ^[22].

Vertical farming

Vertical farming is one of the most popular concept of urban agriculture. Dickson Despommiers, retired professor from Columbia University in New York is one of the biggest supporter of this innovative idea. By this method production of more crops are possible in per unit area. Hence therefore reduce large expansion of land in urban area. Biggest advantage of this system is that it allow close proximity of a large scale production of exotic vegetables in a control environment (Despommiers 2013) ^[5]. A new method of vertical farming is introduced by (Germer *et al.* 2011) ^[13] in which he gave a idea of growing staple crop like rice this method of crop production is called Skyfarming. He gave a brief note on the possibility and the challenges in rice cultivation throw vertical farming technique. This method he include about the lowering the weight, and providing nutrient throw aeroponic method in which ideal nutrient solution is sprayed in the form of mist on the roots of plants (Germer *et al.* 2011) ^[13]. However this method can be used to grow rice practice throw vertical farming but this method need a good economic analyses (Eigenbrod C and Gruda N 2014) ^[15]. Vertical farming in today world is fully operational and profitable as many Asian cities have adopted this methods and it is predicated to be more demanding on near future. In Japan demand of qualitative food is increasing but at same time there is limiter space in cities this methods is most popular in this countries (Despommiers 2013) ^[5].

Quality evolution

Soilless farming has a clear advantage over soil base production in term of quantity and quality (Santamaria and Valenzano, 2001) ^[23]. Due to the high production of crops mainly horticulture crop made a confusion among scientific

community to make significant changes in quantity profile of that specific crop. This changes mainly include the changes in terms of growth, yield and efficiency toward nutrients (Gruda, 2009) ^[14]. If we talk about quality analysis soilless product had showed enhanced organoleptic characteristic decrease in phytosanitary residues and longer shelf life (Cefola *et al.* 2011) ^[2].

Table 1: List of crops that can be grown profitable in soilless culture.

Type of crop	Name of the crop
Fruit	Strawberry
Leafy vegetable	Kang Kong, Lettuce
Medicinal crops	Solenostemon scutellarioides, Aloe vera, Stevia.
Condiments	Mint, Parsley, Sweet basil,
Flower	Marigold, Roses, Carnations, Dalhia

List of the plants that can be grown at economical level are listed below (Singh S and Singh B.S)

Urban Agriculture

Urban agriculture can be explain as industry in cities or town in which plant of high economical values can be grown in limited space with maximum production by using large materials and human resource (Mougeot 2000) ^[20]. Urban agriculture can be characterized on some factors which are location of production, quantity and quality of product, resources involve, total production and market valuation (Dubbeling *et al.* 2010) ^[8]. Food production in cities has been a long tradition around different parts of world and it has a significant role in food security for social welfare (Mok *et al.* 2014) ^[18]. One major challenge of urban agriculture is cost of space or land which increase total cost input. This problem can be solved by selecting those horticulture crops which are effective to high water and nutrient then other crops can be grown. Most of the vegetable have short life cycle, and they can fulfill quick increase in demands (Dubbeling *et al.* 2010) ^[8]. According to (Orsini *et al.* 2013) ^[22] it is possible to achieve 50 kg of yield from 1 m² of space with proper management and proper vegetable, fruit selection. In compare to other crops it is very high yield. Total land used for cereal production is ten times more in campier to land occupied by urban settlement. But the total land used for fruit and vegetable production is almost equal to land of urban settlement. This report lead to birth of a thought that urban cultivation could be possible by using high-tech machinery and proper management. This could lead our society to achieve self-sufficiency and a security of food supply to some certain degree (Hamilton *et al.* 2013) ^[16]. One possible benefit of urban agriculture could be in purification of air as plant use carbon dioxide while photosynthesis and are stored in their vegetative parts which in outcome release oxygen. It can also be slightly helpful in decreasing greenhouse gases. However it can be only for some time because after some time decomposition of vegetative parts of plants will release these gases again (Deelstra and Girardet 2005) ^[4].

Food security

Food security of urban population mainly depend on following factors: available food at a time, food access, and quality of food. Urban farming is a perfect solution of this problems. Several methods desiccated above can significantly contribute to society and family members to achieve self-sufficient. Keeping in consent producing food for self-consumption, irrespective of revenue it give food and nutrient security (Kortright and Wakefield 2011) ^[17]. Rendering to

(Orsine *et al.* 2013) urban cultivation has significantly contributed in accomplishing food and nutrient security in cities. This cultivation practice is gaining popularity in developing countries. One of the leading continent is North America which is on the way to make roof top farming common and highly economical for everyone. Already many American supermarket companies had showed interest on rooftop farm culture and one of the most popular “Gotham Green” first greenhouse factory is suited in Brooklyn by Zeveloff in year 2011 (The Duke 2011) [32].

Restoration of greenery in cities

Beautification of urban area through hydroponic methods is not a new technique it goes back to Floating gardens of Aztecs and Hanging garden of Babylon which were used in public center. In addition fruit and vegetables were also cultivated through these methods. Today in modern society it is for physical and mental in and outdoor relaxation (Schnitzler W.H 2016) [29]. Urban Horticulture prominence on Hydroponic has optimistic impact on ornamental beautification of society and micro climate change. Most important of this method is people of cities will enjoy to live in greenery, encouraging community to save environment and spreading awareness among people about environment protection (FAO 2010). One of the best example of green cities take our attention to Singapore where two architects, Richard Hassel and Wong Mun Summ had introduced a new concept in which skyscraper in tropical cities has removed big glass panel and replaces this with nature’s wall. They had grown enthusiastically dense plant on the outer wall and allowed these plants to cover whole building like an umbrella which further protect them from scorching sun heat (Schnitzler W.H 2016) [29].

Challenges of urban agriculture

As discussed above urban agriculture has a positive role in urban environmental, economical, and social aspects (Fleury and Ba 2005) [11]. But on the other hand if poor practices and mismanagement can lead to a negative impact on the environment and human health. Therefore proper guidelines of urban and traditional agriculture should be followed with high responsiveness of people participation (Drescher 2004). Application of this knowledge at a profitable level needs expertise and high practical knowledge and high amount of money investment (Sardare M.D and Admane S.V)

Future scope of soilless farming

In cities like Tokyo land is extremely expensive due to high density population. To feed its growing population mass countries have shifted their focus on hydroponic rice production rather than traditional farming systems (De Kreij *et al.* 1999) [3]. Hydroponic cultivation is best suitable in water scarce countries. Israel is the perfect example of this which has a dry arid climate. An Israeli company named Oganitech had grown crops in only 40 foot long containers, by this method. They had grown huge quantities of fruit, berries, banana, and citrus fruits. Hydroponics method has been also planned for future space programs. As this technology will help in space exploration and future settlement on Moon and Mars (Sardare M.D and Admane S.V 2016) [26].

Conclusion

From the above analysis it can be concluded that urban agriculture is the need of today’s world to achieve self-sufficiency in terms of food production. Soilless farming is the best way to go in urban areas as they are non-bulky and easy

for set up for beginners. Horticulture products obtained from soilless cultivation are quality and quantity superior in comparison to soil based production. There are several challenges in soilless cultivation which yet to be solved specially to make it more economically so that it could be used by every common man. In the future we see as a revolutionary method of farming.

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