International Review of Social Sciences and Humanities
Vol. 6, No. 2 (2014), pp. 141-156
www.irssh.com
ISSN 2248-9010 (Online), ISSN 2250-0715 (Print)

Transformation of Fertile Agricultural Soil into Housing Schemes: A Case of Bahawalpur City, Punjab, Pakistan

Muhammad Mohsin
(Corresponding Author)
Department of Geography, Govt. S.A. Postgraduate College
Dera Nawab Sahib, Ahmedpur East, Bahawalpur
Punjab, Post Code: 63350, Pakistan
E-mail: mohsinshahzad10@yahoo.com

Farrukh Jamal
Department of Statistics
Govt. S.A. Postgraduate College, Dera Nawab Sahib
Ahmedpur East, Bahawalpur, Punjab, Post Code: 63350, Pakistan
E-mail: farrukhmphil@yahoo.com

Asad Ali Khan
Department of Geography, Faculty of Science
The Islamia University, Baghdad-ul-Jadid Campus
Bahawalpur, Punjab, Post Code: 63100, Pakistan
E-mail: asadkhaniub@yahoo.com

Fahad Ajmal
Cholistan Institute of Desert Studies (CIDS)
The Islamia University, Baghdad-ul-Jadid Campus
Bahawalpur, Punjab, Post Code: 63100, Pakistan
E-mail: fahadajmal2011@yahoo.com

(Received: 24-10-13 / Accepted: 28-11-13)

Abstract

The objective of the study is to calculate the rate of agricultural land transformation into housing schemes in Bahawalpur City during 1988-2008 and also analyze the properties of soil to prove either its fertile or infertile? Seven study sites from different locations of the city were selected and data had been collected from owners and builders of these colonies through structured interview. Results shown, from 1988 to 2008 these housing colonies have been converted 256 acres of precious farmland (12.8 acres/ year) with high rise in land prices. To certify the soil fertility of these colonies, 14 soil samples (2 from each area) were gathered and selected soil properties have been tested in soil and water testing laboratory of agriculture department of Bahawalpur. Analysis had revealed that soils have loamy to moderate loamy texture suitable for agricultural crops. Yellow and light brown color of soil showed the presence of less organic content and less iron oxide. The pH of soil in sampled colonies was ranked suitable and moderate for crops production. Electrical conductivity (EC) in sampled

colonies was suitable for the cultivation of all crops. Moderate value of soil phosphorus (P) was found in five colonies. Potassium (K) in study sites was classified fertile and moderate fertile. However, organic matter of soil in study sites was poor. In sum, agricultural land in Bahawalpur is fertile.

Keywords: Agricultural land transformation, Bahawalpur City, Housing colonies, Land prices, Soil properties.

Abbreviations: DCR (District Census Report), FAO (Food and Agriculture Organization of the United Nations), GDP (Gross Domestic Product), Govt. (Government), GRID (Global Resource Information Database), H/S (Housing Scheme), IFPRI (International Food Policy Research Institute), IIASA (International Institute for Applied System Analysis), ISRIC (International Soil Reference and Information Centre), PCO (Pakistan Census Organization), PKR (Pakistani Currency Rupee), USAID (United States Agency for International Development), WWF (World Wildlife Fund).

1. Introduction

Soil is the uppermost layer of the land surface that supports the plants growth with requires nutrients and water needs. It is one of the prime renewable resources of the earth like water, air etc. Soils can vary greatly from place to place. Although, soil is essential for high production of agricultural crops but the fertility of soil is declining in developing countries due to population pressure, harsh climate, land controls and poor soil management practices (Tandon 1998; Henao & Baanante 1999). The dangers associated with soil degradation are wide in range and consist both natural and human induced i.e. erosion, leaching of chemical and toxic material, excessive use of fertilizers etc. but the most dangerous one and is little concerned is the establishment of housing colonies on fertile agricultural soil. Worldwide, nearly 4.9 billion acres arable land (22% of all arable land) had been degraded since the decade of 1950s (Deichmann & Eklundh, 1991). Soil erosion and land degradation becomes more disastrous problems in nature especially in those countries where intensive agriculture is practiced (e.g. Pakistan). Since the year of 1960 about one-third of the world's cultivated land had been lost through erosion and other forces of degradation. Erosion makes vast areas non-productive. It has been estimated that about 39.5 million acres of productive land is lost annually, 24.7 million acres to soil erosion, 4.9 million acres to salinization and water logging and 9.8 million acres to deforestation (Gardner, 1996). Further, if this problem continues then about 24.7 million acres of productive land is expected to loss per year (Pollard et al., 2010). Now enhancing international interest is being focused on land use and land cover alterations and the consequential human-induced environmental decline (Engelman & LeRoy, 1995; Fischer et al., 1996; Gardner, 1996).

Urban areas worldwide covered only 1% of the earth's total land area however, land resources are always been under huge stress because of transportation, residential, industrial and recreational purposes that necessary for urban spatial expansion (UNEP, 2000). As world population is surging, the need for the provision of more food is becoming acute to ensure the food security. Therefore, it would be more difficult task to keep with growing population and enhancing land shortage than in the past (Gruhn et al., 2000). It is now become an issue of the public attention to conserving farmland and farmers from increasing and deepening urban strain (Larson et al., 2001). At local or regional scales, the loss of fertile land to urbanization has reached notable proportions and may have significant implications for local food security, climate and environment (Imhoff et al., 1997a). Urbanization disturbs soil and sediment which leads to erosion (Einstein, 1999). So, human induced soil erosion has made soil erosion more serious around the urban areas (Hu et al., 2001). Rapid urbanization is also effects quality of soil and water badly in Iran (Yones et al., 2012). It is expected that loss of farmland

due to urbanization between 1990 and 2020 is estimated to be 34.5 million acres (USAID, 1988).

Cities devour farmland for housing, industry and recreational uses. Irrigated land shrinks as ground-water is depleted and water is diverted to urban areas. In reality, cities rely on far away rural places to fulfill their food, fuel and water demands (Mason, 2010). The accelerating urbanization also resulted in degradation of agricultural landscapes, which may influence a variety of ecological processes and finally pose threat to regional sustainability (Fu et al., 2006). Europe's agricultural area is expected to be decrease by 49.4 million acres till 2030 due to claims from urban development etc. Population and economic growth are the most important drivers for converting agricultural areas (Verzandvoort et al., 2009). Residential development of agricultural lands is driven by a desire to be in proximity to major highways or recreational resources (Maitland, 1990). Lands with better qualities (flat and well drained) are more attractive for housing development. Farms close to a city and major highways are prone to be converted to urban uses (Firman, 1997). It is clear that burgeoning population growth of both suburbs and fringe areas of expanding cities is likely to mean that much more agricultural land will be converted (Berry & Plaut, 1978; Lockeretz, 1989). For instance, fringing agricultural land in Calabar (Nigeria) is facing the threat of reduction and fragmentation from rapid urbanization (Atu et al., 2012). Farmland conversion from residential development presents municipal planners with a challenging problem because a greater number of houses are being built in less time.

Pakistan is a country that highly relies on agriculture sector that accounts about 25% of the country's GDP and about 60% livelihood of the rural population is directly and indirectly linked with it (Govt. of Pakistan, 2012). But agricultural land is facing several types of dangers from erosion to conversion into other uses. Some major problems that facing Pakistan's agriculture is included reduction in the amount of farmland and shortage of water (Ehrlich & Ehrlich, 1990). This phenomenon is common in many growing cities of Pakistan including Bahawalpur. In recent years Bahawalpur witnessed robust increase in population and socio-economic rise that inversely affects local farmland deeply. Population of the city is growing with the rate of 3.08 per annum (Govt. of Punjab, 2012). This high increase in population raised the housing demands and resultantly city is experiencing great decrease in its agricultural land resource on fringing areas and pure agricultural soils rapidly engulfed in the form of housing schemes.

1.1 Objective of the Study

The main objective of the study is to calculate the rate of agricultural land transformation into housing schemes in Bahawalpur city during 1988-2008 and also analyze the properties of agricultural soil in order to prove either its fertile or infertile?

1.2 Study Area

Bahawalpur is a fertile alluvial tract in the Sutlej river valley that is irrigated mainly by canal water (Figure 2). The chief crops of this area are wheat, gram, cotton, sugarcane and dates. Typically, city is lying at the hub of trade routes from the north, east, south-east and south and favorable for commerce. It is a center for trade in many crops i.e. wheat, cotton, rice etc. grown in the surrounding region. In recent years, the population of the city is increasing rapidly. Population of the city was 408,305 in 1998 (DCR, 1998) that reached 560,588 in 2012 with an annual growth rate of over 3% (Govt. of Punjab, 2012). As a result of this high culmination in population, city land use is subjected to change mainly peripheral agricultural land is substantially being transformed into urban housing schemes.

2. Methodology

To achieve the desired objective of the study, seven housing colonies were randomly selected and visited in Bahawalpur city. The sample study sites namely Allama Iqbal town, Bahria city housing scheme, Rehman garden housing scheme, Khayaban-e-Ali housing scheme, Royal city housing scheme, Gulshan Iqbal town and Madina town have located in different directions of the city and mostly on peripheral agricultural land. Data about these colonies was gathered through structured interview from the colonies builders and owners and 14 soil samples (2 samples from each study site through random sampling) were also collected to test the selected parameters of soil properties (soil pH, soil texture, soil color, Electrical conductivity, Potassium etc.) for determines its fertility. Later, these samples have been tested in soil and water testing laboratory of agriculture department of Bahawalpur. The results were discussed and elaborated with the standards provided by regional laboratory of agriculture department of Bahawalpur. These standards used as yardstick to interpret the soil analysis results.

3. Transformed Agricultural Land Area

The transformed agricultural land area of selected colonies is shown in table 1 and figure 1. It depicts the name, starting year, total area and land values per Marla of these colonies. Among these, the oldest colony was Gulshan Iqbal town had been originated in 1988 and comprising the area of 25 acres. Initial price that was only 12,000 PKR per Marla at its startup later shoot up and become 150,000 PKR in 2013. This indicates the high rise in land prices and the demand and stress on land. Khabayan-e-Ali housing scheme was originated in 1994 and covered a huge area of 120 acres. The initial price per Marla of this colony was similar to Gulshan Iqbal town but current price was 160,000 PKR. Madina town was also originated in 1994 and occupied the area of 20 acres. Initial price of this colony was 20,000 PKR per Marla that raised and become 120,000 PKR in 2013. Rehman Garden housing scheme was established in 2005 and occupied the area of 26 acres. Initial price was 45,000 PKR per Marla that become 170,000 PKR in 2013. Allama Iqbal town and Royal city housing scheme were originated in 2007 and occupied the equal area of 20 acres each. Initial price per Marla was 85,000 PKR in Allama Iqbal town that rose to 270,000 PKR in 2013 whereas initial price of Royal city housing scheme was 100,000 PKR per Marla that become 250,000 PKR in 2013. Both of these housing schemes are considered high class residential colonies and housed financially strong families. Bahria city housing scheme was found in 2009 and covered the area of 25 acres. Initial price of this colony was 70,000 PKR per Marla that climbed up to 180,000 PKR in 2013.

Table 1: Sample Colonies and their Total Area and Price Variations in Bahawalpur City

Sr. No.	Name of Area	Year of Starting	Total Area (Acres)	Present Urban Land Value (PKR/ Marla)	Initial Urban Land Value (PKR/ Marla)
1	Gulshan Iqbal Town	1988	25	150,000	12,000
2	Khayaban-e-Ali H/S	1994	120	160,000	12,000
3	Madina Town	1994	20	120,000	20,000
4	Rehman Garden H/S	2005	26	170,000	45,000
5	Allama Iqbal	2007	20	270,000	85,000

	Town				
6	Royal City H/S	2007	20	250,000	100,000
7	Bahria City H/S	2008	25	180,000	70,000
	Total		256		

Source: Field Survey
Note: Marla = A size of land equal to 272 sq. feet.

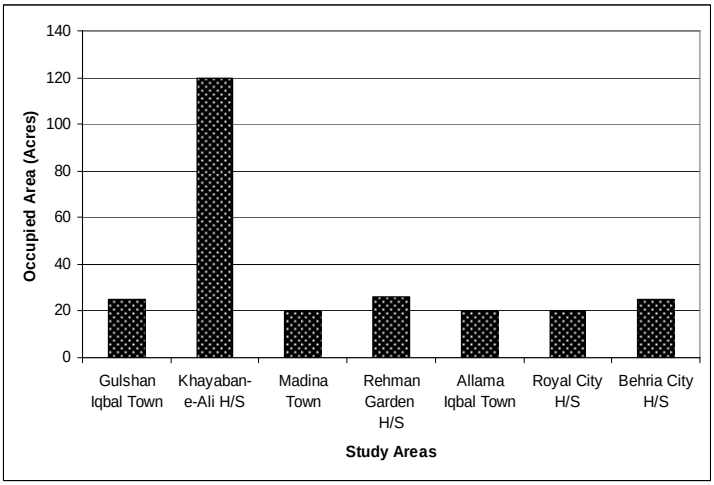

Figure 1: Sample Colonies and their Total Converted Area
Source: Field Survey

Hence, all of these colonies transformed the total area of 256 acres from 1988 to 2008 (20 years) with the average of 12.8 acres per year. Moreover, all of these colonies were occupied cultivated agricultural land area except Royal city that have partial barren sandy tract. The price variations were also noteworthy for land transformation. These results have proved that transformation of agricultural lands into housing colonies is an ongoing threat and high increase in land values indicates that it is now becoming a sort of business for land owners and ultimately land prices boosted very high in Bahawalpur city.

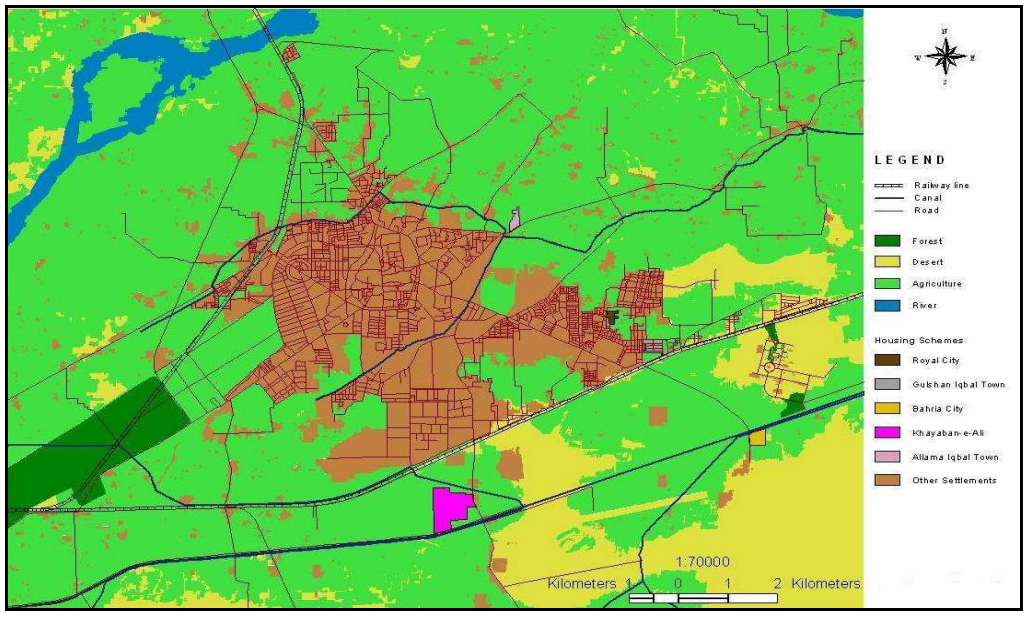

Figure 2: Location Map of Sample Study Sites in Bahawalpur City
Source: Author (2013)

4. Laboratory Analysis of Soil Samples

Soil is a natural surface layer contains living and rocky matter and supports plants. It consists in all three states of solid, liquid and gacious and includes both inorganic and organic matter. Inorganic matter is largely derived from rock particles (sand, silt and clay) whereas organic matter based on living or dead organisms. Both living and non-living matter are crucial for healthy plants growth and acts with water and surrounding air. The dissolved substances or nutrients in soil possess chemical, physical and biological characteristics and play a key role in plants and crops development. Soil has a unique importance regarding agriculture, environment and economy of any region. The understanding of these substances is particularly important in an area due to its many issues i.e. urban developments, water erosion, irrigational practices, solid waste dumps on soil etc. Therefore it needs to proper guidelines and instruction. The main properties of soil in Bahawalpur city are discussed as follows;

4.1 Physical Properties of Soil
4.2 Chemical Properties of Soil
4.3 Biological Properties of Soil

4.1 Physical Properties of Soil

The physical properties of a soil have determine the suitability for many uses i.e. rigidity and supporting power, drainage and moisture storage capacity, plasticity, ease of penetration by roots, aeration and retention of plant nutrients etc. are all directly connected with the physical condition of the soil. Followings are the important physical properties which were considered for the current study;

4.1.1 Soil Texture
4.1.2 Soil Color

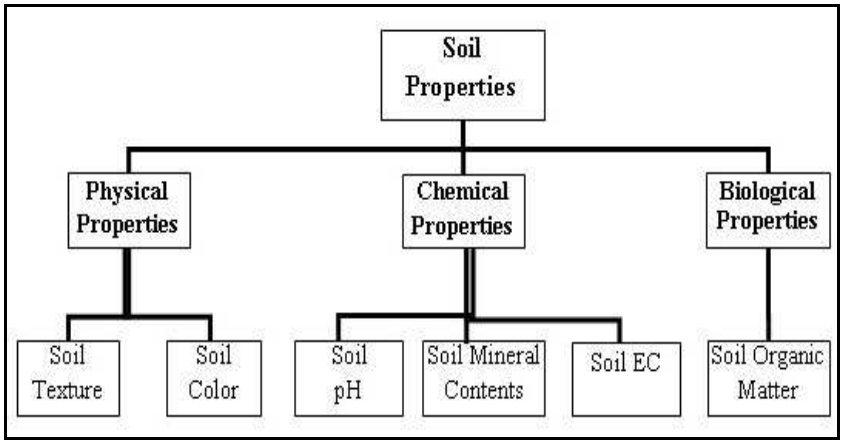

Figure 3: Common Properties of Soil
Source: Author (2013)

4.1.1 Soil Texture

Soil texture has expressed the relative size of the soil particles which refers to the fineness or coarseness of the soil. The extent and rate of many important physical and chemical reactions in soils are governed by texture because it determines the amount of surface on which the reactions can occur. The main standard of soil texture set by the agricultural department of Bahawalpur is shown in the table 2.

Table 2: Standard for Soil Texture

Saturation %age	Nature of Soil	Cultivable Crops
1. 19%	Sandy soil	Peanuts, Barley, Grams
2. 20-30%	Sandy loam	Peanuts, Barley, Grams
3. 31-45%	Loamy to moderate heavy loam	Almost all crops
4. 46-60%	Heavy loamy or clay	Suitable for Rice and Sugarcane cultivation
5. More than 60%	Clay	Onions, Carrots and many grain crops

Source: Soil and Water Testing Laboratory of Agriculture Department, Bahawalpur

According to agriculture department the soil saturation from 31 to 45% have the ability to support all crops cultivation. In study areas the saturation percentage varies from 30 to 45%, which shows that the soil agricultural potential in study area is quite high. All soil samples have loamy to moderate loamy texture suitable for agricultural activities and crops (Table 3).

Table 3: Soil Texture and Saturation Percentage in Sample Areas

Sample Areas	No. of Samples	Saturation %age	Texture
Allama Iqbal Town	Sample 1	42	Heavy Loam
	Sample 2	44	Heavy Loam
Baharia City H/S	Sample 1	36	Moderate Loam
	Sample 2	32	Moderate Loam
Khhayaban-e-Ali H/S	Sample 1	30	Sandy Loam
	Sample 2	32	Moderate Loam
Royal City H/S	Sample 1	33	Moderate Loam
	Sample 2	34	Moderate Loam
Rehman Garden H/S	Sample 1	34	Moderate Loam
	Sample 2	32	Moderate Loam
Gulshan Iqbal Town	Sample 1	40	Heavy Loam
	Sample 2	36	Heavy Loam
Madina Town	Sample 1	36	Heavy Loam
	Sample 2	32	Moderate Loam

Source: Laboratory Analysis

4.1.2 Soil Color

Soil color serves to understand and interpret soil properties in terms of organic matter content, drainage condition and aeration etc. The soil scientists and agronomists uses color as an aid in soil classification and draws from the color of the different horizons during soil formation i.e. soil color tends to reflect compositional characteristics, black or brown color indicates soil rich in organic matter while soil having poor organic matter often white or gray in color, reddish or yellowish color shows high contents of iron oxide etc. The color exhibits by the soil in the sample study areas vary from yellow to light brown color showing the presence of less organic contents and less iron oxide except Royal city where the color of the soil samples was recorded grey to yellowish. Over all, the color of the soil samples has clearly indicated the high agricultural potential of soil properties in the sample areas.

Table 4: Soil Color in Sample Areas

Sample Areas	No. of Samples	Color
Allama Iqbal Town	Sample 1	Dark Brown
	Sample 2	Light Brown
Baharia City H/S	Sample 1	Light Brown
	Sample 2	Yellow
Khhayaban-e-Ali H/S	Sample 1	Dark Brown
	Sample 2	Reddish
Royal City H/S	Sample 1	Grey
	Sample 2	Yellow
Rehman Garden H/S	Sample 1	Light Brown
	Sample 2	Light Brown
Gulshan Iqbal Town	Sample 1	Dark Brown
	Sample 2	Light Brown
Madina Town	Sample 1	Yellow
	Sample 2	Dark Brown

Source: Laboratory Analysis

4.2 Chemical Properties of Soil

Chemical properties of soil are equally important as physical properties. These properties determine the nutrients of soil i.e. soil pH, boron, phosphorus, copper, sulfur etc. and provided guidance in order to choose what fertilizer nutrients are required to better cultivation of crops? Therefore, chemical test is applied by the soil experts to test the quantity of various nutrients of soil. Major chemical properties taken for the analysis of agricultural potential in the sample areas of Bahawalpur are following;

4.2.1 Soil pH
4.2.2 Electrical Conductivity (EC)
4.2.3 Phosphorus (P)
4.2.4 Potassium (K)

4.2.1 Soil pH

Soil supports a number of inorganic and organic chemical reactions. Soil pH is one of the most important chemical properties influencing these reactions. Soil pH is primarily controlled by the concentration of free hydrogen ions in the soil matrix. Soil fertility is

directly influenced by pH through the solubility of many nutrients. At a lower pH than 5.5, many nutrients become very soluble and are readily leached from the soil profile whereas at high pH value, nutrients become insoluble and plants cannot readily extract them. Maximum soil fertility exists in the pH range of 6.0 to 7.2. Soil having pH of 7.5 caused easy provision of all necessary nutrients to the plants. Results shown that in study areas pH of soil varies from 7.6 to 8.5.

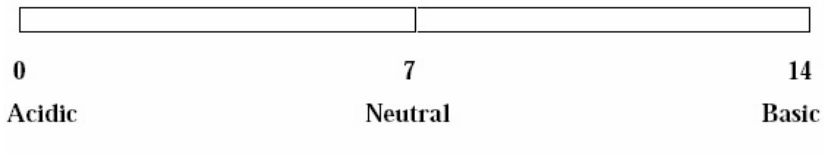

Figure 4: Soil pH Scale
Source: Author (2013)

Table 5: Standard for Soil pH and its Representative Fertility

Soil pH	Nature of Land
1. 7.5	All the nutrients easily available to the plants.
2. 7.6-8.0	Nutrients easily available expect Zinc, Iron, Manganese, Boron are not easily available.
3. 8.1-8.5	Among macro-elements, it is difficult to gain Phosphorus but micro-elements like Molybdenum face shortage.
4. More then 8.5	There is a problem of Alkalinity in land which must be removed by the farmer.

Source: Soil and Water Testing Laboratory of Agriculture Department, Bahawalpur

The pH of soil in sampled colonies was ranked suitable and moderate for crops production i.e. Baharia city, Allma Iqbal town and Gulshan Iqbal town have soil pH values of 7.6, 8.0 and 8.0 respectively which were quite adequate for nutrients availability in plants. Rest of the sampled colonies has soil pH of more then 8.0. Table 5 made it clears that soil pH ranges from 7.6 to 8.0 holds all micronutrients for plants expect of Zinc, Manganese, Iron and Boron. Hence, the soil pH in study sites falls in moderate alkaline (basic) range.

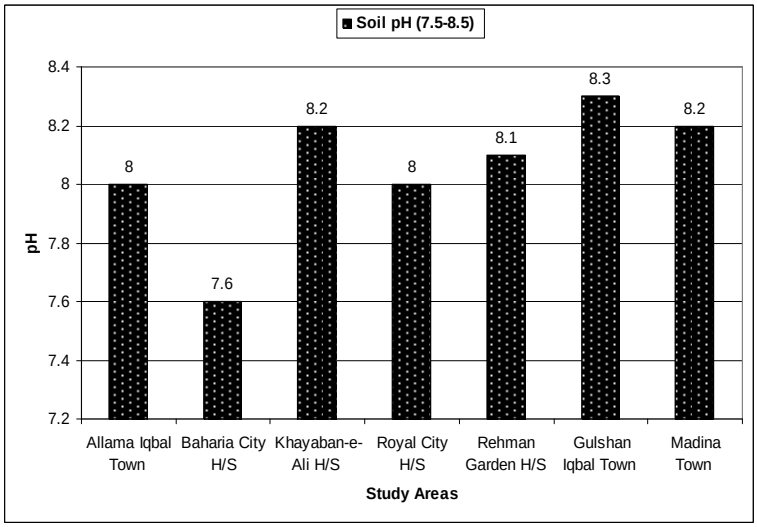

Figure 5: Soil pH Values of Sample Area
Source: Laboratory Analysis

4.2.2 Electrical Conductivity (EC)

Electrical conductivity (EC) of soil estimates the amount of total dissolved salts (TDS) or salt content. It is determined by standardized measures of soil conductance by the distance and vicinity through which a current travels and varies from field to field. Environmental conditions also affect EC i.e. rainfall etc. Traditionally, soil paste has been used to assess soil salinity (Rhoades et al., 1989). But now, new commercial devices rapidly and economically measure and map mass EC of soil across vast agricultural land (Hartsock et al., 2000). Measurement of electrical conductivity (EC) of the soil profile indicates the depth of soil layers, organic matter, water content, cation exchange capacity and salinity stage etc.

Table 6: Standard for Electrical Conductivity (EC) in Soil

Electrical Conductivity (dS/m)	**Nature of Soil**	**Effect on Crops**
Less than 4	No salinity or very less salinity	Not much effect on productivity of crops
4.1-8.0	Moderate salinity	Production of Maize, Sugarcane, Groundnut, Rice etc. is affected
More than 8.1	Much salinity	Only those crops could be cultivate which bear salinity i.e. Barley

Source: Soil and Water Testing Laboratory of Agriculture Department, Bahawalpur

Analysis of the soil samples of study areas has demonstrated that soils in these sites were classified as less salinity and moderate salinity (Figure 6). Only Baharia city has higher salinity of 38.3 dS/m. Other colonies have the EC that is suitable for the cultivation of all crops i.e. Allama Iqbal town, Royal city, Gulshan Iqbal town and Madina town have 3.5, 3.1, 3.6 and 2.2 dS/m which means no major bad effect on crops productivity could be happened. In Khayaban-e-Ali housing scheme and Rehman garden housing scheme salinity were observed 7.4 and 8.0 dS/m which was slightly high but falls in moderate limit (8.0 dS/m) and supportable for many crops.

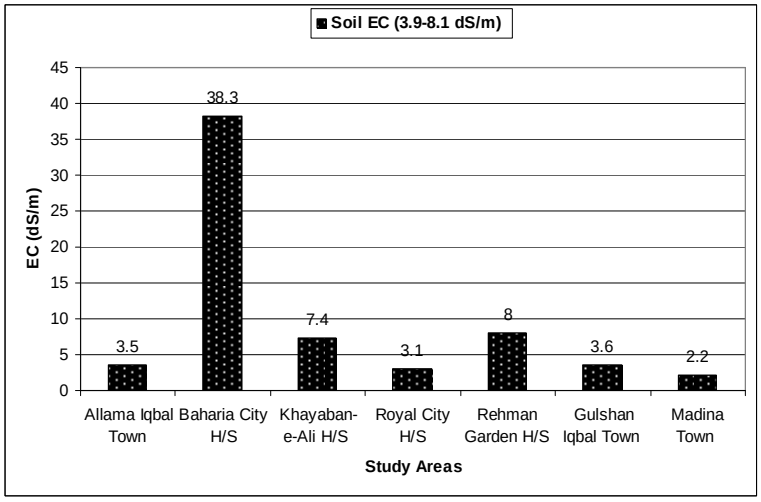

Figure 6: Electrical Conductivity (EC) of Sample Areas
Source: Laboratory Analysis

4.2.3 Phosphorus (P)

Phosphorus (P) is the constituent of the cell nuclei of plants and is essential for their division. Its presence is critical at early stages of growth. Phosphate deficient plants tend to be stunted growth, to lack new shoots, to have a dull grey or green color etc. But on the other hand, excessive use of Phosphate may speed up maturation and thus lower the final yield of crops. Therefore phosphorus concentration is usually determines the level of fertilizers or manure that were previously used.

Table 7: Standard for Phosphorus (P) in Soil

Phosphorus (mg/ppm)	Nature of Soil	Need of Phosphorus
Less than 7.0	Poor land	Profitable production couldn't be gain without application of phosphorus
7.1-14.0	Moderate fertile land	Positive results could be gain by application of phosphorus
More than 14.0	Fertile soil	Possibilities of positive results but depends on kind of crop and its need

Source: Soil and Water Testing Laboratory of Agriculture Department of Bahawalpur.

Phosphorus is an important plant micronutrient. Soil having the value of 7.1-14.0 mg/ppm phosphorus is considered moderate fertile soil (Table 7). Laboratory analysis of soil samples verified that in study areas quantity of phosphorus was ranges from 5.5-15.7 mg/ppm (Figure 7). Soil with Poor phosphorus quantity (5.5 mg/ppm) only found in Royal city. Moderate fertile soil was found in Allama Iqbal town, Baharia city, Khayaban-e-Ali housing scheme, Rehman garden housing scheme and Madina town having phosphorus quantities of 12.3, 8.6, 7.8, 7.9 and 11 mg/ppm respectively. While, phosphorus quantity of soil in Gulshan Iqbal town was recorded 15.7 mg/ppm which suggests it the fertile soil. Thus it was observed that the study areas generally were consisted moderate fertile soil before transformation except Royal city that have deficit phosphate quantity.

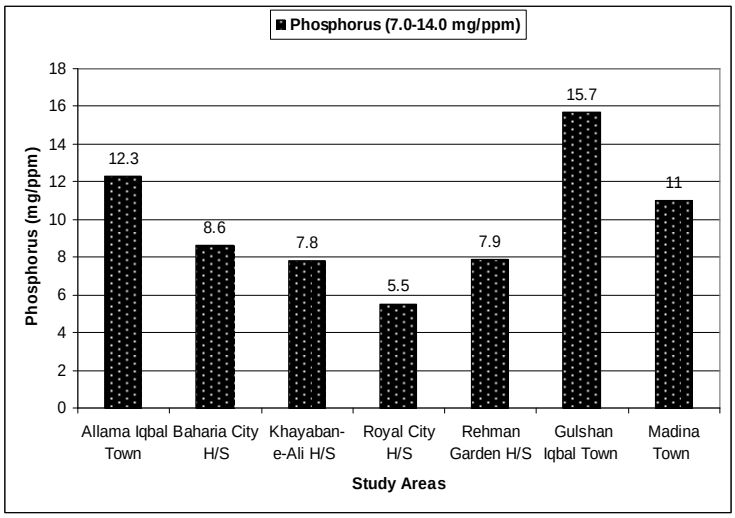

Figure 7: Phosphorus of Soil in Sample Areas
Source: Laboratory Analysis

4.2.4 Potassium (K)

Potassium (K) differs from nitrogen and phosphorus in soil because it is concerned to plant metabolism activity rather than the cell formation. Plants continue to absorb potassium ion throughout their lives but as they ripen they returned to the soil. It is noticed that half of the phosphorus and almost all of the nitrogen in the topsoil are found in organic combination but only a little share of potassium is available in this form. Potassium is relatively abundant in soils of arid areas.

Table 8: Standard for Potassium (K) in Soil

Potassium (mg/ppm)	Nature of soil	Need of Potassium
80-120	Poor soil	Profitable production couldn't be gain without application of potassium
121-180	Moderate fertile soil	Positive results could be gain by application of potassium
More than 180	Fertile soil	High possibilities of positive results but depend on kind of crop and its needs

Source: Soil and Water Testing Laboratory of Agriculture Department of Bahawalpur.

Soil having more than 180 mg/ppm quantity of potassium considered fertile soil and 121-180 mg/ppm ranked moderate fertile land (Table 8). In study areas, poor quantity of potassium was ranges from 80 -120 mg/ppm and only found in Madina town (110 mg/ppm). Moderate fertile soil having potassium 121 to 180 mg/ppm was found in Allama Iqbal town, Royal city and Rehman garden housing scheme in the quantity of 175, 165 and 125 mg/ppm respectively. Fertile soil having potassium of above 180 mg/ppm was observed in Baharia city, Khabayan-e-Ali housing scheme and Gulshan Iqbal town housing scheme in the quantity of 330, 225 and 195 mg/ppm respectively (Figure 8). These results made it clear that potassium quantity in study areas was detected in appropriate level and suitable for crops production.

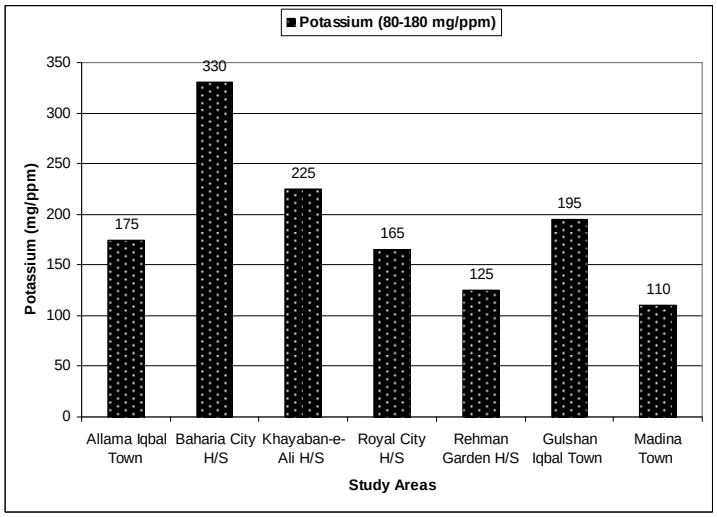

Figure 8: Potassium of Soil in Sample Areas
Source: Laboratory Analysis

4.3 Biological Properties of Soil

Soil holds variety of living organisms mainly in developed portion of its top including bacteria, fungi, earthworms and small insects that interact in complex type of food web. At the same time it also covers plants, grasses, small shrubs, wood sorrel etc (Miller, 1997). These organic components continuously perform their works and after dying added into the soil and increase its fertility.

4.3.1 Organic Matter

The organic components of soils consist of living plants and animals un-decomposed remains and decomposed dark brown residual of litter known as humus. Humus is found on top soil and is the result of complex bio-physical interaction and decomposition of organic components considered essential for high yield of crops.

Table 9: Standard for Organic Matter in Soil

Organic Matter (%age)	Nature of Soil
0.86	Poor according to organic matter
0.87-1.29	Satisfactory according to organic matter
More than 1.29	Adequate according to organic matter

Source: Soil and Water Testing Laboratory of Agriculture Department of Bahawalpur

Table 9 depicts that 1.29% organic matter in soil is adequate for better crops cultivation. But by the analysis, the organic matter percentage of different soil samples of colonies was differed from required amount (1.29%). Satisfactory organic matter ranges from 0.87 to 1.29%. However, in study areas the soil organic matter was less than 0.87% (Figure 9). Therefore, the organic matter of soil in study sites was poor. This is because of Bahawalpur lies in hot and dry region that is classified as arid and semi-arid and received less precipitation annually.

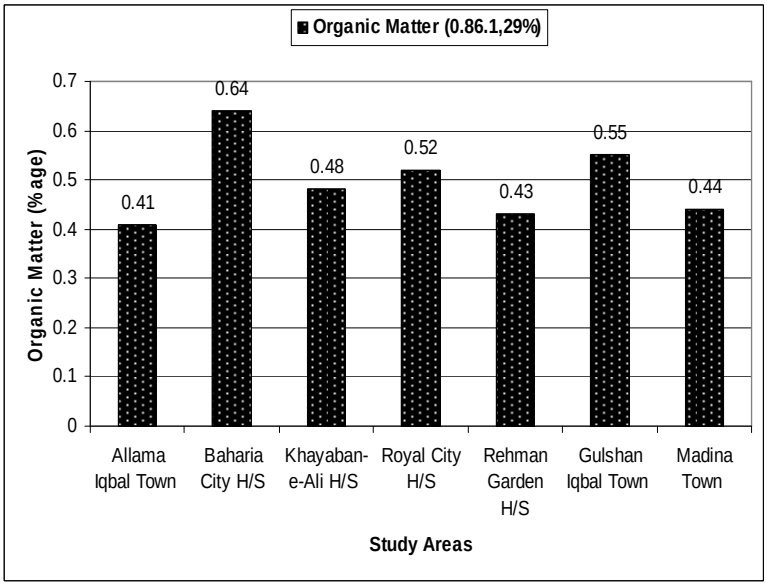

Figure 9: Organic Matter of Soil in Study Areas
Source: Laboratory Analysis

5. Conclusion

Soil is the uppermost layer of land that supports the plant growth and is one of the precious renewable resources of the earth vital for life. Unfortunately soil is being declined and degraded throughout of the world particularly in the cities of developing countries like Pakistan. Under the huge stress of increasing population, soil is being transformed into many urban uses like housing colonies. Bahawalpur city is also rapidly growing and experiencing significant change in land use due to housing colonies.

Study results indicated, from 1988 to 2008 (20 years) an area of 256 acres of fertile agricultural land was transformed with an average of 12.8 acres per year into seven colonies (Allama Iqbal town, Baharia city H/S, Khayaban-e-Ali H/S, Royal city H/S, Rehman garden H/S, Gulshan Iqbal town and Madina town) in different directions of the city and resultantly price of the land is shoots up.

Furthermore, to verify the soil fertility, selected soil properties were chosen and 14 samples from study sites were gathered (2 samples from each colony) and got tested in soil and water testing laboratory of agriculture department of Bahawalpur. Analysis had declared that saturation percentage of soil varies from 30 to 45% and soils have loamy to moderate loamy texture suitable for agricultural crops. Yellow and light brown color of soil showed the presence of less organic content and less iron oxide. The pH of soil in sampled colonies was ranked suitable and moderate for crops production i.e. Baharia city, Allama Iqbal town and Gulshan Iqbal town have soil pH values of 7.6, 8.0 and 8.0 respectively which were adequate for nutrients availability in plants.

Electrical conductivity (EC) in sampled colonies was suitable for the cultivation of all crops i.e. Allama Iqbal town, Royal city, Gulshan Iqbal town and Madina town have 3.5, 3.1, 3.6 and 2.2 dS/m respectively. In Khayaban-e-Ali housing scheme and Rehman garden housing scheme salinity was observed 7.4 and 8.0 dS/m which was slightly high but falls in moderate limit (8.0 dS/m) and supportive for many crops. Only Bahria city had higher EC value of 38.3 dS/m. The moderate value of soil phosphorus (7.1-14.0 mg/ppm) was found in Allama Iqbal town, Baharia city, Khayaban-e-Ali housing scheme, Rehman garden H/S and Madina town having phosphate quantities of 12.3, 8.6, 7.8, 7.9 and 11 mg/ppm respectively whereas just Royal city have deficit phosphate quantity.

Fertile soil having potassium of above 180 mg/ppm was observed in Baharia city, Khabayan-e-Ali housing scheme and Gulshan Iqbal town housing scheme in the quantity of 330, 225 and 195 mg/ppm respectively. Moderate quantity of potassium (125 to 180 mg/ppm) was found in Allama Iqbal town, Royal city and Rehman garden housing scheme in the quantity of 175, 165 and 125 mg/ppm respectively. Organic matter of soil in study sites was poor and less than 0.87%. This is because of Bahawalpur lies in semi-arid region and received less amount of annual precipitation. Hence, it is concluded that in Bahawalpur agricultural land bearing fertile soil suitable for the cultivation of various crops i.e. Wheat, Cotton, Sugarcane etc. is rapidly being transformed into housing colonies. This trend should be checked by concern authorities to conserve fertile agricultural soil for food commodities and environmental stability.

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