THE ECONOMIC AND ENVIRONMENTAL IMPLICATIONS OF LIVESTOCK MANURE IN ISLAMABAD

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"A Dissertation Submitted to the Pakistan Institute of Development Economics, Islamabad, in partial fulfillment of the requirements of the Degree of Master of Philosophy in Environmental Economics"

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CERTIFICATE

This is to certify that this thesis entitled: **"The Economic and Environmental Implication of Livestock Manure Islamabad".** submitted by Naeem Bahadar is accepted in its present form by the Department of Environmental Economics, Pakistan Institute of Development Economics (PIDE), Islamabad as satisfying the requirements for partial fulfillment of the degree in **Master of Philosophy in Environmental Economics**.

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In the name of Allah, Most Gracious, Most Merciful.

DEDICATION

I dedicate this research to ALLAH Almighty my creator, my strong pillar, my source of inspiration, wisdom, knowledge and understanding. He has been the source of my strength throughout this program and on His wings only have I soared. I also dedicate this work to my Family for their patience and encouragement, they are the reason behind all my success, their prayers and effort supported me and brought me to this level.

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Naeem Bahadar

LIST OF ABBREVIATION

CO_2= Carbon Dioxide

EDC= Economic Development Community

Gg= Gegagrams

GHG= Greenhouse Gases

MDG= Millennium Development Goals

UNICEF= United Nations International Children's Emergency Fund

WHO= World Health Organization

WTP= Willingness to Pay

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ABSTRACT

The research aims to investigate the economic and environmental implications of livestock manure and to investigate the household's willingness to pay for clean drinking water in Islamabad. The study is based on primary data, which was collected from livestock farmers, households and agriculture farmers in Bhara Kahu. After investigating the issue this research found that society near by the livestock farmers are not satisfied from the manure management and facing a lot of issues, that are affecting them in different ways. The local residents are willing to pay for clean drinking water. The livestock farmers and agriculture farmers have no such mechanism for manure management across their areas to use that as of fertilizers. Furthermore, it is also observed that the farmers were willing to pay for the natural fertilizer in order to develop such mechanism that they can easily collect it from the sites and use it instead of artificial fertilizer. According to our estimates, if the production of manure from all the livestock farms are 22500 ton/year, then by applying the technique of manure storage only, we are able to save 765000 tons CO_2 eq/yr. Our study recommends that government should take some precautionary measures such as introducing the waste tax system so that the farmers become serious about the issue of their waste production and also develop some vocational training programs so that they may deal with the waste produced and convert it into useful fertilizer like composting.

Chapter 1

Introduction

The term livestock defined as "cattle, sheep, goats, swine, poultry (including egg-producing poultry), equine animals used for food or in the production of food, fish used for food, and other animals" (Cornell, 1988).

According to FAO (2013), Livestock sustain the livelihood of about 1.3 billion people globally and are currently had to live less than $1 a day. Moreover, about 50 to 75 percent of these intense pitiable people depend on agriculture for their source of revenue. Livestock is an important asset, with a global value of at least $1.4 trillion and more than 600 million poor smallholder farmers are supported by it in the developing economies. Thoronton (2010), Furthermore, livestock contribute right around 40 percent of the worldwide worth of agribusiness creation and it take up around 26 percent of the without ice worldwide surface. While the cropland and grazing land devoted to the fabrication of feed is about 80 percent of the agriculture land showing that the livestock is one of the leading user of land resources (LEAD, 2016).

The livestock has a considerable share in the agriculture economy of Pakistan. Agriculture sector grew at 2.9 percent in the year 2015, in which the share of Livestock were 4.1 percent. Moreover, Livestock engage 35 million people and fabricate almost $500 million of products. The major components of the livestock sector are dairy, meat and poultry. Livestock agriculture value added is about 56.3 % and 11.8% to national GDP during 2014-15. Gross Value Added of the animal's sector has been improving at a slow rate by which the cost has enhanced from Rs 778.3 billion (2013-14) to Rs 801.3 billion (2014-15) indicating expansion of 3.0 percent when compared with previous year. (Ministry of Finance, 2014-15).

Table 1.1 Agriculture Growth Percentages (Base=2005-06)

Sector	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15 P
Agriculture	3.5	0.2	2.0	3.6	2.7	2.7	2.9
Crops	5.2	-4.2	1.0	3.2	1.5	3.2	1.0
i)Important Crops	8.4	-3.7	1.5	7.9	0.2	8.0	0.3
ii) Other Crops	0.5	-7.2	2.3	-7.5	5.6	-5.4	1.1
iii)Cotton Ginning	1.3	7.3	-8.5	13.8	-2.9	-1.3	7.4
Livestock	2.2	3.8	3.4	4.0	3.5	2.8	4.1
Forestry	2.6	-0.1	4.8	1.8	6.6	-6.7	3.2
Fishing	2.6	1.4	-15.2	3.8	0.7	1.0	5.8

Source: (Pakistan Economic Survey, 2014-15)

P: Provisional

Similarly, almost 40% of Pakistan rural households are engaged in livestock, which enables 11% of their earning from this sector. Livestock contributes a key portion to the economy of Pakistan, not only through the usage of animals for ploughing and transport, but it is also used for other commercial purposes which helps poor families to fulfill their needs for dairy products like milk, butter, whey and yoghurt. It also increases income of rural households and can operate as a shelter net in case of crop failure particularly in rain-fed areas (Farhad, Saleem, Cheema, & Hammad, 2009).

According to Akhtar, Younas, Iqbal, and Alam (2008) the growth of livestock is the second most important and the way of income after product farming for the rural occupants of the nation. In Pakistan 67% of people were living in rural areas during the year 2006 which is measured to 67.5% of the total population in the year 2016. To expand the overall livestock sector, the economy needs

to integrate small landholders, landless livestock owners or leaseholder on time. Rural farmers are in need for cost effective technologies for husbandry packages innovations. They also need effective and efficient technologies which rouse and make more grounded them to remain on their feet furthermore to lead the domestic animal's production framework towards more supportable.

Table 1.2 livestock Land Holdings in Pakistan

Ranges of farm size in hectares (ha)	No. Of farms Percentage		Farm area Percentage		Size of farm area (ha)
	Number	%	Hectare	%	
Private Farms	5070963	-	19149673	-	3.8
Government Farms	149	-	103035	-	-
All Farms	5071112	100	19252672	100	-
Under 0.5	678538	13	193126	1	0.3
0.5- <1.0	689233	14	510397	3	0.7
1- <2	1036286	20	1446796	8	1.4
2- <3	841295	17	1973800	10	2.3
3- <5	857387	17	3309432	17	3.9
5- <10	623110	12	4134346	22	6.6
10- <20	237929	5	3032872	16	12.7
20- <60	91831	2	2613767	14	28.5
More than 60	15354	-	1935101	10	126.0

Source: Census Pakistan (2014-2015)a

The share of number of farms by the Government sector is very small (Table 1.2). Majority of the individuals, including both men and women workers are engaging in small and medium enterprises (SME's) having less than 2 hectares, which contains almost herds of 1 to 3 animals (Farhad et al., 2009). Most of the farms have the area of less than 2 hectares for which it is difficult to apply any type of technology.

Table 1.3 Livestock Population in connection with environmental Degradation in Pakistan (Million Numbers.)

Species	2012-13	Total estimated Manure Production Mt/day*	Expected Manure Methane emission (Gg/year)	2013-14	Total Manure Production Mt/day*	Expected Manure Methane emission (Gg/year	2014-15	Total Manure Production Mt/day*	Expected Manure Methane emission (Gg/year
Cattle	38.3	597480	229.8	39.7	619320	238.2	41.2	642720	247.2
Buffalo	33.7	195460	168.5	34.6	200680	173.0	35.6	206480	178.0
Sheep	28.8	46080	5.76	29.1	46560	5.82	29.4	47040	5.88
Goat	64.9	116820	14.278	66.6	119880	14.652	68.4	123120	15.048
Camels	1.0	18400	2.56	1.0	18400	2.56	1.0	18400	2.56
Horses	0.4	7360	0.876	0.4	7360	0.876	0.4	7360	0.876
Asses	4.9	59780	5.88	4.9	59780	5.88	5.0	24500	6.0
Mules	0.2	3680	0.24	0.2	3680	0.24	0.2	3680	0.24

Source: (Pakistan Economic Survey, 2014-15)

***author's Calculations**

Table 1.3 shows that the population of the livestock followed by its environmental degradation has increased overtime. The waste of the livestock population is also associated with environmental implication which sometime becomes more sever in the urban areas which needs proper management system. As shown in the table 1.3 that the population of livestock increases their manure production also increases because of which the environmental degradation is also increasing in the form of GHG emissions.

The increasing amount of waste generated by these livestock population is threatening the health as well as the environment. According to an estimate, 10 to 15% of the world-wide emissions are from the livestock sector (Herrero et al., 2011). Orheruata and Omoyakhi (2008)explored that the improper livestock waste management is equally damaging the environment as well as the society

and economy. Moreover, emission from the livestock waste is regular and may be high environmental damaging if not properly managed.

According to Mathias (2014), the waste produced by the livestock have both environmental and health concerns. It contaminates the water and soil resources and pollutes the air. The manure of livestock has the wide content of nitrogen oxide which if left on the open land causes emissions of nitrogen gases which in turn also adds more nitrogen to the soil. However, if these wastes are properly managed it can be used for better purposes which are environment friendly. If the livestock waste is used as a natural fertilizer instead of chemical fertilizer, it can save the environment by reducing the use of harmful fertilizer and CO_2 emissions. So this promotion of natural fertilizer also reflects countless environmental benefits directly and indirectly.

Table 1.4 Fertilizer consumption (000 tones) and environmental degradation from chemical fertilizer (Pakistan)

Description	Kharif (Apr-Sep) 2014				Rabi (Oct-Mar) 2014-15				Kharif (Apr-Sep)* 2015			
	Urea	Gg CO2-eq/ product**	DAP	Gg CO2-eq/ product**	Urea	Gg CO2-eq/ product**	DAP	Gg CO2-eq/ product**	Urea	Gg CO2-eq/product**	DAP	Gg CO2-eq/product**
Opening stock	386	1987.9	99	200.97	184	947.6	430	872.9	151	777.65	118	239.54
Imports	122	628.3	524	1063.7	576	2966.4	498	1010.9	39	200.85	0	
Domestic production	2,451	12622.6	400	812	2,493	12838.9	332	673.96	2,550	13133	366	742.98
Total availability	2,959	15238.8	1023	2076.7	3,253	16752.9	1260	2557.8	2,740	14111	484	982.52
Off take/Demand	2,716	13987.4	586	1189.6	3,100	15965	1140	2314.2	2,900	14935	600	1218
Write on/off	-59		-7		-2		-2		0		0	
Closing stock	184		430		151		118		-160		-116	

Source: National Fertilizer Development Center of Pakistan (2014-15)

***: Outlook**

****: Own Calculation**

In Table 1.4 it is clearly shown that a large number of fertilizers are used every year in every season. It is also clear from the table that the use of fertilizer is increasing every year while the capacity of domestic producing chemical fertilizer is not enough to meet the requirement of the country. So for in order to meet the requirement every year chemical fertilizers are imported. Besides that, a number of studies have shown that the use of chemical fertilizers is damaging both the fertility of the soil as well as the health of the community. Farmers have the option to use either

livestock manure or chemical fertilizers for maximizing crops yield. However, both type of fertilizer may not have same environmental implication.

Safe drinking water is the basic requirement of the good health. In the era of this modern world safe drinking water is decreasing to the individual's day by day. A number of studies have been conducted keeping different themes but so far did not overcome the issue of safe drinking water. According to Hunter, MacDonald, and Carter (2010) at least 50 litres per day of water is required by a single person for all purposes including hygiene, drinking and other purposes. But unfortunately, a large amount has been taken by the agriculture, about billions of people in developing countries are not having the safe drinking water supply for several decades.

One of the Sustainable Development Goal is the environment sustainability which aims to reduce the number of people about to half who has not having the safe drinking water and sanitation. According to an estimate by UNICEF around 1.3 million children are subjected to death because of diarrhea. And a joint report by UNICEF and WHO reported that about 780 million people worldwide has no adequate drinking water and this lead to waterborne diseases specially to diarrhea (Young, Wolfheim, Marsh, and Hammamy, 2012). The unavailability of safe drinking water leads to multiple diseases and this suffers the low income countries more and remains a foremost public health matter and become a challenge for development (Orgill, Shaheed, Brown, and Jeuland, 2013)

1.1 Significance of the study

Economy needs livestock to feed growing population. However, it may also challenge the economy if these wastes are not properly managed. If we don't manage the animal manure on farms as a resource, the wastes will generate the GHG emissions. Besides, the farmers are also

using chemical fertilizers which also generate GHG emissions. The natural fertilizer (livestock manure) can be substituted for N, P and K fertilizer by farmers (Pimentel, 2005). The farmers also sometimes do not use livestock manure due to lack of proper marketing and availability of these manure. Furthermore, mismanagement of these livestock manure also affects the nearby community.

Livestock manure on one side degrade the quality of the soil, water and air (Orheruata & Omoyakhi, 2008) but on the other hand it is also the important factor for promoting sustainable environment through reducing methane and CO_2 emissions. Particular to our study area these livestock farms are situated within the community or nearby the community and their wastes are not managed properly lying on the pastures because of which the community faces the issue of bad smell, visuals, ground water pollutions and health related problems (Shih, Burtraw, Palmer, & Siikamaki, 2008). Moreover, the land prices of the nearby plots are also affected due the improper arrangement of these manure. The study focused on calculating the costs associated with farm animal manure. It includes the costs such as the ground water quality degradation, GHG emissions and health cost faced by community in Islamabad. There is no proper management system for livestock waste in the study area. However, if the farmers themselves manage it, then it will cost them. This the reason willingness to pay for safe drinking water of the people living near the livestock farms has also been estimated.

Furthermore, proper management of livestock manure may also have serious implication for the local community. With this background, this study captures such issues in its scope.

1.2 Objectives of the study

The key objectives of the study are:

1. To analyze the economic implication of livestock manure such as manure potential, manure marketing and their effects on property values.
2. To estimate willingness to pay for safe drinking water of the local community living close to the livestock farms.
3. To analyze the environmental implications of livestock manure such as health costs, reduction of CO_2 emissions considering livestock manure and water pollution.

1.3 Research questions

1. Does livestock manure affect property values?
2. How much people are willing to pay for safe drinking water in the surrounding area of manure?
3. Does the local community bear any health costs due to livestock manure?
4. Does livestock manure impact water quality?
5. What is the potential of reducing CO_2 emissions through proper manure management of the livestock manure

1.4 Hypotheses of the study

1. Livestock manure has negative impact on the property values.
2. Household size and distance from the livestock farm has a negative impact on WTP for safe drinking water while Income, Ownership of house and Education has positive impact on WTP.

3. Household Size, Income has a positive impact on the health cost of the nearby community while Education, Distance from the livestock farm and Awareness has a negative impact.
4. Livestock manure has a negative impact on the water quality due to waste production.

Chapter II

Literature Review:

2.1 Economic Significance of Livestock waste:

Pimentel, Hepperly, Hanson, Douds, and Seidel (2005) conducted a field research from 1981 through 2002 at the Kutztown, Pennsylvania in order to observe the economic and environmental issues related to the organic and conventional farming system. This experiment included three cropping systems conventional, organic with livestock waste and without livestock waste. They found that an organic farming shows best fits to the farms. The soil organic matter was considerably more in the organic farming systems than in the conventional system which was more favorable for the sustainability of the farming.

Farhad et al. (2009) studied the effects of poultry manure on the productivity of spring maize. They used the different levels of poultry manure to measure the yield of spring maize applying six different levels of manure to the field and then collected the data through standard procedure to measure the growth and yield parameters. The data then examine statistically using Fisher's analysis of variance technique and standard deviation. They found that yield from the highest level of manure is recorded more than the lower level except the number of cobs per plant which is not affected by it.

Mathias (2014) presented an idea of using manure as a resource not as waste in Brazil. Brazil is a country which is rich in livestock waste resources but management of these resources is a big issue. Particularly in rural areas there is no proper treatment plant for animal waste management. Results showed that biogas generation system through livestock waste in rural areas of Brazil will give

economic benefits in the form of energy generation and environmental benefits in form of animal waste treatment.

2.2 Livestock waste and Environment:

Gerber, Chilonda, Franceschini, and Menzi (2005) analyzed the determinants and environmental implications of livestock waste production in Asia. Under the high demand of livestock, its production and intensive production system is increasing rapidly in all over Asia, which then affects the environment, community health and the rural development. The main problem of the environment is because of the livestock waste and its mismanagement which pollute air, soil, land and water. They also observed that livestock manure accounts for 39.4 percent for the phosphate pollution while the remaining is from the chemical fertilizer. Livestock is the dominant source of the phosphate emission in agriculture while chemical fertilizer is dominant in crop yield. They also suggest substituting chemical fertilizer for animal manure which will decrease the impacts on environment.

Shih, Burtraw, Palmer, and Siikamäki (2008) estimated air emissions of ammonia and methane from livestock waste. They stated that livestock waste is an immense contributor of methane and ammonia and eventually contributes in the greenhouse gas emissions. The finds helped in understanding the technical and economic relationships in order to realize the benefits of managing air emissions and waste discharges from agriculture.

Orheruata and Omoyakhi (2008) discussed issues and options about livestock and environment interaction in Nigeria. Normally animal waste production damage environment in many ways some of them are air pollution, land degradation, heavy metals, and social economic problems. It is obvious in the light of the above that the government, animal scientists, livestock producers and

environmentalists have their responsibility for the public safety and the protection of the environment.

Petersen, et al., (2013) examine the impact of increasing production of livestock which leads to livestock manure on greenhouse gases, nitrous oxide (N_2O) methane (CH_4). This study was based on regional comparison which contains Southeast Asia, Sub-Saharan Africa, Europe and China. This study concludes that production of manure management which based on solid manure management leads to more greenhouse gases, N_2O and CH_4 rather than liquid manure management. The research also discussed the complexity relating to model formation, and implications.

Ogbuewu et al. (2012) studied livestock waste and its impacts on environment. They stated that increase in production of livestock waste significantly increase greenhouse gas methane emissions, livestock waste contributes 5% in total emissions of methane in 1990s globally. Livestock waste affecting environment included water, air and soil quality. Results showed that theses wastes can be utilized as bio-fuel production, organic fertilizer, Vermicast production, and alternative animal feeds.

Cook, (1998) examined the impact of different way or best practices of animal waste management on Bacteriological Value of Surface Water. This study was based on monitoring project which is started in 1986 in Virginia and continue till next 10 years. This study collect data throughout the project and include both post and pre-BMP monitoring data. In this study nonparametric tests are applied. According to results of data analysis, rainfall quantity is approximately constant in two periods and bacteriological surface water quality is also not changed in project time period.

Moreover, this project also suggests that by decreasing fecal bacteria best management practices can improve water quality.

Iqbal, (2013) has conducted his research in India for knowing the effects of animal husbandry on the environment. He found that as the rapid expansion of animal husbandry damaging the environment in multiple ways. He uses secondary data for the analysis and that data has been collected through different channel of media like magazines national, international, reports and journals and after that applying a simple econometric technique. They found that that apart from the economic benefits the livestock damaging the environment differently, the livestock enteric fermentation share is more than 68 percent of the total agriculture methane share. Apart from it there are multiple health problems are also seen there which was just because of the poor management of livestock and their wastes.

2.3 Livestock waste and Health:

McCubbin, Apelberg, Roe, and Divita (2002) studied the impacts of management of livestock ammonia on health in United States. They stated that at United States ammonia emissions are already causing adverse health effects like premature mortality, chronic bronchitis, hospital admissions, and asthma attacks. The areas where management practices are undergone resulted to decrease the adverse health effects and resulting significant economic benefits. Four factors of agriculture livestock emissions have been addressed including housing, storage, spreading, and grazing.

Donham et al. (2007) tried to estimate the impacts of increase in the intense animal feeding operation on supporting the health of rural communities. They came to the conclusion that strict

policy decision should be made for concentrated animal feeding programs which include limiting the animal per watershed, handling the manure management and many more.

Olusoji & Charles, (2016) investigated the different way or practices of livestock waste management for Oyo state in Nigeria. The research also checked the impact of different way or practices of livestock waste management on human health and environment. Descriptive statistics were used for analysis of different way or practices of livestock waste management. Peer reviewed and pre tested questionnaire were filled with structured farm visits for data collection. According to descriptive analysis, 45% open dumping, 14% flushing, 10% sun drying, 25% mixed combination, 5% feeding to animals and 2% biogas method were used for livestock waste management. The results also reveal that mostly used methods are not environment friendly hence livestock waste disposal management effect human health and environment.

Vinten, Potts, Avery, & Strachan, (2009) conducted experimental based thesis to know the symptoms of E.coli virus in human faeces who used the contaminated from the livestock. they conducted the research in two zones south-West region of Scotland and North-east region of Scotland assuming that in the SW region there is a risk of seaside waters which are the cause of the main water borne diseases while in the NE region the people used the groundwater for the purposes which are assumed to be contaminated by the livestock. A combination of process models and the survey data was used to assess the risk. Their risk assessment results shows that because of the livestock there is a significant to the human health which has been caused by the water borne diseases.

Fafioye & Dewole, (2012) examine the environmental condition and health of farm workers due to open dumping animals waste. The Data sample was collect from Deborah and Serah farms

which are situated in Southwestern Nigeria. Chi-Square's test is applied for hypothesis testing. According to empirical results, open dumping of animal's waste has significant impact on farm worker's health and environment. Quality of waste disposal or waste management education has significant impact on the method or way to disposal which is already working on the farm. Results also reveal that industrial training is inadequate for waste disposal management in the farms.

Zhanga, (2011) checks the impact of livestock manure management on human health, air quality, psychological stress and environmental condition in Canada. This study discusses statistics which is reported by Environment Canada 2005-2008. According to data and summary statistics, this study concludes that livestock manure management effects air quality, environment and human health. According to this study, livestock manure management increases emissions and damages air quality.

2.4 Willingness to Pay for Safe Drinking Water:

Sattar, Ahmad, and Pant (2007) conducted a field research in Hyderabad Sindh on order to obtain the community level willingness to pay for the quality drinking water They used the random sampling technique for collection of the data. They analyzed the data through multinomial logit model and came to the conclusion that the households with higher education level are selecting more expense method for purification of water indicating that they are more conscious towards it. Exposure to the media is also playing a significant role in it.

Mezgebo & Ewnetu, (2015) investigate the trend of willingness to pay for clean water facilities in Nebelet. Cross sectional data is used which contains 181 households in 2011-2012. This study also includes many factors which influence willingness to pay such as per unit price charged, interruption, maintenance delay, irregular public water supply and unequal distribution of public

water supply. The probit model is applied for analysis. The Results of descriptive analysis indicate that around about 96% people are willing to pay for clean and improved water facilities. The results of probit model indicate that distance, income, education, bid, water expense, previous satisfaction on water and marital status are affiliated with willingness to pay for clean water.

Haq, Mustafa, & Ahmad, (2007) check the trend of willingness to pay for improved water facilities and improved water quality in Abbottabad during 2007-2008. This study highlights the issue of drinking water facilities in Abbottabad. This study applies two approaches for analysis such as CV (Contingent Valuation) method which also called direct approach and indirect approach which include behavior preferences. For empirical analysis this study used Multinomial Logistic model. According to results, both quality and water services is important for HHs. Both quality and services are important, hence HHs are willing to pay for clean water facilities and quality of water.

Orgill et al. (2013) has accompanied the WTP for the safe drinking water in peri-urban area of Cambodia. They surveyed 915 households and using the multivariate logit regression technique and then analyses the responses through contingent valuation model. They find that around 77% of the people are treating their water in some ways in which 88% of the population using the boiling method. Interestingly they revealed that about all the people are willing to pay for the safe drinking water and there are no taste differences as well. Their calculations for average WTP for the rural Cambodians are $2.70 per month for an average Household of 5.3 people.

2.5 Impact of Fertilizer use on Environment:

Zhu and Chen (2002) estimated the impacts of fertilizer use on environment and the production of food in China. They found that there is an increase in the concentration of Nitrogen in the earth

surface and also the concentration is increasing in the ground water as well because of which serious problems were seen like the red tides and the more emissions of ammonia.

Binaj, Veizi, Beqiraj, GJoka, and Kasa (2014) focused on the soil degradation and its economic impacts on the farmers in Albania. Soil degradation is one of the crucial problems now a days and it impacts the farmers in number of ways. They found the economic losses due to the degradation of the soil and its impact on the farmers due to less productivity and an increase in the cost of fertilizer. They found that there was enormous loss due to the nutrient loss by water erosion and yield losses due to soil compaction and the economic losses per year due to it was about 5.5% of the agriculture GDP.

2.6 Fertilizer use and Health:

Savci (2012) showed the environmental and health impacts of the excessive chemical fertilizer use. The population increases with such a fast rate that per unit maximum efficient yield is the requirement of the time because of which heavy metal accumulation, soil salinity and other problems associated with it leads to the problem of greenhouse effect. They found that there will be an increase in the nitrogen and phosphorous concentration in the drinking water and in the river as well and the plants grown in the excessive concentration of the nitrate will be harmful because of carcinogenic substances in it.

Hauser (2013) investigated the effects of nitrification from the soil and its effect on the greenhouse gases. He investigated that application of nitrogen and ammonia fertilizers to the soil release certain amount of GHG emissions including nitrous and carbon dioxide gases. He observed that use of ammonia fertilizer to agriculture fields releases more nitrogen gases and also ammonium nitrate fertilizer should be avoided. He also observed that other factors like temperature and

moisture also affect the nitrogen release and also the soil type like water logged area will areas more nitrogen through denitrification.

Islam et.al (2017) investigated the quality of fruits and tomato production by using various kinds of inorganic and organic fertilizers in Bangladesh. This study is conducted in Bangladesh Agriculture University and experiment is conducted at horticulture farm. BARI 15 and ROMA VF are types of tomatoes which are picked for experiment. According to results, mixed fertilizers produce best results on fruits measurement and both types of tomatoes such as BARI 15 and ROMA VF. Moreover, ROMA VF produce best results rather than BARI 15. Hence combination of inorganic and organic fertilizers produces best results.

This study evaluates the economic and environmental implications of livestock manure in Islamabad. None of the studies have focused on this issue in Pakistan, and this gap had a bridged by this study. Unlike urban area of Islamabad, rural needs the focus of researchers because it has been neglected for long as rural areas of Islamabad do not have proper disposal systems due to which manure becomes a problem instead of a resource. So focus of the study was to analyze this issue. The area is under the federal development authority but not focusing such issues happening there so this study also tried to focus that the government should take some serious step towards this destruction of environment and the health of people.

CHAPTER III

DATA AND METHODOLOGY

This Chapter includes the theoretical background of the study, data description, data collection techniques, explanation of the variables and the econometric modeling used in the study. All these are discussed below.

3.1. Description of the study area

Bhara Kahu was the study area, which falls in Islamabad's Zone-IV, the rural areas administered by the Islamabad Capital Territory administration rather Capital Development Authority. The area has population of more than 250,000 people. The town is a semi developed residential-cum-business sector consisting of seven villages namely Kot Hatyal, Subban Syedian, Mandla, Mohra Noor, Malpur, Mangial, and Shahdara. (Hashmi, 2013).

In our study area, the livestock farms were only having milk producing animals mostly having buffalos and cows. So, our restriction to data collection was, only the farms having milk producing animals**.**

Table 3.1. Area and population of Bara Kahu

S.No	Name Of Village	Area (acre)	Population
1	Kot Hathyal	1,914	150,000
2	Subban Syedian	2,681	2,293
3	Mandla	1,098	1,098
4	Mal Pur	CDA Acquired	978
5	Mohra Noor	2,481	17,718
6	Mangial	476	140
7	Shahdra	2,006	5,643

Source: (Hashmi, 2015)

3.2. Data Description:

The primary data was used for the analysis which were collected through questionnaire (see appendix-A-C). The questionnaires included the information on number of livestock, manure generated by animal farms and their costs to the community, water and land values.

3.3. Sampling Design:

The respondents of the survey consisted of nearby households living within the radius of 500m from livestock farm and outside the radius, livestock farms owners, agriculture farmers. The primary data was collected from 384 households. The sample size for the households was calculated through sample size calculator with 95percent confidence level, 5percent confidence interval with projected population of Bhara Kahu for 2015 as 188,3163. (PBS, 2014).

Table 3.2. Sampling Design

Respondents	Sampling Size	Sampling Method	Instrument of data collection
Households of Surrounding Community within radius 500m from farm	192	Simple Random	Questionnaire
Households of Surrounding Community outside radius of 500m from farm	192	-do-	Questionnaire
Total	384		
Livestock Farm owner	10	Purposive	Interview
Farmer	10	-do-	Interview

3.4. Theoretical Framework:

The value of any commodity comes from the utility that it generates after one unit of that commodity is consumed. This is called the marginal utility. This is further interpreted as the price (the value of a commodity) because we know that a consumer is at equilibrium at the market price

which consumer actually wants to pay for that commodity. From this notion, we derive the marginal utility or the willingness to pay, which is taken for the price that consumers are willing to pay. The basic model is as follows:

U = f (Household Size, Household Income, Household Ownership, Education, Distance) …. (3.1)

Willingness to pay is the marginal utility and hence it would be:

$U^{/} = f^{/}$ (Household Size, Household Income., Household Ownership, Education, Distance) … (3.2)

To estimate the WTP logit model is used by many studies like Khan et al. (2010) to elicit WTP in Hayatabad Peshawar, Fillipis (2005) also used logit model to find the determinants of willingness in Greece. Logit regression model is specified bid as dependent variable and bid is the function of other variables such as household size, household income, owned house, distance from tannery, environmental awareness of the respondent, education of the respondent, and age of the respondent and marital status of the respondent.

WTP = f (H_SIZ, HHI, H_OWN, DST, E_AWA, EDU, AGE, M_STA)

Where:

WTP = the respondent is willing to pay for the stated bid, if willing then taking value 1 otherwise 0.

H_SIZ = Household size, in this we took the total number of person living in the house. Household size is expected to negative relation with WTP. It is assumed that large household size will be willing to pay less as compared to small household size due to the budget constraint. So it is expected that there will be a negative sign.

HHI = Household Income, in this variable we take the total household monthly income in rupees. Environmental economics theory suggests that with an increase in income demand for

environmental quality also increase. Those household with higher income are expected to high WTP for improved water quality.

H_OWN = House ownership, we collect the data of this variable as if the household have their own home then value 1 otherwise value 0. It is expected that there will a positive relationship with WTP and house ownership.

DST = Distance from livestock farm, the value take as 1 if the household is within the radius of 500m from livestock otherwise 0.

E_AWA = Environmental Awareness, this variable is showing that either respondent is environmentally aware or not, and the data coded in software as if respondent is environmentally aware then coded as value 1 and 0 for if respondent is not environmentally aware.

EDU = Education of respondent, in this variable we take the education of respondent in years. WTP for improved water quality is expected to be positive relation to education. The people who got higher education know more about the waterborne diseases so educated people will be WTP higher as compared to illiterate.

AGE = Age of respondent, the variable age is coded in number of years. It is very difficult to say that how a respondent age will impact on WTP so the expected sign can be positive and as well as can be negative.

M_STA = Marital status, the marital status coded 1 if respondent is married otherwise 0. This variable is expecting a positive sign because the married can be more concerned about their child's.

$WTP = 1 / 1 + e^{\ln zi}$

$\ln z = \beta_0 + \beta_1 HHS + \beta_2 HHI + \beta_3 H\_OWN + \beta_4 DST + \beta_5 E\_AWA + \beta_6 EDU + \beta_7 AGE + \beta_8 M\_STA + ui$

Second model involves the explicit costs on availing the health services. It includes the costs borne on medicine and consultation services as well laboratory costs. For individuals, health cost as included in our model depends upon several factors. Educated families are more aware of the complications of health problems and hence they avail health services regularly. Other factors include, Household income, Household size, distance of Household from livestock farm and awareness.

Third model which is used for calculating the property value is hedonic Price model which is the best model used by several researchers for estimating the property value like Kiran (2016) used the rent of the houses and applied the hedonic price model for estimating the socioeconomic and environmental factors affecting the house rents in Islamabad. The basic function is as follows:

$P(X)= f (X_1, X_2, X_3, \ldots\ldots\ldots\ldots., X_n)$ …… (3.3)

Where P(X) is the price value of the property whereas the f (X_1, X_2, X_3, ……, X_n) are the vectors of n characteristics which influence the prices of the property.

3.5. METHODOLOGY:

3.5.1. Manure generation

The data on number of livestock animals and types of cattle, waste per head per day, trips of waste supplied had been collected from livestock farms. Their economic value was estimated on monthly basis.

3.5.2. Households' willingness to pay for safe drinking water

Besides, the willingness to pay for safe drinking water was also be asked from the respondents of local surrounding community living within and outside the radius of 0.5 km.

$WTP = b_0 + b_1 HH\_SIZ + b_2 HH\_I + b_3 HH\_OWN + b_4 EDU + b_5 DHR + \mu)$ ……(3.4)

WTP = A Binary variable taking value 1if the respondent is willing to pay for safe drinking water and 0 otherwise. The Government supply water was considered as safe drinking water.

HH_SIZ = Household size in number. The number of the people is likely to have an impact on the expenditure of the household for the reason that if the number of person in a household increases they would have less to pay for safe drinking water (Shahid, 2015).

HH_I = Household monthly income in rupees. The income is expected to have a positive impact on the WTP because as the income increases, the household would be willing to pay more on safe drinking water (So-Yoon , Seung-Hoon, & Chang-Seob, 2013).

HH_OWN = House ownership, it is the dummy variable taking value 1 if the household had their own home and 0 otherwise. Its expected sign is positive because the owner of the corresponding house would be more conscious about the safe drinking water for the household where he lives permanently (Shahid, 2015).

EDU = Education of head of the household in years is taken to capture the level of awareness of the respondents on health issues and it was expected to have positive sign because education creates awareness and knowledge about the waste which in turn he will be more conscious about the environmental protection and safe drinking water (Mezgebo & Ewnetu, 2015).

DHR = Dummy of house within the radius of 500 meters from the livestock farm, it took the value one if the household is inside the 500 meters' radius otherwise zero (Shahid, 2015).

3.5.3. Property Value

Rent of houses, per Marla price of plots in connection with manure dumped in specific area was asked from the people living in the study area. The following rent model was used

$lnH\_Rent = \alpha_0 + \beta_1 H\_INC + \beta_2 COV\_ARE + \beta_3 DIS\_FRM + \beta_6 AVL\_GOVTWTR + \beta_7 AVL\_SEW + \beta_8 DIS\_HOSP + \mu$ ……(3.5)

H_Rent = Monthly Gross rent of the house in rupees.

H_INC = Household monthly Income in rupees. It was expected to be negative because as the income increases the household will try to shift to better place affording a higher rent for better environmental conditions.

COV_ARE = This variable represents the total covered area or living space in the provided building. This variable was taken in square meters. The sign of the coefficient of the area was expected to be positive (Khan, 2015).

DIS_FRM = Distance from farm in meters. It was expected to be positive because the distance from the farm increases the environmental condition was become better so there was an increase in the rent of the house.

AVL_GOVTWTR = Availability of the government supply water. It was the dummy variable if the govt. supply water was available taking the value 1 otherwise 0 and it is expected to be positive.

AVL_SEW = Availability of proper sewerage system. It was also the dummy variable takes the value 1 if proper system was available and otherwise 0.it is also expected positive.

DIS_HOSP = Distance to the nearest hospital measured in km. it was expected to be negative because as the distance of hospital increases the rent of the houses was decrease (Khan, 2015).

3.5.4. Health cost

Health cost function was estimated to achieve third objective of the study. It was intuitively understood that HH near the farms had experienced unhygienic environment due to which they may suffer from different diseases and hence undergo the health cost.

The local community was asked about the reasons of illness like chronic bronchitis, asthma attacks and hospital admissions and other diseases related to livestock waste. To this end, the following healtaah cost function was estimated:

$HC = \alpha + \beta_1 HHS + \beta_2 Edu + \beta_3 I + \beta_5 Awr + \beta_6 DHR + \varepsilon$ ………………………………(3.6)

HC: Health cost incurred by the households due to livestock manure per month in Rs. The costs include medication cost, laboratory cost, doctor's fee, travel cost for health.

HHS: Household size in number. The number of the people was likely to have an impact on the expenditure of the household for the reason that if the number of person in a household increases, their expenditures on health would also increases. So, its sign is expected to be positive.

Edu: The education of the main earner of the household in years was taken to capture the level of awareness of the respondents health issues and it is expected to have positive impact as if the individual is aware about the harmful effects he would be having more conscious about the health of the family and would take measures on time increasing the health cost (Link & Phelan, 1995).

I: is the household monthly income in rupees. The income has a positive impact on the health cost because as the income increases the household would be having more money to spend on it for better treatment and would prefer to do treatment from high cost hospitals and specialist doctors (Link & Phelan, 1995).

Awr: is a discreet variable taking values of Likert scale from 1-5 (It takes value 5 if the respondent was aware and 0 if he was not aware) and its impact was expected to have negative. This variable have also been used by (Kiran, 2011).

DHR = Dummy of house within the radius of 500 meters from the livestock farm, it takes the value one if the household was inside the 500 meters' radius otherwise zero.

3.5.5. Reduction of CO_2 emissions by using livestock manure

The farmers was asked how much manure could be used interchangeably with chemical fertilizer. This would help us to calculate how much of GHG emissions could be reduced by using natural fertilizers. For the estimation of GHG emissions IPCC Tier-1 method was used. The total emissions in GHG are estimated as follows:

Emission Factor (kg/head/yr) • Population (head) / (10^6 kg/Gg) = Emissions Gg/yr.

3.5.6. Water pollution

The nearby residents would be asked about the quality of water like odor in water, taste, suspended particle, and color of the water to know the quality of water.

3.6 Estimation Technique:

This study determines the relationship of willingness to pay and clean drinking water with that analyzing the health cost and impact on the property value of the impacted area. This study employs Contingent Valuation Method (CVM) for valuing the WTP or household demand for clean drinking water. This study includes the estimation techniques for the three different regression models. The technique of logit method is used for estimation of equations because the dependent variables are binary. To estimate the WTP logit model is used by many studies like Abbas (2014) to find the health impact of cement industry on workers and surrounding area, Shahid (2014) also used logit model to find the determinants of willingness in Sialkot.

We use the simple multiple regression technique (OLS) to estimate the aforementioned third model, namely health cost. The OLS is the most simplicity econometric technique to draw the causal relationship among the variable in the model.

CHAPTER IV

RESULTS AND DISCUSSION

This chapter provide all the descriptive and empirical results of the current study. This chapter is divided into four sections for the readers to understand it easily. Section one is about animal waste and water in Bhara Kahu, second section is about animal waste and human health in Bhara Kahu, third section is about property values and waste in Bhara Kahu and last section is about to animal waste generation and market, role in offsetting CO_2 emissions from agriculture.

4.1. Descriptive Statistics and Comparison of the Important Variables inside and outside of the Radius

Table no. 4.1.1 and 4.1.2 shows the average age of respondents was 44.5 years. The youngest respondent is 19 years old and the maximum age is 73 years. The respondents of our study were almost educated; however, we can see illiterate respondents as well. Ranging from zero to 18 years of education, the study shows that on average every respondent is matriculate. Bhara Kahu is place with highly diversify family structures. Smallest families to larger family's. Many different compositions have been observed during the survey, however, the average size of families is 6 in Bhara Kahu. The average income of household is 36075 PKR in Bhara Kahu, while starting from 12000 PKR, more than one lack is earned in Bhara Kahu. There are some households living very close to the animals' farms on the distance of only 20 meters. On average, People of Bhara Kahu has shown 349 rupees of maximum willingness to pay for better water facility. The prices of land are still high, starting from 2 lacks per Marla to 5 lacks per Marla depending on other features of the location like the rapid expansion of the property and near to Islamabad and also to Murree having a moderate weather because of which people prefer to reside there.

Table 4.1.1 Descriptive Statistics of Variables Outside the Radius

Variables	Mean	Standard Deviation	Minimum	Maximum	Count
Age	43.25	12.36402	19	73	192
Education	9.739583	5.057253	0	18	192
Family Size	5.807292	2.324319	2	11	192
Income	33526.04	13700.59	12000	120000	192
Employed Family Members	1.057292	0.274289	1	3	192
Health Cost	3249.479	1822.948	500	12000	192
Water Cost	49.47917	55.46033	0	200	192
Max WTP	217.6563	110.2697	0	500	192
Per Marla Price of Land	402083.3	79894.13	300000	500000	192
Monthly Rent	7244.792	2474.472	4000	20000	192

Table 4.1.2 Descriptive Statistics of Variables Inside the Radius

Variables	Mean	Standard Deviation	Minimum	Maximum	Count
Age	45.82813	12.22848	24	71	192
Education	9.713542	4.795965	0	16	192
Family Size	6.609375	2.294659	3	13	192
Income	38625	17596.26	12000	120000	192
Employed Family Member	1.03125	0.287729	0	3	192
Health Cost	7610.938	4609.816	1300	15000	192

Water Cost	183.0729	86.22228	100	400	192
Max WTP	368.8021	204.3022	0	900	192
Per Marla Land Price	246875	50032.71	200000	300000	192
Monthly Rent	7098.958	2559.368	4000	15000	192

The results in above tables shows that the Average Monthly Health cost of HHs outside the radius is 3249.479 with minimum 500 and maximum 12000 PKR. While HHS inside the radius is with the average of 7610.938 PKR per month, with minimum 1300 and maximum 15000 PKR per month. It's clearly indicate the HHs inside the radius are suffering more and as compare to the HHS outside the radius.

HHS Monthly average water cost for the outside the radius it is 49.48 while for inside the radius its 183.07 PKR, it shows that HH outside the radius are paying comparatively less on water consumption.

HHs average willingness to pay for outside the radius is 217.65, with maximum 500 PKR. While for inside the radius the average willingness to pay is 368.80 with maximum 900PKR, which signals that the HHs inside the radius are willing to pay more for clean drinking water as compare to HHs outside the radius because of its geographical location and water pollution.

Land cost per Marla price outside the radius is 402083.3 with minimum price of 300000 and 500000, while inside the radius it is 246875 with minimum of 200000 and maximum 300000. It reveals that the price land Outside the radius are much higher as compare to land inside the radius. Because of the availability of clean drinking water and adequate water provisions. Same situation can be suggesting for the average monthly rent of both location. outside the radius the average

monthly rent is 7244.8 with minimum of 4000 and maximum 20000 PKR. While inside the radius the average monthly rent Is 7098.6 with minimum 4000 and maximum 15000PKR.

4.2. Willingness To Pay For Clean Drinking Water In Bara Kahu

Below Table no 4.2 shows that, willingness to pay is a dependent variable while age, education, monthly income, household ownership, distance of farm from residence, ground water quality are the independent variables determining the probability of willingness to pay for clean drinking water. WTP is positively associated with age, education and house ownership. Coefficient of age, according to results is not statistically significantly different from zero. Household ownership has significant and positive impact on probability of WTP. Monthly income is affecting the willingness to pay positively (So-Yoon , Seung-Hoon, & Chang-Seob, 2013), means high income households have shown higher willingness to pay for improved water quality and facility. However monthly income has minor effect and it is significant at 90 percent of confidence. The issue of water contamination looks more crucial, as residents living closer to livestock farms. The results indicate, individuals have shown increasing willingness to pay for better water facility, the reason is that, available water quality is not much better in houses near the livestock farms (Shahid, 2015). Most of respondents outside the radius showed satisfaction from the water quality which was measured on binary valued variable assuming yes or no as a response. This area of study is still not served due to which the area population has shown significant willingness to pay for better water quality and facility. The most important determinant of the willingness to pay for clean or improved water facility is the location and distance of house. The household living inside the radius of 500 meters around the livestock farms, are willing to pay for better water facility. This effect is captured by the positive and highly significant value for dummy used for household location, which was .402. This means that a house inside the 500 meter radius will on average have 40% more probability

to be willing to pay for clean drinking water. Positive perceptions about pipe water quality is positively associated with willingness to pay for better water facility, as the current study have taken pipe water facility as a better water facility and positive perception lead higher willingness to pay.[1]

Age has insignificant positive relationship with willingness to pay. All other variables are statistically significant below 10% error margin. Education increases the probability of WTP by 17%. The same value for monthly income, HH ownership and location of the household is 10%, 15% and 40% respectively and all values are positive and statistically significant.

Table 4.2 Estimating Household Willingness To Pay For Improved Water Facility

Dependent Variable: Willingness To Pay				
Method: Logistic Regression				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
Age of the Household	.067	.444	0.150	0.253
Education of the Household	.174	.066	2.90	0.010
Monthly Income	.103	.0601	1.71	0.080
Household Ownership	.151	.0712	2.15	0.040
Distance from Farm	.402	.171	2.36	0.030
Pseudo R-squared	0.30			

[1] About 50percent residence of Bhara kahu use tap water and 50 percent outside the range of available pipe line are using ground water and water has been supplied to households, per household 200 bill is charged and total amount 20-30 million PKR is collected every month.

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4.3. Willingness to Pay for Bid Rs. 100:

In this section, we will show the results of household willingness to pay for bid Rs. 100 which are shown below in the table. In our regression household income showing the positive relationship, which means as if income of the household increases their willingness to pay for improved water facility also increases and more people are willing at this bid to pay for it (So-Yoon , Seung-Hoon, & Chang-Seob, 2013). While the distance from the farm showing the negative relationship, which means that if the distance from the from the farm increase household are willing to pay decreases and also at this bid more people are willing to pay whose are near the livestock farms (Shahid, 2015). While age showing the positive relationship with willingness to pay it but has statistically insignificant coefficient. Our results are similar with (Shahid, 2015), (Adenike & Titus, 2009) and (Mondal, Saxena, & Singh, 2005).

Table 4.3 Estimating Household Willingness to Pay for Improved Water Facility Bid 100

Dependent Variable: Willingness to Pay for Bid 100				
Number of Observations: 299				
Method: Logistic Regression				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
Age of the Household	.002	.013	0.150	0.253
Education of the Household	.003	.001	2.90	0.010
Monthly Income	.318	.186	1.71	0.080
Household Ownership	.035	.016	2.15	0.040
Distance from Farm	-.503	.213	-2.36	0.030
Pseudo R-squared	.147			

4.4. Willingness to Pay for Bid Rs. 200:

Now we are estimating the willingness to pay for bid Rs. 200 by using simple multiple regression technique, the results are shown below in the table. In the regression below household monthly income showing positive relationship which was also observed in bid 100 as well which means that if the monthly income increases then the household are more willing to pay (Adenike & Titus, 2009), (Shahid, 2015) and (Lema & Beyene, 2012). Age, education and household ownership also showing positive relationship which means that if all these age and education increases their willingness to pay also increases because with age and education their knowledge and knowing about harmful effects of polluted water increases which eventually results in the increase of their willingness to pay similar results are also obtained by (Haq, Mustafa, & Ahmed, 2007), (Lema & Beyene, 2012) and (Mezgebo & Ewnetu, 2015). The distance from the farm showing the negative relationship with willingness to pay which means as the distance from the farm increase their willingness to pay decreases this because the harmful effects of the farm decreases which eventually results in decrease in their willingness to pay (Mondal, Saxena, & Singh, 2005) and (Shazia, 2016) has the same results.

Table 4.4 Estimating Household Willingness to Pay for Improved Water Facility Bid 200

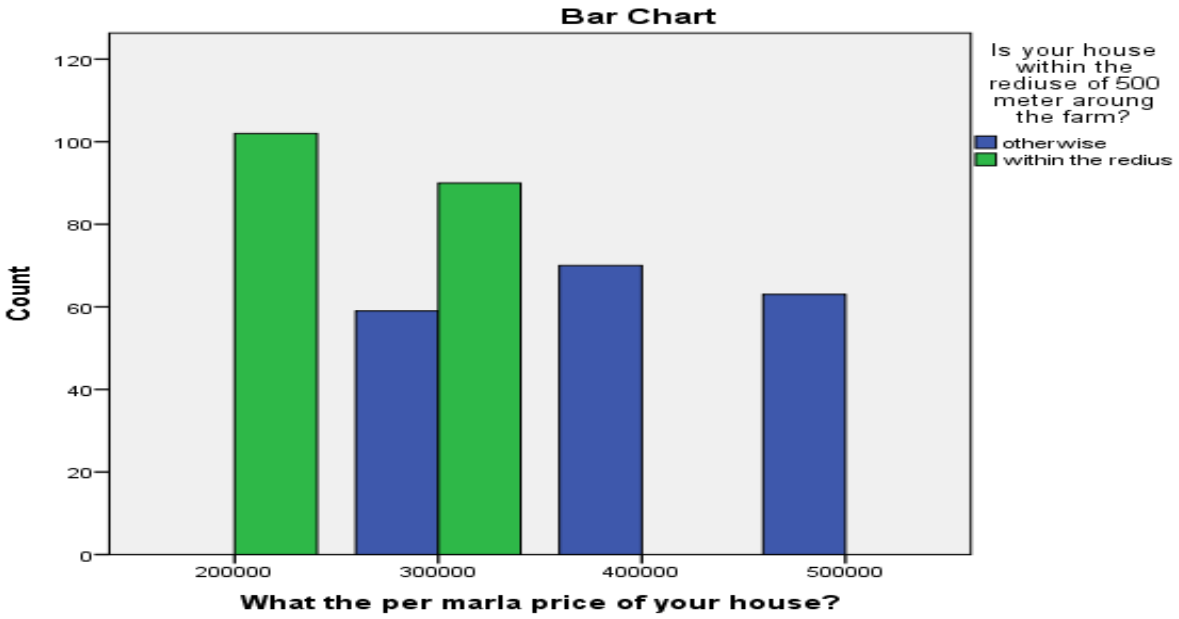
Dependent Variable: Willingness to Pay for Bid 200				
Number of Observations: 211				
Method: Logistic Regression				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
Age of the Household	.022	.137	0.160	0.253

Education of the Household	-.004	.001	-2.70	0.090
Monthly Income	.278	.162	1.72	0.078
Household Ownership	-.033	.015	-2.25	0.040
Distance form Farm	-.473	.199	-2.37	0.030
Pseudo R-squared	.182			

4.5. The Effect of Animals Manure on Property Values:

In the below figure on the Y axis frequency for each bar is shown, while on the X axis price of the Marla are shown whereas the first bar shows that 100 houses within radius of 500 meters around the livestock farm have the market value of 2 lacks PKR per Marla, while 92 houses within radius have the market value of 3 lacks per Marla. Out of the radius the land value of houses increases, where 59 houses out the radius have the market value of 3 lacks per Marla, 70 houses out of the radius have market value of 4 lacks per Marla and 63 houses with the highest value of 5 lacks PKR on per Marla. This shows that land value out of the radius away from livestock farms is much higher than the land within the radius of livestock farms. There are several justifications to values dissimilarities, one might be the environment that is effected due to livestock farms within the radius and second is the land use around the livestock farms and away from the livestock farms is quite different.

Figure 4.1 Property value within the radius and out of the radius in Bhara Kahu



4.6. Determinants of property value in Bhara Kahu

The regression results in the below table for the dependent variable monthly rent of the houses in Bhara Kahu which is positively associated with size of house and it is statistically significant. Houses with in the radius of 500 meters around the animal's/livestock farms, have less rent as compared to the houses out of the radius. The livestock farms are effecting monthly rent negatively or we can say that monthly house rent is negatively associated with house location if it is within radius of the livestock farm, because the house are covered by the livestock manure which is effecting them in many ways specially health problems. Government water facility has positive and statistically significant relationship with monthly rent of a house in Bhara Kahu. Income of the household is positively associated with rent of the house. The households with higher income were living in house, with high rents and higher rent of the house is also the indication of better facilities. The rent of the house was negatively associated with distance from health care this was

also confirmed by (Khan, 2015) who use the hedonic price method for determination of the house rent. The houses on high distance from health facilities in Bhara Kahu has comparatively less rent and the distance from the hospital is consider as a proxy of deprivation from access to health facility our study results are also similar with (Shazia, 2016).

Table 4.5 Determinants of monthly rent in Bhara kahu

Dependent Variable: MONTHLYRENT				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
Size of house in marlas	0.052639	0.023191	2.505024	0.0200
House within radius	-.8038425	0.189572	-4.46991	0.0123
Govrnment water facility at home	0.32238	0.128184	2.51758	0.0320
Income_4	0.14005	0.05753	2.73753	0.0300
Distance from health care	-0.398492	0.185528	-2.157906	0.0400
R-squared	0.424630	Adjusted R-squared		0.414336

4.7. Determinants of Health Cost Bhara Kahu

The regression analysis for the monthly health cost of the households which is also the dependent variable, that health cost has positive relationship with age of household and negative relationship with education of household. The reason for decreasing health cost due to increasing education is, that educated households prevent themselves for the all hazardous effects caused by these farms means tries to minimize the effects by taking precautionary measures (Link & Phelan, 1995). Increasing family size will cost high on health of household and statistically significant. Monthly income has positive influence on health cost but minor effects are shown in the results of current estimation. Distance from livestock farms has negative relation with household's monthly health cost. Increase in distance from livestock farms will lead to reduce the health cost of households in Bhara Kahu. This is because of reducing the chances of illness from long distance to waste points

and livestock farms. The health cost of the household is positively associated with the residence of household inside the radius around the live-stock farms in Bhara Kahu. Inside the radius means closer to livestock farms and waste created by the farms, this can lead to higher cost for households in Bhara Kahu, our results are similar to one of other research which was done for the cement industry waste (Abbas, 2014). Proper sewerage system in house can reduce the cost of illness and current study results shows that households with proper sewerage has less health cost in Bhara Kahu and has shown negative relation with monthly health cost of the residence our results are also been confirmed by the researcher (Shazia, 2016) who conducted the research in the same area. Finally, if everything remains constant even though each resident of Bhara Kahu will spend 86 rupees on their health every month. Still there are some unobserved factors effecting the health cost of the residence of Bhara Kahu.

Table 4.6 Determinants of Health Cost

Method OLS				
Dependent variable Monthly health cost	Coefficients		T	Sig.
	B	Std. Error		
(Constant)	86.362	34.403	2.161	0.02
Age	.035	0.018	1. 971	.061
Education	.153	0.062	2.459	0.025
Family size	.022	1.813	2.112	.042
Monthly Income	.023	0.010	2.349	.021
Proper Sewerage System	-.050	0.056	-.898	.370
Distance from Farm	-.418	0.107	3.911	.008
R sq.	Adjusted R Square = .475			
.502				

4.8. Output of Livestock Farms:

The table 4.8 shows that livestock farmers are earning around 6-18 thousand rupees per month from each cattle or cow, while each farmer spend 3-7 thousand rupees on each cow or buffalo. The output of farms are in form of milk production, manure production and meat production. The feed is required and most of the farmers take it from agriculture farms on trollies but some of these buys from markets. The production of milk is the source of income on daily basis for the livestock farmers in Bhara Kahu.

Table 4.7 Output of livestock farms

Animal type	Cost per month In thousands Rs.	Monetary output per month Rs.	Milk per day	Feed required per day
Cow	3-6	6000-18000	3-9 kg	40-70kg
Buffalo	4-7	9000-27000	4-12kg	50-90kg
Others	1-2	-----	1-3kg	5-10kg

4.9. Animal manure production on livestock farms in Bhara Kahu:

Bhara Kahu is highly congested and dense populated area in Islamabad. Bhara Kahu has 25 to 30 livestock farms. This study has collected information from only 10 farms. On average, there are 36 cattle on each farm. Single cattle produce 25 tons' manure per year multiply by 36 animals, which is 900 tons on each farm per year in Bhara Kahu. This level of manure production cannot be ignored and becomes more noticeable, when total production is considered, which is 22500 tons per year. This is a huge amount of manure to produce a fertilizer for agriculture farmers in

nearby areas around the Bhara kahu. This only requires a storage and transporting mechanism as a basic requirement and Pakistan government can easily manage if intentions are applied to actions.

Table 4.8 Animal manure production on livestock farms in Bara Kahu and Emission Status

Variable	Number	Unit
Livestock quantity	900	Cattles
Average manure production	25	Tonnes/yr/cow
Total manure available	22500	Tonnes/yr
Standard emission reduction factor (ERF) for anaerobic digestion of dairy cattle manure instead of volatilization into the open air	34	kg CO2 eq./ton manure
Direct emission Status	765000	Kg CO2 eq./yr

4.10. Manure Marketing:

Use of artificial fertilizer in this fast-growing population has been increased and avoiding the natural fertilizer among the agriculture farmers has been seen in the study area to increase the production of agriculture products to feed the community and themselves. Manure that has now not used under the artificial fertilizer now dumped in the open air causing more destruction of environment. There are other multiple methods are also available for disposing the animal manure but storage of animal manure and then land application of it is one of the most cost saving and easiest method of its disposal. Absence of formalized and other sufficient support is the main hurdle in marketing of these manure in the region. At present in the study the farmers rely on the informal method of disposing these manures like using it individually in their own farms.

Table 4.9 Descriptive Statistics of Agriculture Farmer

Variables of the study	Count	Minimum	Maximum	Mean	Std. Deviation
Farmer Age	10	28	55	39.60	6.398
Monthly Income	10	20000	90000	51100.00	6136.412
Farm Size	10	2	5	3.50	.972
Education	10	5	12	8.00	2.749
Experience	10	3	20	11.30	2.751
How Much Fertilizer Do You Use	10	5	8	6.20	1.317
If Natural Fertilizer Provided To Farm R U Willing to pay	10	0	1	.90	.316
What Will Be Max WTP	10	0	1200	695.00	469.308

Table 4.10 Descriptive Statistics of Livestock Farmer

Variables of the Study	Count	Minimum	Maximum	Mean	Std. Deviation
Age	10	27	61	42.30	11.681
Education	10	0	9	4.70	2.584
Monthly Income	10	20000	80000	38000.50	13.754
Experience	10	3	18	9.30	2.494
Farm Size	0				
Cost Per Month Because Of Manure Waste	10	550	2000	1350.00	783.511
If Fertilizer Disposal Facility Provided To U Willing To Pay	10	0	1	.95	.316
What Will Be Max WTP	10	500	4000	2250.00	469.308

Bhara Kahu is place with highly diversify family structures. Many different compositions have been observed during the survey. The average income of Agriculture Farmer is 31100 PKR while of Livestock Farmer is 38000 PKR in Bhara Kahu. On average, Farmers of Bhara Kahu has shown Willingness to pay of 1200 rupees by agriculture farmer and 2250 rupees by Livestock Farmer for better waste management facility.

The farmers of the study area were showing considerable amount of willingness to pay for the facilitation of manure transport from these farms to a supportable and maintainable market place and price to result in proper utilization and marketing of these manure. Low market price of these manure is the first issue to be addressed because most of the farmers were also not showing willingness to pay because of the low market price. They suggest that the current prices should be raised to such levels so that they meet the agronomic value of it.

In addition to it there was also seen a considerable lack of sound, specific information and techniques that how much manure should be applied to the fields who were using it as a fertilizer and also what to do with the excess remaining amount of manure. If proper marketing plan has not been formalized the destruction will be continuously like previous years. So there is a need to address the issue at broaden level to address the economic and environmental problems in the area. Such infrastructure should include sufficient mechanism so that the determination of minimum and maximum volumes of manure can be determined and the area for services can also be defined with that proper prices, rules and regulations, transportation facility should be pre-determined. Satisfactory transportation and pick-up of manure timing and their delivery to corresponding places should be realized for an effective and efficient marketing of these manure.

CHAPTER V

Conclusion and Policy Recommendation

5.1. Major Findings of the study

The study found that livestock farms have significantly affected the environmental quality in Bhara Kahu, as the livestock manure was dumped on the sites for a long period of time which was causing the runoff of nutrients and some other hazardous minerals to the underground water and also rain runoff let the manure spell into the water channels and it has also affected the water quality in some of the places. With that because of dumping of manure some serious health issues were also observed like skin rashes and respiratory problems which was also confirmed by the doctors as awell. The farmers of agriculture have limited access to farmers of livestock due to the locations of the farms and distance from each other. Both the farmers were willing to pay for a confined storage facility so that both of them easily have the accessibility to it for dumping of the manure and agriculture farmers can easily collect it from the sites for to use it as a fertilizer. The study found that the health expenses of the families in Bhara Kahu are negatively associated with distance from livestock farms and proper sewerage system in their houses in Bhara Kahu. The study also found that the houses in the radius of 500 meters around the livestock farms have lower rent as compared to the houses out of the radius around the livestock farms. however, the property land value was not significant to the effects of livestock farms and their waste in Bhara Kahu. The study also found that the people of Bhara Kahu are willing to pay for clean drinking water, the users of pipe water were not so much in favor of payment for clean water but the ground water users in Bhara Kahu think that water contaminated and are willing to pay for it if the services could be provided. From our calculations made above it is clear that if a proper management of livestock

manure has been taken place then it is possible to reduce the emissions to a significant level which is less costly as well having multiple other benefits as well like reducing the health cost and solving the problem of dirty water. Additionally, some detailed factors that affecting the manure marketability can be grouped together involving infrastructure and logistics and other various parties that are involved. Such Infrastructure to be made that the sound market has been established for buying and selling in order also to facilitate the ownership and transfer of these manures.

5.2. Conclusion

Emissions from manure storage are important The reduction of emissions from manure storage is also very important. The reduction of emissions is heavily dependent on the outside temperature, our calculations which we made was for low temperature (winter season), so a more significant amount of emissions can be reduce if calculations were made for higher temperature. For 22500 ton/year of manure production in the study area the savings from the emission by storage of manure alone accounts for 765000 ton CO2 eq/year. For the reasons of the manure storage facility the local farmers were also willing to pay for the proper management of the livestock manure.

The study has investigated the determinants of health cost and water cost for residence of Bhara Kahu. Estimations shows Bhara Kahu has still the issues of water (drinking and household use both) and waste management. Different sources of pollution are recorded with increasing population and needs of daily uses. One of significant sources of pollution is livestock farms with in residencies areas of Bhara Kahu causing the health cost higher, water cost and degrading the property value in terms of rented houses. The household of the community was bearing extra health cost due to nearby these farms and also their willingness to pay for the clean drinking water was also higher than those who was far from these livestock farms. The houses inside the range defined by the author were of lower rents and outside the radius the rent was higher. The farmers of

livestock in Bhara Kahu earns around 10000 to 20000 from each cattle as it cost them half of them earn from each cattle. The households are more disturbed of their smell and waste when its runoff by rains into the streets and sometimes into some houses.

It is also observed that if satisfactory and necessary mechanism or infrastructure develop to handle large quantities of manure that can be transported over long distances farmers were showing willingness to pay for it. In addition, such approach should be adopted so that the price of the chemical fertilizers should be much higher than the animal manure or imposing some environmental tax on it compared to livestock manure so that farmers can easily switch to it.

5.3. Policy recommendation

The study recommends the following policy recommendations.

- No new livestock farming or expansions should be allowed in residence areas that have already created the ground water pollution. Take into account for growing pollution effects from these livestock farms in the area, nearness to households and to the environmentally sensitive areas and water sources when giving permits.
- The government should also implement some mechanism for the monitoring of the groundwater facility, their recordkeeping of monitoring results, and some systematic checkups of the livestock farms to trace the possible leakages. With that regular monitoring, should also be made for checking the Surface waters quality for pathogens and bacteria which were runoff from these farms.
- The management of manure is required to avoid the health consequences and monetary losses even these individuals are willing to pay for the removal of negative externality progressed by these farmers in the residential areas.

- There is a need of creating an equilibrium between the society and the creators of problems that the output is utilized and health cost is reduced.
- Develop some methods or mechanism for agricultural priorities that hold special emphasis on sustainable methods and procedures for growing and maintaining the animals at farms and utilizing the livestock manure.
- Also Encourage the improvement and use of composting systems that will help the agriculture farmers to use that manure as a fertilizer which will also help in the reduction of odor, visual pollution and break down of animal manure into a safe and useful agricultural product.
- The livestock farmers should use some simple tools and technologies to improve the air quality in the area and also to reduce the odors near these farms.

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Appendix A:

QUESTIONNAIRE:

Livestock Farmers

Name	Age in Years	Gender	Education	Experience in years	Farm size in hector	Income per month	Total No of cattle

Livestock Manure generation

1. Which type of cattle you have in your farm? _____

	Buffalo	Cow
2. How do you feed your cattle?	a) Open Grazing b) Stall Feeding c) Other	a) Open grazing b) Stall Feeding c) Other
3. How much feed is required per animal per day in Kg?		
4. How much average manure is generated by each animal per day in Kg?		

5. How many trips in trolleys are generated by the whole farm in one month? _____
6. Do you wash animals? Yes, No

7. If Yes, how often in Summers?

    a) 1 time per day b) Once in a week c) others

8. If Yes, how often in Winters?

    b) 1 time per day b) Once in a week c) others

9. How much clean water is used for this purpose?

    a) Time of Machine running per day per cattle b) No. of Balti used per cattle

10. Where is the flow of this dirty water?

    a) Canal c) Sewerage system

    b) Agriculture Land d) Open

Manure Management:

11. How is waste collected from the farm?

    a) Through machines b) through workers,

12. Where is the waste dumped?

    a) On farm c) Outside the farm

    b) Near Agriculture land d) Openly

13. Do you use this waste again? Yes, No

14. If yes, for what purpose the waste of animals is used?

    a) As a fertilizer c) Sell it

    b) Dried and burnt for fuel d) Others

15. In the case of the manure left heaped for later disposal, how many days does it take before its disposal?

a) It stays there permanently c) Less than 7 days

b) 1-3 months d) more than three months

16. Do agriculture farmers demand for this waste as a natural fertilizer? Yes, No

	Summers	Winters	Autumn	Spring
17. If Yes, how many trolleys are provided in these season?				

Manure marketing:

18. Does the animal manure cost you directly or indirectly? Yes, No

19. If Yes, what kind of cost do you face?

a) Machinery cost b) labors c) Others

20. Can you specify per day cost of waste in Rs._____

21. Does animals waste have any benefits for you directly or indirectly? Yes, No

22. If yes, then specify _____

23. Do you sell the waste or provide it as a free good to fellow farmers?

24. If you sell it, then all the waste generated or its surplus?

25. What is the unit of selling?

26. What is the price of per unit?

27. How much units are sold per month or per year?

28. Do you sell all the waste generated or its surplus?

Environmental implication of livestock waste

29. Do you dump the waste in open air? Yes, No

30. Do you think it will disturb the residents of the area as a result of bad smell? Yes, No

31. If Yes, any measure you take for it? Yes, No

32. If Yes, the what measures you take for it?

33. If proper waste collection points are arranged at your area, then are you willing to pay for the facility?

    a) Yes b) No

34. If "Yes" then what would be your maximum willingness to pay for that facility PKRs _____ per month?

35. If "No" then specify the reason_____

36. If the services of collector are provided at your farm, then are you willing to avail that facility?

37. If "Yes" then what would be your maximum willingness to pay for that services PKRs_____ per month?

38. If "No" then specify the reason_____

39. What best option you suggest for the management of the manure? _____

Appendix B: Agriculture farmers:

Name	Age in years	Gender	Education	Experience in years	Income per month	Cultivable land in hector

1. What are the major crops of your farming?
2. Do you use fertilizer? Yes, No
3. Which kind of fertilizer do you use most of the time?
    a) Animal Manure b) Artificial fertilizer
4. How much fertilizer is used per hector?
5. What is the price per unit?
6. Do you use animal waste as a natural fertilizer?
7. How much is used for one hector of land?
8. Which fertilizer yield high productivity?
    a) Artificial fertilizer b) Natural fertilizer
11. If proper collection points for natural fertilizer are arranged at your area, then are you willing to pay for the facility?
    b) Yes b) No
12. If "Yes" then what would be your maximum willingness to pay for that facility PKRs _____ per month?
13. If "No" then specify the reason_____

14. If the natural fertilizer is provided at your farm, then are you willing to avail that facility?
15. If "Yes" then what would be your maximum willingness to pay for that services PKRs_____ per month?
16. If "No" then specify the reason_____
17. What better options you can suggest for the marketing of the manure?

Appendix C: local residents

a) Name of the respondent? (optional) _____

b) Are you the household head? Yes No

c) Location of the area? _____

Education in years	Age in years	Occupation of HH?	Marital Status of the HH?	Per month income of the HH in Pkr?	Family Size
		Own business Govt. employ others			

Health Cost:

1. For how long (years) have you been residing at the current home?
2. What is the ownership of house?
   a) Own house b) Rent c) Others
3. What is the distance in meters of the animal farm from your house? _____
4. Do you feel nuisance in your area because of livestock waste?
   If Yes, then go to Q. No: 5, If No, then go to Q. No: 6
5. If Yes, then the nuisance you feel is due to:
   a) Smell c) Infectious diseases
   b) Insect, mosquito and flies birth d) Other, Specify

6. If No, then specify the other reason?
    a) Standing water (Pound)
    b) Household Dumped waste
    c) Others
7. If Livestock waste, what remedial measures you take for it?
    a) Mask
    b) Mosquito net
    c) Others
8. How much monthly cost you incur in remedial of it in Rs.? _____

Perception about Air Pollution:

9. Do you feel the bad smell in your area? Yes, No
10. Do you feel any difficulty in breathing? Yes, No
11. Do you feel respiratory irritation due to bad smell while passing through livestock farm?
    Yes, No
12. What other symptoms are you facing from livestock waste?
    a) Asthma
    b) Skin and eye problems
    c) Others, specify
    d) Chemical burns to respiratory tract
    e) Lung diseases
13. How much health (Asthma, lung diseases etc.) cost do you bear due to air pollution?
    PKR_____ per months (if your health effect has been diagnosed due to air pollution by doctor/lab)

HH WTP for safe drinking water:

14. What is your source of drinking water? _____
    a) Piped water
    c) Others

b) Ground water

15. Do you think the water you are using is safe for drinking? Yes, No

16. Do you have facility of govt. supply water at your home? Yes, No

17. Do you use water supplied by the Govt. for drinking purposes?

Yes, No

18. Do you bare any cost for safe drinking water? Yes, No

19. How much monthly cost you incur for safe drinking water in Rs.? _____

20. Which is the major issue in drinking water?

a) Taste c) Odor

b) Appearance d) Other, Specify

21. Do you think that contaminated water can cause disease? Yes, No

22. What kind of diseases are most frequently facing by your family because of unsafe water?

a) Cholera c) Typhoid

b) Diarrhea d) others, specify

23. How much health (Cholera, Typhoid etc.) cost do you bear due to water pollution? PKR_____ per months? (if your health effect has been diagnosed due to water pollution by doctor/lab)

24. Do you willing to avail the facility if the facility of Govt. Supply water provided at your home?

Yes, No

25. If "Yes" then what would you be willing to pay Rs 200/month for the water services supplied by govt. to ensure safe drinking water? Yes, No

26. . If "YES", then for the better services the service provider asks for a bit higher amount like Rs. 300/month, would you be willing to pay? Yes, No

27. If "NO", can you afford and be willing to pay Rs 100/month? Yes, No

28. What is your Maximum/Minimum Willingness to pay? Rs. _____/ Month.

29. If you are not willing to pay anything, please explain why?

a. You are satisfied with existing services b. You cannot afford

c. You don't want to pay because it is government responsibility d. Don't trust the local government capacity e. Other, please specify _____

Property Value

Information about House:

a. Is your house within the radius of 500 meters from animal farm? Yes, No

b. What is the price per Marla of your house? _____

c. Total covered area of your house in Marla? _____

d. What is the monthly rent of the house in Rs? _____

e. Is there any proper sewerage system available in your house? _____

f. What is distance of the primary health care from your house? _____

g. What is distance of the school from your house?

h. What is distance of the main road from your house?