

Strategic Technologies for Peri-Urban Agriculture

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Abstract

Peri-urban agriculture occurs surrounding the boundaries of cities throughout the world and includes products from crop and livestock agriculture, fisheries and forestry in the peri-urban area. Agriculture practices around cities compete for resources (land, water, energy, labor) that could also serve other purposes to satisfy the requirements of the urban population. It also includes non-wood forest products, as well as ecological services provided by agriculture, fisheries and forestry. Often multiple farming and gardening systems exist in and near a single city. Peri-urban agriculture is becoming vital for urban populations of many developing countries including India. Peri-urban agriculture can neither be reduced nor removed. Increases in both industrialization and urbanization have been associated with pollution that threatens urban food production and its quality. Sewage water and industrial wastes have been a major concern in peri-urban agriculture and animal husbandry. The serious pollutants get recycled back in urban population with short- and long-term serious health hazards in the human population. Peri-urban agriculture predominantly relates to horticulture production but also includes small livestock and aquaculture. A practical strategy needs to be executed with direct and indirect support from the public sector so as to use the treated sewage water and industrial wastes for agricultural purpose. The Indian Council of Agricultural Research and other agricultural universities in various states have the technology which can be combined for the benefit of peri-urban agriculture.

Keywords: Air, Crops, Land, Pollutants, Population, Tolerant, Vegetables, Water.

Introduction

As per the Census of 2011, India's population rose to 1.21 billion people over the last 10 years - an increase of 181 million. The population is increasing at a faster rate in urban areas of India. In India, according to 1901 census, it was 11.4%. The count of the population residing in urban areas increased from 11.4% in 1901 to 28.53% in 2001, and today it is crossing 30% as per 2011 census, standing at 31.16%. According to a survey by UN State of the World Population report in 2007, by 2030, 40.76% of the country's population is expected to reside in urban areas.

In a developing and highly populous country like India, resources are limited or even scarcer. Thus, unless we can develop a technology urban and peri-urban agriculture that provides solutions that are perceived globally to meet the demand of food.

There are a number of ways through which peri-urban agriculture can, in principle, have an impact

on food security. Peri-urban agriculture can be a source of income as well as subsistence and can provide direct access to a larger number of nutritionally rich foods. The main peri-urban activities are horticulture (fruits/ vegetables/ flowers), fisheries, livestock rearing, poultry, vermi composting, composting, water treatment, usage, etc.

Of India's population of more than one thousand million people, 35-40 percent currently lives in cities. This proportion is expected to increase to about 60 percent by 2025 [1].

Peri-urban agriculture is defined as the practices around cities which compete for resources (land, water, energy and labor) that could also serve other purposes to satisfy the requirements of the urban population. The primary components are horticulture; livestock; fodder and milk production; agriculture, and forestry.

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It is estimated that peri-urban agriculture involves 800 million urban residents worldwide in income-earning and/or food-producing activities. A significant number of city and peri-urban households are involved in farming.

As cities expand physically, the frontiers between urban, peri-urban and rural activity are blurring and merging, creating opportunities as well as risks. There are a large number of cities and towns in the country which are surrounded by peri-urban area.

In last few decades, the urban area has expanded vis-à-vis the peri-urban area which has expanded many folds. The larger cities (Delhi, Mumbai and Kolkata) exhibit less intensive expansion and in smaller cities of Bhopal and Coimbatore, however, settlement patterns remain dominated by the dispersed network of villages that predated the late 20th century wave of urbanization.

Peri-urban regions are the fastest growing regions around cities. In a UNDP estimate, 15% of food worldwide is grown in cities and many countries had successfully grown peri-urban to evade food shortage.

Peri-urban farming is grown today for income and subsistence of the residents of peri-urban areas. The collective value to humanity and ecosystems is globally significant, yet their extent and values are being rapidly reduced. Urban food security is becoming a matter of increasing concern and peri-urban poverty is reflected in the nutritional status of people

Key Characteristics of Peri-urban Agriculture

There is a wide range of activities in peri-urban agriculture which include fisheries, poultry and goat rearing, horticulture, floriculture, dairy farming, cattle farming and arable farming.

The area is densely populated with poor small holders involved. The area has easy access to nearby urban ready markets to sell its produce and products. It also has the advantage of cheap migrant labor as well as highly qualified urban professionals that make peri-urban areas valuable locations for national and international industries. The natural resources like air, land, water, etc., are under increased pressure and are over-utilized. In addition, the pollution stress on land and water leads to its degradation beyond acceptable threshold limits.

Pollutants that Affect Peri-urban Agriculture

Peri-urban agriculture is more affected by pollutants than rural areas and is primarily caused by air, water and soil pollution which are related to each other. This may be due to the proximity of the area to industries, vehicles and their exposure to the urban sewage. These pollutants directly or indirectly affect the agriculture especially in the peri-urban areas. These pollutants affect not only the producers but also the consumers in the urban areas.

Air Pollutants

It is the introduction of particulates, biological molecules, or other harmful materials into earth's atmosphere, causing disease, death to humans, and damage to other living organisms such as food crops, or the natural or built environment. Air pollution can be of natural origin or man-made. Major air pollution is from industrial emissions (52%) from factories, motor vehicle exhaust (27%) and even from agricultural burning (10%).

Pollutants are classified as primary or secondary. Primary pollutants are usually produced from a process, such as ash from a volcanic eruption. Major primary pollutants produced by human activity and agriculture include sulfur oxides (SO_x), nitrogen oxides (NO_x), carbon monoxide (CO), volatile organic compounds (VOCs), ammonia (NH_3), chloro-fluorocarbons (CFCs), suspended particles, persistent free radicals, toxic metals, such as lead and mercury, especially their compounds, radioactive pollutants - produced by nuclear explosions, nuclear events, war explosives, and natural processes such as the radioactive decay of radon. Secondary pollutants are not emitted directly. Rather, they form in the air when primary pollutants react or interact. Ground-level ozone is a prominent example of a secondary pollutant. Some pollutants may be both primary and secondary: they are both emitted directly and formed from other primary pollutants.

Various pollutants cause damage to the agriculturally useful plants like ozone injury to soybean, sulfur dioxide injury to raspberry, fluoride injury to plum foliage, ammonia injury to apple foliage, and cement-dust coating on apple leaves and fruits. These pollutants not only damage the agriculturally important crops but also reduce their market value and appeal.

Harmful gases like nitrogen oxides and sulfur oxides are released into the atmosphere during the burning of fossil fuels. When it rains, the water droplets combine with these air pollutants, become acidic and then fall on the ground in the form of acid rain. Acid rain can cause great damage to humans, animals and crops.

Water Pollutants

Water pollution is the contamination of water bodies. This form of environmental degradation occurs when pollutants are directly or indirectly discharged into water bodies without adequate treatment to remove harmful compounds. Water pollution is a major global problem worldwide. Natural phenomena such as volcanoes, algae blooms, storms, and earthquakes also cause major changes in water quality and the ecological status of water. However, the major water pollution caused by man is through sewage, industrial wastes, radioactive wastes, accidental oil leakage, plastics, chemical wastes, marine dumping, underground storages and leakages, chemical fertilizers and pesticides, etc.

Water use has been growing at more than twice the rate of the population increase during the last century. Management of water resources has become an urgent issue as peri-urban farmers often apply water from municipal sewage, mostly in its untreated form, increasing the risk of illnesses to farmers and consumers.

In peri-urban agriculture, locally-adapted small-scale irrigation and plant production methods and schemes are possible solutions to save water. Low-cost water-savings technologies are most recommended such as:

Drip Irrigation

This can increase water efficiency and infrastructure using porous ceramic containers or pipes with holes in which water is dripped onto the soil above the root zone only. Drip irrigation also offers the added benefit of minimizing the contact of wastewater and the crop, decreasing the likelihood of contamination.

Salt-Tolerant Crops

In case of salt-tolerant crops, the brackish water can be used in localized irrigation schemes.

Hydroponics

Peri-urban horticulture and micro-gardens such as simple hydroponics may be utilized to add economic and nutritional benefits by securing year-round supply of fresh produce. Simple hydroponics promotes water saving in recycling and decontamination of water and will facilitate growing of plants in areas with marginal conditions for crop production, such as adverse climate, soil, space limitations in cities, water scarcity, and pest occurrences. It also generates local markets in supply food chains. Simple hydroponics can be considered an effective alternative to be integrated in food security and nutrition rural and peri-urban development programs with low-resource populations.

In addition, the peri-urban farmers and the youth may be educated on responsible use of water, irrigation system design, use of timers for controlling irrigation schedules based on plant water needs, and soil water holding capacity.

Soil Pollutants

Soil pollution occurs due to the presence of toxic chemicals, pollutants or contaminants in the soil in high enough concentrations to be of risk to plants, wildlife, humans and the soil. It is typically caused by industrial activity, agricultural chemicals, or improper disposal of waste. Contamination is correlated with the degree of industrialization and intensity of chemical usage. The main causes of soil pollution are polluted water from sewage and industrial effluents, excessive use of herbicides, pesticides, etc., settling down of air pollutants, oxides of sulfur, nitrogen, chlorides, fluorides, ammonium, etc., from industries that come down as acid rain in dry or wet deposition and lowers the pH. The soil acidity reduces the decomposition of organic matter, bases in the soil are leached down, damages root hairs resulting in reduction in nutrient uptake, mobilizes heavy metals like Al, Cd, Zn, Hg, Mn, Fe, etc., and acidification increases weathering of silicate minerals destroying soil's mineral structure.

Sewage, ash and other pollutants have negative effect on soil health like excessive organic matter in sewage decomposes and produces nitrogenous substances, releases various toxic heavy metals, detergents and ash deposits from industries, radioactive waste materials like Strontium-90,

Cesium-137, Iodine-131, plutonium, uranium, americium, curium, neptunium, etc.

There are a number of ways in which soil problems can be addressed like use of salt-tolerant crops/vegetables and varieties (Table 1), application

of lime based on the pH of the soil (Table 2), identifying plants like mosses and lichens that are resistant/tolerant under radiations. In addition, there are a number of technologies as released by Indian Council of Agricultural Research and various state-level agricultural universities.

Tolerant	Moderately Tolerant
Crops	
Barley, cotton, wheat grass, tall Bermuda grass	Broccoli, sorghum, Sudan grass, field pea, wheat, pima cotton, acala cotton, sunflower, maize, oats
Vegetables	
Date palm, coconut palm, sugar beet, garden beet, alfalfa, onions, turnip, cabbage, lettuce, carrot	Potato, tomato, sweet pea, radish, pumpkin, bell pepper, sweet potato, Lima bean

Table 1. Tolerant and Moderately Tolerant Crops and Vegetables

Buffer	Target soil pH=6.5 (Lime if soil pH below 0.1) T/acre to apply if (Av Index=75)
7.0	0.9
6.8	0.9
6.6	1.4
6.4	1.8
6.2	2.7
6.0	4.0
5.8	5.4
5.6	6.8
5.4	8.5
5.2	9.0
<5.0	9.0

Table 2. Lime Needs Based on Soil pH

Fruits	Fodder	Medicinal products	Timber, poles fuel wood
Grafted mango (Mangifera indica)	Calliandra calothyrsus	Warburgia Ugandensis	Gevillea robusta
Tree tomato (Cyphomandra betacea)	Leuceana Trichandra	Azadirachta indica	Giant bamboo Dendrocalamus Giganteus
Grafted avocado (Persea Americana)	Morus alba	Moringa oleifera	Eucalyptus spp
Tamarindus indica	Glericidia sepium	Mondia whytei	Trichilia emetica
Zizyphus mauritiana	Desmodium sp.	Salvadora persica	Albizia species

Table 3. Possible Species and Their Uses for Peri-urban Areas

In peri-urban agriculture, the leading products are vegetables like cauliflower, cabbage, carrot, spinach, mustard (leaves), okra and tomato, floriculture and animal products like milk, eggs, meat, etc. The emerging technologies in the peri-urban agriculture must not only give higher yields but also give reasonable returns. In order to achieve so, the models of aquaponics, vertical farming, micro-green operations, and green house approach

are most suitable. Even the agroforestry can also be integrated in peri-urban agriculture as was achieved in Kisumu in Kenya (Table 3).

Charting a Path

In the past few decades, the increasing population which has forced the youth to move toward the peri-urban and urban areas has led to increased

pressure on the resources of peri-urban area. Peri-urban agriculture continues to gain momentum in coming times. Peri-urban farming is one strategy for developing strong local and regional food systems.

Peri-urban agriculture can neither be reduced nor removed; hence there is a stronger need to bring together the technical innovations developed for various stress conditions so that peri-urban must be both highly productive and reasonably profitable. The Indian Council of Agricultural Research and the state agricultural universities have suitable technology to the acceptable level that is safe for both farmers as well as consumers. The whole new complete agricultural technology needs to be developed and promoted in a systematic manner. The participatory approach of government agencies, NGOs and peri-urban small farmers will help in supplementing our overall agricultural production. The take-away lesson for us is peri-urban farming is an emerging sector with potential to bring many benefits to communities. Local governments are strategically positioned to become key partners in enabling urban farming and building strong local food systems.

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