

Effect of Industrialization and Urbanization on Agriculture

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Abstract— *Industrialization and urbanization becomes a bane for the agriculture now days. With increase in industrialization and urbanization, the growth of agriculture sector decline continuously. Large area of land is covered under industry and infrastructure, which results in shortage of agriculture productive lands. The waste products of industry and urban areas are flowed in water bodies such as river, lakes and ponds which pollute them and make them unsuitable for any kind of use. The harmful effluents released from industry contaminate the air with harmful gases and suspended material. These gases and suspended particles affect the growth and development of plants and animals. The suspended particles are inhale during breathing and cause blockage in veins and arteries of animals and humans. To feed the ever increasing population of our country, the farmer put high pressure on shrinking land to get higher output. For this, farmer use modern technology and chemicals which reduce the productivity and fertility of soil. The polluted water of lakes and ponds become poisonous for the water living entities and results in death of plants and animal species. The waste effluents of urban areas and industry have high concentration of heavy metals which are very poisonous for animals and plants which survive under water and on land. The growth of plants and microbes in soil is reduced due to increase in concentration of heavy metal in soil. The effects of industries and urbanization need to be decreased to get a healthy environment for plants and animals. Special management practice needs to be developed to suppress this increasing problem to survive on earth.*

Keywords— *industrialization, urbanization, suspended particles, productivity, fertility, heavy metals, etc.*

I. INTRODUCTION

World population has been rising continuously since the end of the Black Death, around the year 1350 (Dunham, 2008). Population began growing rapidly in the Western world during the industrial revolution. The most significant increase in the world's population has been since the 1950s, mainly due to medical advancements (Greenwood, 2014) and increases in agricultural productivity (Armelagos *et al.*, 1991). Population growth is the increase in the number of individuals in a population. Global human population growth amounts to around 83 million annually or 1.1% per year. The global population has grown from 1 billion in 1800 to 7.774 billion in 2020. It is expected to keep growing, and estimates have put the total population at 8.6 billion by mid-2030, 9.8 billion by mid-2050 and 11.2 billion by 2100 (Nations, 2017). The 29 % (149 million km²) surface of the earth is covered with land. Out of 29 %, 71 % is habitable land and 10 % under glaciers and 19 % under barren condition. Out of this 71 %, 50 % is under agriculture and rest under shrubs and forests. Only 23 % of this 50 % is under crop and rest 77 % is under livestock and dairy (Ritchie and Roser, 2013). In this way, only 11 million km² is under crop production. This area is used to feed the ever increasing population of our world. To feed that amount of population, farmer use heavy machinery and chemicals to increase the productivity of land. This rapid increasing population and food shortage leads to industrialization. It is believed that industrialization is the root of urbanization (Mitra and Sato, 2007, Li *et al.*, 2014).

Industrialization has historically led to urbanization by creating economic growth and job opportunities that draw people to cities. Urbanization typically begins when a factory or multiple factories are established within a region, thus creating a high demand for factory labour. Other businesses such as building manufacturers, retailers, and service providers then follow the factories to meet the product demands of the workers. This creates even more jobs and demands for housing, thus establishing an urban area (Invetopedia, 2019). In 1900, worldwide, there were 6.7 rural dwellers to each urban dweller; now there is less than one and projections suggest close to three urban dwellers to two rural dwellers by 2025 (Satterthwaite *et al.*, 2010). This fast growing urban areas and industries result in shortage of agriculture land. The continuous expansion in urbanization and the increasing demand for agriculture production are in continuous race with each other in competing for scarce natural resources such as land and water. The shrinkage resource base for agriculture production on the one hand and the increasing demand for food production and population place severe pressure on both the quantitative and qualitative aspects of land and water resource (Balasubramanian and Choi, 2010). Urbanization and industrialization not only contaminates the land and water bodies but also change the crop and land use pattern. Kurucu and Christina (2008) reported change in the land use patter in metropolitan cities around the world.

II. INDUSTRIALIZATION

Industrialization is the process by which an economy is transformed from primarily agricultural to one based on the manufacturing of goods. Individual manual labour is often replaced by mechanized mass production, and craftsmen are replaced by assembly lines (Investopedia, 2019). Characteristics of industrialization include economic growth, more efficient division of labour, and the use of technological innovation to solve problems as opposed to dependency on conditions outside human control. Industrialization is most commonly associated with the Industrial Revolution of the late 18th and early 19th centuries. Industrialization has rapidly taken the stage of public attention and debate in the past few years (Drabenstott, 1995). Industrialization enhances productivity, raised per capital income and accelerates the pace of saving and capital formation. It is the key for the development of a community (Holkar *et al.*, 2018).

III. EFFECT OF INDUSTRIALIZATION ON AGRICULTURE

Industrialization has both positive as well as negative effect on agriculture. It plays an important role in the development of a nation by generating employment and by utilizing the resource available which help in expansion of business (Holkar *et al.*, 2018). It helps in earning foreign exchange and enhances the system of farming by developing modern machinery and inputs. However, continues utilization of these machinery and input degrade the fertility and productivity of soil. Because of uncontrolled and unorganised industrial advancement in developing countries, destructive effect on the environment, wildlife and biodiversity was reported by Hatami and Shafieardekani (2014). Zhang *et al.* (2015) reported that with rapid industrialization in the recent years, China is now facing great challenge in heavy metal contamination in farmland soil.

Particularly, in the recent years the use of chemical fertilizer, sewage irrigation and pesticide is increased. The use of these products disturbs the natural ecosystem and pollutes the environment and soil (Liu *et al.*, 2014). The waste materials of industries have high concentration of heavy metal which degrades the physical, chemical and biological properties of plants (Sethy and Ghosh, 2013). High concentration of Cd and Pb in various industrial area of Pondicherry was reported by Devy (2002). Concentration of heavy metal beyond the prescribed standard in soil destroys the soil structure, fluctuate the pH and Ec of the soil and reduced the plant water and nutrients uptake (Sahid *et al.*, 2015). After uptake inside the plants, they form complexes which affect the photosynthesis and chlorophyll content in leaves. Toxicity of heavy metals results in poor seed emergence and seedling growth which cause reduction in yield. Pokharel *et al.* (2000) observed that the root growth and the number of root per bulb in onion is in all effluents as compared to growth. Seed germination and seedling growth in some agricultural crop is reduced due to the addition of brewery industry effluent (Acharya, 2001). Ghani (2010) reported decreased dry matter and seed yield, reduced nitrogen content in plant tissues, and lowered protein content in seeds of maize under treatment of heavy metal. Significant reduction in the yield of crop was reported by Fathi *et al.*, 2011 and Okoye *et al.*, 2019 due to heavy metals.

Rapid advancement in industrialization shrinks the forest area and change the land use pattern. Significant changes in the arable land and land cover due to industrialization was reported by Lu *et al.*, 2011. High quality cultivated land was changed to developed land and low quality land generated from unused land has resulted a serious threat to food supplies (Wand *et al.*, 2011). The shrinkage of forest area and polluted environment results in extinction of several wildlife and water species. The indiscriminate and untreated discharge of industries and municipal solid waste is the principal source of surface water contamination (Abbasi *et al.*, 2002). Paints industries use numerous chemical for the production of paints which are responsible for high concentration of organic compounds, suspended particles, coloured materials and other hazardous material which when discharge into environment may penetrate and leach in to the subsurface environment and leach down in to water bodies (Olaoye *et al.*, 2015).

Non-treated discharge of industrial waste into lagoons, river and streams had become a treat for the aquatic environment. These water bodies have high chemical oxygen demand (COD), high biological oxygen demands (BOD), less dissolve oxygen and nitrate and phosphate concentration. Aniyikaiye *et al.* (2019) evaluated that the effluents discharge of five industries have BOD of 840.6, 502.9, 162.8, 974.7 and 595.8 mg/L which was very high above the BOD standard of WHO (60 mg/L). High COD and BOD values was reported by Jordao *et al.*, (2005) in Uba stream (Brazil) because of a great load of organic untreated pollutant was flowed from kaolin processing plant. Microorganism activities in the water bodies decrease the amount of oxygen which cause suffocation and death of the aquatic organisms. Excess of nitrate and phosphate results in heavy growth of algae on the water surface also deplete the dissolve oxygen and create suffocating condition (Bhateria and Jain, 2016). Industrial waste products also have oil and greases which remain suspended on the surface of water bodies and restrict the penetration of sunlight which is necessary for photosynthesis of water (Aniyikaiye *et al.*, 2019). The effluents from the industry contains large amount of bacteria and fungi. Some of them are beneficial help in

decomposition of organic matter but some are pathogenic to plants. They cause different diseases to plants.

Similar to the water, the quality of air is also affected by the industrialization. At the end of nineteenth century, a large number of industries such as calcium carbide, pesticide and fertilizer industries was established which release a huge load of harmful gases in the environment. The emission from these industries increases as the demand of the product is increased. The concentration of CO₂ increased from 365.26 ppm to 416.18 ppm from 1998 to 2020 (CO₂ earth, 2020) due to continuous emission of gases (oxidized and reduced forms of carbon (CO₂, CO, CH₄), SO₂, O₃, C₆H₆ vapours, Hg, etc.), particulate matter (PM₁₀ and PM_{2.5}) and radioactive isotopes (Agbaire and Esiefarienrhe, 2009). These poisonous gases emitted by industries in the atmosphere cause acid rain which is rich in sulphur and other chemicals. Microorganism which add nutrients to soil eventually die because of acid rain (Manisalidis *et al.*, 2020). The acid rain acidifies the water and soil environment, damage the tree and plantations. Suspended particle and gases are the main reason of depletion of ozone layer and cause global warming result in increases the temperature of earth. Depletion of ozone layer exposed the crop to harmful UV radiation which causes significant reduction in the yield of crop (Teramura, 1983). Harmful gases and PMs are also responsible for vegetable injury and yield loss (Joshi and Swami, 2007) and also affect the germination of seed and flowers in inflorescence (Nithamathi and Indira, 2005). SO₂ is the major component of air pollutant which affects the morphological character of plants such as number of leaves, length of shoot and root, leaf area and number of flower and fruits (Wali and Iqbal, 2004).

Air pollutants also affect the photosynthetic rate by decreasing the chlorophyll content of the leaf (Joshi and Swami, 2007). Air pollutant also leads to stomatal closure which reduces the entry of CO₂ in the plant leaves and inhibits the carbon fixation (Seyyednejad *et al.*, 2011). Reduction in the area of leaf also reduces the photosynthetic activity due to decreasing in the net radiation absorption (Tiwari *et al.*, 2006). Chapla and Kamalakar (2004) reported reduction in the total chlorophyll content, RuBisCo enzyme activity and net photosynthetic rate under fumigation of 40, 80 and 150 ppbv concentration of O₃. Decrease in the chlorophyll content increase the respiration rate and CO₂ fixation which result in reduction of total soluble sugar. Joshi and Swami (2009) also found reduction in the carotenoid content in the leaves of six tress species which are exposed to air pollutant. Sravanakumar (2014) also found decrease in the photosynthetic pigment in plant leaves around urban and industrial sites. High exposer of plant leaves to air pollutant also produces ROS (Woo *et al.*, 2007) which destroy the cell wall and cell membrane (Tiwari *et al.*, 2006).

The yield of crops is also affected all over the world by the industrialization. There are numbers of study in which reduction in the yield of crop was due to industrial air and water pollutant. Khai and Yabe (2013) reported 12% reduction in the yield and 26% profit loss in rice crop due to water pollution in Vietnam. Significant reduction in the grain yield of 8.46 % in rice and 9.52 % in wheat and straw yield of 11.08% in rice and 12.24% in wheat were reported by Malay *et al.* (2017). Chakrabarti *et al.* (2014) indicated that straw yield was reduced up to 17.6% and 24.5% rice and wheat crop respectively due to air pollution. Raja *et al.* (2014) also showed that similar types of results, he reported that straw yield of rice was significantly reduced over control. Mills *et al.* (2018) also estimated the reduction of 12.4%, 7.1%, 4.4% and 6.1% in the yield of soybean, wheat, rice and maize, respectively due to high concentration of ozone.

IV. URBANIZATION

Urbanization refers to the population shift from rural to urban areas, the decrease in the proportion of people living in rural areas, and the ways in which societies adapt to this change. It is predominantly the process by which towns and cities are formed and become larger as more people begin living and working in central areas (Wikipedia, 2020). The United Nations projected that half of the world's population would live in urban areas at the end of 2008. By 2050 it is predicted that 64.1% and 85.9% of the developing and developed world respectively will be urbanized (Science daily, 2008). Urbanization is closely linked to modernization, industrialization, and the sociological process of rationalization. Urbanization can describe a specific condition at a set time, i.e. the proportion of total population or area in cities or towns, or the term can describe the increase of this proportion over time. Urbanization is not merely a modern phenomenon, but a rapid and historic transformation of human social roots on a global scale, whereby predominantly rural culture is being rapidly replaced by predominantly urban culture.

V. EFFECT OF URBANIZATION ON AGRICULTURE

Agriculture is the backbone of Indian economy, which provides livelihood to 65 to 70% of the total population and employ about 52% population of the country (Pramanik and Sarkar, 2011). With the onset of British government and industrial revolution in the 18th century, the relationship between the population and agriculture was broken and an unprecedented

growth in the urban population takes place over the course of 19th century both through continued migration from the countryside and due to the tremendous demographic expansion that occurred at that time. The urban population of the world will grow by more than billion between 2010 and 2025, whereas the rural population will hardly grow at all (Satterthwaite *et al.*, 2010). Rapid urban population growth because of continue migration results in increase in the demand of land, particularly for housing, water and energy (Iheke and Ihuoma, 2016). Iheke and Nto (2010) reported that urbanization is an important driving force in migration and community.

Urbanization has led to conversion of agriculture land into non agriculture purpose such as factories, buildings, residential or other commercial use (Malik and Ali, 2015). Ho and Lin (2004) found that the urban population growth was the cause of farmland conversion into coastal cities. Han and He (1999) found a significant positive relationship between urban population growth and farmland conversion in to cities. They also found that real estate speculation also result in agriculture land conversion. Land conversion (conversion of agriculture land into urban land) has negative impact on the agriculture land. Uncontrolled land conversion has greater impact on environment and agriculture yield. Loss in the prime agriculture land reduces the agriculture crop production, agriculture job employment (Malik and Ali, 2015). Land conversion increases the pressure on shrinking land to feed the increasing population which decline the health of land. These lands were put into uses which benefit the urban people neglecting agriculture use. Land conversion result in fragmentation of land, change in land supply and increment in land values (Iheke and Ihuoma, 2016).

Rapid population growth and migration also cause a serious threat to the environment which directly and indirectly affects the properties of soil and plants which cause reduction in yield. Expansion of urban area results in increase in the temperature of atmosphere with usage of modern equipment. Han *et al.* (2019) found that the station surrounded by large urban land experience rapid warming and high temperature. Much of the solar heat reached on the surface of earth is used in evaporation of water from vegetation and soil. In cities, where vegetation is less and exposed soil, most of the solar energy is absorbed by buildings and asphalts, result in increases the temperature of surface (Kolokotroni and Giridharan, 2008, Peng *et al.*, 2013). Vehicles, factories and industries also release more heat. This rising temperature results in depletion of soil moisture and reduction in reabsorption of CO₂emission (Sanders, 2004). Urbanization also results in eutrophication in water bodies. When rain occurs in urban areas, the rain filters the pollutant in the air onto the ground below. Then this running water enters into the rivers, ponds and lakes causing in decline in the quality of water and marine ecosystem (Jiang *et al.*, 2008).The ocean also absorbs small quantity of CO₂ released by human which help in maintaining the balance of CO₂in nature (Abas *et al.*, 2014). Eutrophication results in increase in the pH of the ocean water (Feely *et al.*, 2010) which inhibits the formation of calcium carbonate which is a crucial component for many marine organisms for the formation of shells and skeleton (Anderson *et al.*, 2015).

Urbanisation also results in the alteration in the physical, chemical and biological properties of soil (Liu *et al.*, 2016; Luo *et al.*, 2020). Cutting of trees, construction, mining activities changed the soil structure, soil porosity and contaminate the soil with harmful substances. Urbanization led to change in the hydrological cycle, reduced the infiltration rate of the soil and changes the stream flow (Marcotullio *et al.*, 2008). Heavy rainfall in the cities creates water logging condition because of high compaction and less infiltration rate of soil. Wang *et al.* (2018) also found high compaction and less infiltration rate of soil in urban area. Water logging condition also creates anaerobic condition which inhibits the growth of plant roots and soil microorganism. The soil of urban area easily prone to soil erosion poses serious threat to life and property (Yao *et al.*, 2015). Poor vegetation cover increase the impact of raindrop on soil result in disintegrates the soil aggregate. Because of less vegetation cover and heavy traffic burden on soil increase the surface crust formation which reduces the infiltration rate (Marcotullio *et al.*, 2008). Surface crust formation restricts the exchange of O₂ and CO₂between the soil and atmosphere. Rapid urbanization decreases the organic carbon status of soil. Less vegetation and microbial activities reduced the easily oxidising organic carbon status of the soil in urban areas. Luo *et al.* (2020) found that the 20 % loss in the easily oxidising organic carbon in the soil which id surrounding to the cities. However, the total carbon content was found higher in the soil of urban area (Lorenz *et al.*, 2006; Asabere *et al.*, 2018; Liu *et al.*, 2018). The decomposition process of urban litter was very slow because of repressed soil organism.

Urbanization affects both the crop and livestock sector by affecting the demand and supply of agriculture and livestock products. Because of extension in the urban area, the grazing area is shrinking. Land availability per livestock is decreased as farmer minimized the herd size to grow crops (Swain and Teufel, 2017). With expending urbanization, the demands of the concentrated feed also increased. Farmer feed higher amount of concentrated feed to the milch animal to get more milk which decreased the quality of milk. Tian *et al.*, 2017 found that long term feeding of high concentrated diet decreased the milk fats concentration. Decreased in the yield and milk fat percentage in the milk of dairy cows due to concentrated feed of

Alfalfa was observed by Khafipour *et al.*, (2009). Urbanization has significantly affected the cereal grain consumption in many countries. Urbanization leads to a significantly reduction in the demand of cereal food while the demand of non-cereal food was increased (Swain and Teufel, 2017). Huang and David (1993) also found that urbanization had a negative impact on the consumption of rice and coarse grain. Mottaleb and Mishra (2016) also reported that urbanization leads to a dramatic shift in the rice consumption pattern in the major rice producing countries of Asia and the world. Mottaleb *et al.*, (2018) also found that education, income and urbanization were the main driving forces behind the changing food and cereal consumption in Bangladesh.

VI. CONCLUSION

With the increase in the population, the demands for food and land were increased. To feed the increasing population, chemical fertilizers are used which decrease the fertility of the soil and crop productivity. This increasing demand of chemicals and processed food result in establishment of industries. These industries have both positive as well as negative impact. The positive impact is the generation of employment and processed products for the people. The negative impact is that they release poisonous gases and suspended particle in the environment and climate change. These gases result in global warming which increases the temperature of earth. Harmful gases and suspended particles deteriorate the quality of environment which affects the functioning of plant and animals. Poisonous gases and suspended particle also cause acid rain which decreases the pH of soil and water bodies. The heavy metals destroy the soil structure, fluctuates the pH of soil and affect the metabolic activities of plants and animal by forming complexes inside them. The discharge effluents of industries contain organic material, oil, grease and high concentration of heavy metals. These materials pollute the natural environment of water bodies which become lethal for aquatic species.

Increasing population and industrialization result in migration of people from rural to urban area. It is considered that industrialization is the root of urbanization. However, urbanization enhances the living and education standard of people, but it also pollutes the natural environment. With rapid urbanization, agriculture land is converted into non-agriculture land as land was covered under houses, industries, roads and buildings. Urbanization affects the properties of soil by decreasing its pore space, infiltration rate, easily oxidizing organic carbon, increasing surface compaction and bulk density. Vehicles, household emission, air conditioners, etc. release the green-house gases in environment which cause global warming. The polluted environment of urban area affects the crop and livestock production. Decreasing in the cereal consumption and the quality of milk was the harmful effect of urbanization and industrialization.

Industrialization and urbanization are necessary for the development of a nation. Both of them play an important role in increasing the GDP of the nation. Excess of both degraded the environment. Special measure and techniques needs to be developed to overcome this problem. The waste of industries and urban area should be dumped outside the city and away from the water bodies after the proper treatment. The area of land should be reserved for the agricultural and forests which maintain a healthy living environment on earth.

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