IMPACT OF BRICKFIELD ON CARBON DIOXIDE EMISSION, AGRICULTURAL PRODUCTION AND LIVELIHOOD OF BRICKFIELD WORKERS OF KURIGRAM DISTRICT IN BANGLADESH

A THESIS

BY

MD. TOWFIQUR RAHMAN TOWFIQ

Registration No. 1605109
Session: 2016-2017
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MASTER OF SCIENCE (M.S.)
IN
AGROFORESTRY AND ENVIRONMENT

DEPARTMENT OF AGROFORESTRY AND ENVIRONMENT
HAJEE MOHAMMAD DANESH SCIENCE AND TECHNOLOGY UNIVERSITY, DINAJPUR

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DECEMBER 2017

DEDICATED TO

MY

BELOVED PARENTS

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The Author

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ABSTRACT

A study was conducted to investigate the impact of brickfield on carbon dioxide emission and livelihood of brickfield workers in Chilmari and Ulipur upazila under Kurigram district. The study was conducted during the period from January to July 2017. It was a survey based study where data were taking from twenty (20) brick fields on the study area. Data has been collected based on questionnaires form. Data about production of bricks, fuel consumption rate and livelihood of brickfield workers, information about various crops production adjacent about one km, two km and five km were collected physically from some selected brick kilns and the adjacent area of brickfields. Measurement of the variables constitutes is an important task of any social research. In this study, carbondioxide emission from brickfields, brickfield workers livelihood and various crops production adjacent to brickfields were the focus issues. In addition owners, workers and farmer's age, education, family size, sex, farm size, kiln height, labor, power supply, fuel use, production of bricks, CO_2 emission, production of crops, physical effect, environmental effect, income level of brickfield workers, workers satisfaction, family types of farmers, farm size of farmers, farmers innovativeness, occupation of farmers, annual income of farmers and agricultural knowledge were selected characteristics of this study. The mean of the brickfield kiln height was 30.05 m. There was 85% owner used generator and 15% owners used electricity to control the exhaust fan. In Kurigram districts 90% brick field owners were used coal and only 10% owners were used wood as brick field fuels. The uses of natural gas in brick fields was absent in Kurigram district. The mean of the brick production was 2.28 million among 20 brickfields. The maximum amount of CO_2 emission was 7.94 (t/lakh bricks) and minimum amount was 3.64 (t/lakh bricks). Maximum workers were affected in back pain (33.3%) whereas minimum affected by cough (3.3%) due to brick field emissions. Maximum brick field workers (62.2%) commented that flying ashes was more emitted from the brick field. Again, 24.4% workers commented that emitting ashes from brick kiln were usually burn tree and crops. Moreover, 7.5% stated that the kiln was caused heat. 95% farmer used tractor for the land preparation, 71% farmer cultivated hybrid variety of rice, 26% farmer used BADC seed for crop cultivation, 13% farmer used sex pheromone and 4% used bio fertilizer and 2% used IPM in rice field. The study also revealed that the yield of the principle crops like wheat, potato, jute, aus, aman and boro rice were higher with the increased distance from the brickfield. However, due to the high demand of infrastructure development brick making industries in Bangladesh is a rapidly growing sector. Therefore, to minimize the negative impact of brick fields on agricultural land and nearby environment, appropriate knowledge about agricultural production technology, installation of modern brick kilns, proper awareness among local farmers, brick field owners and brickfield workers are needed.

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CHAPTER I

INTRODUCTION

CHAPTER 1

INTRODUCTION

Bangladesh is a densely populated country with more than 160 million people. The existing people as well as new migrants need housing facility. At present the annually required shelter varies from 3 lakh to 5.5 lakh units (UNDP, 2011). Rapid urbanization in the country has created a booming construction industry and spurred the production of 8.6 billion bricks each year, with demand for the bricks rising at an annual rate of about 5.28 percent (UNDP, 2011). The cities of Bangladesh, one of the world's most densely populated countries are growing fast, and there's a never ending need for cheap construction materials.

Brick is one of the most important building materials or unit of construction. Brick making in Bangladesh is a sector related with infrastructure development, contributing about one percent to the country's gross domestic product (GDP) and generating employment for about one million people. Bricks are made, sold and circulated from a brick kiln. Brick fields are generally situated both in urban and rural areas of Bangladesh. Brick-making provides a better income than agriculture or other jobs available in rural Bangladesh, but it is dangerous and often devastating to workers' health. Accidents are common and usually workers have no protective gear for safety.

Despite the importance of brick making, the vast majority of kilns use outdated, energy-intensive technologies that are highly polluting the environment. In the Kurigram district brick kilns are the city's main source of fine particulate pollution, accounting for nearly 40 percent of total emissions during the 5 months operating period. It leads to harmful impacts on health, agricultural yields and global warming. The New technologies, such as the Vertical Shaft Brick Kiln (VSBK) and the Hybrid Hoffmann Kiln (HHK), are substantially cleaner than the Fixed Chimney Kiln (FCK) currently used. These improved technologies consume less energy and emit lower levels of pollutants and greenhouse gases (GHGs) (BUET, 2007; Heirli and Maithel, 2008; World Bank, 2011). The existing brick kilns are the number one cause for fine particulate pollution in Bangladesh and its total greenhouse gas (GHG) emission is estimated to be 15.67 million tons of carbon dioxide (CO_2) equivalent (tCO_2e) per annum as of 2011 (World Bank, 2011). Global warming is an issue that calls for a global response. The rapid change in climate will be too great to allow many eco-systems to suitably adapt, since the change has direct impact on biodiversity, agriculture, forestry, dry land, water resources and human health. In addition, Bangladesh is one of the most climate change vulnerable countries. In Bangladesh, 92% of the 4,880 brickfields are highly polluting Fixed Chimney Kilns (FCKs) because of a combination of low capital cost requirement and high investment return. But these kinds of kiln use more coal/wooded fuel which emits more carbon.

In Bangladesh, with the rapid economic and population growth, the construction sector will continue to expand at the current rate of 8%-9% per year (REHAB, 2012). As the bricks constitute 44% of total construction materials, the demand for bricks will grow at least at about 5.6% per year. Since, we can't reduce the brick demand; we need to take actions to reduce carbon emission in the brick fields. Bangladesh has about 45000 authorized traditional brickfields and thousands more illegal ones (BUET, 2007). Altogether, these kilns produce some 12 million bricks annually, according to the United Nations Development Program (UNDP, 2010) brick making is considered to be the largest contributor to GHGs emissions in Bangladesh in the order of 3.0 million tones of CO_2 emissions annually. Brick making significantly contributes to local air pollution including emission of various harmful gases such as Sulphur Oxides (SO_2), Nitrogen Oxides (NO_2), Carbon dioxide (CO_2) and Suspended Particulate Matter (SPM) and PM10. About half of Bangladesh bricks are baked with the use of coal, which is now considered to be the source of some 20 percent of global greenhouse-gas emissions. The industry consumes more than one-fourth of Bangladesh annual wood supply, or about 1.5 million cubic meters, which may help explain why Bangladesh has the highest deforestation rate in South Asia. But brick making in Bangladesh is not only energy-intensive. It is also a vicious carbon-emitting activity. Just a single brick kiln already emits some 1,500 tons of carbon dioxide a year. Bangladesh brickfields emit a significant amount of black carbon as well. Although it has a short life in the atmosphere, black carbon is nevertheless second only to carbon dioxide among the big contributors to climate change. Some experts have said that a shift to the green kilns would cut the industries carbon emissions by almost half. Now scientists are concerned enough that human activities may be modifying this natural process, with potentially dangerous consequences. When coal burns it emits carbon dioxide, carbon mono oxide, sulphur dioxide, smoke, nitrogen oxide, methane etc.

Among the following gases CO_2 is the most concerning GHG due to 60% contributor for global warming. Brick-making kilns, of which the majorities are of the conventional type, use coal and wood as their source of energy. This is mainly due to the non-availability of natural gas in most parts of Bangladesh. The air pollution from these kilns is not only due to the type of fuel used, but also due to the thermal inefficiencies of the conventional kilns. Another significant factor is that brick kilns are usually clustered near big cites in various parts of Bangladesh. Therefore, the parts of the city in the immediate vicinity of the clustered brickfields have serious air pollution problems and the environmental impacts will only exacerbate it as urban populations expand and create a growing demand for bricks.

The cumulative emissions effect is responsible for the increasing smog evident most noticeable around urban centers of Bangladesh including Dhaka City, which is adversely affecting the health of the adjacent urban population. Though brick field has a great contribution in the GDP but its consequence in widespread. Soundless environment, crops damage are occurred by brick field. Dust of the brick field lead to pulmonary diseases as well as silicosis. According to Bangladesh country report the brick kilns emit toxic fumes containing suspended particulate matter rich in carbon and containing a high concentration of carbon mono oxides that are harmful to eyes lungs and throat.

Current technologies for brick production such as clamps, high draught kilns and bulls trench kilns consume large quantities of fuel such as coal, firewood and other biomass.

At present many developing countries like China, India and Brazil are getting financial benefits through Carbon trading. Bangladesh being developing country has immense opportunities to earn credits through carbon trading. Bangladesh has the possibility to earn USD 70.00 million every year by trading carbon in Global Carbon Credit Market for USD15.20 per tons of carbon dioxide (Certified Emissions Reduction). But due to lack of awareness, we could not attain desired level of benefits from this Clean Development Mechanism (CDM). We are hopeful that presently some institutions (IIDFC, Grameen Shakti, etc) are coming forward to utilize these opportunities. In the meantime, IIDFC already signed Memorandum of Understanding (MOU) with Denmark and got register with WB and UN Agency for carbon emission reduction trading. Thus, ADB's proposed fund may be considered as cheaper credit window that can help us to introduce energy efficient and environmental friendly technology in brick manufacturing sector by reducing GHG emission which can be traded in the Global Carbon Credit Market and thus, we can earn foreign currencies.

Kurigram District (Rangpur division) area 2296.10 sq km, located in between 25°23' and 26°14' north latitudes and in between 89°27' and 89°54' east longitudes. It is bounded by West Bengal state of India on the north, Gaibandha and Jamalpur districts on the south, Assam state of India on the east, West Bengal of India, Rangpur and Lalmonirhat districts on the west. In Kurigram district only bulls trench kilns are used for brick production. In here 90% owner of the brick field are used coal in the brick field .Other types of brick fields are absent here.

Those kilns emit different greenhouse gases like carbon dioxide and sulphur dioxide. It has trimendous impact on local people livelihood. There are also some observed impacts of brickfield on agricultural production in Kurigram district. Indeed many people of Kurigram depend on agriculture. But no information about the impact of brickfield on agriculture and livelihood are still available. Realizing the importance of estimating the level of greenhouse gas emission to combat against climate change and related ill consequences on ecosystem the present research was taken to fulfill the following objectives:

- To estimate the amount of greenhouse gas mainly CO_2 emission from brick kilns in Kurigram district.
- To evaluate the future prediction of environmental condition and/or problems associated with the present level of GHG emission to help the policy makers to take necessary steps in time.
- Background and livelihood status of brick field workers.
- To find out the impact of brickfield on agricultural production and health of local people.

CHAPTER II
REVIEW OF LITERATURE

CHAPTER 2

REVIEW OF LITERATURE

Review of literature relevant with the objectives of this study is presented in this chapter. This study concerned with the rate of CO_2 gas emission from brickfield areas in Bangladesh. The researcher attempted to search the literatures and observed that only a few number of studies have been conducted on CO_2 gas emission from brickfield for environmental degradation. Brick manufacturing industry is one of the biggest manufacturing industries in Bangladesh. A few works has been done in this sector focusing the worse situation of soil condition and pollution surrounding brick field areas. However, a succinct review of literature on the relationship of each independent variable with rate of CO_2 gas emission from brickfield and related issues are presented in this section according to the objectives of the study.

2.1 Review on general context

ALA (2006) found in their research that, for the PM in air premature deaths rate increased three times higher than the previous studies. Child mortality rate were also increase for air pollution.

According to Development Alternatives Practical Action i.e. DAPA (2009) assessed that 6,400 acres of land would be needed over a 20-year program to build new factories in either brick parks or in other places specifically designated for brick production. At the same time, about 3,300 FCK entrepreneurs would have switched to VSBK and/or Zigzag factories, freeing up approximately 8,000 acres of lowland for cultivation.

Arifur *et al.* (2006) conducted a survey along with World Bank that about 60 percent of brick enterprises produce less than 10 million bricks per enterprise annually, accounting for about 20 percent of total bricks. These enterprises followed simple production and management models, apply outdated technologies, and use unskilled labor. Therefore, their productivity and energy efficiency were also relatively low. In addition, their dominance makes it difficult to phase out solid clay bricks and encumbers the adoption of new technologies and carbon emissions. Awareness due to establishment of brickfield was important because of the global environment, which was changing more rapidly than before. However, some important observations and comments of some scholars are presented in this section related with environmental degradation, global awareness and brickfield issues.

Baum (2010) showed that various types of materials could use as internal fuel, such as mixing coal with bricks. Obtaining a high quality of the fired bricks depends on the internal fuels particle size (maximum of 3 mm), calorific value (greater than 1,000 kcal/kg), amount used (depending on the calorific value), and mixing process (preferably mechanical).

Biswas *et al.* (2009) found that a 4-inch layer could reduce maximum surface temperature from 350°C to 150°C, leading to a substantial decline in heat loss. Considerable amount of heat could be lost also from coal feedholes on the top. Using insulated and better-fitted feedhole caps could minimize gas emission. By operating the dampers appropriately, heat in the flue gas could be used for better drying the green bricks loaded in front of the firing zone, thus reducing the need for fuel for brick-drying.

Chowdhury (2005) made an environment report on Bangladesh that the GOB introduced a rule that made the use of 120-ft chimneys for brick kilns compulsory. This requirement was successfully enforced, especially in the vicinity of urban areas, and most Bulls Trench Kilns (BTKs) were upgraded to FCK technology and environmental clearance certificates would not be renewed if the owners did not shift to alternative fuel and improved technologies by 2010.

DAPA (2010) stated that newer technologies usually employ the internal fuel. The pilot implementation of the VSBK in Bangladesh had demonstrated that the internal fuel helps to reduce emissions, increase energy efficiency, and yield stronger bricks.

Environmental Protection Agency EPA (2012) claimed that particulate matter, ground-level ozone, carbon monoxide, sulfur oxides, nitrogen oxides, and lead were the main pollutants for the air pollution. These pollutants could harm your health and the environment, and also cause property damages.

Gupta *et al.* (2008) conducted an investigation by the United Nations Food and Agriculture Organization (FAO) on the current status of CO_2 emission from brick kiln in Bangladesh revealed that there was a general trend towards declining or stagnating cropping yields. These adverse trends were considered to be the result of global warming and agricultural sectors and some other activities those had generated new set of problems such as soil erosion, loss of soil fertility, deficiencies of sulfur and zinc, etc.

Hasan and Baum (2010) found that Brick burning not only alters the physicochemical properties and habitats of the nearby soils but also contributing to the pollution of environments and ecosystems. The topsoil nutrient elements and soil biota were destroyed through brick burning. Brick burning were largely influencing the concentrations of greenhouse gases in the atmosphere and it is essential to investigate the contribution of soils to the release and /or fixation of greenhouse gases.

Ijaz and Edmond (2003) observed that brick manufacturing in many Asian countries was predominantly a cottage industry and employs traditional kilns, which were energy inefficient and polluting. In Bangladesh, about 4500 brick kilns were in operation, producing about 9 billion bricks per year. Of the 4500 kilns, more than 4000 are of the Bull's trench kiln (BTK) type. The BTK employed an extremely crude technology to fire bricks. There were also about 400 fixed chimney kilns, 15 zigzag kilns, 25 Hoffman kilns and 5 modern tunnel-type kilns currently in operation in the country. Other than the Hoffman kiln, which uses natural gas, the other three types of kiln use low-grade coal and firewood as fuel. The pollution from these kilns had reached alarming proportions. There is an urgent need to make a transition from these polluting technologies to more environment-friendly technologies.

Khaliquzzaman (2009) made a survey and found that brick kilns in Bangladesh were mostly informal and small-scale operations. More than 90 percent of brick kiln owners were small-scale operators. Most FCKs were individually owned, with each owner possessing one kiln only. Multiple ownership of one kiln and multiple kilns under the same ownership are rare. In a few cases, established business house sown brick kilns that were part of a portfolio of industrial establishments. The kiln owners were organized as the Bangladesh Brick Manufacturers Owners Association (BBMOA). This association was expected to support actions perceived as beneficial to the interest of its members; thus, it must be involved in any reform concerning the brick sector.

Khan (2009) found that, internal combustion of injected fuel in green bricks and application of heat optimization techniques in a minimum heat-loss chamber in the kilns combustion zone to capture waste heat for recirculation in the drying tunnel. The HHK, like traditional technologies, did not require a tall chimney.

Larsen *et al.* (2011) of UNDP reported that the brick-making industry remains largely unregulated. More than 90 percent of the country's brick kilns use 150-yearold energy intensive and highly polluting technology. This technology emits around 6 million tones of CO_2 annually, making it one of the largest sources of greenhouse gas emissions in the country. If Bangladesh maintains its current economic growth rate, continued use of this outdated brick-firing technology would raise the level of greenhouse gas emissions to 8.7 million tons by 2014.

Maithel *et al.* (2008) also reported that gravity settling chambers, along with improved coal feeding, could reduce PM emissions below 750 mg per m^3, which was the Indian emissions standard.

Nandita (2003) found that brick prices in Bangladesh have been rising in nominal terms over the last 10 years at an average annual rate exceeding 10%. A part of this increase can be attributed to rising input prices and a part to rising demand and supply rigidity. In addition to this overall increasing demand, the disaggregated" demand for new technology bricks would, in fact, increase because of improvements in quality. The new technology" bricks would be more even, darker red in color from the oxidizing atmosphere of the VSBK and the salt content would decline.

PA (Practical Action) reported that the operation of pilot VSBK kilns in neighboring countries (e.g., India, Nepal, and Afghanistan) had demonstrated energy savings of at least 30 percent in comparison to the best existing kilns. In addition, use of the VSBK reduced air pollution by a factor of 5 or more. (P A, 1999)

Pandit *et al.* (2004) reported emission measurements for two kilns in Nepal (122 mg per m^3 and 160 mg per m^3), and Maithel, Vasudevan, and Johri (2003) recorded emissions for two kilns in India (78 mg per m^3 and 80 mg per m^3). Thus, it is reasonable to expect that VSBK in Bangladesh would emit less than 200 mg per m^3. In addition, VSBK would likely improve the energy efficiency and carbon benefits by about 50 percent.

UNDP–GEF (2006) observed that, the HHK represents a hybrid version of the Hoffmann kiln technology developed in Germany in the mid-19th century. Unlike the gas-based Hoffmann kiln, the HHK used coal as fuel. The HHK combines fuel injection and external firing in highly insulated kilns, leading to lower energy use, high-quality bricks, and reduced pollution. It was introduced in Bangladesh in 2006 under a GEF supported project (UNDP–GEF, 2006). Eight HHKs were operating in Bangladesh, and another eight are in the pipeline.

Wang *et al.* (2009) observed in his study that as the brick industry started to diversify, comparing energy efficiency among processes became more complicated. Energy efficiency depended on the raw material used, the final product, and the techniques applied in the processes of brick molding, drying, and firing. According to the energy-efficiency and production scale, fired brick-making processes in China can be categorized into three tiers.

World Bank (2012) conducted a survey on small operators, incremental, low-cost retrofit technology appears better suited for upgrading kilns. Lower-emission, higher-efficiency kilns (e.g., coal-based HHKs) cost 10 times or more than checks Moreover, these kilns operate year-round on highlands above flood level; these were scarce and those near major cities were very expensive. Because of these constraints, current FCK owners were unlikely to adopt the HHK or other modern technologies unless flood-free land was made available to them at an affordable cost. World Bank (2012) reported that in the South Asian region, brick kilns were the major source for air pollution. Brick industries were growing rapidly in Bangladesh, India, Nepal and air pollution increases along with it. More than 108000 brick kilns were in operation in these countries and for the urban air pollution, brick kilns are taking the leading position in rank.

World Health Organization, WHO (2013) reported that air pollution was contamination of the indoor or outdoor environment by any chemical, physical or biological agent that modified the natural characteristics of the atmosphere. Household combustion devices, motor vehicles, industrial facilities, and forest fires were common sources of air pollution.

2.2 Review of literature about the effect of brick field on environment

BCAS (2011) prepared a report on the basis of the Bangladesh Country Environmental Analysis reports that poor air quality in Dhaka city (due to all polluting sources, including brick kilns, transport, road dust, metal smelters, another causes) contributes to an estimated 3,500 premature deaths per year (World Bank, 2006). While the 1,200 brick kilns north of Dhaka were an important contributor to air pollution, their overall health impact had not been quantified. This analysis was limited to estimating the health impacts of the North Dhaka cluster (530 kilns) in terms of PM 10 and PM 2.5 pollution only. Despite these limitations, the analysis shows that PM10 and PM 2.5 pollution from these 530 kilns currently leads to 750 premature deaths per year, accounting for 20 percent of total premature deaths due to poor air quality.

BCAS/BIDS/BUET/BUP (1996) conducted a number of studies which estimated greenhouse gas emissions but the Asian Least-cost Greenhouse Gas Abatement Strategy (ALGAS) project conducted a comprehensive inventory of emissions in 1990 for energy, agriculture and livestock, and forestry and land used changes using IPCC methodology. ALGAS studies revealed that per capita emission of greenhouse gas for Bangladesh in terms of CO_2 equivalent is less than a ton, about 670 kg per year.

Enters (2000) made a survey regarding the farmers awareness and assessment of environmental degradation due to carbon emission. He showed that, farmers were usually aware when degradation process threatened resources critical their own livelihoods. When farmers did not appear concerned about such degradation, it was often because they did not yet consider degradation effects to be a serious threat. He also stated that in several situations however, farmer's awareness had been found to be an important constraint to positive adoption. When degradation effects or their causal factors were not observable to without modem technology, such as may occur with soil acidification, micro-nutrient depletion, spread of disease vector, etc due to carbon emission.

Iqbal and Hasan (2007) reported that bricks were the most essential component for the expanding urbanization but Brickfields were one of the main contributors of air pollution in Bangladesh. The most important greenhouse effect was global warming referring to the increasing temperature of the earth. This increasing temperature ultimately affected vegetation and thus total agricultural production decreases. Thesis partially due to the emission of greenhouse gases associated with human activities including emission of Brickfield.

Islam (2012) reported that brick kilns were one of the major sources for air pollution. So, as environmental rules, brick kilns should not be set up on arable lands and minimum three kilometers distance away from any housing area, reserve forest, and educational institution. However, no rule was maintaining for setup brick kilns. As a result brick kilns produces black smoke which ultimately move away the species which are involved pollination process. This ultimately declined the agricultural and farming production.

Maity (2011) stated that in the valley, along with the rising construction activity brick kilns were growing fast. Negative rate of growth in construction activity in past few years had resulted in a proliferation of brick kilns, which had reappeared in the valley with spectacular speed raising serious concerns about the deteriorating air quality. It had been reported that brick kilns, producing in excess of 350 million bricks were the major and single source of SO_2 and PM in the environment of Kathmandu valley; contributing over 60 percent of the emissions.

Morley (2012) mentioned that for the brick production, top soil was removed from the land and it takes between 25 to 30 years for those lands to be fertile as earlier. The period could be longer if vast quantities of toxic wastes such as in the form of carbon monoxide and sulphur oxide will mix into the land. On average each kiln burn 350 tones of woods a year, so more kilns means having a devastating effect on the forests.

Nath (2005) observed that the two such technologies that could readily be employed were the Hoffman kiln and the vertical shaft brick kiln (VSBK). There placement of the existing technologies would result in significant reductions in greenhouse gas emission, especially if the coal-based technologies could be replaced by natural gas-based technologies. Calculations show that these technologies were able to reduce GHG emissions by 42 and 29 % respectively compared to the existing BTK technology.

Pokhrel and Lee (2011) reported that the effects of brick kilns had both long term and short-term impacts in the environment. In short term the vegetation process hampers, crops production decreases, plants fruits falls down etc. and long term impacts were ozone depletions, global warming, photochemical smog, land fertility decreases, ground water level down etc.

Rashid (2008) showed that combustion of coal and other biomass fuels in brick kilns results in the emissions of particulate matter (PM), including black carbon (BC), sulphur dioxide (SO_2), oxides of nitrogen (NOx), and carbon dioxide (CO_2). The emission of these pollutants had an adverse effect on the health of workers and vegetation around the kilns. In recent years, the higher cost and a shortage of good quality bituminous coal had resulted in an increased use of high-ash, high-sulphur coal, as well as in the use of industrial wastes and loose biomass fuels in brick kilns. All of these had resulted in new air emission challenges. The used of large quantities of coal in brick kilns contributes significantly to emissions of carbon dioxide (CO_2). Good quality agriculture topsoil was used for brick production. Area shaving large concentration of brick kilns suffered from land degradation.

Roy (2009) observed that burning coal emitted CO_2, which contributed to global warming and climate change. In addition, low-quality coals were energy inefficient and produce further CO_2 emissions. Similarly, poor insulation and heat losses require additional coal, which used leads to further CO_2 emissions.

Sutradhar (2004) reported that 58 per cent of the respondents had medium awareness on environmental degradation caused by the use of modem agricultural technologies; while 31 per cent had poor awareness and only 11 percent had high awareness on CO_2 emission from brick kiln. Tiny airborne particles or aerosols those were less than a hundred micrometers were collectively referred to as total suspended particulate matter (TSP) (EPA, 2012). Most of the brick kilns in Bangladesh were poorly designed, which causes incomplete combustion of coals (Ahmed, 2007). This incomplete combustion produced carbon monoxide (CO), which increases risk for heart diseases. If rubber tires were used as fuel then along with CO, emission from brick kilns comprises of fine dust particles, hydrocarbons, sulphur dioxide (SO_2), oxides of nitrogen (NOx), fluoride compounds and small amount of carcinogenic dioxins (Joshi and Dudani, 2008; WHO, 2013). Fuel type for brickfields mainly depended on its availability. Typical brick kilns used wood, recycled motor oil, coal, diesel, rubber tire, trash, and plastics as fuel.

However, all types of fuel were responsible for the emission of toxic gases. Brick kilns were one of the major sources of air pollution in Bangladesh (Guttikunda, 2009). About 33% of brick kilns illegally used firewood to burn bricks due to unavailability of coal. To meet the demand, a large number of trees are cut down; causing significant deforestation. Firewood accounts for nearly 25 percent of fuel used in brick kilns in Bangladesh every year. Many brick manufacturers set up kilns near forests with intention to exploit forests illegally (IPS, 2001).

Tuladhur (2003) found that the emission data for the Gasser brickyard running on renewable fuels were among the lowest in the industry. It had been possible, as a result of the carbonaceous and fluxing properties of the by-products used in substitution of traditional raw materials and optimization of the feedstock, to reduce the firing temperature of the bricks considerably resulting in a much lower heat requirement than before. The emission of non fuel related substances such as chlorides and fluorides had been reduced drastically due to optimization of the firing process itself.

WHO (2011) reported that fog was another phenomenon whose effect could extend to nearby areas. Due to air pollution, ratio of fog formation was accelerating. This fog could damage normal transportation systems, reduce the growth of crops due to decrease of sunlight. Bio-diversity of different areas could degrade due to air pollution because all these chemical components were affects the organisms.

World Bank (2006) found that Currently, FCKs contribute up to 20 percent of the total premature mortality caused by urban air pollution in Dhaka (all causes combined). The Bangladesh Country Environmental Analysis reported that poor air quality in Dhaka contributed to an estimated 3,500 premature deaths in 2002. Emissions of PM10 and PM2.5 from the kiln cluster north of Dhaka were responsible for 750 premature deaths annually. Thus, current FCKs are likely to contribute up to 20 percent of total premature deaths in Dhaka due to poor air quality.

World Bank (2006) reported that Brick industries were important sources of greenhouse gases as they use wood fuel coal and fuel oil for high temperature brick burning. The level of fuel use had increased a lot during 2005-2006 from that of year 2000 because the growing rate of urbanization and rapid growth of urbanization and rapid growth of Brickfields meeting the requirements of urbanization. Brickfields were the major source of air pollution and a huge amount of various gases are emitted every year. In Bangladesh for the burning of 1800000 tons of coal, 3492681 tones of CO_2; 376.76 tones of methane, 52.74 tones of N_2O, were estimated. On the other hand for the burning 1260000 tons of wood fuels, 4006246.86 tons of CO_2; 567 tons of CH_4; 1890 tons of NOx; 37800 tons of CO_2, 5040 tons of SO_2 were produce each year. Of the other pollutants particular matter and the fluoride were mainly emitted from brick kiln. In Bangladesh, for burning of coal in Brickfield, 28350 tons of particulate matter, 22050 tons of particulate matter-10, 13702.5 tons of particulate matter-205 and 9292.5 tons of fluoride was produced during 2005 and 2006. By considering all categories of fuel, the study revealed that, the total emission from 6000 Brickfield in Bangladesh were 7505931 tons of CO_2, 943.9 tons of CH4, 21763.4 tons of NO_2, 407772 tons of CO, 176223 tons SO_2, 283.50 tons of particulate matter, 22050 particulate matter-10, 13702.5 tons of particulate matter-2.5 and 9292.5 tons of Fl produced per year. Among all of categories of pollutants emitted from brick kiln in Bangladesh, CO_2 is the most prominent pollutant. Wood fuels and fossil fuels were responsible for the emission of trace and non trace greenhouse gases, such as CO_2, CH_4, N_2O, NO_3, NO.

2.3 Review of literature about the livelihood of brick filed workers

Bijetri and Sen (2014) stated that manual brick manufacturing was an age-old profession practiced all over the world and brick was a very important building material for a developing country, especially like India to improve infrastructure. Women had become an integral part of manpower resources in these unorganized sectors, but unfortunately the female workers here suffered a silent agony. The present study examines the occupational profile, impact of work factor in terms of physiological, biomechanical, musculoskeletal and psychosocial discomforts prevalence among workers in brick kilns. A study was conducted on female molders engaged indifferent brick-kiln of West Bengal. Physical parameters such as body weight, height, grip strength; occupational status based on socioeconomic profile; physiological parameters like pulmonary status, biomechanical assessment; and psychosocial assessment were studied. From the result it is seen that 18% of the sample population falls under severe Grade III chronic energy deficiency. More than 90% of body pain was felt in wrists, back, both knees, both thighs and both ankles due to the awkward postures adopted by them. Postural assessment by REBA, RULA and OWAS method shows that most of the posture adopted during work should be corrected immediately. Majority of the workers were in the borderline tending towards development of Chronic Obstructive Pulmonary Disease. The workers worked for more than 8 hours per day, with very less monthly income. Long working hours without adequate rest, low wages, job insecurity and bullying by superiors contribute to various physiological and psychosocial stresses which in turn tends workers to various addictive behaviors. Thus, immediate ergonomic interventions were required to improve the quality of life of these workers so that they could continue working for a longer period under the conducive and safe work condition which in turn would influence the social security, health and safety of the workers.

Das (2014) stated that the brick field industry was one of the oldest industries in India, which employs a large number of workers of poor socioeconomic status. The main aim of the present investigations in to determined the prevalence of musculoskeletal disorders among brick field workers, ii) to determine the prevalence of respiratory disorders and physiological stress among brickfield workers compared to control workers. For this study, a total of 220 brick field workers and 130 control subjects were selected randomly. The control subjects were mainly involved in hand-intensive jobs. The Modified Nordic Questionnaire was applied to assess the discomfort felt among both groups of workers. Thermal stress was also assessed by measuring the WBGT index. The pulmonary functions were checked using the spirometry. Physiological assessment of the workload was carried out by recording the heart rate and blood pressure of the workers prior to work and just after work in the field.

Das (2015) reported that brick industry in India was the second largest brick producer in the world after China. The industry was one of the largest employment generating industries employing millions of people. Brick kiln workers always remained under heavy work pressure to work more efficiently for higher production during seasons with fewer resources and management skills. This stressful situation becomes worse by physical discomforts in the workplace. Brick manufacturing was a labor intensive informal industry using child workers as the major work force in India. Workers were required to use physical strength, carry heavy loads and remain in a squatted posture for longer periods doing repetitive tasks posing threats to musculoskeletal system. His study involved cross sectional study of children aged 17 years and below. The study respondent included 301 cases in Khejuri blocks under Purba Medinipur district of West Bengal. Lack of adequate physical infrastructures, poor working conditions with nonexistent safety procedures had posed risk to physical, mental and overall well-being of children. The study identifies work related physical ailments and discomforts dominate brick industries of Khejuri. The musculoskeletal disorder related pain and discomfort was experienced by 73 per cent of working children in this region. This study finds that presence of poorer physical environment, working conditions and practices had contributed to musculoskeletal injuries and problems exposing working children to risks and hazards.

Genc *et al.* (2012); Joshi and Dudani (2008) stated that inhalation was the most common route for pollutants to enter the human body and damage the respiratory system. Exposure to air pollutants could overload or break down natural defense mechanisms in the body, causing or contributing to respiratory diseases such as lung cancer, asthma, chronic bronchitis, and emphysema. Air pollution also had adverse impacts on other important systems such as cardiovascular system and central nervous system.

González *et al.* (2002) reported that all these typical brick kilns used woods, recycled motor oils, coals, fuel oils, diesels, tires, trashes, and plastics for fuel. Really, what they would use for fuel it mainly depends on what was available for the brick makers. However, ultimate reality was that all these fuels were responsible for the emission of toxic gases. In Spain, it was reported that the open brick kilns were also responsible to emit fluoride, chlorine, and bromine in addition with other toxic gases.

Khan and Vyas (2008) reported that Indian brick industry was the second largest brick producer in the world after China. The industry has an annual turnover of more than 10000 cores and it was one of the largest employment generating industries. In Ujjain (India), many brick industries are situated on the banks of Kshipra river. The objective of the present study was to evaluate the impact of brick making process on environment and human health. The results showed that there were adverse effects of these industries on soil, water, air, vegetation and human health. Bricks were mainly made of soil and numbers of additives were added to the soil to increase the strength of bricks. The used of excessive amount of soil causes soil degradation. These industries used huge amount of fuel and kiln process used at present in these industries was highly inefficient which leads to air pollution and causes damage to vegetation and human health. Besides these, the waste along with water flows back in the Kshipra river, increasing the total solids, suspended solids, dissolved oxygen, calcium hardness, total hardness etc. High pollution levels in Kshipra river near these industries has been noticed, which could be possibly due to leaching of compounds from raw materials used in brick industries. It is not possible to prohibit these industries because they were essential for economic growth and development of the city. The paper discusses the effect of these industries on the environment and human health and suggests alternative sustainable strategies for the kiln process, so that economic development and environmental protection could go hand in hand.

Mandal and Majumdar (2014) stated that quartz crushing and brick making industry were informal and demands heavy manual labour. They were socio-economically backward and were unable to avail of social security's scheme meant for protection of the health and welfare of Indian workers. To evaluate cardiovascular and respiratory status of stone grinders and brickfield workers and to compare the above parameters with the control group. This cross-sectional study was carried out among 94 stone grinders and 82 brick fieldworkers of West Bengal. They were mainly exposed to stone dust particles, silica dust and fumes. Pulmonary function and cardiovascular parameters were measured, and respiratory impairments were assessed by questionnaire.

Rana and Das (2014) reported that social norms and economic realities mean that child labor was widely accepted and very common in Bangladesh. Many families rely on the income generated by their children for survival, so child labor was often highly valued. Additionally, employers often prefer to employ children because they were cheaper and considered to be more compliant and obedient than adults. When children are forced to work, they were often denied their rights to education, leisure and play. Studies revealed that one in every six children in Bangladesh was working children. The gravity of the situation led our initiative to study on child labor in brick field in the work area in Char Bhadrasan under Faridpur district .This study used data to examine the different components of child labor in brick field. Study used quantitative method for data collection and particularly survey was used. A total of 103 respondents of five brick fields in Char Bhadrasan upozila were interviewed. SPSS windows program was used to process and organize the data for the study. The respondent were interviewed regarding various aspects related to the child labor in brick field includes causes and consequences of child labor to engage their risky job, working environment, their schooling profile, their future goal etc. The fieldwork observation showed that the working environment in brick field were hazardous to child health due to unsanitary environment, unsafe working environment (such as heat, burning ashes, flying ashes, and pieces of broken bricks everywhere), and the hazardous work (prolonged working hours, heavy work, and dangerous jobs).They also suffered from breathing problem, cold & fever, minor injuries and sometime more than that. Inspire of that majority of child workers had a very common expectation that is all of them want to lead a happy life with their work and their family.

Sharma *et al*. (2013) stated that the brick kilns served as a source of livelihood for thousands of unskilled laborers from across the country. The seasonal nature of the work attracts migrant labor, many of them landless farmers. Objectives: The study was done with a view to know the clinic social problems of the families. The following study was a focused group discussion with brick kiln workers in the catchment area of RHTC of Pramukhswami Medical College. In the current study it was found that the condition of these migrant brick kiln workers is very pathetic on account of number of conditions. All the workers were migrant and marginal workers with migration duration of 8 months every year and then they were going back to the native place. These workers were mostly illiterate or had primary education. Females were uneducated. These workers were getting daily wages and there was no holiday as such. The days these workers don't work are non-paid days. Almost all these workers complained of bodily pains. Children in these families were usually suffering from respiratory tract infections, diarrhea and intestinal infections. Irrespective of the migration status, local governance should do something for their benefit and health so that some decent work can be ensured.

Shewale *et al.* reported that brick workers were known for poor health and poor access to health care. Workers health should be evaluated from time to time, to look for possible solution for provision of effective health care and occupational environment. To assess socio demographic, nutritional status and morbidity profile of brick kiln workers and to review working conditions and safety measures practiced at brick kilns. Three brick kilns in Sakwar village were randomly selected for the study. All 86 workers were included in the study. Interviews were conducted and field checklist for presence of basic amenities and safety conditions was used at the brick-kiln sites. Result: Young adults of 20-30 age & children (below 14 years) formed majority of the working population (42%). 19% working population had some or another form of addiction. 83% of worker were working beyond 8-9 hrs per day. Majority of the workers were undernourished (44.6%). 58.7% of workers complained musculoskeletal problems. Majority of the workers were not aware about safety measures and none was practicing such measures. Study shows high prevalence of child labour, illiteracy and low income among the workers. Confirms high malnutrition and poor health status among brick kiln workers. Socio-Economic Conditions of Female Workers in Brick Kilns-An Exploitation to Healthy Social Structure: A Case Study on Khejuri CD Blocks in Purba Medinipur, West Bengal.

WHO (2000) reported that globally, it was difficult to estimate how many people die off prematurely or get sick due to air pollution because people were exposed to so many different pollutants in various concentrations over their lifetimes. However, according to WHO for air pollution approximately 3 million people had died each year. Among them, 800,000 people died prematurely every year due to lung cancer, cardiovascular and respiratory diseases, which were caused by outdoor air pollution.

World Bank (1997) reported that the main contributing sources for Total Suspend Particles (TSP) in the valley were cement factories (36%), brick kilns (31%) domestic fuel combustions (14%), road re-suspensions (9%) and vehicle exhausts (3.5%). However, particulate matter of size less than 10 microns (PM10) concentration, which was another major reason for damaging the respiratory system; contribution by the brick kilns were found highest than other sources and it was about 28%.

2.4 Review of literature about the effect of brick filed on agricultural crops

Butler *et al.* (2004) mentioned that the brick producers should strictly follow the rules restricting the use of agricultural topsoil for brick production. They could also adopted suitable international technology to produce bricks or blocks with a good quality, as practiced in the developed countries, through the use of alluvial clay and cement or brick cotton and lateritic clay.

Eswaran and Guttinkunda (2009) found that a relationship between Soil degradation and environmental pollution due to CO_2 emission from brick kiln was one of the most serious problems in the world today, because of their adverse effects on agriculture and the life on Earth. Three quarters of the world soil degradation occur in tropical areas and about 7% of the total land area (13,391 km^2) of Bangladesh was experiencing land degradation where the loss through brick kilns was not considered.

Islam and Rahman (2011) stated that once top soil was removed for making bricks, it takes 25 to 30 years for those lands to regain fertility. On average, each kiln burns 350 tones of woods per year, so more active kilns caused rapid deforestation. Black smoke from brick kilns moves away the species which were involved in pollination process, in turn declines agricultural production.

Maithel *et al.* (2003) found that in the existing FCKs, as much as 35 percent of total heat was lost through kiln surfaces (15 percent from the top and the rest from the sides and bottom) and an additional 12 percent was lost to moisture in the green bricks The heat loss was caused by air leakage from numerous points in the kiln and by conduction through sidewalls and to the top which ultimately enhance gaseous emission.

Pokhrel (2011) showed that brick kilns had long term and short-term impacts on the environment. Hampering normal vegetation process, reducing crop production, deforestation etc. were short term effects while long-term impacts include ozone layer depletion, global warming, production of photochemical smog, reduction in land fertility, etc.

Rahman *et al* (2006) reported that Brick kilns were one of the principal agents of topsoil degradation and environmental pollution. Bricks kilns were destroying large area of land every year especially in Bangladesh where bricks' were made by collecting soil from a depth of about 1 to 2 m in agricultural land which extended over about 5000 ha during the 1998-99 period in different pockets of Brickfields.

CHAPTER III

MATERIALS AND METHODS

CHAPTER 3

MATERIALS AND METHODS

In any research paper, methodology plays an important role. Appropriate methodology enables the researcher to collect valid and reliable information and to analyze the information properly in order to arrive at valid conclusion. The methods and procedures followed in conducting this study has been described in this chapter.

3.1 Research Design

Research design is a comprehensive master plan of the research. It is the conceptual structure within which research is conducted, constitutes blue print for collection, measurement and analysis of data. It is also the strategy, plan and structure of conducting the research. The purpose of designing the research is to provide a plan that permits accurate assessment of cause and effect relationships between the variables and to answer the questions being investigated. There are many types of research design. The design of this study was mixed-method research design. The research design of this study is given below.

- Selection of topic or research theme
- Literature review and consultation with specialist researcher
- Selection of Location and variables
- Data collection
- Qualitative analysis
- Quantitative analysis
- Data analysis
- Preparation of the thesis

3.2 Location

The study was conducted in Chilmari and Ulipur upazila under Kurigram district. Twenty (20) brick fields were selected for data collecting.

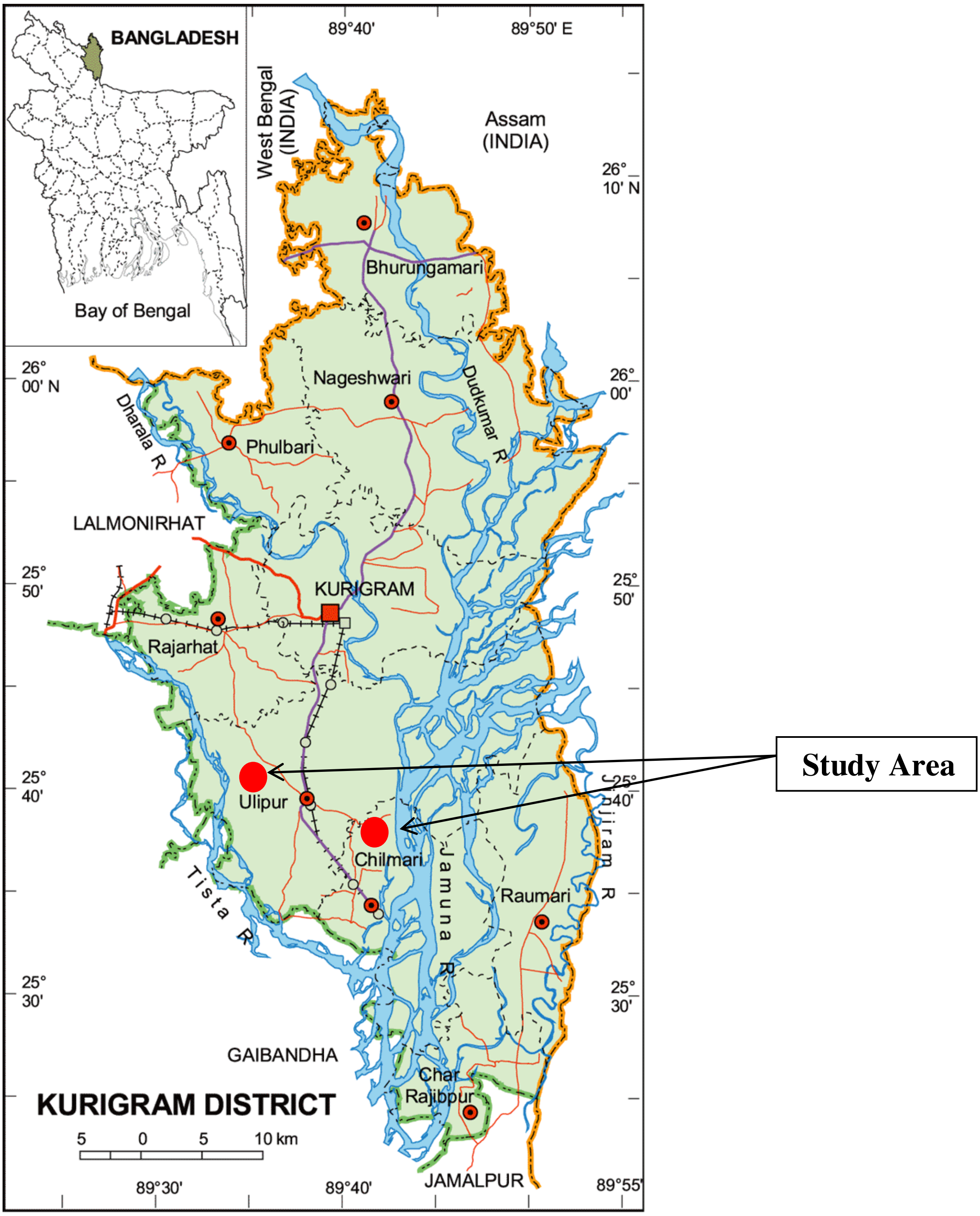

Fig. 1: Map Showing Kurigram district, Rangpur, Bangladesh

3.3 Experimental period

The research study was conducted during the period from January to July, 2017.

3.4 Data collection

Data about production of bricks, fuel consumption rate, and livelihood of brickfield worker, information about various crops production adjacent about 1 km, 2 km and 5 km were collected physically from some selected brick kilns and the adjacent area of brickfield.

3.5 Estimation Method

Currently, there is no recommended estimation method to estimate CO_2, non- CO_2GHGs and other gas pollutant emission from brick kilns. In this research study, CO_2 non- CO_2 GHGs and other gas pollutant emissions have been estimated based on natural gas and coal consumptions. CO_2 non- CO_2 GHGs and other gas pollutant emissions of brick kilns are divided into two categories, namely direct and indirect emissions. In this research study, direct gas emissions have been estimated independently. Direct an emission, which is due to natural gas and coal combustion from energy conservation units, were calculate based on Intergovernmental Panel on Climate Change (IPCC) guideline by using natural gas and other fossil fuel consumption. The CO_2, non-CO_2 GHGs and other gas pollutant emissions from brick kiln was calculated by the following equations:

Equation (1) direct $CO_2 = FC \times CEF \times fo \times 44/12$

Where

FC = Total annual natural gas and/or coal consumption in energy conservation unit of brick kiln during a year (TJ)

CEF = Carbon emission factor of natural gas and coal (tC/TJ)

fo = Carbon fraction of natural gas and coal that has been oxidized during combustion process

44/12= Mass conversion factor of mass carbon to mass CO_2 generated during combustion processes [BCAS, 2011]

Firstly, the quantities of natural gas and coal consumption are converted into energy units as tera joules, (TJ) using appropriate conversion factor, then transformed into carbon emissions based on carbon emission factor (CEF). Thought he IPCC has established CEF values, which can be used for general cases, data regarding fuel combustion in particular country has not been determined. As an approximation IPCC provides CEF value of natural gas, diesel, and coal that are15.3 tC/TJ. 20.2 tC/TJ, and 26.4 tC/TJ (the average value of CEF for anthracite, coking coal, other bituminous coal, sub-bituminous coal and lignite). The fraction oxidized value is used to account the carbon compound of natural gas and other fossil fuel that are not oxidized during combustion process. As an approximation, fraction-oxidized value of natural gas, diesel, and coal that are 0.995, 0.99, and 0.98 [IPCC- 2000] respectively.

3.6 Variables of the Study

Measurement of the variables constitutes an important task of any social research. In this study, brickfield workers livelihood and the adjacent farmer of brickfield were the focus issue. In addition owners, workers and farmers age, education, family size, sex, farm size, kiln height, labor, power supply, fuel use, CO_2 emission, production, physical effect, environmental effect, worker satisfaction, farmer innovativeness, amount of various crop production and agricultural knowledge were selected characteristics of this study.

3.6.1 Independent variable

3.6.1.1 Age

The age of a respondent was determined in terms of the actual years passed from her birth to the day of interview. A score of one (1) was assigned to each year

3.6.1.2 Education

The education was measured on the basis of grade (class) passed by a respondent. A score of one (1) was scored for each year of schooling in formal institution. For example, if a respondent passed the final exam of class V, her education score was taken as 5. Score 0.5 was given to the respondent who could sign her name and a zero (0) was given to the respondent who could not read and write.

3.6.1.3 Family size

The total number of the family member is measured by assigning a score of one (1) for each member of the family. For example, if a family contained three (3) members, the score of the family was three.

3.6.1.4 Farm size

Farm size of the respondent referred to the total area of land on which his own land under own brickfield and land taken from others on lease.

3.6.1.5 Kiln height

Approximate height of the kiln was 90-120 ft. The effect of the brick field pollutant also depend on the kiln height of the brick field.

3.6.1.6 Power supply, fuel used

Both electricity and generator was used in brickfield. on the other hand the main fuel of the brick field was coal and wood which was used to burn the muddy brick to convert commercial brick.

3.6.2 Dependent variable

Impact of brick field to the environment workers and the crops were the dependent variable of the study.

3.6.2.1 Production of bricks

Production of bricks mainly depends on the amount of brick field size. If, brick field size become large then the production of bricks become higher.

3.6.2.2 Bricks quality

There are various types of brick in brick field such as good, medium. Mainly maximum brick field owner produces good bricks.

3.6.2.3 CO_2 Emission from brick field

There are various types of gases emission from the brick fields such as CO_2, N_2O, NO etc. Among those gases carbondioxide is the main greenhouse gas which emission depends on the use of fuel and control method.

3.6.2.4 Labor distribution of brick field workers

The labor distribution in brick making process are divided into various categories such as loading mud, carrying mud, preparation of mud clay ,carrying clay , molder etc.

3.6.2.5 Innovativeness

Innovativeness such as cultivation of hybrid variety of rice, use of BADC seed in crop cultivation, land preparation by tractor, use of bio fertilizer, use IPM in rice field, use of sex pheromone of a respondent on performing agricultural activities was collected from the adjacent farmers of brickfield. Those farmer were cultivated various types of crops such as wheat, potato, mustard, jute, boro rice, aus rice, aman rice etc.

3.6.2.6 Physical effect of worker of brick field

Muscle pain, back pain, body weakness, cough, burning, and fever were the main physical effect caused by brick field.

3.6.2.7 Environmental effect cased by brick field

Burning trees and crops, emission of flying ashes, heat formed and pieces spread various place were common environmental effect which were commented by the workers of the brick field and farmers.

3.6.2.8 Production of the crops near by the brick field

Various crops are grown in Kurigram district. Among those crops wheat, potato, jute, boro rice aus rice and amon rice were the main crops which were grown nearby the brick field.

3.7 Statistical Analysis

The coded data were put into the computer for statistical analysis. The SPSS (Statistical Package for Social Sciences) computer program was used for analyzing the data. Various descriptive statistical measures such as frequency, number, percentage, mean and standard deviation were used for categorization and describing the variables. In addition the graphs and tables were also used to interpret the finding.

CHAPTER IV
RESULTS AND DISCUSSION

CHAPTER 4

RESULTS AND DISCUSSION

The findings of this study and their logical interpretations have been systematically presented in different sections of this chapter according to the objectives of the study. The first section deals with the owners of the brick fields. The second section deals with the selected characteristics of the workers in the brickfield. The third section deals with the selected farmer characteristics and production of the various crops adjacent to the brick fields.

4.1 Selected characteristics of brickfield owner

4.1.1 Age

On the basis of the age the respondents were classified into three categories as shown in table 1. Among age group of brickfield owner 65% owner were ranged below 50 years, 30% were ranged among 50-60 years and 5% were selected above 60 years. Table 1 also indicated that majority of the respondents 65% belong to the age group of below 50 and standard deviation was 10.04.

Table 1: Age of the respondent in study area

Categories	Number of respondents	Percentage of the respondent	Standard Deviation
Below 50	13	65	10.04
50-60	6	30	
above 60	1	5	
Total	20	100	

4.1.2 Education

Education helps individual to become aware of their environment and develop rational insight into many matters of life. Education status of the people in our country is increasing day by day. So, the brick field owner have to educated person. In case of education level, maximum respondent (55%) were above secondary level (HSC) condition among the three different education levels. The result also showed that 35% owner were secondary level (SSC). On the other hand, 10% owners were in primary level (1-5). Table 2 also indicated that there were no illiterate person in case of the brick field owner. It also indicated that the standard deviation was 0.67.

Table 2: Education level of the owner of the brick field

Categories	Number of respondents	Percentage (%) of the respondents	Standard Deviation
Primary level	2	10	0.67
secondary level	7	35	
above secondary level	11	55	
Total	20	100	

4.1.3 Brickfield size

There are highly acre land are needed for a brickfield. Though bricks are the main element of the infrastructure but it also causes of the decreasing agricultural land. Brickfield size were calculated on the basis of own land under own brickfield and land taken from others on lease. In table 3 brickfield size was calculated into three categories such as the ranges are 3-5 acre, 6-10 acre and 11-15 acre in Kurigram district. In here 15% owner have 3-5 acre land, 65% owner have 6-10 acre land and 25% owner have11-15 acre land for brickfield. The standard deviation was 3.57 among 20 brickfields.

Table 3: Brickfield size of the owner

Categories	Number of respondents	Percentage of respondents	Standard deviation
3-5 acre	3	15	3.57
6-10 acre	12	60	
11-15 acre	5	25	
Total	20	100	

4.1.4 Kiln height

In our country brick kilns are curing out the basic ingredients for construction in a way that is doing more harm than good. The government recently ordered the brick kiln owners to raise their chimneys to a height of 40 meters (120 feet) in a move to limit the kilns destructive pollution emissions. It is not only crops that are being affected by the tons of smoke coming out of the chimneys. Experts now says that brick kilns are emitting harmful particulate matters (pm) into the air which are responsible for the alarming rise of respiratory elements. Table 4 showed that the standard deviation was 3.20 among 20 brick field. It also indicated that 70% brick kiln height were above 100 feet whereas 20% brick kiln height was 81-100 feet.

Table 4: Kiln height of the brick field

Categories	Number of respondents	Percentage of respondents	Standard deviation
Below 80 feet	2	10	3.20
81-100 feet	4	20	
above 100 feet	14	70	
Total	20	100	

4.1.5 Gender categories of labor

Working in the brickfield is a dangerous work for the health of the people specially for child, women and adult. Kurigram district is situated in the poverty line. So for the deficiency of working capacity child, women and adult are taken risk and continued their working hours in brickfield. There were various type of labor in the brickfield such as child, women, man and adult. Table 5 indicate that 82.60% labor were man and 17.40% labor were women.

Table 5: Gender categories of the brick field labor

Categories	Number of respondents	Percentage of respondents	Standard deviation
Male	95	82.60	1.46
Female	20	17.40	
Total	115	100	

4.1.6 Child and above sixty years old labor of brick field

Among 115 labors 9 labors were child and 15 labors were above sixty years. Table 6 indicated that 13% labors were above sixty years and 7.8 % were child. The standard deviation was 4.73.

Table 6: Child and above sixty years old labor in brick field

Categories	Number of respondents	Percentage of respondents	Standard deviation
Child	9	7.8	4.73
Above 60 years old	15	13	

4.1.7 Power supply

Generally electricity and generator are used in the brick field as a power. Those powers are mainly used to control the exhaust fan of the brick field kiln. In Kurigram district electricity are not available for continuously 24 hours. So 85% owner was used generator and 15% owner used electricity to control the exhaust fan (table7). The standard deviation of power supply in brick field was 0.55.

Table 7: Power supply in brick field

Categories	Number of respondents	Percentage of respondents	Standard deviation
Electricity	3	15	0.55
Generator	17	85	
Total	20	100	

4.1.8 Fuel use

Coal, wood, natural gas is generally used in different brick field. In Kurigram districts 90% brick field owners were used coal and only 10% owners were used wood only bull's trench brickfield which was indicated in table 8. The uses of natural gas was absent in Kurigram districts. The standard deviation of fuel use in brick field was 0.46.

Table 8: Fuel use in brick field

Categories	Number of respondents	Percentage of respondents	Standard deviation
Coal	18	90	0.46
Wood	2	10	
Gas	0	0	
Total	20	100	

4.1.9 Production of brick

Table 9 indicated that 60% owner of brick field were produced 2.1-3.9 million bricks where 15% worker produce 2 million bricks. It also indicated that standard deviation of production of bricks was 994.62 among 20 brickfields.

Table 9: Production of bricks

Categories	Number of respondents	Percentage of respondents	Standard deviation
2 millions	3	15	994.62
2.1-3.9 millions	12	60	
above 4 millions	5	25	
Total	20	100	

4.1.10 Bricks quality

Maximum (80%) brick field owners stated that the amount of bricks made by their brick fields were good whereas 20% owners of brick fields told that their bricks were medium. However there were no lower quality of bricks in their brick fields. The standard deviation of quality of bricks producer was 0.61.

Table 10: Quality of bricks

Categories	Number of respondents	Percentage of respondents	Standard deviation
Good	16	80	0.61
Medium	4	20	
Total	20	100	

4.1.11 CO_2 Emission from brick field in Kurigram district (ton/year)

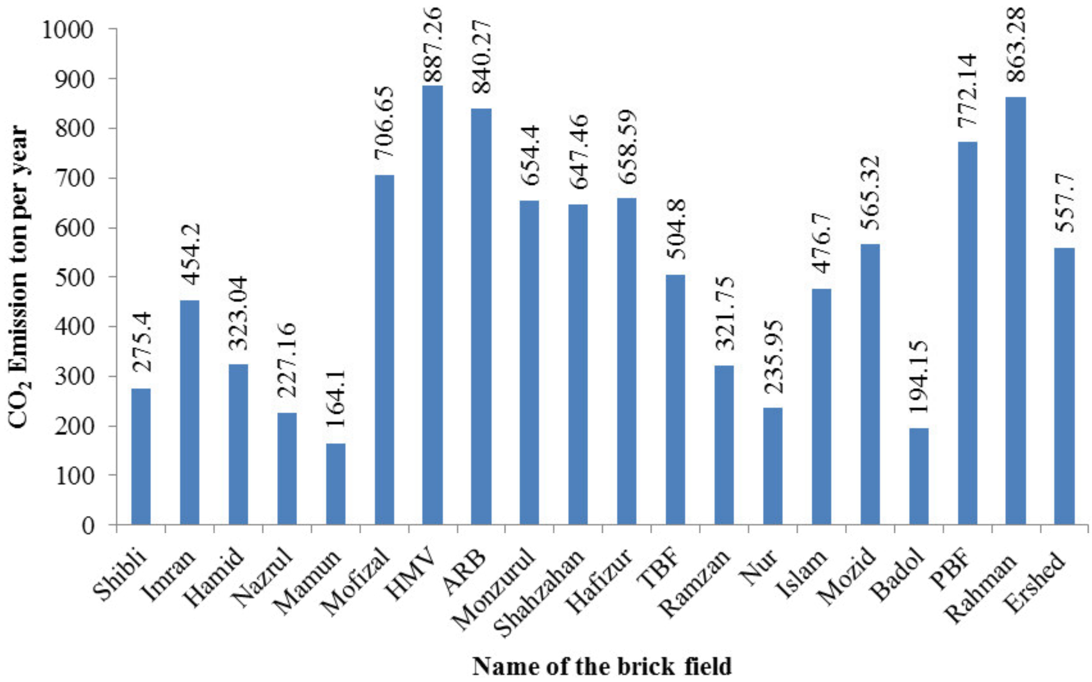

Figure 1: Graphical representation of CO_2 Emission from different brickfield in Kurigrm districts

The major concerning greenhouse gas carbondioxide emission from brick kilns around Kurigram district is presented in graph 1. Coals were used in the BTK, FCK and zigzag kilns. Natural gases were used only in Hoffman kilns. In Kurigram district all those brickfield are BTK. So only coals were use in here. Coal consumption of different brick field such name as Shibli, Imran, Hamid, Nazrul, Mamun, Mofizal, HMV, ARB, Monzurul, Shahzahan, Hafizur, TBF, Ramzan, Nur, Islam, Mozid, Badol, PBF, Rahman and Ershed were respectively 17 tons, 18 tons, 16 tons, 15 tons, 12 tons, 16 tons, 19 tons, 18 tons, 13 tons, 19 tons, 18 tons, 20 tons, 17 tons, 17 tons, 18 tons, 16 tons, 14 tons, 18 tons, 19 tons and 17 tons per 100000 bricks. From those coal consumption carbondioxide emission from selected brickfield of Kurigram district were calculated by the selected equation (BCAS, 2011) and shown in graph 1. It has been found that the highest amount of CO_2 emission was 887.26 tons per year and lowest amount was 164.1 tons per year. The mean of CO_2 emission among 20 brickfields was 516.51 tons per year. Again in case of the owner side, the maximum carbondioxide emissions were high in HMV brickfield where were the minimum found in Mamun brick field.

4.2 Selected characteristics of the brick field workers

4.2.1 Age

It was found most of the brick field workers on the study samples were in their early adulthood (age 21-30) which was 56.7%. The second majority of the workers were on their midlife region (age 31-50) which was 23.3%. Some of the workers were in the range of adolescence age and child labors were also present in some brick kilns on the survey area. The standard deviation of age of brick field workers was 10.74.

Table 11: Age of the worker

Categories	Number of respondents	Percentage (%) of respondents	Standard deviation
Adolescence (12-20)	6	6.7	10.74
Early adult hood (21-30)	51	56.7	
Midlife (31-50)	21	23.3	
Mature adulthood (above 50)	12	13.3	
Total	90	100	

4.2.2 Education

Education is still a luxury for low income classes in Bangladesh. Specially in Kurigram district where there are 71% people are present in poverty line. In this study it was seen most of the workers (52.2%) could sign name only. Because in here most of the workers did not get opportunity for any kind of institutional education. 25.2% workers were identified who passed the stage of primary education class 5. Table 12 also identified that 20% workers could not read and write.

Table 12: Education level of worker of brickfield

Categories	Number of respondents	Percentage of respondents	Standard deviation
Can't read and write	20	20.1	3.49
Can sign name only	47	52.2	
passed above class 5	23	25.2	
Total	90	100	

4.2.3 Sex

In case of sex (table13) maximum (86.7%) workers were man whereas only 13.3% workers were women. The standard deviation was 0.34.

Table 13: Sex status of worker

Categories	Number of respondents	Percentage of respondents	Standard deviation
Man	78	86.7	0.34
Women	12	13.3	
Total	90	100	

4.2.4 Labor distribution of brick field workers

Brick making is a labor intensive industry in Bangladesh which generally employs a large number of works of poor socio economic status. The labor distribution in brick making process can be sub divided into following steps such spreading for mud collection, loading mud, caring mud, preparation of mud clay, caring clay, molder, staking bricks , setting bricks and loading-unloading bricks. Table 14 indicated that the height (22.2%) of labor were molder and lowest (5.5%) workers worked as loading mud. The standard deviation of labor distribution of brick field workers was 1.53.

Table 14: Labor distribution of brick field worker

Categories	Number of respondents	Percentage of respondents	Standard deviation
Spading for mud collection	8	6.7	1.53
Loading mud	5	5.5	
Carrying mud	12	13.3	
Preparation of mud clay	7	7.8	
Carrying clay	15	16.6	
Molder	20	22.2	
Stacking bricks	7	7.8	
Setting bricks	6	6.7	
Loading-unloading	10	11.1	
Total	90	100	

4.2.5 Working hours per day of labor in brickfield

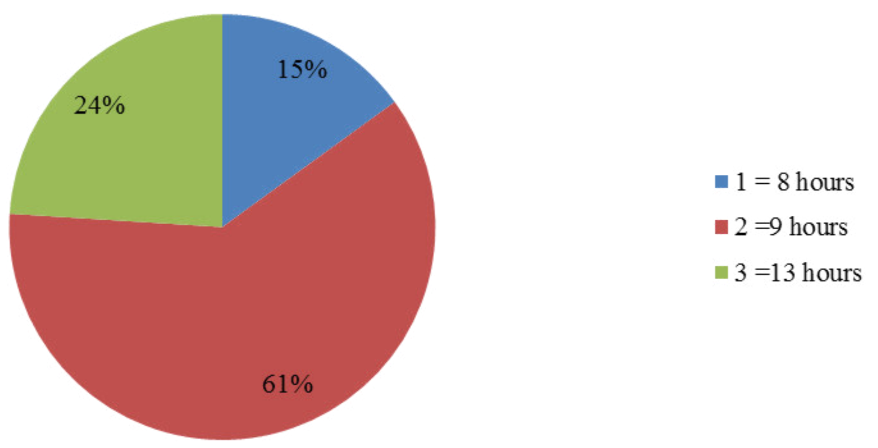

Figure 2: Working hours per day of a brick field worker.

About 61% worker worked in the brick field within 9 hours, 24% workers worked in the brickfield during 13 hours and 15% workers worked during 8 hours.

4.2.6 Income level of brickfield workers

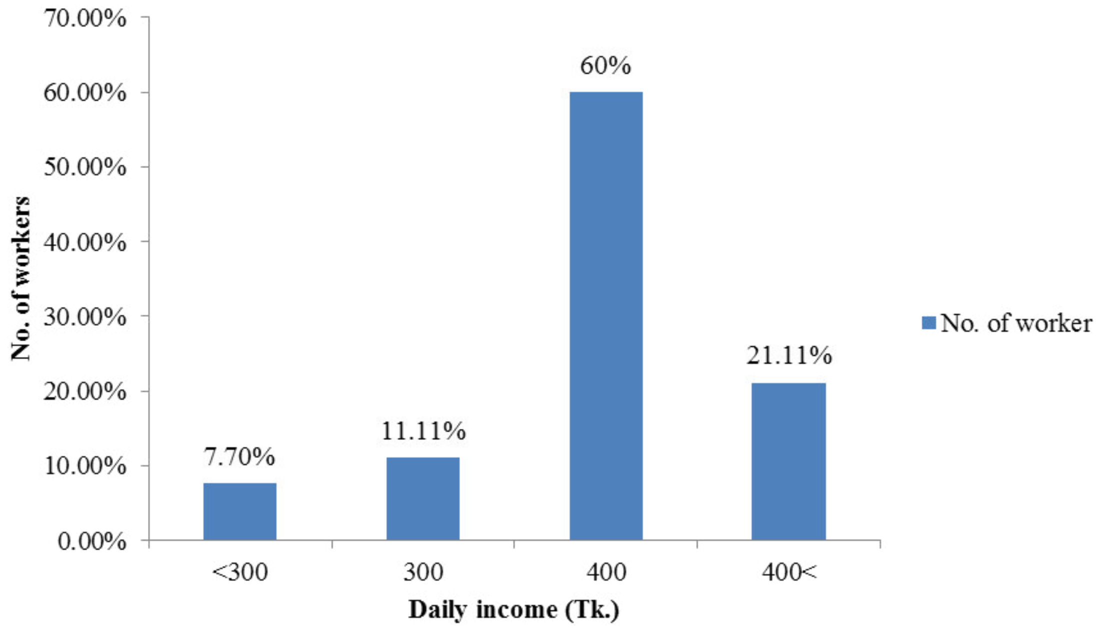

Figure 3: Income level of brickfield worker

This figure showed that about 60% worker's daily income were 400 tk. and the lowest income below 300 tk. occupied in 7.70% workers.

4.2.7 Facilities of workers obtained from the owner

There were 30% workers got extra facilities such as bonus money, medical treatments, money for smoking etc. But 70% worker did not get extra facilities.

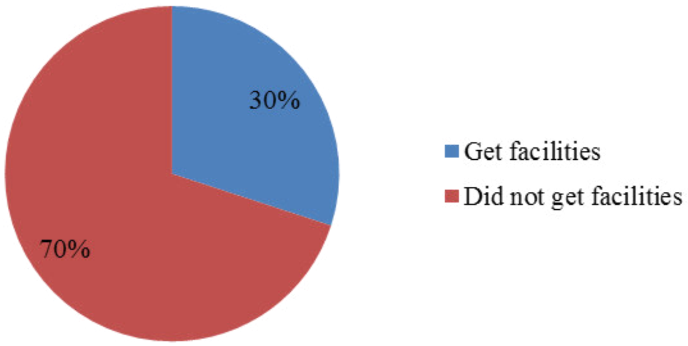

Figure 4: Graphical representation of extra facilities of brick field workers.

4.2.8 Physical effect of the worker caused by brick field

The working environment in the brick field factory is hazardous to workers health due to unsanitary environment, unsafe working environment and the hazardous work. Most of the brick factories do not have any work regulations or do not use any low safety measures and protective equipment. Actually there is little use of modern safety gears like head gear, glass, plastic boot, mask etc. They work in a field for 8-9 hours daily and seven days in a week generally. There are two major categories under Physical disability group. Whose are musculo skeletal disability, neuromusculo disability. Musculo skeletal disability is defined as the inability to carry out distractive activities associated with movement of the body parts due to muscular or body deformities, diseases on degeneration. The inability to perform controlled movement of affected body parts due to diseases degeneration or disorder of the nervous system. Workers in the brick field were faced various diseases such as muscle pain, back pain, body weakness, cough, burning, fever etc. Table 15 indicated that the maximum workers were affected in back pain (33.3%) minimum affected by cough (3.3%). Again 30% were faced muscle pain, 17.8% body weakness, 10% burning and 5.6% fever. Table 15 also indicated that the standard deviation was 1.02.

Table 15: Physical effect of the worker causes by brick field

Categories	Number of respondents	Percentage of respondents	Standard deviation
Muscle pain	27	30	1.02
Back pain	30	33.3	
Body weakness	16	17.8	
Cough	3	3.3	
Burning	9	10	
Fever	5	5.6	
Total	90	100	

4.2.9 Environmental effect of brick field

Being one of the largest consumers of coal in the country, it is one of the important sources of carbondioxide emission in the country. Air pollutants from brick kilns are SPM in the fuel gases which is generated mainly due to incomplete combustion of fuel or comes from fine coal dust , ash present in coal and burnt clay particles, hydrocarbons and carbon monoxide due to incomplete combustion of fuel, sulphur oxides, concentration of which mainly depends on the amount of sulphur content coal is used, dust pollution generated during removal and laying down of ash layer on the top of the kiln and also due to blowing of ash stacked on the top and sides of the kiln. Pollution also has an effect on agricultural crops and fruit plantations. The damage caused to mango and other fruit plantations due to pollutants from brick kilns is well known. In the survey area people complained that burning trees and crops, emission of flying ashes, heat formed and pieces spread various place were occurred by the brick kilns. By those caused agricultural crops, trees and soils were damaged. However, 90 workers 62.2% were commented that flying ashes were more emitted from the brick field, 24.4% workers were commented coming ashes from brick kiln can burn tree and crops, 7.5% were provided that the kiln also produce heat (By table 16).

Table 16: Environmental effects of brick field

Categories	Number of respondents	Percentage of respondents	Standard deviation
Burning trees and crops	22	24.4	0.79
Emission of flying ashes	56	62.2	
Heat formed	7	7.7	
Pieces spread various place	5	5.5	
Total	90	100	

4.2.10 Satisfaction of the brick field workers

Satisfied worker is a plus point to any industry. Because those have higher intention to the work. In the study area it was found that the percentage of medium satisfaction were higher (62.6) whereas only 5.5% workers had higher satisfaction. The standard deviation was 0.95.

Table 17: Satisfaction of the brick field workers

Categories	Number of respondents	Percentage of respondents	Standard deviation
Lower satisfaction	21	23.1	0.95
Medium satisfaction	57	62.6	
Satisfaction	8	8.8	
Higher satisfaction	5	5.5	
Total	90	100	

4.3 Selected characteristics of the Farmer and production of various crops adjacent to the brick field

4.3.1 Age

On the basis of age the respondents were classified into three categories as shown in table 18. Among age group of farmers 60.5% were ranged between 31-50 years, 31.1% were presented above 50 years and 3.3% were presented between 20-30 years. The standard deviation of age of farmer was 8.41.

Table 18: Age of Farmer adjacent to brickfield

Categories	Number of respondents	Percentage (%) of respondents	Standard deviation
Young (up to 30)	3	3.3	8.41
Middle (31-50)	59	65.6	
Old (Above 50)	28	31.1	
Total	90	100	

4.3.2 Education

Education helps individual to become aware of their production of crops, safe environment and develop rational insight into many matters of life. Education status of the people in the survey area is increasing day by day. According to the level of the Education the respondents were categories as shown in the table 18. In case of education level maximum respondent (54.5%) were in above class five among the 3 education level. The result also showed that 32.2% farmer can sign name only. On the other hand 13.3% farmers could not read or write. Table 19 also indicated that standard deviation was 0.58.

Table 19: Educational level of farmer

Categories	Number of the respondents	Percentage (%) of the respondents	Standard deviation
Cannot read and write	12	13.3	0.58
Can sign name only	29	32.2	
Passed above class5	49	54.5	
Total	90	100	

4.3.3 Family types

Table 20 showed that among the family types the study have three type of family in the selected area. Maximum families (56.6%) were found in joint Categories in the selected area. Minimum 18.8% were found in nuclear Categories. On the other hand 24.4% extended family. The standard deviation of family types of farmer was 18.36.

Table 20: Family types of the Farmer

Categories	Number of respondents	Percentage (%) of respondents	Standard deviation
Nuclear (3-4)	17	18.8	18.36
Joint (6-9)	51	56.6	
Extended (>10)	22	24.4	
Total	90	100	

4.3.4 Farm size

The study result revealed that, in case of farm size maximum respondent had small farm in all the selected area among the four categories of farm size. Table 21 also indicated that 57.8% of the farm categories were small farm size whereas large farm size was only 5.5.

Table 21: Farm size of the Farmer

Categories	Number of respondents	Percentage (%) of respondents	Standard deviation
Marginal (<0.0) ha	14	15.5	20.50
Small (0.05-1) ha	52	57.8	
Medium (1-1.5) ha	19	21.11	
Large (>1.5) ha	5	5.5	
Total	90	100	

4.3.5 Home stead size

The study result revealed that, in case of homestead size, maximum respondents had small homestead in the selected study area among the four categories of homestead size. Table 22 indicated that 46.6% farmer had small (0.08-0. 14) ha homestead where 8.9% farmer had large (>.2 0) ha.

Table 22: Home stead size of farmer

Categories	Number of respondents	Percentage of respondents	Standard deviation
Marginal (0.02-0.08) ha	27	30	15.29
Small (0.08-14) ha	42	46.6	
Medium (0.14-20) ha	13	14.4	
Large (>0.20) ha	8	8.9	
Total	90	100	

4.3.6 Occupation

Occupation of the respondents were classified into the following categories as shown in table 23. The research revealed that majority (22.2%) were day labors. However, service holder, shopkeeper, rickshaw puller, farming small business, tailoring homemakers, servant of the others house were 16.7, 8.9, 20, 3.3, 5.5, 2.2, 6.7, 11.1 percent respectively. Few female were involved in day labor and in shop keeping. 3. 3 % of the respondents were engaged in other jobs. The standard deviation was 6.55.

Table 23: Occupation of the farmer adjacent to brickfield

Occupation	Number of respondents	Percentage (%) of respondents	Standard deviation
Service	15	16.7	6.55
Shopkeeper	8	8.9	
Rickshaw puller	18	20	
Day labor	20	22.2	
Farming	3	3.3	
Small business	5	5.5	
Tailoring	2	2.2	
Homemaker	6	6.7	
Servant to other's house	10	11.1	
Others	3	3.3	
Total	90	100	

4.3.7 Annual income

In Kurigram district, 71% people were situated in poverty line. So their income levels were not very high. Annual income of 43.3 % farmers was low level (5000-25000). Whereas annual income of 7.8% farmers was high. (above 1000000). The standard deviation of annual income was 13.48.

Table 24: Annual income of the farmer

Annual income (Tk.)	Number of respondents	Percentage of respondents	Standard deviation
5000-25000 (low)	39	43.3	13.48
25000-50000 (small)	26	28.9	
50000-100000 (medium)	18	26	
Above 100000 (high)	7	7.8	
Total	90	100	

4.3.8 Innovativeness

Global change forces farmers to adapt more rapidly to changing condition than ever before. So farmers have to adopt various innovative formulas to produce higher production of crops. Table 25 indicated that 95% farmers used tractor for the land preparation, 71% farmer cultivated hybrid variety of rice, 26% farmer used BADC seed for crop cultivation, 13% farmer used sex pheromone and 4% used bio fertilizer and 2% used IPM in rice field. The standard deviation of innovativeness was 0.34.

Table 25: Innovativeness of the farmer

Innovativeness	Total people	Respondents of individual innovativeness	Percentage of respondents	Standard deviation
Cultivation of hybrid variety of rice	90	64	71	0.34
Use of BADC seed in crop cultivation	90	24	26	
Land preparation by tractor	90	86	95	
Use of bio fertilizer	90	5	4	
Use of IPM in rice field	90	3	2	
Use of sex pheromone	90	12	13	

4.3.9 Production of the crops

Majority of the respondents opined that brick field had major effect on soil fertility as well as agricultural production. The respondents who owned agricultural land near brick fields were negatively affected by black smoke and ash that spread over the crop. On the other hand, 5% respondents complained about minor effect and 0% respondents felt no impact on soil fertility. The Upazila Agricultural Officer and block supervisor also reported that crop production has reduced adjacent to the brickfield area in recent years. Burning of soil decreases soil pH, increase sand and decrease clay content. (Glaser *et al.*, 2002). It has serious impacts on physical, biological and chemical properties of soil resulting sharp declination in soil fertility and productivity (Khan *et al*., 2007; Thapa, 2011) Some farmers also emphasized on the fact that some of the adjacent lands were fertile arable land where all kind of crops and vegetables could grew only few years ago. But after brick kiln was set up near that crop field, production of crop had been declined. During survey, we could observe directly that many of the agricultural land had become unsuitable for producing any crops due to over exploitation of its top soil. Farmers in this area have already experienced the problems of drying water source, low water holding capacity on soil, poor crops stability and reduce crop productivity. To recover the level of production farmers are now applying high doses chemical fertilizers which have harmful consequences to ecological system. Majority of the respondents told that agricultural production were decreasing with time and brick field had major effect on vegetation. The respondents how were owner of brick field did not confess effect of brick field on vegetation alleged by the farmer. However, 30% of them confessed some major effects, saying that flowering and fruiting trees were affected only.

4.3.9.1 Wheat production (ton/acre)

Figure 5 indicated that the highest wheat yield (1.1 t/acre) was founded in the distance of five km and the lowest yield (1.02 t/acre) was founded in the distance of one km. So it is clear that the yield was reduced due to the pollution of brick field. It was found that in five km distance from brickfield 7.80% wheat production was higher than from one km distance.

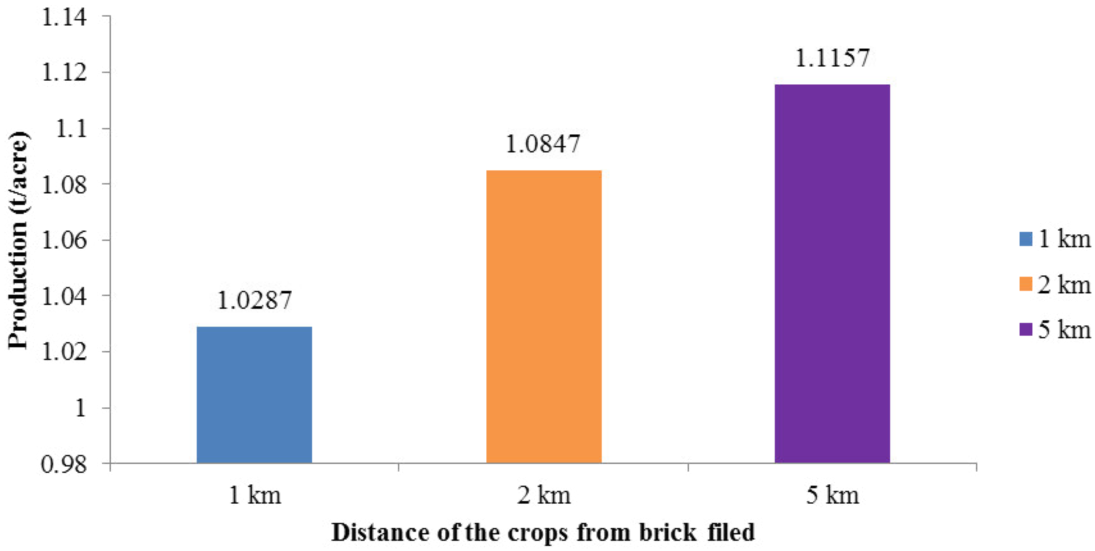

Figure 5: Graphical representation of wheat production

4.3.9.2 Potato production (ton/acre)

Figure 6 indicated that highest potato yield (15.66 t/acre) was founded in the distance of five km and the lowest yield (11.68 t/acre) was founded in the distance of one km. It was found that 34.1% production of potato was higher in five km distance from brick field than one km distance. So, close to the brickfield the yield was reduced due to the pollution of brickfield.

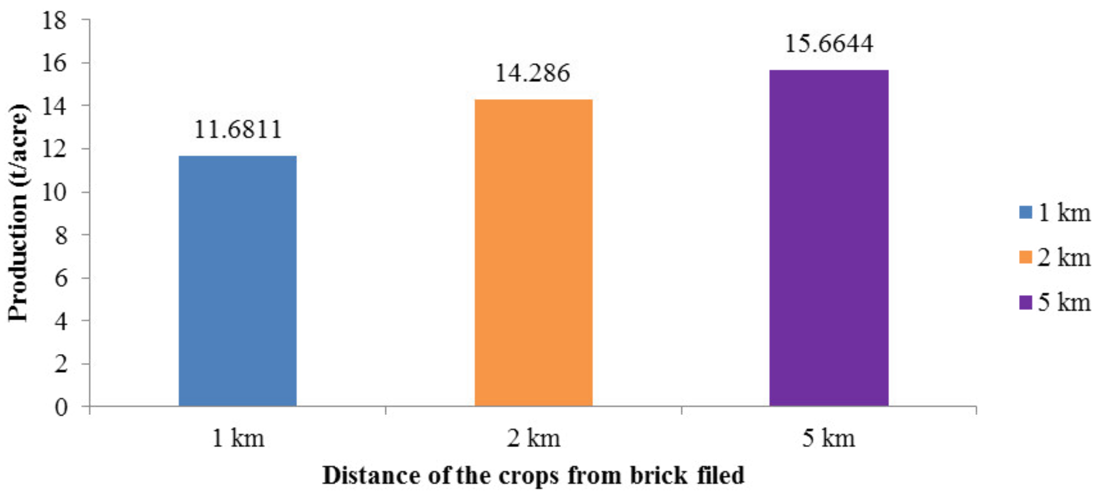

Figure 6: Graphical representation of potato production

4.3.9.3 Jute production (ton/acre)

Highest jute yield (1.24 t/acre) was founded in the distance of five km and the lowest jute yield was (1.15 t/acre) founded in the distance of one km. By the calculated it was found that 7.1% jute production was higher in five km distance from brick field than one km distance.

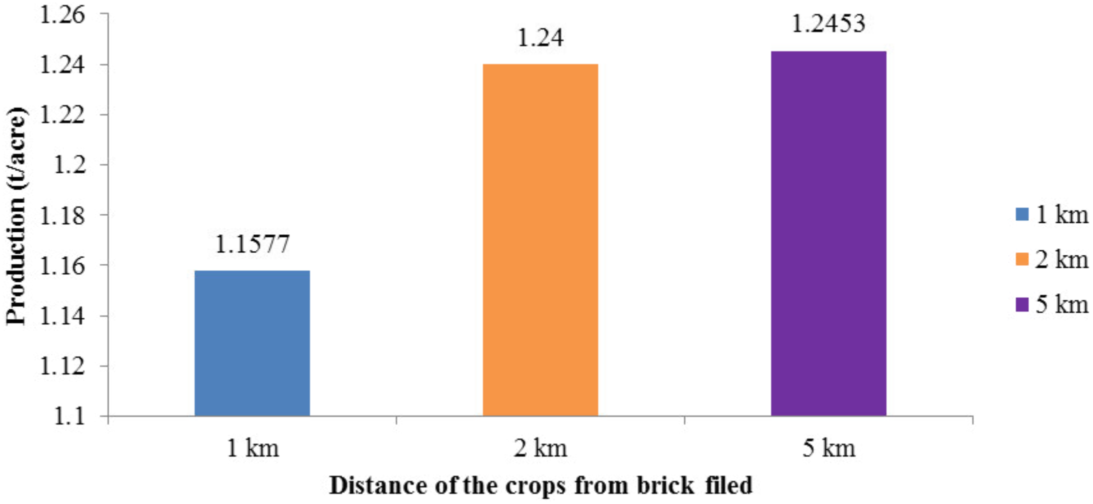

Figure 7: Graphical representation of jute production

4.3.9.4 Boro rice production (ton/acre)

Figure 8 indicated that highest boro rice yield (2.39 t/acre) was founded in the distance of five km and the lowest yield (2.06 t/acre) was founded in the distance of one km. 15.54% production of boro rice was higher in five km distance from brickfield than one km distance.

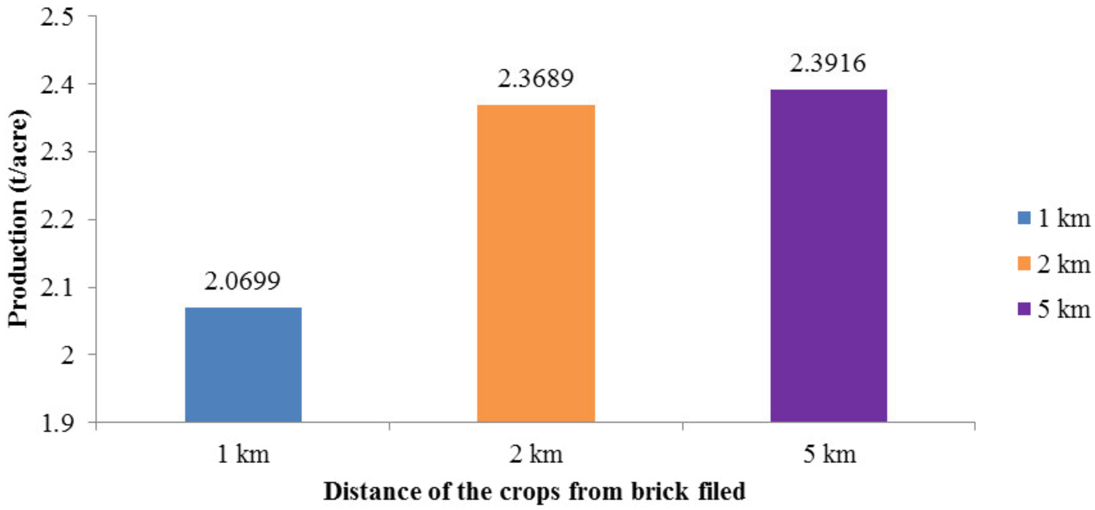

Figure 8: Graphical representation of boro rice Production

4.3.9.5 Aus rice production (ton/ acre)

Figure 9 indicated that the highest aus rice yield (1.4 t/acre) was founded in the distance of five km and the lowest yield (1.12 t/acre) was founded in the distance of one km. 23.31% aus rice production was higher in five km distance from brickfield than one km distance.

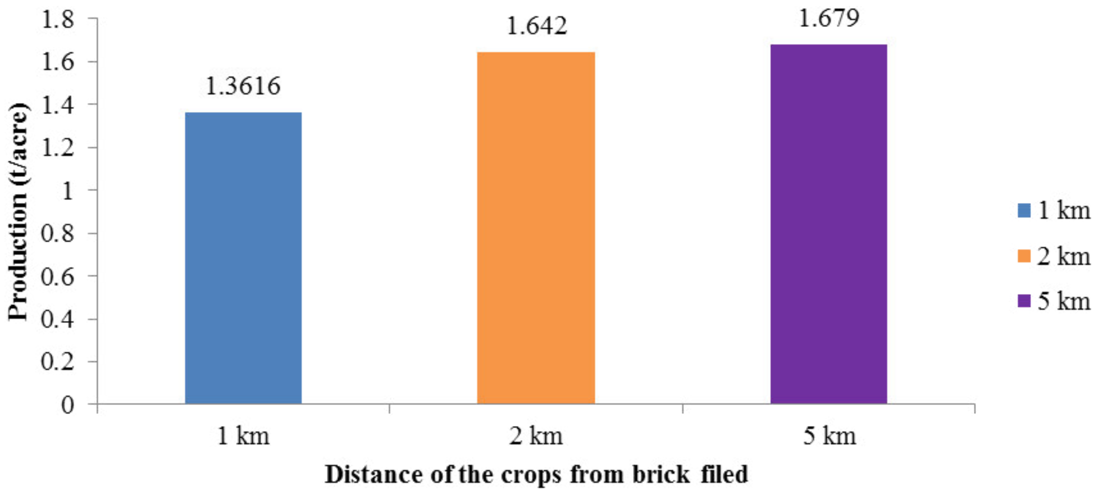

Figure 9: Graphical representation of aus rice Production

4.3.9.6 Amon rice production

Result indicated that highest amon rice yield (1.6t/acre) was founded in the distance of five km and the lowest yield (1.3 t/acre) was founded in the distance of one km. By the calculated it was obtained that 32.30% amon rice production was higher in five km distance from brickfield than one km distance.

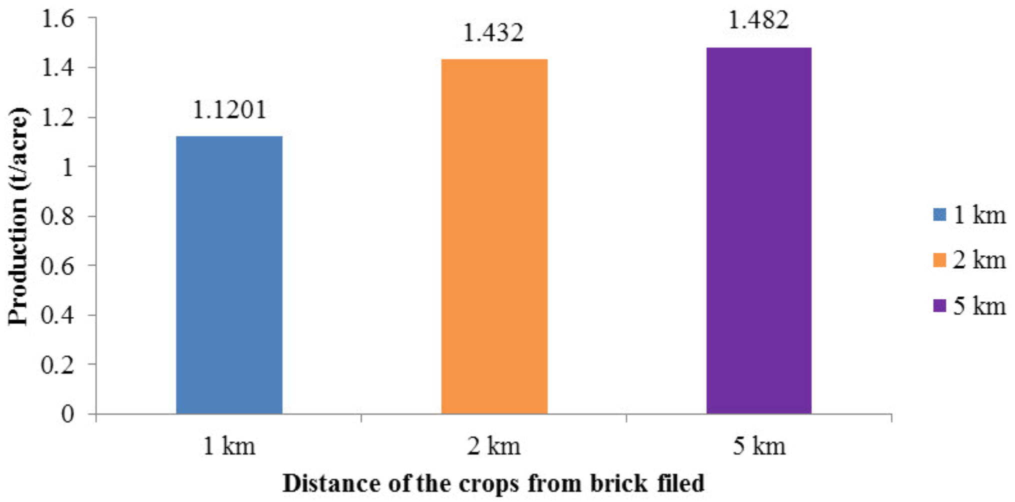

Figure 10: Graphical representation of amon rice Production

Therefore, it may be calculated that all the Agricultural crops yield were higher with the increased distance from the brickfield.

CHAPTER V

SUMMARY, CONCLUSION AND RECOMMENDATIONS

CHAPTER 5

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

The study was conducted in Chilmari and Ulipur Upazila under Kurigram District. Twenty (20) brick field were selected for collecting data. The research study was conducted during the period from January to July, 2017. Data about production of bricks, fuel consumption rate, and livelihood of brickfield worker, information about various crops production adjacent about 1 km, 2 km and 5 km were collected physically from some selected brick kilns and the adjacent area of brickfield. Measurement of the variables constitutes an important task of any social research. In this study, brickfield workers livelihood and the adjacent farmer of brickfield were the focus issue. In addition owners, workers and farmers' age, education, family size, sex, farm size, kiln height, labor, power supply, fuel use, CO_2 emission, production, physical effect, environmental effect, worker satisfaction, farmer innovativeness, amount of various crop production and agricultural knowledge were selected characteristics of this study. Age of brickfield owner, 65% owners were ranged below 50 years, 30% were ranged among 50-60 years and 5% were selected above 60 years. Education level maximum respondents (55%) were above secondary level (HSC) condition among the 3 education level. The result also showed that 35% owner were secondary level (SSC). On the other hand 10% owners were selected in primary level (1-5). The mean of the brickfield size was 6.48 and standard deviation was 3.57 among 20 brick field. The mean of the brickfield kiln height was 30.05 m and standard deviation was 3.20 among 20 brick field. Among those labors the higher percentage was 63.3 and lower percentage was 7.8 which were occupied respectively men and child. Again the women workers percentage was 14.8 and adult workers percentage was 13%. There was 85% owner used generator and 15% owner used electricity to control the exhaust fan. In Krigram districts 90% brick field owners were used coal and only 10% owners were used wood only bull's trench brickfield. The uses of natural gas was absent in Kurigram districts. The mean of the brick production was 2.28 million and standard deviation was 994.62 among 20 brick field. Bricks qualities were good in 80% and medium in 20%. The maximum amount CO_2 emission was 23.98 and minimum amount was 16.41 (t/ lakh bricks). The mean of CO_2 emission among 20 brickfields was 516.51 ton C per year. Among age group of brickfield worker 36% were ranged between 20-30 years, 52% were present between 31- 50 years and 12% were selected above 50 years. Education level maximum respondents (52.2%) were in can sign name only among the 3 education level. The result also showed that 20% worker were cannot read or write. On the other hand 22.5% workers were selected in passed any class. Among those worker 86.7% were men and 13.30 were women. Maximum workers were affected in back pain (33.3%) minimum affected by cough (3.3%). Again 30% were faced muscle pain, 17.8% body weakness, 10% burning and 5.6% fever. Workers 62.2% were commented that flying ashes was more emitted from the brick field, 24.4% workers were commented coming ashes from brick kiln can burn tree and crops, 7.5% were provided that the kiln also produce heat. Medium satisfaction was maximum which percentage was 62.6 and the minimum percentage was 5.5 which was indicate higher satisfaction. Among age group of farmers, 60.5% were ranged between 31-50 years, 31.1% were presented above 50 years and 3.3% were presented between 20-30 years. Education level maximum respondent (54.5%) was in above class five among the 3 education level. The result also showed that 32.2% farmer can sign name only. On the other hand 13.3% farmers cannot read or write. Maximum family (56.6%) was found in joint categories in the selected area. Minimum 18.8% were found in nuclear categories. On the other hand 24.4% extended family. 95% farmer use tractor for the land preparation, 71% farmer cultivated hybrid variety of rice, 26% farmer used BADC seed for crop cultivation, 13% farmer used sex pheromone and 4% used bio fertilizer and 2% used IPM in rice field. Overall results were observed from various crops production such as wheat, potato, jute, aus, aman and boro rice etc were higher with the increased distance from the brickfield.

5.2 Conclusion

From the findings of the study it can be concluded that brick field has a tremendous impact on both environment and agricultural crops production in the nearby areas. The main fuel used in brick field was coal in Kurigram district. Emission of carbondioxide was the main component from brick field. In case of physical element, emission of flying ashes were higher pollutant. All the agricultural crops were affected by flying ashes which were very close to the brick field. Therefore, all the agricultural crops yield were higher with the increasing distance from brickfield. Finally, in case of health, maximum brick field workers suffered by back pain due to hard work in brick fields.

5.3 Recommendations

The following recommendations are made on the basis of findings of the current study:

- Brick field owner should take proper action to replace traditional polluting technologies by modern cleaner technologies.
- Proper disposal of coal ash, proper layout, proper height of kiln, use of a properly graded coal, proper firing practices and environmental measures should be adopted by all brickfield owners.

- Brick field should be set up in a proper distance from agricultural land, orchards, forest and other sensitive areas such as school, hospital, wild life sanctuaries etc.
- Workers should drink enough water during work to avoid dehydration and other related disorders due to it.
- Every worker should use soap in hand washing & use sanitary latrine.
- Sever work related pain should not be ignored and medical attention is required.
- Various kinds of stretching exercises should be practiced to minimize muscle aches.
- Protective equipment's like, gloves, masks, headgear must be used to avoid work related injuries.
- Brick kiln owner should provide medical facility to its workers or medical bonus can be included to their salary.
- Applications received for setting up new brick fields shall be examined properly by the government so that the owner must be followed all sustainable environmental rules to control the environmental pollution and hazard on crop production.

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APPENDICES

APPENDICES

APPENDIX-I

An English Version of Interview Schedule

Department of Agroforestry and Environmental Science
Hajee Mohammad Danesh Science and Technology University, Dinajpur

An interview schedule of the research study entitled

Impact of Brickfield on Carbon dioxide Emission and Livelihood of Brickfield Worker in Kurigram District of Bangladesh

Date: - - - - - - - - - - - Serial No. ☐

Name of Respondent - - - - - - - - - - - - - - - - -Father's/Husband's Name - - - - - - - - - - -

Village: - - - - - - - - - - - - - - Union - - - - - - - - - - -

(Please answer the following questions and put tick (√) whenever necessary)

1. Age: Please mention of your present age? ☐ Years

2. Educational qualification: Mention your educational qualification

a) Can't read and write ☐
b) Can sign name only ☐
c) Passed .... class

3. Brickfield size: Please indicate the area of the brickfield

Sl. No.	Nature of holding	Area		
		Local Unit		Hectare
		Decimal	Bigha	
a.	Own land under own brickfield			
b.	Land taken from others on lease			
c.	Others (if any)			
	Total=			

4. Investment:

Initial Investment	Taka
Working Capital	Taka

5. Type of Brickfield:

Types	Used	Not Used
Bull's Trench Kiln		
Fixed Chimney Kiln		
Zigzag Kiln		
Hoffman Kiln		

6. Raw Materials:

A. Labor

Labor Type	Number	Comment
Child		
Man		
Women		
Adult		

B. Electricity

Used	Not Used

C. Fuel

Name	Yes	No	Unit (Tones Per 100.000 Bricks)
Coal			
Wood			
Natural Gas			

7. Production Time:

Duration	Million Brick	Wastage (%)
January to June		
July to December		

8. Quality of Bricks

Medium	Good	Very Good

9. Problems: Mention some problems you faced during producing bricks

1.	
2.	
3.	
4.	
5.	

10. Suggestions: Please give your opinion to overcome the above mentioned problems

1.	
2.	
3.	
4.	
5.	

Thanks for your kind cooperation.

Signature of interviewer

APPENDIX-II

An English Version of Interview Schedule

Department of Agroforestry and Environmental Science
Hajee Mohammad Danesh Science and Technology University, Dinajpur

An interview schedule of the research study entitled

Impact of Brickfield on Carbon dioxide Emission and Livelihood of Brickfield Worker in Kurigram District of Bangladesh

Date: - - - - - - - - - - - Serial No. ☐

Name of Respondent - - - - - - - - - - - - - - - - -Father's/Husband's Name - - - - - - - - - - -

Village: - - - - - - - - - - - - - - Union - - - - - - - - - - -

(Please answer the following questions and put tick (√) whenever necessary)

1. Age: Please mention of your present age? ☐ Years

2. Educational qualification: Mention your educational qualification

a) Can't read and write ☐
b) Can sign name only ☐
c) Passed .... class

3. Farm Size: Please indicate the area of the brickfield

Sl. No.	Use	Local Unit	Hectare
1.	Homestead area		
2.	Own land under own cultivation		
3.	Land taken from others as lease		
4.	Land taken from others as borga		
Total land			

4. Annual Income: Please indicate the production and income of your family has earned last year from different sources.

Sl. No.	Source of income	Production (kg)	Market price (Tk.)	Total price (Taka)
A.	Agriculture			
B.	Fisheries			
C.	Livestock			
D.	Service			
E.	Small Business			
F.	Others			
Total Income =				

5. Various Effect Faced By Brickfield during Work

Effect Name	Yes	No	Comment
Physical Effect			
Environmental Effect			

6. Problems: Mention some problems you faced during work

1.	
2.	
3.	
4.	
5.	

7. Suggestions: Please give your opinion to overcome the above mentioned problems

1.	
2.	
3.	
4.	
5.	

Thanks for your kind cooperation.

Signature of interviewer

APPENDIX-III

An English Version of Interview Schedule

Department of Agroforestry and Environmental Science

Hajee Mohammad Danesh Science and Technology University, Dinajpur

An interview schedule of the research study entitled

Impact of Brickfield on Carbon dioxide Emission and Livelihood of Brickfield Worker in Kurigram District of Bangladesh

Date: - - - - - - - - - - - Serial No. [ ]

Name of Respondent - - - - - - - - - - - - - - - -Fathers/Husbands Name - - - - - - - - - - - -

Village: - - - - - - - - - - - - - - Union - - - - - - - - - - -

(Please answer the following questions and put tick (√) whenever necessary)

1. Age: Please mention of your present age? [ ] Years

2. Educational qualification: Mention your educational qualification

- Can't read and write [ ]
- Can sign name only [ ]

c) Passed .... class

3. Family size: Please mention your total number of family members (including yourself)

Male	- - - - -	Female	- - - - -	Total=	- - - - -

4. Farm size: Please indicate the area of land in your possession

Sl. No.	Nature of holding	Area		
		Local Unit		Hectare
		Decimal	Bigha	
a.	Homestead (including garden and fallow land)			
b.	Own land under own cultivation			
c.	Land given to others on lease			
d.	Land taken from others on lease			
e.	Pond area			
f.	Others (if any)			
	Total=			

5. Family income: Please mention your annual family income according to the following sources

Sl. No.	Sources of income	Production (local unit)	Market price (Tk./local unit)	Total (Tk.)
➢ **Agricultural**				
1.	Rice			
2.	Maize			
3.	Wheat			
4.	Potato			
5.	Vegetable			
6.	Fruits			
7.	Fish			
8.	Poultry			
9.	Dairy			
10.	Land lease			
➢ **Non-Agricultural**				
1.	Service			
2.	Business			
3.	Others (if any)			
			Total=	

6. Occupation

What are your main sources of income please indicate all the activities that you practice and that contribute to sustain your household average putting at the first the main one?

Occupation	**Income generated (in taka)**
Service	
Shopkeeper	
Rickshaw puller	
Day laborer	
Farming	
Small business	
Tailoring	
Homemaker	
Servant to other' house	
Others	

7. Cropping Pattern

Please tell me about your production of different crops.

Season	Name of crops	Production area	Production (ton/ha)
Robi (Mid Nov.-Mid March)	Wheat		
	Potato		
	Mustard		
	Winter vegetables		
	Boro rice		
	Others		
Kharif 1 (Mid March-Mid July)	Jute		
	Summer vegetables		
	Aus rice		
	Others		
Kharif 2 (Mid July-MidNov.)	T. Amon		
	B. Amon		
	Soybean		
	Others		

8. Innovativeness: Please furnish your information about the duration and extent of uses of the following technologies

Sl. No.	Name of technologies	Do not use	Duration of adoption			Extent of adoption	
			Within 1 year	Within 2 years	Above 2 years	Cultiv able land	Technology applied land
1.	Cultivation of hybrid variety of rice						
2.	Use of BADC seed in crop cultivation						
3.	Land preparation by tractor						
4.	Cultivation of green manuring crops						
5.	Use of bio-fertilizer						
6.	Use of sulphur in crop production						
7.	Use of IPM in rice field						
8.	Use of sex pheromone trap						
9.	Use of flora (growth hormone enhancing flowering and fruiting) in increasing yield						
10.	Artificial pollination in vegetable cultivation						

9. Organizational participation: Please indicate your involvement in the following social organizations

SL. No.	Name of social organization	No Participation	Nature of involvement		
			As a member	As an executive member	As a chief executive
1.	School/ Madrasa committee				
2.	Mosque /Mondir committee				
3.	Village development committee				
4.	Youth club				
5.	Bazar committee				
6.	Business samitte				
7.	Union parishad				
8.	Others (if any)				

10. Problems: Mention some problems you faced by the Brickfield

1.	
2.	
3.	
4.	
5.	

11. Suggestions: Please give your opinion to overcome the above mentioned problems

1.	
2.	
3.	
4.	
5.	

Thanks for your kind cooperation.

Signature of interviewer

APPENDIX-IV

Plates of some brick field industries

Plate 1: Data collection from brick field owner using questionnaire by interview

Plate 2: Data collection from brick field worker using questionnaire by interview

Plate 3: Data collection from the farmer using questionnaire by interview

Plate 4: Site view of brick field in Kurigram district

Plate 5: Chamber of brick field

Plate 6: Generator used in brick field

Plate 7: Coal used in brick field

Plate 8: Molder of brick field

Plate 9: Muddy bricks loading in brick field chamber

Plate 10: Old ages worker of brick field

Plate 11: Child worker of brick field

Plate 12: Unloading brick from brick field chamber