2016

Intervention of Bio-Security in Broiler Farming of Bangladesh

Ali, Mohd. Younus

University of Rajshahi

Ph.D. Thesis

INTERVENTION OF BIO-SECURITY IN BROILER FARMING OF BANGLADESH

INTERVENTION OF BIO-SECURITY IN BROILER FARMING OF BANGLADESH

A Dissertation

Submitted for the Degree of

Doctor of Philosophy

By

Mohd. Younus Ali

B.Sc. A. H., M.S. in Dairy Science

DEPARTMENT OF ANIMAL HUSBANDRY & VETERINARY SCIENCE, UNIVERSITY OF RAJSHAHI, RAJSHAHI-6205, BANGLADESH

January 2016

January, 2016

INTERVENTION OF BIO-SECURITY IN BROILER FARMING OF BANGLADESH

A Dissertation

Submitted for the Degree of

Doctor of Philosophy

By

Mohd. Younus Ali

B.Sc. A. H., M.S. in Dairy Science

DEPARTMENT OF ANIMAL HUSBANDRY & VETERINARY SCIENCE, UNIVERSITY OF RAJSHAHI, RAJSHAHI-6205, BANGLADESH

January, 2016

CERTIFICATE

We have pleasure in certifying the thesis entitled "**Intervention of bio-security in broiler farming of Bangladesh**" submitted to the Department of Animal Husbandry and Veterinary Science, Faculty of Agriculture, University of Rajshahi, for the Degree of Doctor of Philosophy.

We hereby certify that the candidate has fulfilled the requirements and the research work embodied in the thesis was carried out by the candidate. To the best of our knowledge, all the data and materials are genuine and original. No part of the research work has been submitted for any other Degree.

Supervisors

Principal Supervisor

Dr. Syed Sarwar Jahan
Associate Professor
Department of Animal Husbandry
and Veterinary Science
University of Rajshahi
Rajshahi, Bangladesh

Co-supervisor

(Dr. Md. Abdur Rahman Howlider)
Professor
Department of Poultry Science
Bangladesh Agricultural University,
Mymensingh,
Bangladesh

DECLARATION

I hereby declare that the thesis title "**Intervention of bio-security in broiler farming of Bangladesh**" has been prepared by me from an original research work and has not so far been submitted to any other University/Institute for any Degree. All sources of information are shown in the text and listed of References. The assistance and help received during the course of investigation have duly been acknowledged.

January, 2016
Rajshahi

(Mohd. Younus Ali)
Research Fellow

ACKNOWLEDGMENTS

All praises and compliments are due to the Almighty Allah who has enabled the author to complete the present research and to prepare this thesis for the Degree of Doctor of Philosophy.

The author feels immense proud to express his heartfelt respect and deepest sense of gratitude, indebtedness and profound respect to his research Supervisor Dr. Syed Sarwar Jahan, Associate Professor, Department of Animal Husbandry and Veterinary Science, University of Rajsjhahi, Bangladesh for his cordial inspiration, scholastic supervision, valuable suggestions, sympathetic co-operation, helpful advice, timely and solitary instructions, constructive criticisms and affectionate encouragements at all stages of research work and preparation of this dissertation.

The author is extremely glad to avail himself of the opportunity to express his heartfelt gratefulness, sincere appreciation and immense indebtedness to his respected teacher as well as Co-supervisor, Dr. M.A.R. Howlider, Professor, Department of Poultry Science, Bangladesh Agricultural University, Mymensingh, Bangladesh for his keen interest, active and sincere guidance, supervision, creative suggestions, kind help, co-operation and meticulous review of the manuscript for improvement of this dissertation.

The author also wishes to express his deepest sense of gratitude and respect to Dr. K.M. Mozaffor Hossain, Associate Professor and Chairman, Department of Animal Husbandry and Veterinary Science, University of Rajshahi, Bangladesh for his kind help and co-operation throughout the research.

The author specially expresses his sincere gratitude to Prof. Dr. Md. Aminul Islam, Head, Department of Dairy & Poultry Science, Faculty of Veterinary Medicine and Animal Science, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh for this generous help and cordial co-operation to make and publish paper at international level of the research findings.

The author expresses his cordial thanks to Dr. Jalal Uddin Sarder, Professor, Department of Animal Husbandry and Veterinary Science, University of Rajshahi, Bangladesh for his cordial inspirations, encouragement and valuable suggestions during the research work.

The author is also very much grateful to all honorable teachers and the employees of the Department of Animal Husbandry and Veterinary Science, University of Rajshahi, Bangladesh for their wholehearted co-operation during the study period.

The author is very much thankful to Dr. Md. Akhtarul Islam, Associate Professor, Department Animal Husbandry and Veterinary Science, University of Rajshahi, Bangladesh and Dr. M.H. Kawsar, Associate Professor, Department of Poultry Science, Patuakhali Science and Technology University, Dumki Patuakhali, Bangladesh for their encouragements and cordial co-operation.

The owners of broiler farmers under district of Rajshahi, Pabna and Kishoregoanj are also highly acknowledged for their generosity to allow the author to set and conduct the research works.

The author would like to acknowledge to DLS for using Animal Nutrition Laboratory to analyze of broiler meat. The author is also very much thankful to Dr. A.B.M. Khaleduzzaman, Upazila Livestock Officer, DLS, Dhaka for his encouragement and cordial co-operation.

Shaila Akter–my wife, Epshita and Pushpita the beloved daughters, always encouraged the author scarifying moments to get together and expectations.

The author is grateful to Md. Fajar Ali, Computer Operator for his sincere efforts to support in presenting data and composing the report.

The Author

ACRONYMS

- FCR- Food Conversion Ratio
- PFI- Problem Faces Index
- SPSS- Statically Packages for Social Science
- AI- Avian Influenza
- BCR- Benefit Cost Ratio
- BBS- Bangladesh Bureau of Statistics
- SME- Small- Medium Enterprise
- BRAC- Bangladesh Rural Advancement Committee
- PDTTP- Poultry Development Technology Transfer Project
- FAO- Food and Agricultural Organization
- DLS- Department of Livestock Services
- DLO- District Livestock Office
- WPSA- World's Poultry Science Association
- DANIDA- Danish International Development Assistance
- GDP- Gross Domestic Product
- DOC- Day Old Chick
- WHO- World Health Organization
- BDT- Bangladesh Taka
- NGO- Non- Government Organization
- FC- Feed Consumption
- FSES- Farming System and Environment Study
- CP- Crude Protein
- EE- Either Extracts
- ND- New Castle Disease
- CF- Crude Fiber
- UNO- United Nation Organization
- MBWT= Marketable body weight

Dedicated to my beloved

Father and Mother

ABSTRACT

The purpose of the study was to determine the productive performances & profitability and meat quality of broiler farming carried out with and without bio-security management interventions during winter and summer in different locations of Bangladesh. In the first step, a survey study was carried out to assess the broiler production performances reared in different locations; Pabna, Rajshahi and Kishorgonj having 30 broiler farmers in each. Data were collected from a total of 90 broiler farmers by direct interviewing using a semi-structured questionnaire during January 13 to June 2014. Socio-economic conditions of small & medium scale broiler farmers were considered, the factors influencing profitability were analyzed and constraints to broiler farming at rural households were identified. Data were edited and categorized as per farm sizes, such as 23% farmers of 500 broilers, 20% of 600, 16% of 700, 17% of 800, 14% of 900 and 11% farmers of 1000 broilers. The data were processed using mean, percentage and master tabulation sheet. Regression models were used to determine the relationship between some socio economic factors and broiler production performances considering net return. Broiler production performances were positively related with education, farm size, training, land size and age of the farmers and significant differences of education & farm size ($P<0.01$), training & land size ($P<0.05$) and age ($P<0.001$) were found. On the other hand, in case of farmer's annual income had no significant relationship with the broiler performance. In terms of production performance, feed conversion efficiency was improved trends with an increasing in the size of the farms and significant difference ($P<0.01$) was found among the farm sizes. The study also focuses on broiler production constraints and production systems for the improvement of broilers farming in Bangladesh. Lacking of quality chicks was the major constraint appeared to be a common complaint to the farmers. Fluctuating price of chicks & marketable live broiler, low price of finished broiler, risk of diseases including Avian Influenza (AI), bio-security of the farm and high feed cost ranked by turns second, third, fourth, fifth and sixth respectively. The present study revealed that the socio-economic status of the broiler farmers affect broiler production as well as profitability. In the second step, a survey study was undertaken to determine the productive and economic performances of broiler farming with or without bio-security management conditions during summer season reared in different locations; Pabna,

Rajshahi and Kishoregonj district of Bangladesh. Total 41farms were selected into three locations considering bio and non-biosecured managed farms of which 14 in Rajshahi, 14 in Pabna and 13 in Kishoregonj. Data were collected from a total of 41 broiler farms by using semi structured questionnaire. Categories of farm (bio-secured & non bio-secured) were identified by using measures of bio-security standard which were based on marks. As per bio-security standard of broiler farm, the farms those got above 60 marks treated as bio-secured farms and below 60 marks treated as non-bio-secured farms (out of 100 marks). Of the 41 farms, 27%, 21%, 15%, 15%, 12% and 10% farms have 500,600,700,800 900 and 1000 broilers respectively. During summer, a significant difference was found on marketable body weight and FCR among the farm sizes. FCR was better trend with increasing farm sizes. Overall FCR was improved in bio-secured managed farm than those of non bio-secured managed farm. Results indicated that farm category and farm size had clear impact on broiler productivity. The highest BCR was found in 1000 farm sizes (1.30) and the lowest was in 500 farm sizes (1.01). The lowest cost of broiler production was found when bio-security management was practiced. Therefore, significantly higher BCR value was found in bio-secured managed farms (1.17) than those of non bio-secured managed farms (1.03). In the third step, a total of 49 farms were selected into three locations of which 16 in Rajshahi, 16 in Pabna and 17 in Kishorgonj. Data were collected from a total 49 broiler farms by using same questionnaire in winter season with considering bio-secured and non-biosecured managed farms to determine the production and economic performances of broiler farming. Of the 49 farms, 20% farms had 500 broilers, 19% had 600, 16% had 700, 18% had 800, 14% had 900 and 13% farms had 1000 broilers. In case of productive performances, body weight and FCR showed better trend as the farm size increased and significant differences were found among the farm sizes. When farms of similar sizes were maintained with bio-secured conditions, overall, FCR tended to better than in non-biosecured managed farm. The highest BCR was found in largest farm (1.38) and very poor BCR was found in smallest farm (1.08). BCR was found higher trends as the farm size increased. Moreover, higher BCR value (1.25) was observed in bio-secured managed farm than those of non-biosecured managed farm (1.09). The cost return analyses indicated that broiler farms size may consider at least 700 birds to have profitability. Growth performances were found higher to winter in

comparison with summer. Profitability also was found to be higher in winter compared with summer season. Excessive colds, lack of knowledge on disease outbreak, poor management due to insufficient technical knowledge of the farmers, high temperature, frequent power failure in rural areas, improper marketing facilities, risk of diseases and lack of biosecurity of the farm were the major constraints of broiler farming in both seasons. In the fourth step, a study was undertaken to determine the quality of meat through proximate analysis of broiler farming carried out with and without bio-security management intervention in Rajshai, Pabna and Kishorgonj districts of Bangladesh. A total of 36 broiler meat samples were collected from broiler farmers with considering bio-secured & non bio-secured managed broiler farms during summer and winter between June, 13 to December'14 and having 12 meat samples in each location. No significant differences were found in moisture, crude protein, ash, crude fiber and either extracts in both seasons among the broiler farm locations. However, between of the two management intervention (bio and non-biosecured farm) during summer and winter seasons had a significant effect on proximate parameters. CP, moisture, Ash, EE and CF were found higher in bio-secured managed farm in comparison with non-biosecured managed farm in both seasons. Average proximate parameters of broiler meat samples in both seasons showed the following composition: moisture 76.09%, CP 20.07%, Ash 1.07%, CF 0 .033% and EE 1.05% respectively considering as fresh basis. Overall relatively better meat quality was found in bio-secured managed farms compared to non -biosecured managed farms. Moreover, between the two seasons, in terms of meat quality, CP, Ash and EE were found higher in winter season in comparison with summer season. It was concluded that satisfactory productive performances and improve meat quality is achievable and profitability may be enhanced from small and medium scale broiler farming at rural households of the farmers if bio-security management intervention is made. Finally, some suggestions and recommendations were made to ensure productivity and profitability of small and medium scale commercial broiler farming in Bangladesh.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

CHAPTER ONE
GENERAL INTRODUCTION

Bangladesh is agriculture based tropical country where over 80% of the country's 150 million people are living in rural areas and highly dependent on agriculture. Livestock contributes 6.5% to GDP on the basis of value added through their production of egg, milk, meat, hides and skins. The growth rate at 7.23% in GDP in 2004-05 for livestock was the highest of any sub sector comparing with 0.15% for arable crops and 3.65% for fisheries (Bangladesh Economic Review, 2006). Livestock contributed 3 percent to the total GDP and nearly 10 percent to the agricultural GDP (NLDP, 2007) which was 7.6 percent in 1973-74 and projected to increase to 19.9. The poultry sector happens to be one of the prime components of the total livestock population. Poultry constitutes 14 percent of the total value of livestock output (Raihan & Mahmud, 2005).

In Bangladesh, agriculture sector is blessed with its 35335 thousand hector crop lands having 176.9% cropping intensity (BBS, 2010) which is notable to feed over 140 million people with qualitative foods at the present time. Mixed farming is the main feature of Bangladesh agriculture with an average of 0.8 ha land, 1.6 cattle head, 1.0 goat-sheep and 5.3 poultry per household to sustain a 5.3-member family (BBS, 2012). With these very limited resources, it is very difficult to fulfil the basic needs of people. A large number of Bangladeshi people do not have the ability to have adequate nutritious foods and they suffer from malnutrition. About 40.4% of total people, live below poverty line (intake less than 2122 kcal per capita per day) of which the population below absolute poverty line (intake less than 1805 kcal per capita per day) is 19.5% (BBS, 2012). The small and landless farmers generally have an extremely low level of education, knowledge and health. They suffer chronic indebtedness, lack of institutional credit, inputs, inadequate extension supports and are unable to use services of other delivery systems. Due to low level of inputs requirement,

livestock especially poultry can therefore be raised by even poorest social strata of the rural population (Guèye, 2002). Although secondary to other agricultural activities, small-scale poultry farming constitute an important component of the agriculture and household economy of low-income food-deficit (LIFD) farm families and appear as effective means to supply good quality protein for fast growing human population as well as to provide additional employment and income (Barua and Yoshimura, 1997; Guèye, 2002; BLRI, 2005). Women, assisted with children, in some cases, play a vital role in the management and rearing of poultry, as they are the main owners and managers (Guèye and Bessei, 1996; Paul *et al.*, 1997*;* Khan, 1998; Guèye, 2000a, 2000b). It has been recognized as a profitable enterprise and income-generating activity for the rural poor, particularly for women and unemployed youths. Poultry raising has emerged as an integral part of agribusiness in the farming community of Bangladesh (Latif, 2007). In addition to extra household income, family labour is also an important concern for this type of enterprise. Small and medium scale poultry farming, as a sub-sector of agriculture, plays an important role in improving rural livelihood, food security as well as poverty decline in rural and semi-urban communities in the country. The present poultry production system in Bangladesh can broadly be divided into several categories like traditional rural backyard scavenging system, semi-scavenging system, commercial broiler and layer farming. Sonaiya (1990) reported that most of the poultry in developing countries are kept in small rural farms. But, shortage of natural feed, high disease incidence and shortage of vaccines are the main constraints to rural poultry production (Barua and Youshimura, 1997) that reduce the number of indigenous poultry day by day. Hossain (1999) estimated that farm-produced chickens (broilers, spent hens and cockerels) constitutes about 55% of the total chickens marketed in Dhaka city, which indicated the diminishing scenario of native poultry stocks in Bangladesh. Small and medium scale broiler farming has been introduced at village level and semi urban level, in

such a situation, to meet the demand of poultry meat as well as to earn cash income and employment generation.

1.1 Background of development of poultry industry

Improved variety of laying hen (white Leghorn) was first improved from western countries in India in 1935. In 1947 six poultry farms were established in different locations for supplying eggs and chicks to the villagers. Since then several small farms were established under village AID program for rural development. In 1950, the former Pakistan International Airlines (PIA) established a poultry farm. In 1962-63, the Department of Livestock Services (DLS) established 91 poultry units in 91 districts with an intention of supplying of improved birds to farmers. In 1964, a farm in private sector named "Eggs and Hens Limited" was established by the late Ekramul Hossain at Gazipur. Bangladesh Agricultural University, Mymensingh brought Day Old Chicks (DOCs) of broiler from Pakistan International Airlines (PIA). Bangladesh Biman started a poultry farm which is known as "Biman Poultry Complex Limited" at savar to meet the fight catering needs of Biman Bangladesh Airlines. This farm supplied DOC to private farms to a certain extent. DLS launched a program of distributing DOC to villagers and farm owners through its central regional farms during late 1980s.

In response to increase demand for animal products and expanding market opportunity in the early 1990s, commercial broiler and layer sector have emerged in Bangladesh. Jabbar *et al.* (2007) reported this sector is characterized by intensive production techniques (exotic and crossbred birds, concentrate feeds and drugs) and technical and policy support (subsidized loan, local production and import of day-old-chicks etc.) The total poultry population of Bangladesh increased from 91 million in 1990 to 123 million in 1995 and 153 million in 2007 and this increase was almost in commercial poultry sector. In 1998, poultry population dropped sharply to 138 million due to severe flood

then stabilized at 140 million in 2006 (http:/faostat.fao.org/site/573/desktop Default.aspx). Most commercial poultry farms in the country are small and medium scale (less than 5000 birds per batch). In 1995, large and small scale commercial poultry farms accounted for 12% and 2% of the total poultry meat production in the country with the scavenging system accounting for the rest (Alam, 1995).

1.2 Global meat production of poultry farming

Poultry meat has been growing faster than that of any other meat in both developed and developing countries. This growth pattern can be expected to continue because of the inherent efficiency in feed conversion and the lower production costs associated with intensive poultry production. Such production efficiency is particularly beneficial to developing countries, which tend to have limited agricultural resources but burgeoning, and often poor populations. Declining poultry prices and increasing incomes have been attributed to increases in per capita poultry consumption, which is sensitive to both price and income changes (Taha, 2003). The significant growth in poultry (especially broiler chicken) production and consumption in the developing countries has important implications for the global trading of all meat products, as well as feeds and related inputs (Landes *et al.*, 2004; Taha 2003).

In spite of its many advantages and the positive market outlook, the world broiler sector faces increasing challenges (Shane, 2003). One of these is the increasing consumer concerns over food safety, animal welfare, product quality, and environmental issues associated with industrialized poultry production systems. In addition, there is global competition, intensified by increasing trade liberalization and growing consumer choices. The increasing global competition is of particular concern for many small broiler producers in the developing countries, such as the Philippines, because their production and marketing systems are not yet developed or not as efficient.

Broiler production in Bangladesh is not satisfactory than other Asian countries from 2000-2011. It is also too much lower most of than other countries like Japan, China, Thailand, Philippine, Pakistan, Korea etc.

Table 1. Meat production statuses in selective Asian countries (1000x metric ton)

Name of the Country	Production years							
	2000	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Bangladesh	94.0	130.0	138.0	147.0	150.0	156.3	163.0	170.0
India	1,080	1,900	2,000	2,240	2,490	2,550	2,650	2,700
Myanmar	216.9	560.7	649.6	726.5	797.5	800.0	802.2	805.0
Nepal	12.7	15.5	15.6	16.1	16.6	16.7	17.0	17.0
Pakistan	327.0	384.0	521.0	564.3	575.1	517.7	539.7	563.7
Sri Lanka	63.2	97.3	78.8	100.1	102.5	99.3	102.0	105.0

E estimated, F forecast Sources: FAO, USDA5M estimates

The per capita broiler meat consumption is much lower (1.9 kilogram) compare to other Asian countries. The meat consumption in Pakistan is 3.9 kg, the Philippines 6.8 kg, China 5.4 kg, Thiland 14 kg, Malaysia 33.3 kg, Hong Kong 57.5 kg and Japan 13.8 kg (Saleque, 2009). The availability of meat is much lower than is needed in Bangladesh. So the broiler can provide such deficit in shortest possible time than any other animal sources.

1.3 Present poultry farming at a glance in Bangladesh

The poultry industry in Bangladesh has multi-dimensional prospects. Before reviewing the opportunities and challenges, it is necessary to look at the commercial poultry sector in Bangladesh. The total investment in poultry sector has been estimated to be 15,000 crores with an annual turnover of BDT 20,000 to 25,000 thousands crores (National Poultry Development Policy

2008). About 6 million people are employed in this sector (Raihan & Mahmud, 2005). About forty seven feed mills are producing concentrated feeds for the birds (DLS, 2007). Table 2 shows that the number of commercial poultry farms in the country has been reduced to approximately 75000 in March 2011 from 114000 in June 2010. A declining trend in both chicken and egg production was also observed during this period. It is believed that the outbreak of avian influenza (AI) in 2011 caused closed down of at least 30% of the farms. Loses to the industry in the same year have been estimated to be US$ 27 million by the local branch of World's Poultry Science Association. It appears that AI has become a constraint to the Bangladesh Poultry Industry affecting the production of quality food with consequent threat to food and nutrition.

1.4 Rural poultry and its importance in Bangladesh

Small scale poultry production has developed in a large number of developing countries around the world as an important source of earning for the rural poor people. In the last few years, the recognition of small scale commercial poultry production helps to expedite of poverty reduction riding in new height in Bangladesh. The poultry industry has been successfully becoming a leading industry of the country. The current farming structure of poultry in the country can be generally separated as mentioned below: Conventional countryside backyard or scavenging /semi-scavenging system while another system is business related farming system. Conventional poultry production is an essential part of rural farm household activities; few birds are reared with little or no complement to generate eggs and meat for home consumption and any excess is selling that is known family poultry. Business related poultry farms are definite for raising birds in restricted environment support on high yielding breed, for profit and business exercise that is called commercial poultry farming. Family poultry was traditionally clarified as "small flocks managed by individual farm families in order to obtain food security, income and gainful employment generation for women and children" (Sonaiya, 1990c). Family

poultry is quite distinct from medium to large scale commercial poultry farming.

The small and medium scale commercial poultry farming is gradually increasing during the last decades and playing an important role in uplifting socio-economic status of the farmers. Farmers are gradually showing increasing interest in establishing small-scale poultry farms than that in cereal production. Poultry rearing is now culturally accepted, technically and economically viable. Rural poultry provides employment opportunity especially for women and youth unemployment. Poultry is the only activity open for a large number of landless women to participate. About 70 percent of the rural landless women are directly or indirectly involved in poultry rearing and may be an important tool of poverty alleviation. The important feature of poultry production is regular income, quick return (especially in case of broiler) the superior and economic converter of feed among the farm animals, provide essential nutrients through increased intake of egg and meat, low capital and space required, easy management, less labour required and supply poultry manure for use in the crop husbandry. The growth in the commercial egg has been rather slower than that of broilers possibly for higher household income in a short period. Once the small-scale commercial broiler farms are established in rural areas, there will be several ways to upgrade the rural living standards. It can be established in small marginal lands and therefore, is getting popular in rural areas. It is needed to focus on small-scale commercial broiler farming and also important to provide necessary support to maintain the development of the rural broiler sector.

1.5 Poultry farming system in Bangladesh

The present farming system can be broadly divided into two categories:

i) Traditional rural backyard system and

ii) Commercial farming system

Also there are two types of commercial poultry farms:

a) Independent farms and

b) Few contract farms

Traditional poultry production is an essential part of rural farm household activities; a few poultry are reared with little or no feed supplement to produce eggs and meat for home consumption and any surplus is sold. Commercial poultry farms are defined as those that raise poultry in confined using high yielding breeds, commercial feeds and improved management (Ali, 1993). In response to rapidly increasing demand for animal protein and expanding market opportunity in the early 1990s, commercial broiler and layer farming has emerged in Bangladesh.

ABFL (*Aftab Bahumukhi* (Multipurpose) Farm Limited first introduced credit contract farming, with an intension to add a new potential chapter for broiler farming in Bangladesh in 1994. BRAC also attempted to start credit contract farming in 2001. This system failed its growing momentum for some unwanted events. Breach of contract by some farmers appeared to be the principal reason for failure of contract. Initially, contract broiler farming was profitable and potential venture in income generation (Begum, 2005 & 2006 and Jabbar *et al.*, 2007). Integrators changed their contract agreements from credit to cash with farmers considering that the arisen situation might be overcome and regain its past flow. But unfortunately, the performance is still rather unsatisfactory. As a result, contract farming system is still under trail with some unsolved issues to be resolved. Contract broiler farming of ABFL did not spread out in other areas and BRAC only in some limited areas. Independent farming system is therefore, play a dominating role in Bangladesh and independent broiler farming has been exclusively performed for the development of broiler sector. Indeed, the commercial broiler farming system started in 1980 but until now there is a big gap between demand (43.25 kg per person per year) and supply

(9.12 kg per person per year) of meat (Saleque, 2007). Small-scale broiler farming could be one possible solution in this deficiency situation. Moreover, small-scale broiler farming needed low investment and any one can perform it side by side as a secondary occupation with other main occupation. This type of farming mainly made in adjacent to house and the family member including woman, children etc. can easily provide their valuable labor for performing better production. So, this type of farming easily creates extra benefit to family. Thus, the researcher hypothesized that small-scale independent broiler faming had a great potentiality in rural areas.

1.6 Prospect of commercial poultry farming in Bangladesh

Begum (2008) stated that growth rate in poultry sector increased significantly during 1980-1990 (6%) and 1990 to 2000 (8%). Dolberg (2008) reported that 66% of all poultry meat consumption came from commercial broiler sector. In spite of this fact, production is not sufficient to meet the domestic requirement. The outbreak of AI in 2007 and 2011 has further aggravated the situation. Referring to FAO statistics, Ali and Hossain (2012) pointed out that the per capita consumption of all meat is 14.67 kg and that of egg is 31 number as against the requirements of 56kg and 365 eggs respectively. The per capita poultry meat is approximately one-fifth of the consumed meat (3kg) which needs to be increased more than doubled to satisfy the current demand of 7.67kg (Begum *et al*., 2010) while that of egg more than three times to meet the per capita minimum requirement of 102 eggs. All these statistics revealed that there exist tremendous opportunities to increase production and therefore commercial poultry sector should be flourished.

Table 2. Poultry sector at a glance (farms and production figures) in Bangladesh

Parameter	June 2010	December 2010	March 2011
No. of commercial poultry farms	1,14,000	98,000	75000
Chicken production, million kg/day	1.95	1.70	1.60
Egg production, million/day	27.50	26.0	23.50
No. of GP farms			6
No. of PS farms			89-90
No. feed mills			60-65 (15-20 major producers)
Broiler DOC production, No/week			81,66,000
Layer DOC production, No/week			8,19,000

Source: National Committee for the protection of Poultry Industry, 2011

1.7 Present scenario of broiler production status in Bangladesh

Commercial poultry farm, Eggs and Hens Ltd. was recognized as a mother poultry industry in the private poultry sector. After the liberation of Bangladesh, BIMAN Bangladesh Airlines, started a commercial poultry farm in the name of Biman Poultry Complex at Gonakbari, Savar, to meet up the demand of flying services with introduce or transferring the commercial poultry farming technology to the farmers. The scale and quality of investment of different private sector companies and NGO's completely revolutionized prevailing ideas of poultry farming in Bangladesh. In the early 90's a number of private Parent Stock Poultry Farms started their operation to produce commercial broiler and layer chicks. Since 1995, a significant annual growth rate of 15-20% in commercial poultry has been achieved until 2007 and slow downed after due to the Avian Influenza (AI) outbreak. The government is getting interested in this sector and is encouraging both urban and rural people

to work here and enhance capacity. People in rural areas are getting attracted to this sector and taking it up as a business. Six Grand Parent Stock Farms have already been established in Bangladesh and supplies about 80 % of the total demand of Parent Stock; the rest 20% is imported (Saleque, 2010). Presently 82 Parent Stock farms are in operation in Bangladesh and producing 50-60 Lac Day Old broiler and 5 Lac Day Old Layer Chicks per week, it was about 90-95 Lac in October 2011 (estimated by Breeder's association).The number of farms increased by more than 26 times in 2001-02 compared to 1994-95 (Raha, 2005). At present 1, 10,000 commercial farms of variable size have been established throughout the country. About sixty three feed mills are producing concentrated feed for the birds.

Most commercial farms (About 50%, BRAC, 2005) in Bangladesh are quite small and their owners do not have the requisites fund to embrace modern technology. However, of late a few large breeder farms emerged through a system of contract and vertical integration i.e. Feed mill+ Broiler Grand Parents + Broiler Parents (Kazi, Paragon and Kasila); Feed mill+ Broiler Parents + Contract growing+ Processing (Aftab and BRAC) and Feed mill+ Broiler Parents + Contract growing (Lion Agro and Renata Agro). This type of integration enables such farms owners in adopting modern management practices (Kabir, 2005). The growth of contract farming has been very slow, and sometimes is not very satisfactory. The contact system of broiler farming has a resolved issue and still under trial. The independent farming is therefore, dominant and performed for the development of broiler sector as an important profitable venture. In urban areas, most of the independent farms are large and used hired labour. However in rural areas, most of the farms rearing small number of broilers using family labour and utilizing own backyard or fellow land to maximize farm income considered as family poultry producer or small scale farmers.

The growth of the poultry sector is positive and impressive. Now this sector is an integral part of the farming system in Bangladesh and it has created direct or indirect employment opportunity including support services for about 6 million people (Raihan & Mahmud, 2005). Development of poultry has generated considerable employment through the production and the marketing of poultry and poultry related products in Bangladesh. Its steady growth results in attaining country's economic growth, which contribute in i) rural poverty reduction ii) new employment generation iii) improve food security and supply of protein in people meals.

1.8 Socio-economic importance of broiler production

The importance of broiler production in the context of socio-economy of any developing nations cannot be overlooked. Some reports on rural areas of Bangladesh stated that the overall socio-economy of the beneficiaries, consumption capability and employment were significantly increased after the intervention of broiler farming (Rahman *et al*., 2006; Alam, 1997). Oluyemi and Roberts (1979) claimed that broiler production in warm climate countries has a priority in comparison with other livestock because broilers are superior energy and protein converter and also that net return on investment are relatively higher. The economic importance of broiler is very significant particularly for the small farmers and rural people. In fact, broiler has a shorter life cycle, a number of batches raised within a year and its production requires relatively less capital and land in comparison with other meat-producing animals such as cattle, sheep and goats. So, broiler farming provides more cash income within a shorter period. Broiler can contribute towards the increase meat production perhaps efficiently and now more economically than of indigenous chicken. With a view to popularize broiler farming on commercial basis and to meet the increasing demand for meat, a good number of educated unemployed youth and rural peoples have already came forward to initiate

broiler production. As a result, socio-economy and the employment are improving gradually for the rural people.

Broiler farming unlike crops is not seasonal, produced in the country throughout the year, and plays a vital role in the rural economy. Income from sale proceeds helps them to satisfy their various economic needs and to fulfill their day-to-day consumption. Broiler meat has delicious along with demand as compared to other meat (Jabbar and Green, 1983). Children and young people of urban consumers became familiar in taking broiler meat compared to few years back. As a result, chicken meat production is increasing tremendously. Poultry meat production has had the largest expansion among other meat producing species. The scarcity of fish as well as the rapidly increasing price of beef and mutton for less availability also helped the promotion of broiler rearing. People are now also more health conscious. They prefer poultry meat compared to beef or mutton because of low cholesterol and low fat contents. Broiler manure has high fertilizer value and can be used for increasing the yield of any crop (Bhende, 2006). Therefore, poultry excreta have become a considerable source of income to the poultry farmers (Abdullah Amin *et al.*, 2009).

Several studies revealed that rearing of broiler is a profitable venture for the farmers (Alam, 1997; Jabbar *et al.*, 2007; Begum, 2005&2006 and Ershad *et al.*, 2004). The people are suffering from a shortage of meat for a wide gap between the availability and requirement. However, the production of broiler has to be increased manifold to meet the increasing demand of consumers. Social scientists, planners and NGOs do not have adequately knowledge on socio-economic information on small-scale broiler production in rural areas. Whatever studies are available on the poorest farmers and their families in villages with limited financial services and support by government, NGOs and donor agencies to establish and maintain small farms. The government and NGOs are mainly concerned in alleviating poverty of poor farmers through

small number of birds. Virtually, no attempt has been made in the country to study the economics of the production of self-financed independent small-scale broiler farms in rural areas. It was observed that the level of profitability of small-scale broiler farming was positively correlated with the farm size (Alam *et al*., 1998; Jabbar *et al.*, 2005; Kumar and Mahalati 1998; Mishra *et al.*, 1988 and Moorti *et al*., 1990) found that large farms exhibited economics of scale in the broiler farming and the profit considerably is increased with the increase in the size of farms. Although, large farm size is more profitable than that of smaller farms, farmers may not be interested to expand their farm size beyond their income target. Unfortunately, no attempt has been made to study about the farmers' economic behavior in respect to expansion of their farm size.

In the light of the above discussion, farmers' economic achievement through small-scale independent broiler farming in rural Bangladesh and their attitudinal and behavioral pattern with expansion of farm size based on household income are necessary to be identified, explore and quantified.

1.9 Importance of bio-security measurement in broiler farming in Bangladesh

Presently poultry production system in Bangladesh is broadly categorized into three –(a) Traditional rural backyard scavenging system, (b) Semi-scavenging system and (c) Commercial farming system (Small, Medium and large) (Saleque, 2009). The farms maintain different levels of bio-security, which is more or less similar as classified by FAO. In the classification, sector I is industrial large scale GPs, PS, Commercial farms; sector 2 consists of GPs, PS, commercial farms; sector 3 is commercial (small scale); and sector 4 family poultry /scavenging/village/indigenous/rural backyard. It is reported that sector 1 and 2 is sufficiently bio-secured. We need to focus on sector 3 which is almost 100 times the sum total of sector 1 and 2 by number of birds. Sector 3 is conscious and aware but needs to be more focused on all aspects of

implementation. But sector 4 is unaware and it is long way to make them educated. The government and private sector and NGO's involvement is necessary.

Besides, live broiler market is a major concern which is mostly located in large urban and pre-urban region in Bangladesh. Some live bird markets are located in the residential area, on the sidewalks of roads, Poultry sellers or traders buy both local and commercial hybrid (broiler, culled layer) and also eggs directly from poultry farms, collection centres, dealers or the whole sealer markets in rural areas. Customers usually buy eggs and live poultry either local or commercial birds of chicken, ducks and pigeons to take them home or process them in the market in traditional system (Ghosh *et al.*, 2009). Current bio-security is generally very poor in the live bird market; eventually in some areas they are not aware about the bio-security and safety of meat, eggs and themselves. Thus entire poultry production and marketing system requires policy intervention, public private partnership, practice and promotion of bio-security. Bio-security represents a series of management practices and procedures to reduce or prevent the entrance and spread of microbes in any stage of rearing, transportation, processing and marketing of poultry. It deals with the breaking down of the chain of contamination through the elimination or reduction of susceptible host, infectious agent, reservoir of pest and insects; providing quality feed and water, and the limitation of the entrance of people and unnecessary equipment. In simple term, bio-security means "don't bring germs to poultry, and don't bring poultry to germs" (Nelson and Tablante 2004). There are several factors that may influence the type of bio-security measures adopted by broiler and layer smallholder poultry farmers in Bangladesh. These include:

a. Potential loss of production and income;

b. Characteristics of farmers e.g. experience as a poultry farmer, experience with poultry disease including HPAI, farmer age and education and understanding of bio-security and the potential benefits, attitude to risk;
c. Characteristics of farms e.g. number of farms, size and capacity of shed and farm location;
d. Management and marketing systems;
e. Resource, information and capital availability;
f. The importance of poultry as an income source; and
g. The type of farm specifically broiler or layer

In order to provide a recommendation for improving farm biosecurity, more information is required on current bio-security implementation at farm level, and a better understanding of the factors that influence the adoption of bio-security measures.

1.10 Outbreak of diseases in broiler farming of Bangladesh

Poultry farming in Bangladesh is now considered as a growing Industry. But one of the major constraints in the development of poultry industry in Bangladesh is the outbreak of diseases, which cause about 30% mortality of chickens (Ali, 1996). Occurrence of disease is most common in broiler farms. Newcastle Disease, Fowl Cholera, Salmonellosis, Colibacillosis etc. are common to broiler farms (Sarker, 2012). Generally, the farmers take advice of feed/DOC suppliers, medical representative or quacks for the treatment of their birds. At the eleventh hour, they come to a qualified doctor.

Avian Influenza (AI), commonly known as bird flu, one of the most serious health threats today (WHO, 2005) is an infectious disease of birds caused by influenza virus type A (Ergin, 2006). It has imposed serious threat for the growing poultry industry of Bangladesh with a risk of affecting humans. Domestic poultry are highly vulnerable. In its highly pathogenic form, the disease is extremely contagious and mortality in poultry can approach 100%.

The disease is an agricultural disaster that can wreck local economies. Avian influenza a virus subtype H5N1 has caused many human fatalities and continues to pose an increasing pandemic threat (WHO, 2005).

The farmers are little aware of bio-security and therefore doing little for it. Consequently, mortality due to outbreak of disease is quite common which causes economic losses to the farmers. Although nutritional deficiency diseases seldom occurs in commercial flocks, toxicity resulting from poor quality feed and problems associated with faulty management are still threat for the broilers farm.

1.11 Food value of broiler meat

The poultry sub-sector is crucially important in the context of Agricultural growth and improvements of diets of people in Bangladesh. There are 43.2 percent (urban) and 39.5 percent (rural) population live below the poverty line (BBS, 2011) and suffer from serious malnutrition problem. Protein deficiency has been taken as the major contributory factor in malnutrition. The per capita consumption of animal protein in Bangladesh is only 11.8 gm per day (BBS, 2011) whereas the standard requirement of 36 gm is recommended by UNO (Ahmed and Islam 1985). The poultry sub-sector can contribute in combating this problem where about 37 percent (Bhuyian, 1999) of the total animal protein supplied in the country comes from poultry meat.

Broiler meat is the most desirable source of animal protein and highly accepted by most of the people of Bangladesh irrespective caste and religion. It can efficiently and rapidly fill in the shortage of body requirement. Broiler meat is low in calories in relation to other nutrient priest and thus it is essential for those people who like to control body weight.

Again poor people who rear poultry tend to consume a greater quantity of poultry products than do those without poultry. Thus, it is possible to increase

the consumption of animal protein by improving the husbandry of poultry kept by the poor people of Bangladesh (Table 3).

Table 3. Comparative food value of broiler and other poultry species

Poultry species	Energy (k.cal)	Protein (gm)	Fat (gm)	Mineral (gm)	Riboflavin (microgram)	Niacin (mg)	Moisture (%)
Chicken Broiler)	151	23.30	7.20	3.90	160	16.20	65.90
Chicken (Layer)	104	20.20	0.50	3.80	90	10.50	65.40
Duck	326	16.00	28.60	4.10	240	5.60	64.00
Quail	168	-	-	4.70	-		-
Pigeon	279	18.60	22.10	3.80	240	5.60	-
Turkey	268	20.1	20.2	3.90	141	8.00	-

Source: Rahman (2004)

1.12 Preferences of broiler meat

Broiler meat has a great demand as compared to other meat, because of the spiritual beliefs as well as religious constraints in the case of pork and beef (Jabbar and Green 1983). Most of the people of Bangladesh are non-vegetarian. So, broiler meat is very attractive. Young segments of urban consumers became habituated in taking broiler meat. Besides, broiler meat is widely using in different restaurants as well as weeding party in Bangladesh. On the other hand, people are not able to buy indigenous chicken meat, because market price of indigenous chicken is 2-3 times more than that of broiler chicken (Islam *et al.*, 2011; Ahmed *et al*., 2012). As a result, chicken meat production is increasing massively compared to different species of meat production. Moreover, due to low cholesterol and fat contents to poultry meat comparted to beef or mutton, people prefer the poultry meat commonly. Especially people who are more health aware.

1.13 Constraints of the small and medium scale broiler production

Commercial poultry farming system in Bangladesh faces many constraints such as inadequate technical knowledge of farmers, inadequate availability and high price of inputs (feed, day-old chicks, vaccines and medicines), interruption in electricity supply, improper marketing facilities, lack of capital, lack of bio-security measures, heat stress, excessive cold, inadequate institutional credit, lack of training and lack of extension services (Uddin, 1999; Begum and Alam, 2009; Das *et al.*, 2008). In another study, Miah (1990) reported that the small and medium poultry farms are profitable but acute shortage of medicine and vaccine, lack of technical knowledge together with resource content were observed as the major constraints of those poultry farms. Mohsin *et al.* (2008) found that cost of production in small farms was higher than that of medium and large categorized farms due to lack of efficient extension services in Rawalpindi district of Pakistan. Muhammad *et al.* (2010) studied the early chick mortality of small-scale poultry farms in Central Nigeria and suggested that farmers need to be aware of production and availability of quality chicks and quality feeds and also excessive use of antibiotics can lead to drug resistance in human through the production of drug resistance bacteria.

1.14 Justification of the study

Broiler production is showing increasing trend day by day. Entrepreneurs are adopting this enterprise due to its being highly remunerative and profitable. For poverty alleviation, nutritional nourishment, gender empowerment and employment creation government is promoting the development of poultry especially in broiler sector.

A thorough study into the production and marketing will be useful to the rearers so that they can look forward for necessary changes in the production patterns and marketing practices of the broilers, which are still reared on traditional methods. The results of the study may also help government

agencies, policymakers, credit institutions, co-operative societies, marketing agencies, traders and other private agencies etc. to take measures regarding the production, trade and marketing practices of broilers. It will also help further research pertaining to poultry industry. Also, the work shall be of academic utility and may show some guidelines for the extension workers of the study area.

In this context, sporadic works have been done limiting mostly to survey works. Therefore, it seemed worthwhile to determine minimum flock size of small and medium size broilers farming for profitability production through an analysis of growth performance and cost benefit ratios covering different seasons of the year. It was also important to determine the meat quality through proximate analysis between bio & non bio-secured broiler farming. The ultimate goal is to make sustainable production for the small and medium size broiler farmers.

1.15 Based on the above discussion, the present study was considered to address the following objectives:

i) To assess the socio - economic profile of the small & medium scale broiler farming;
ii) To evaluate the productive performance, costs and returns and effects of bio-security management intervention on small and medium scale broiler farming in different seasons;
iii) To determine the minimum farm size for profitability broiler production;
iv) To identify the constraints of small and medium scale broiler farming;
v) To determine the broiler meat quality through proximate analysis reared under bio-secured & non-biosecured management conditions in different locations.

CHAPTER TWO
REVIEW OF LITERATURE

2.1 Poultry farming in Bangladesh

Raha (2013) reported that poultry industry in Bangladesh: ample opportunities for improvement. Based on report, in Bangladesh indigenous poultry rearing is a very common activity from the time immemorial to the villagers. The birds are reared with low inputs but yield quick return in terms of egg and meat. The indigenous chicken is a source of income for the rural women and provides animal protein to both rural and urban people. The prospect of poultry production in the country is discussed in terms of requirement of meat and egg. Lack of consistency between prices of inputs and outputs of poultry farming are very common and evident in the country.

Chowdhury (2011) reported that commercial poultry farming in Bangladesh: the rolling tears of farmers and its consequences. Within report, focusing on the current scenario of commercial poultry sector of Bangladesh, the paper found farmers, the key elements of production, as the worst suffers resulting from price instability of chicks and feeds and threats from diseases in particular. The farmers who are weeping all the time believe that their interest is mostly ignored by all quarters: the government, hatchery owners, feed millers, pharmaceutical companies and middlemen involved in the marketing channel of inputs and outputs. A few breeder farms and hatchery owners already stared commercial broiler and egg production, and few others are thinking so far in the future.

Chand *et al.* (2009) a baseline surveys conducted on poultry sector and results indicated that the total number of small (up to 3000 flock size) and medium (3001to 20000 flock size) commercial farms across the country is about

110,000. Although such farms were previously concentrated in and around Dhaka and Gazipur districts these are now spread all over the country.

Akter and Uddin (2009) argue that as an important sub sector of livestock production, the poultry industry in Bangladesh plays a vital role in economic growth and simultaneously creates numerous employment opportunities. The poultry industry as a fundamental part of animal production, is committed to supply the nation which a cheap source of good quality nutritious animal protein in terms of meat and eggs.

Islam and Nabul (2003) comment that the poultry subsector is crucially important in the context of agricultural growth and improvement of diet of people in Bangladesh. The sub-sector is particularly important in that it is a significant source for the supply of protein and nutrition in a household's nutritional intake. It is an attractive economic activity as well, especially to women poor population.

Banerjee (2004) observes that in comparison to other livestock, poultry requires less investment to start the farming. Persons from low income group may also start the business on a small scale. Poultry farming offer opportunities for fulfillment / part-time employment particularly- women, children or elderly person on the farm operation.

2.2 Current scenario of broiler production in Bangladesh

Ansarey (2012) reported that prospects of poultry industry in Bangladesh. The poultry is an integral part of the farming system in Bangladesh and it has created direct, indirect employment opportunity including support services for about 6 million people. Development of poultry has generated considerable employment through the production and the marketing of poultry and poultry related products in Bangladesh. Its steady growth results in attaining country's economic growth, which contribute in (i) rural poverty reduction (ii) new employment generation and (iii) improve food security and supply of protein in

people meals. In the early 90s, a number of private parent stock poultry farms started their operations to produce commercial broiler and layer Day Old Chicks (DOC). Since 1995, a significant annual average growth rate of 15-20% in commercial poultry has been achieved until 2007 and slow downed after due to Avian Influenza (AI) outbreak.

Saleque *et al.* (2009) reported that the per capita of broiler meat consumption is much lower (1.9 kilogram) in comparison with other Asian countries. The meat consumption in Pakistan is 3.9 kg, Indonesia 3.8 kg, the phillipines 6.8 kg, China 5.4 Kg, Thailand14 Kg, Malaysia 33.3 kg, Hong Kong 57.7 kg and Japan 13.8 kg.

Saleque *et al.* (2010) mentioned that the availability of meat and egg is much lower than is needed in Bangladesh. So, there is a deficit condition to be met up. Per person per year demand and supply of meat and eggs as below:

Table 4. **Per person per year demand and supply of meat and eggs**

Product	**Requirement**	**Availability**	**Deficit**	**Deficit%**
All meat (Kg)	43.25	9.12	34.13	78.91
Egg (Nos.)	104	36	68	65.38

Islam *et al.* (2010) found that in Bangladesh, there are two types of broiler farming of which contract broiler farming is still under trial while independent small-scale broiler farming is dominant and performed for the development of broiler sector. The present study examined the potentials of small-scale independent broiler farms and farmers' economic behavior in relation to farm size. Farm size is found to be closely related to farmers' behavior and attitude. Farmers' behavior and attitude appeared to be very crucial factor for the development of broiler production. The results showed that independent small-scale broiler farming is a profitable venture for rural farmers. Farmers are involving in this sector because of lower investment, less space requirement, utilization of family labor and quick returns.

2.3 Economic and production performance of broiler farming

Shaikh *et al.* (2005) conducted a survey to know the Production Performance and Economic Appraisal of BroilerFarms in Anand District of Gujarat. The production performance of different sizes of broiler farms has been studied by collecting data from 60 broiler producers of Anand district during 2005. To examine production performance, the average feed conversion ratio, livability percentage, average body weight and age at marketing have been worked out. Though broiler production is capital-intensive, it has been found profitable. The average cost of production per broiler has been found to be ` 64 and per kilogram live weight of broiler as ` 32. The variable cost and fixed cost constitute 84.5 per cent and 15.5 per cent of total cost, respectively. The major cost components have been found as feed cost (58.6%), chick cost (21.5%) and depreciation on buildings (10.7%). The net profit per broiler as well as per kilogram body weight has been found as ` 7.20 and ` 3.59, respectively for the sample as a whole. The benefit-cost ratio has worked out to be 1.11 for the sample as a whole and it increases with increase in farm-size, indicating that as farm-size increases, the net margin over the rupee invested on broilers also increases.

Kawsar *et al.* (2013a) conducted a survey to know about the impact of scientific intervention on productive performance and profitability of small scale broiler farming at rural households. Productive performance indicated no significant difference among flock sizes with respect to body weight, feed consumption and survivability but FCR improved as the flock size increased. When farms having similar flock sizes were maintained at the rural households with scientific intervention, overall FCR was improved than those of without intervention. Analysis of cost and returns showed that cost of farming per bird decreases and return increases as the flock size increases. It was, therefore, concluded that satisfactory productive performance is achievable and

profitability may be improved from small scale broiler farming at rural households of the farmers if scientific intervention is made.

Gopalkrishnan and mohanlal (2007) found that feed costs represents 65 to 75 percent of the total cost of commercial policy production, depending mainly in the relative costs of food constituents, labour, housing, miscellaneous items of costs in a particular situation. Therefore it becomes imperative that economic as well as nutritionally balanced diets are provided during all phases productive life.

Sultana *et al.* (2012) conducted a research on Small scale broiler farming at Santhia upazilla of Pabna District of Bangladesh. In this study out of 50 respondents 60% were engaged in agriculture, 36% businessman and 4% were in services. About 48% respondents had small size farms (100-500 birds), 40% had medium (501-1000 birds) and remaining were large size (1001-2000 birds). Most of the respondents reared Cobb-500 strain, those were purchased from Kazi Farms Ltd. Out of 50 respondents 30% took necessary suggestions from the experienced farmers, 90% farmers regularly vaccinated their broilers and 70% farmers taken short training on broiler farming. About 78% respondents considered market weight as 1.5 kg per bird, whereas the rest 22% sold broiler weighing about 1.8 kg per bird. Most of the respondents (64%) sold broiler at 30-33 d of age and about 80% respondents marketing their broiler at 110-115 taka per kg live bird. About 36% respondents had production cost approximately 90-95 taka per kg bird.

Ike *et al.* (2011) conducted a survey to know the Profitability of Small Scale Broiler Production in Onitsha North Local Government Area of Anambra State, Nigeria. Findings indicated that most of the respondents (70%) were males and same were aged between 36-55 years while most of the farmers have long years of experience in broiler production. Regression estimates indicated that six variables including experience in broiler production, farming status,

access to credit, labour, number of Day-old chicks and quantity of feeds exerted statistically significant influence on broiler production with an R2 of 0.79 and an F-ratio of 39.1.

Patil (1985) studied by means of benefit cost ratio that broiler production can be a profitable enterprise in India. Since feed is the major cost item, profitability can be improved by proper feeding management, well balanced diet should be prepared by cheaper and easily available ingredients. It was concluded in the study that feed accounted for nearly 65 per cent in the total cost.

Kalla *et al.* (2000) conducted a research for evaluate economic analysis of broiler production at Miango Plateau State, Nigeria. This paper evaluate the economics of broiler production at Miango, Plateau State, Nigeria using a – 9 years record (1992 – 2000). During the period, 76 batches of broilers were reared to point of slaughter. The results shows that the enterprise incurred an average total variable cost of N620,6333.31 out of which feeding cost, day old chicks (stock) and mortality cost represents 58.13%, 19.13% and of 9.64% of the total cost of production, respectively. Total revenue within the period was estimated to be N763,969.44 which was mainly generated from the sales of broiler birds. The gross margin was found to be N143,334.13 with N0.23 as the returns per naira invested in the enterprise. Thus the broiler production is a profitable venture in the study area.

Sarker *et al*. (1999) studied that profitability and meat yield traits of different fast growing broiler strains in winter. A total of 100 ISA vedette, 100 arbor Acres and 100 Hybro fast growing broiler chicks were divided into five replications having 20 chicks in each, reared up to 42 days of age to select the suitable broiler strain of better profitability and meat yield traits. A total 30 representative male & female broiler from each breed slaughters at 42 days of age to investigate the dressing yield. ISA-vedette was the highest in respect of

body weight (1552.25 gm/b) and feed take (3105 gm/b) followed by Hybro (1401.60 & 2764 gm/b) and arbor Acres (1372.48 & 2749 gm/b) respectively. Production cost and profitability of ISA-Vedette, Hybro & Acres were 44.23,50.01 and 50.41 and 25.27, 20.00 and 19.59 BDT./Kg live bird respectively. The strain was significantly for body weight, blood weight and giblet weight. Despite, there was no significant differences among the strain. ISA –vedette was the superior for dressing yield to the other strain. ISA-vedette is the most suitable strain in tropical environment in comparison with the other strain (Hybro and Arber Acres).

Riaz *et al*. (2000) examined the economic viability of broiler farms in Kamrup district of Assam. A typical farm had to incur about Rs 31.00 to produce one kg of broiler and earn a net income of Rs 7.21 from the same in a cycle of eight weeks. The income of farmers increased with an increase in size groups. Both break-even production and break even price were lower than the respective average production and average price received. Regression analysis on gross income showed that coefficients of cost of feed, cost of chick and cost of electricity were positive and significant.

Biswas *et al.* (2003) gave the results of a survey report on broiler production and marketing situation conducted in three coastal districts of west Bengal particularly South 24 parganas, North 24 parganas and Midnapore, are presented. The survey was designed at two levels for broiler farmers and for broiler meat retailers, Four farmers were randomly selected from each village. The relevant parameters of broiler chicken production and marketing are discussed. These include period of operation, stock procurement, market sales, profit, monthly income, sale of meat, utilization of dead stock, rearing systems and marketing age. The study results showed that the larger farms are better managed by trained personnel and give higher returns. The findings indicate the sustainability of broiler farming in the locality. Areas for further improvement are identified and discussed.

Cobanoglu *et al.* (2002) analyzed the economic structure and economic results of commercial broiler producing farms in Aydn province, Turkey. The biggest part of the farms assets consists of building capital (41.46%) and machinery capital (19.75%). Average slaughter age was 42.50 days. Average feed consumption was 3.60 kg and live weight was 1.9 kg per chick at the end of the fattening period. Feed conversion rate was 1.93, while feed efficiency was 51.80. Total production expenses consisted of feed costs (67.95%) chick costs (17.37%) and other costs (14.68%). Average income per live weight was 35,829.24 TL/kg.

Sokoowicz *et al.* (2004a) studied the factors affecting the profitability of broiler production in Poland in 2001-03 were analyzed using a selected broiler farm in Podkarpackie province as case study. For all the cycles analyzed, basic production results were determined and a European production India (EPI) and costs of broiler production were calculated. The production profitability index was also calculated. For all the cycles analyzed, the EPI index exceeds 220, which indicates good productivity. Feed costs accounted for the greatest proportion (61.8-69.1%) of the production costs, while the proportion of non-feed costs of farm operations during the analyzed period tended to decline. The economic analysis of farm performance showed that during the analyzed period the selling price of live broilers showed frequent fluctuation regardless of the prices of inputs. No clear relationship was observed between production results and production profitability.

Sarbiland *et al.* (2004) under took a study to investigate the economic status of 83 broiler farms in chakwal, Punjab, Pakistan during the year 1998-99. The average fixed cost per broiler (Rs 51.92) represented Rs 48.51 and Rs 3.41, respectively, for building construction and equipment cost. Average variable cost, gross return and net profit per broiler was Rs 63.42 + or -1.97, Rs 77.16 + or -1.61 and Rs 13.74+ or - 2.29 respectively. Average turnover rate of net profit on the invested, capital per flock and on an annual basis was 24.17 or -

2.36 and 127.27 + or - 13.90%, respectively. Feed cost was the major component contributing 60.27% to the total cost. All the farmers were following almost similar standard vaccination practices; thus its effect on cost of production and net profit was not established. Rate of mortality, flock size, number of flocks per year, duration between two batches, feed efficiency and broilers age at the time of marketing did not affect cost of production and net profit per broiler. Hygienic conditions at the farm, weight at marketing, floor space utilization and house construction, significantly ($P<0.01$) affected net profit per broiler. Aside from better management, stable market, better utilization of available facilities, appropriate house construction, accelerated gain in weight at the lowest market age and maintenance of standard hygiene would further improve profitability of broiler farming in chakwal district, Punjab province, Pakistan.

Kolic (1994) indicated that main factors in determining the profitability of poultry farming enterprises are income, cost and price of the component. Important factors for total income are weight and quality at delivery, feed conversion and bird mortality rate. Cost and price factors include personal earning, labour, technical equipment, average number of birds and production system. Larger farms have better production as well as profit results.

Shanmugam *et al.* (1997) did the study of economic analysis of broiler production in kamarayar district of Tamil Nadu revealed that Rs. 27.10 per broiler was invested to start a broiler farm. The total cost of broiler production per bird was Rs. 22.18 of which variable and fixed costs constituted 93.24% and 6.76 % respectively. Cost of feed alone accounted for more than 50% of the total cost followed by cost of chicks, about 25%. There is wide scope to reduce the total cost by substituting the least cost farm mixed rations. Amount realized by sale of broilers formed the major source of return (96.21%) in broiler enterprise. The net return per broiler and per kg of live weight of broiler produced were Rs. 5.51 and Rs 3.01 respectively. Benefit cost ratio was 1.25:1

in the present study. Break even analysis revealed that at least 127 broilers must be reared by the farmers to cover the cost of production. The economic analysis also proved that the entire investment could be repaid in one year which reflects the economic viability of the broiler farms located in the study area.

Farooq *et al*. (1999) reported that cost of production and net profit per broiler were Rs 51.38 and Rs 7.92 respectively. Percent mortality has a negative effect on net profit per broiler but did not effect cost of production. Market age and flocks size were positively and negatively associated with net profit. Net profit was lower when the flock size was less than 1500 birds for broilers maintained under average hygienic conditions higher flock size, reduction in mortality and market age, better utilization of the available shed capacity and use of concrete floors were suggested as important factors for increasing net profit for broiler production.

Patel G.S. (1999) study revealed cost benefit analysis that broiler production can be profitable enterprise in India. As feed is the major cost of input in broiler production and cost can be reduced and profitability can be increased by having proper feeding management. Cost of feed and cost of chicks accounted for maximum cost approximately 80 per cent.

Monira *et al.* (2004) determined growth performance, average body weight gain, feed consumption, feed conversion ratio and survivability of Arbor Acre chicks reared on rice husk up to 49 days of age were 1601g and 2.51 respectively.

Ali M.A. (2004) evaluated production performance, cost and profit margin of broilers (Vancobb, Starbro and Arbor Acres) that attained satisfactory body weight at marketing 5-6 weeks i.e.1200 to 1671g with mean body weight of 1471g. Total production cost per broiler varies from Tk.65.56 to 85.42 with average cost of Tk.78.00 while the average cost per kg of live broiler was

Tk.53.49. Feed accounted the highest amount *i.e.55* percent of total cost of production where as chick cost, manpower, medicine, and vaccine, others and litter cost involved 26, 14, 3, 2,1 percent respectively.

Hossain *et al.* (2011) the performance and profitability of three commercial broiler strains reared under farming system were investigated in this study. Day-old broiler chicks (n=156) of three different commercial strains (Hubbard classic, Cobb-500 and MPK) were assigned to three treatment groups in a completely randomized block design, each treatment replicated four times, 13 birds per replicate. The birds were reared from d1 to 35 days of age with similar housing, feeding and environmental management condition. Regarding to all parameters collected, live weight and body weight gain were higher ($P<0.001$) in T2(Cobb-500) group, while the birds of T3 (MPK) group were the lowest. Birds of T1 (Hubbard Classic) and T2 (Cobb-500) strain group consumed higher ($P<0.001$) feeds, while the birds of T3 (MPK) had the lowest feed intake. Cobb-500 broiler strain achieved superior ($P<0.001$) FCR, while the birds of T1 (Hubbard classic) strain group had poorer FCR. Liveability of the broiler strains was unaffected by all the treatment groups. Higher net profit and lower production cost observed in T2(Cobb-500) group than those of other strains, although the difference between the treatment groups was similar. The highly significant measurements of live body weight, weight gain and better FCR values were recorded for Cobb-500 broiler strain, followed by Hubbard classic and MPK, respectively. In conclusion, Cobb-500 broiler strain is appeared to be the most economic to rear amongst the three broiler strains investigated here in response to their performance records.

2.4 Bio-security of Broiler farming

Islam *et al.* (2011) studied that bio-security status and products quality of small-scale commercial poultry farms in Bangladesh. Based on survey data,

farms were categorized as standard, good, fair and poor. Result showed that only 9.38% (43) farms followed standard practices, 41.48% (190) farms attained the level of good practices, 32.53% (149) farms fell in fair category and 16.59% (76) farms remained good and poor category. On the other hand quality of poultry products were assessed on the parameters like hygienic condition of marketable broilers, tables eggs and de-feathering units, withdrawal of antibiotics prior to marketing, storage and handling of table eggs. This study showed erogenous results. Small scale poultry farmers need to have awareness-building training on human health hazards related to broiler and egg production and marketing.

Saleque and Rozen (2011) showed that bio-security: demand for policy, partnership, practice and promotion to protect poultry. However the outbreaks of avian influenza have affected the industry seriously during 2007 and 2008. Presently the situation has improved much, however, because of the environmental changes; new pathogens are continuously being evolved in our surrounding environment. Unstructured intensive poultry farming, contact with migratory and wild birds, huge imports of poultry and poultry products, frequent cross-border movement of people multi age production practices, mixed farming, high regional farm density and unregulated wet markets are putting the industry vulnerable to diseases and marketing bio-security and disease prevention concers even more critical.

Chowdhury *et al.* (2015) observed that bio-security includes measure implemented to prevent pathogens from entering into and exiting from the farm and to reduce spread of pathogens within the farm. Bio-security risk assessment remains as one of the major challenges for bio-security agencies. They also investigated that poor structural bio-security (scored<50%) in commercial farms of the country. The operational bio-security of farms were also very poor, most of them scored <40%. They also identified the bio-security status

and room for implement in many of the farms, especially with regard to structural and operational bio-security.

2.5 Cost items in broiler production

2.5.1 Fixed cost

Rangareddy *et al.* (1997) found that the total cost of broiler production per bird was Tk.22.18 of which variable and fixed costs contributed 24.27% and 6.76% respectively.

Chowdhury (2001) observed that housing cost for broiler production is 1.81%, 1.51%, 1.43% and 1.54% of the total cost in small, medium, large and all broiler farms respectively. Equipment costs were 0.29% 0.38% 0.41% and 0.37% of the total cost in small, medium, large and all broiler farms respectively.

Karim (2000) found that housing costs covered 1.47% of the total costs for all farms. Housing costs per bird per farm for small, medium, large and all broiler farms stood Tk.1.26, Tk.1.19 Tk.1.06 and Tk.1.15 respectively. Equipment costs were 0.36%, 0.38%, 0.45%, 0.39% of the total costs for small, medium, large and all broiler farms respectively.

2.5.2 Chick cost

Siddique (2004) observed that the higher prices of chicks were noted in winter seasons while it was lower during spring seasons and they accounted chick cost for 24-25 percent of total variable cost. But cost price of chick is dependent on present market price determined by the hatchery owners depending on demand and production.

Chowdhury (2001) reported considerable variations in the cost of broiler chicks of different batches. He found that farmers bought chicks for small, medium and large flocks with costs of Tk.19.00, 22.00 and 19.00 respectively.

Golap (2001) mentioned that cots involved for each day-old chick in small, medium and large farmers were Tk.15.12, 22.26 and 22.26 per chick respectively.

Karim (2000) found that farmers bought day-old chicks at a rate of Tk.22.00 in respect of farm sizes. Chick cost included 30.38% and 32.67% of total cost of production in small and large flocks.

Siddique (2004) concluded that flock size or unit (location) did not affect chick cost and interaction effect of season and flock size on cost of chick was also negligible.

2.5.3 Feed cost

Begum (2000) found that feed cost entertained 44.95, 43.62 and 48.02 percent of total cost for a rearing a bird up to marketing age in small, medium and large farms respectively.

Golap (2001) found that the highest feed cost (Tk.0.78/bird) was recorded in small flocks followed by medium (Tk.0.73/bird) and large (Tk.0.73/bird) which accounted for 42.40, 42.05 and 40.45 percent of total expenditure.

Katila *et al.* (2004) observed that 41.55% feed cost needed in small to medium flock size.

Begum *et al.* (2004) and Ali (2004) again found that 54.24% and 55 % cost was required for purchasing feed in small flock size.

Siddique (2004) found that broiler feed cost accounted approximately 60% in winter and 58.01% being higher than that study. He concluded that winter

reared birds consumed more feed and therefore, it involved higher cost than other seasons.

2.5.4 Labour cost

Begun (2000) labour cost, a minor cost item included 4.08, 6.09 and 5.09 percent of total cost of production in small medium and large flock sizes respectively

Chowdhury (2001) reported labour costs of 1.86, 1.91 and 1.75 percent of total production cost in the above mentioned three farm sizes.

Karim (2000) reported that total labour cost per bird up to market age was Tk.2.43, Tk.2.05 and Tk.1.67 in farms small medium and large flock size respectively.

Ali (2004) reported that 14% labour costs were required for rearing small size flock.

2.5.5 Veterinary expenses

Golap (2001) observed medication and vaccination costs for small medium and large flock sizes as Tk.0.15, 0.15 and 0.14 which covered 8.29, 8.33 and 8.42 percent of total expenditure respectively. Cost of medication and vaccination demands of moderate amount of total production cost.

Begum (2000) found the same cost accounted for3.97, 4.03 and3.85 percent of total production cost for small medium and large farms respectively.

Uddin (1999) treatment cost for small and large flocks accounted for 7.26 and 7.47 percent of total cost of production.

Ali (2004) reported that in case of small flock size, 3 % cost was required for vaccination and medication.

2.5.6 Electricity cost

Chowdhury (2001) Found that electricity cost per farm per year was as calculated in small, medium and large was1.41, 1.36 and 1.07 percent, respectively.

Karim (2000) reported that investment in electricity amounted Tk.0.95. Tk.0.85 and 0.68 per bird for small, medium and large flock sizes.

Begum (2000) & Golap (2001) calculated electricity cost as 0.99-1.19, 1.0-1.47 and 0.93-0.90 percent of total production cost in small, medium and large farms, respectively.

2.5.7 Litter cost

Chowdhury (2001) reported that litter cost accounted for 0.54, 0.37 and 0.54 percent of total production cost for small, medium and large farm, respectively.

Karim (1999) observed that litter cost amounted Tk.0.29, Tk.0.31 and Tk.0.27 in small, medium and large farms respectively.

Ali (2004) found that litter cost accounted 1% of total production cost in small size flock.

2.5.8 Transportation cost

Uddin (1999) Cost involvement for transportation of chicks, feed etc. in small and large broiler farms were 1.93 and 1.77 percent of total cost, respectively

Golap (2001) calculated the transportation costs for small, medium and large flock sizes as 1.96, 1.92 and1.79 percent of total production cost.

Begum (2000) transportation costs included 1.10, 1.19 and0.89 percent in three different flock sizes

2.6 Effect of farm size on performance and profitability of small scale broiler farms

Islam *et al.* (2010) independent small scale broiler farming is supposed to be profitable venture in rural farmers because of lower investment, less space requirement, utilization of family labor and quick returns. Large farms (>5000 birds) were more profitable and efficient than small counterparts

Mohsin *et al.* (2008) and Karim (2000) found that most of the results were reported from categorized poultry farms (Small, Medium and large size) i.e. on the basis of the average number of birds reared in a flock from survey sample in specific area. This type of categorization is flexible and therefore differs from country to country and even within a country. Specific size of farm and categorized farms are not similar things. Limited information is available on small scale broiler farms in different flock size (100 to 600 birds) in rural Bangladesh. It is, therefore, important to generate information about such small farms at village level on their productive performance and economic viability with improve intervention strategies.

2.7 Effect of seasons on broiler productivity and profitability

Al Rawi and Verela-Alverage (1983) significant seasonal influences were reported by on weight gain, feed intake and mortality of broilers but they found no effect of seasons (period) on feed conversion ratio.

Okelo *et al.* (**1998)** studied that especially high ambient temperature greatly affects the production performance and mortality of broiler which would reduce the profitability of production. bicarbonate concentration in blood reduced during heat stress. They therefore suggested that carbonated water supplementation to the birds during hot season had a beneficial effects on performance. They also observed that cooling effectively relieved heat stress. Supply of cool drinking water enhanced greater intake of drinking water, cool

roost and carbonated drinking (cool and ambient) caused highest survivability and feed to gain ratio.

Daghir (1991) suggested some management practices like optimum amount of balanced diet, supply of appropriate lighting regimes and addition of extra vitamins and electrolytes to drinking water to minimize heat stress in hot seasons.

Trujillo (1998) analysed 5 years data on millions of broiler in Cuba and found significant differences between birds and hatched in winter and summer with respect to body weight at slaughter (1406.6 vs 1328.6g per birds) and feed consumption per bird 3982 vs 3770g. But no differences in feed conversion ratio and viability were reported between two seasons.

Gracas *et al*. (1990) found that the performances in winter and summer were compared with 2808 broilers housed on floor at different densities in Brazil. Gain from hatching to the end of fattening averaged 1817g in winter and 1682g in summer, it was not significantly affected by housing densities in winter. But in summer, birds housed at lowest densities gained more weight. Survival rate of 97.4 and 99.0% of males and females at 8 weeks of age, and feed conversion ratio in winter and summer were 2.3 and 2.4 in males vs. 2.4 and 2.5 in females, respectively

Baghel and Pradhan (1989a) examined the performance of broilers for 8 weeks in the hot, hot-humid and cold season in India. Marked seasonal influences were reported on growth performance of broilers. Birds performed best in cold season followed by hot-humid and hot seasons weighing 1940, 1440, and 1350g per bird respectively. Feed intake of broilers in cold was also found superior compared to those of hot-humid and hot environment

Baghel and Pradhan (1989b) reared 630 day-old broiler chicks during the hot (May to June), hot-humid (July to September) and cold (December to

February) season. They reported that body weight gain averaged 285, 336 and 399g, respectively from day old to 3 weeks of age, 550, 607 and 854g from 3 to 6 week of age and 462, 454 and 644g from 6 to 8 week of age; feed consumption from 1 to 8 week of age averaged 2670.0, 2976.0 and 5536.0g with gain:feed ratio of 0.5, 0.6 and 0.3.

Scott *et al.* (1982) better growth performance of broilers during winter season was mainly due to maximum amount of feed intake regulated by ambient temperature

Ahmed *et al.* (1995) studied the production characteristics and calculated the economics of broiler farming throughout the year. They reported that feed consumption and live weight of broilers reared in rainy season were 4.25 and 1.36kg per bird which was better than those in summer i.e. 3.2 and 1.14kg per bird respectively. Whereas profitability analyses indicated that profit margin per broiler was the highest i.e. Tk.14.12 in summer and the lowest i.e. Tk. 4.22 in rainy season. Highest feed cost was recorded in rainy season, which was correlated with feed intake.

Ahmed (1997) performance and economics of broiler farming with two different strains (ISAi757 and ISA Veddet) were studied by in different seasons of a year i.e. summer, rainy and winter. The results indicated that mortality of ISAi757 broilers was lower in rainy season by 2.67% but comparatively higher in summer by 7.17%. He also found that total cost of production per bird was the highest (Tk.77.9/bird) in rainy season for ISA- Vedette while it was Tk. 61.8/bird in summer for ISA i757. ISA-Veddet required comparatively less labour (10.1%) than that of ISAi757. He also indicated that profit margin of ISAi757 broiler was the highest i.e. Tk. 21.52/bird in winter season and the lowest of Tk.7.75/bird in summer season.

Rajini *et al.* (1998) reported that up to 4 weeks of age, summer reared broilers maintained the same body weight as winter reared broilers, but after that,

winter reared broilers gained more weight. Pellets gave a better feed efficiency up to 6 weeks of age and feed efficiency was inversely proportional to energy level in the diet. The NORTH's broiler feeding efficiency index (NBFEI), broiler farm economy index (BFEI) and the income over feed cost (IOFC) were favorable with broilers reared in winter and fed a diet containing 2700 kcal/kg in pellet feed.

Yousef and Singh (1989) reported that body weight gain of broiler was maximum in cold weather followed by hot-humid and hot-dry seasons in India. Performance index followed similar trend to growth performance. They further reported that hot-dry seasons were not favorable for survivability of broilers.

Sundarasu and Prabakaran (1989) studied the effect of strain (Cobb and Samrat) and season and observed that strain and season had significant influence on gross income from broiler rearing. They further observed that hot dry summer highly discouraged broiler production from economic point of view.

Islam and Howlider (1990) performance of Starbro broilers in different seasons of the year (winter, summer and rainy) was evaluated. Winter reared broiler were heavier, consumed more feed and convert feed to meat more efficiently than those observed in summer or rainy seasons. They also found better profit margin from broilers reared in winter followed by summer and rainy season.

Gokhan and Akcan (2000) Ross PM3 broilers were reared in two different seasons i.e. summer and winter to evaluate the production performance. They observed that average live weight of broilers in a 6 week period differed significantly between two groups. Birds raised in winter (November) gained heavier weight (1838.4) compared to those reared in summer (1632.2). Feed conversion (1.83 vs 1.88) and survivability (92.54% vs. 91.8%) were not affected by rearing seasons. They calculated broiler efficiency factors for

winter and summer which were 221 and 189 respectively. They also found that cost benefit ratio and net profit per kg broiler were not affected by seasons.

2.8 Management intervention on productive performance of small- scale broiler farms

Fairoze *et al*. (2006) found that in Bangladesh, small-scale broiler farming can be broadly divided into two categories: independent and contract farming. Contract farming in developing countries has experienced mixed yield, with some success and failures. In India, Thailand and Philippines, integrators account for a large proportion of the broiler industry, and contract broiler farming is popular with a sizeable number of poultry farms.

Islam *et al.* (2010) observed that in Bangladesh, however, the growth of contract farming has been very slow and performance is not very satisfactory. This contract farming system is not national wide phenomenon and is practiced only in a few places. The contract system of broiler farming has few unresolved issue (e.g. lack of responsibility, honesty, sincerity on the part of the contract farmers) and is still under trial

Akther (2008) findings also revealed that ABFL (Aftab Bhahumukhi Farm Limited) supervised farmers and farmer's own managed farm owners were not significantly different in terms of profit gain and efficiency achievements in broiler farming in the study area.

Alam (1997) a study report on the impact on Smallholder Livestock Development Project (SLDP) in rural community at different rural areas of Bangladesh revealed that the overall socio-economic conditions of the beneficiaries, their egg and meat consumption capability and empowerment opportunities were significantly increased after the managemental intervention made by SLDP.

Jaim and Islam (2008) also concluded that technical intervention of BREAD-II Model of the Winrock International can make a significant contribution in alleviating poverty of village based medium scale (500 birds) broiler farmers.

Akteruzzaman *et al*. (2009) studied the impact of training on poultry farming for improving livelihood of the smallholders and reported that the beneficiaries having training improved knowledge on feeding, management and health care of poultry which ultimately had effect on productive performances. The cost and return of poultry farming for trained beneficiaries was higher than the beneficiaries who had no training.

Ersad *et al.* (2004) conducted a study to observe the efficiency of trained farmers as compared to farmers without training on the productive performances of broilers as well as the net profit from broiler production. Three categories of farmers were considered in the study, viz., certificate on Livestock and Poultry (CLP) trained farmers, this category of farmers had 6 months' training on livestock and poultry production; Youth Training Centre (YTC) trained farmers, this category of farmers had 3 months training on livestock and poultry production and General farmers', this category of farmers had no formal training on poultry/broiler production. The productive performances like body weight gain (kg/bird), feed consumption (kg/bird), feed conversion ratio (FCR), mortality (%) and net profit were better in both of the trained farmers' categories as compared general farmers.

Badubi *et al*. (2004) small scale poultry operations at village level in Bangladesh are characterized by a generally poor resource base, production inefficiencies, underdeveloped infra structure and week institutional links

Jabber *et al.* (2007) most of the small scale broiler farmers start their poultry rearing by getting minimum know-how from their neighboring farmers or some information provided by the chick sellers or dealer or agents of pharmaceutical companies

Saleque (2009) reported in his study that small scale broiler farmers are reluctant to apply their knowledge in production and their application of different management techniques and their efficiency is very low and most of the time, they take precaution of the diseases, but they are less conscious on prevention and control and bio-security is not followed strictly by them. Although, bio-security is the most important factor for running commercial a poultry farm. As a result profitability is not in a static condition. Most of the time they may incur loss.

Muhammad *et al.* (2010) suggested that chick mortality on small scale farms can be used for the training of farmers on its control. Farmers need to be aware a better rely more on better management such as better hygiene and sanitation and less on antibiotics because excessive use of antibiotics can lead to drug resistance in humans through the drug resistance bacteria. To operate an efficient and cost effective system, farmers need to be maintaining proper production and financial records.

Ochieng *et al.* (2011) found that farmers who had adopted full management intervention package as recommend by extension service had higher productive performance than farmers who modified and selectively adopted components of managemental intervention package. Thus a well developed training program could encourage smallholders on proper housing, brooding, feeding, management practices, productive performance, disease prevention and veterinary services. Proper adoption of the improved management intervention package through conduction of training, providing technical support, awareness in broiler rearing, close monitoring, frequent and most efficient interaction speeded up the broiler performance.

Saleque *et al.* (1996) experience from Bangladesh shown that it is possible to split a modern production system into small enterprises, whereby poor, often

literate, farmers may earn an extra for living from one several interlinked activities, etc.

2.9 Socio-economic factor for broiler production

Akther *et al.* (2008); Chowdhury *et al.* (2010); Ali *et al*. (2010) and Islam *et al.* (2010) found that in Bangladesh, the majority of the broiler farm owner's are relatively younger *e.g*. fell in the age group 25-38 years who were in a position to put more physical efforts in broiler farming and to create their employment opportunity in this field.

Sirohi (1982); Mulla (1995); Alam (1996); Prodhan (1995); Verma *et al.* (1998); Rahman *et al*. (2006) all authors in their studies observed that similar types of employment opportunities are created for rural poor, landless laborers, landless and marginal farmers and employed or under employed laborers.

Miah (1990) found that education makes a man more capable of managing scarce resources and maximizing profit. The level of literacy is generally considered as an index of social advancement of community. It is also an important measuring rod for progressive attitude of the farm households in adopting modern technology. Literacy has its own merits and it contributes to economic and social development. Literacy is likely to influence management of broiler farming because broiler farming requires skill and technical knowledge.

Mellor (1974) observed that although education is not in itself a sufficient condition for development of Agriculture, it is certainly a necessary condition.

Kamruzzaman *et al*. (1999) and Ali *et al.* (2010) all researchers observed that education of the farm owners found to be reduced variability in production and positively contributing to sustainable broiler production.

Rahaman *et al.* (2001) concluded that in Bangladesh, rich and educated farmers raised more poultry got increased productivity from their family

poultry and consequently, were capable to maximize profitability in rearing poultry. Education level is also correlated with the size of the farm.

Chowdhury *et al.* (2010); Ali *et al.* (2010) and Akther *et a*l. (2008) found that the size of the farm increased with the level of education increased as stated by many authors.

Islam *et al.* 2010 and Verma & Singh (1997) revealed that level of general education of entrepreneurs had no significant effect on the profitability of farms as well as size of the farm.

Islam *et al.* (2010) and Akther *et al.* (2008) studied that as per categorization all of sample farmers were under small categories. In Bangladesh, farmers are classified into different categories based on land holding, i.e landless, marginal, small, medium and large-having 0-5, 6-49, 50-249, 250-750 &750 above decimal of land respectively.

Chowdhury *et al.* (2010) observed that most of the small scale broiler farmers were resource poor having few sources of income and reared 100, 200 & 300 birds in a flock in the study area. They reared their broilers as an additional source of income. Contribution of incomes from the production of field crops was the highest in the study areas than those farm service, broiler farms, business, livestock and fisheries.

Hossain *et al.* (2008); Islam *et al.* (2010) and Chowdhury *et al.* (2010) observed from their study that the family size of the broiler farmers is higher than the national average (4.89) of Bangladesh (2010).

Hossain *et al.* (2008) revealed that family size and occupation had no significant relationship but education, farm size, types of medicine and marketing place of broiler had significant ($P<0.01$) and negative correlation with economic loss of flood victim broiler farms.

Mozumder *et al.* (2009) found that the increased income of the farmers influenced them to make more investment in broiler farming and spend more money in different aspects of households

2.10 Problems faced by the small scale broiler farmers at rural house holds

Uddin (1999) discovered that commercial poultry farming system in Bangladesh faces many constraints such as inadequate technical knowledge of poultry rearing, inadequate availability and high price of inputs (feed, day old chicks and vaccine & medicines), uncertainly in electricity supply marketing facilities, lack of capital, inadequate institutional credit, lack of training and lack of extension services.

Miah (1990) in another study reported that the small and medium poultry farms are profitable but acute shortage of medicine, lack of technical know-how together with resource content were observed as the major constraints of those poultry farms.

Mohsin *et al.* (2008) identified that cost of production in small farms was higher than that of medium and large categorized farms due to the lack of efficient extension services in the study area.

Muhammad *et al.* (2010) studied on early chick mortality on small scale poultry farms and suggested that farmers need to be aware of production and availability of quality chicks and quality feeds are also excessive use of antibiotics can lead to drug resistance in humans through the drug resistance bacteria.

2.11 Broiler meat quality

Okarini *et al.* (2013) observed that the chemical composition of broiler breast meat were moisture (73.85%), protein (18.94%), fat (4.70) and ash (1.78%) respectively.

Castellini (2006) stated that the proximate composition of moisture, protein, lipid and ash of Ross broiler at 1 days of age under organic system was 75.36. 22.77. 1.15 and 0.62. respectively.

Smith *et al. (*1993) observed that the moisture, protein, lipid and ash content were 75.27,20.36, 1 .62 and 1.32% with some selected pekin duckling.

Adeniyi *et al.* (2011) found that the proximate composition of broiler meat was investigated in the south-western area of Nigeria and found that moisture, crude protein, fat , ash and crude fibre content were 80.21, 18.82, 2.39, 0.50 and 0%, respectively of broiler meat.

Cobos *et al.* (2000) found that the dry matter, protein, fat and ash content were 26.07, 20.8, 3.39, and 1.27%, respectively in breast meat of wild ducks.

Costs *et al.* (2001) investigated that in growing period (22 to 42 days), in male the protein levels affect linearly the breast yield and abdominal fat while in female only abdominal fat

Ibrahim and Osman (2005) reported that heart, carcass and total edible meat weight significantly increased in the dietary group fed, 20, 23, 18 and 18, 23, 20% CP at starter, grower and finisher period when compared with the other dietary groups.

Lee *et al.* (1990) found that there was no difference in carcass yield of broiler fed 18, 20 or 22% CP during starter and 15, 17 or 19% CP during finisher period

Mazanowski *et al.* (2003) stated that the average water, protein and fat percentage of duck breast and leg meat were 74.4, 20.1 and 1.7%, and 72.3, 18.5 and 3.9%, respectively and the average pH at 24 hour of postmortem was 6.0 and 6.4 from A44 and A55 strains.

Khalifa and Nassar (2001) found that the moisture content in 2 game duck breast meats were ranges between 65.4 to 69.6%, protein content was in between 21.8 to 23.8%, ash content in between 1.0 to 1.4% and total fat content was in between 4.8 to 23.3%.

Kabir (2010) reported that proximate composition of breast meat of broiler were found 74.25%, 22.10%, 1.07% and 1.37% of moisture, protein, fat and ash respectively provided different level of dilatory protein of broiler feed.

Souza *et al.* (2011) studded on proximate composition and meat quality of broilers reared under different production system and found that proximate composition of moisture, protein, either extract and ash of cobb strain was 75.26%, 22.61%, 0.73% and 0.95 respectively. Meat proximate composition was not influenced by genetic strain; however, ash content was affected by sex with the highest values obtained males.

Soliman *et al.* (1999) reported that feeding broiler on diet containing 25% CP and 3100 KCa1 ME 1kg diet during the starter period (1-4 weeks) and 20% CP and 3200 KCa1 ME/kg diet during the finishing period (5-7 weeks) has no significant effect on slaughter characteristics and carcass composition of broiler.

Kassim *et al.* (1996) found that protein levels did not influence meat yield of breast, drumstick and thigh but decreased abdominal and carcass fat when dietary protein increased.

Nworgu *et al.* (2001) conducted a feeding trial with broilers fed varying levels of dietary protein (19, 21 and 22% and 17, 19 and 20% crude protein for the starter and finisher diets) and found that significant treatment effect on dressed, eviscerated, breast and abdominal fat weights.

Ogunmola *et al.* (2013) studied on nutritive value of the meat quality of locally breed chicken, exotic chicken and turkey and found that locally breed chicken, exotic chicken and turkey were obtained from Ajegunle market in Oyo town and processed for their proximate composition and dietary minerals. The proximate composition reveals that the moisture content in percentage ranged from 5.00% in Turkey to 0.50% in exotic Chicken, the ash content ranges from 6.50% in Turkey to 2.00% in locally breed chicken. The fat content ranges from 18.0% in Turkey to 3.70% in locally breed Chicken; the protein content ranges from 68.97% in exotic Chicken to 50.95% in locally breed Chicken.

Qiao *et al.* (2001) observed that the moisture, protein, lipid and ash content were 74.51, 23.05, 1 .21 and 1.34% with some selected broiler breast meat.

Quentin et al. (2005) investigated the effects of two dietary crude protein levels (22.5 and 17% C.P) and four lysine levels (0.56, 0.66, 0.76 and 0.86%) in a 2x4 factorial design on performance and carcass composition of slow growing broilers (Label) during the finisher period (42-77 days). They reported that high protein diet had less abdominal fat (3.3%) than the low protein diet (4.3%) while lysine level had no effect on abdominal fat.

Rezaei *et al*. (2004) studied the effect of crude protein (CP) in the starter (19 and 23% C.P) and grower (17.65 and 20.65% C.P) diets with 3 levels of dietary electrolyte balance (210, 255 and 300 mg/kg diet) on the performance, body composition and blood serum electrolyte (Na, K and Cl) on 1800 male and female broiler chicks. With increasing CP level, carcass fat percentage decreased and carcass protein increased ($P<0.05$). Male broiler had better performance and breast meat yield and percentage than female ($P<0.05$).

Sogunle *et al.* (2010) found that the results on the proximate composition($p<0.05$) of the muscles showed that values obtained for the thigh gross energy (2.11 kcal/g),thigh dry matter (28.73%), thigh fibre diameter(5.24 mm), thigh fat (8.08%), breast dry matter(29.88%) and breast fibre diameter

(5.54 mm)were higher in Marshal MY strain. Hence, it was concluded that meat quality is a function of genotype and environmental factors.

Castellini *et al.* (2002) studied the effect of rearing system on the chemical composition of broiler meat in conventional broilers (8 birds/m2) and organic broilers (8birds/m2+4m2free range/bird) and observed minimum differences in protein content and substantial differences in fat content in different muscle groups.

Bogosavljevic-Boskovic Snezana *et al.* (2006b, 2008) the effect of rearing system on protein and fat content of breast and leg muscles was also reported. The results obtained were attributed to the fact that extensive indoor and free range production systems, with the latter involving access to natural environment (fresh air and sunlight), resulted in differences in terms of the structural manifestations of tissues and organs, as well as in terms of the biochemical processes involved in the metabolism.

Bogosavljević-Bošković1 Snežana *et al.* (2010) reported that nutrition, as one of the most important external factors in broiler production, can have a crucial effect on the chemical composition of broiler meat. Factors that can have a highly variable effect on the chemical composition and quality of poultry meat include the following: choice of raw materials to be used in feed formulation, their characteristic chemical composition, different protein and energy values of formulated rations, different degrees of nutrient utilization, different mutual (synergistic and antagonistic) effects of feed components.

Grashorn and Brose (1997) suggested that different rearing systems lead to different meat quality, with greater differences, though, being observed only for broilers reared under extensive systems in accordance with controlled ecological production, as opposed to label broilers (less intensive fattening following the label concept) which performed similarly to conventional commercially reared animals.

Raphulu *et al.* (2015) found that the crude protein of the grower chickens breast muscles and fat content of the adult chicken leg muscles differed with season. The highest fat content of the leg muscle was obtained in autumn, which could be attributed to abundance availability of cereals and byproducts spilled during harvesting.

Gu *et al.* (2008) it was concluded that a hot environment could affect the performance and meat quality of broiler chicks more significantly than CP level and that high humidity would aggravate the bad influence of high temperature on the broiler. Hot environment had significant effect on average daily feed intake (ADFI), average daily gain (ADG) and feed conversion ratio (FCR). The protein contents of both breast and thigh meat were reduced by hot environment. Also found that in case of meat quality, 24.9% 1.5%, 72.0%, and 1.4% of crude protein, fat, moisture and ash respectively for broiler breast meat.

Lara *et al.* (2013) found that heat stress is one of the most important environmental factors challenging poultry production worldwide. The detrimental effects of heat stress on broilers and laying hens range from reduced growth and egg production to decreased poultry products quality and safety.

CHAPTER THREE

Experiment 1: Impact of socio-economic factors on production performances of small and medium size broiler farming in Bangladesh

3.1 INTRODUCTION

Commercial broiler farming has become a promising and self-motivated industry with enormous potential for animal protein supply, income generation and poverty reduction (Bhende, 2006). Broiler farming is an important venture for the improvement of rural livelihood as well as food security in Bangladesh. However the number of farms has already been decreased in the recent years due to a number of factors like the avian influenza problem, quality of chick, summer stress affecting productivity and survivability, extension activities at grass root level, too much dependency on imports, limited access of farmers to credit, quality feed, bio-security and health care services, poor marketing system and institutional weakness (Chowdhury, 2013).

Approximately 43% of urban and 40% of rural population live below the poverty line (BBS, 2011), and they suffering from serious malnutrition problem. Protein deficiency has been taken as the major contributory factor to malnutrition. Consumption of protein of animal origin in Bangladesh is much lower compared to other countries in the world. This is also reported by Das *et al.* (2008) recently. As recent report, the average per capita availability of meat is 23.6 g/head/day in comparing with the standard requirement of 120 g/head/day (BBS 2010). So there is a huge gap between requirements and availability of meat. Above the scenario in Bangladesh, broiler farming can play a role in meeting up the nutritional deficiency. Broiler can efficiently and rapidly provide animal protein within shortest possible period investing no or minimum capital.

Researches done by the major constraints and factors influencing the performance of fast growing small scale broiler farms under private management in rural areas are very limited. In addition, the farmers' attitude and behavior towards expansion of farm size based on the household's income from broiler farming is yet not been investigated. Farm size is an important factor for increasing growth performance as well as profitability. Several studies have been done on production and profitability of poultry farming (Jaim and Islam 2008; Ali and Hossain 2010). But, Jaim and Islam (2008) worked on village based small farms and concluded that technical intervention as well as good maintaining bio-security could make a significant contribution to increase profitability that reduce rural poverty. Profitability of broiler farming is affected by a number of factors. Sometimes, rural farmer fail to manage their farms efficiently because of their limited resources, lack of technique knowledge and capital. As a result, their net profit is not in a static condition. Now and then, they earn profit or they incur loss because of increasing price of chick and feed, and failure to have remunerative price of their products. Besides, some farmers are illiterate who have no adequate knowledge about the nature of input to have maximum profit. They do not have any financial indicator that may help them to expand poultry farming.

Therefore it is inevitable to identify the factors that may affect profitability in broiler farming. A baseline survey provided necessary information related to existing farm management including housing, brooding, feeding medication, vaccination, practices of broiler farm etc. The present study was conducted in Rajshahi, Pabna and Kishoregonj districts, where broiler farming mostly concentrated. Therefore, the present study was undertaken to identify the relative factors influence production performances of broiler farming, and make some suggestions and recommendations to promote broiler farming in Bangladesh.

3.2 MATERIALS AND METHODS

3.2.1 Study area and time of data collection

The study area covers different Upazilas of Rajshahi, Pabna and Kishoregoanj. Rajshahi, Pabna and Kishoregoanj are located in the north western and south-eastern part of Bangladesh. The areas of Rajshahi, Pabna and Kishoregoanj are 2425.37 sq.km, 2376.13 sq. km, 2688.59 sq.km respectively. According to population census the total population of these districts is 2595197, 2523179 and 2911907 respectively. The population density of the study area is 1070, 1062 and 1883 persons per sq.km., respectively. During summer season (March – June) average temperature in the study area is around 36.5^0C, 35.7^0C and 35.0^0C of Rajshahi, Pabna and Kishorgonj district of Bangladesh respectively. On the other hand during winter (November- February) average temperature in the study areas is around 12.6^0C, 12.5^0C and 13.0^0C of the said districts respectively. The average rainfall is about 1888 mm, 2021 mm and 2174 mm of Rajshahi, Pabna and Kishorgonj districts respectively. The literacy rate is about 53, 46.7 and 40.90 percent respectively. Most of people are involved with agriculture as their main occupation. Poultry is the major source of income and a large number of young unemployment and literate people are engaged with this business as their main source of income. The data were collected during the period from January 13 to June, 2014.

3.2.2 Physical features, land topography and soil type

The study areas are characterized by the presence of the terraced land. The land surface of the areas is uneven. Land topography of those areas is high, medium high, low and very low land. High and medium highland were mostly characterized by typical red soil. Soil types of rest of the lands including crop land were clay-loam to loam. The main crops of these are paddy, secondary fish and broiler farming was practiced as a secondary activity.

Study areas at Rajshahi, Pabna & Kishoregoanj

Figure 1. Orange color in the map indicated study areas

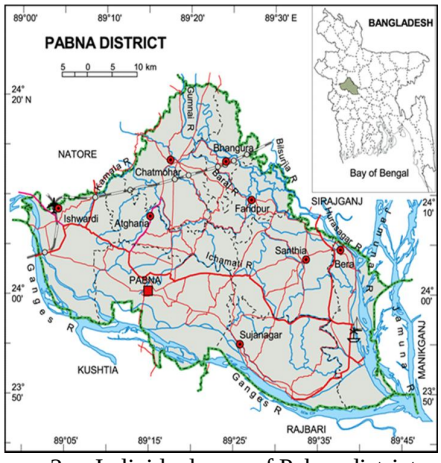

Figure 2. Individual map of Pabna district

Figure 3. Individual map of Rajshahi district

Figure 4. Individual map of Kishorgonj district

3.2.3 Preparation of survey schedule based on farmer socio- economic characters related to poultry productivity

According to specific objectives, survey schedule was prepared. Before making final schedule, pre-tested schedule was used to collect information. The questions related to poultry productivity and profitability were arranged systematic to get information with minimum efforts. The survey data were processed and quantified by using appropriate statistical package to compare among the independent variable. The questionnaire contained both primary and calculated variable information.

a) Socio-economic conditions of the selected small scale broiler farmers, viz. age of the farmer's, sex, level of education, farmer's training received, annual income, family size, land size, income of the households etc.
b) Livestock population
c) Statement of expenditure and income of the farmers.
d) Pattern of food diversity of the farm owners.
e) General question about broiler farm management (Existing housing, brooding, vaccination, feeding, bio-security management pattern rearing and other managemental issues of small and medium scale broiler rearing at rural households).
f) Cost items included the fixed and variable costs of broiler farms. Cost items included the followings.
    i) Housing
    ii) Equipment
    iii) Chick
    iv) Feed
    v) Transportation
    vi) Labour
    vii) Medication

viii) Vaccination

g) Income from broiler farming & others service.

h) Information on disease and its prevention measurement.

i) Information on sanitation measurement

j) Problems & its probable solution in broiler farming.

3.2.4 Method of data collection

A semi-structured questionnaire was prepared, pre-tested and finalized before interviewing the farmers. Direct interview method was followed to collect data from the respondents. The researcher asked questions to the respondent and recorded the answers very carefully. During the interviews each broiler farmers were briefed about the purpose of the study. Farmers were assured that the study was done for academic purpose and to improve poultry productivity and has no adverse effect on them. Then the questions were asked in a simple manner with explanation of questions if necessary. The responses of respondents were recorded directly on the interview schedule. Data collection was performed through several visits in selected areas and taking interview of the farmers.

3.2.5 Collection of data according to farm size

According to the objectives of the study, Rajshahi, Pabna and Kishoregoanj districts of Bangladesh were selected considering the high concentration of broiler farms in that area. Data were collected randomly from a total of 90 broiler farms having 30 farms in each district. Before the collection of data, the objectives of the study were clearly explained to each of the farmers. Always was tried to collect reliable data from the poultry farmers.

3.2.6 Farm categorization

The collected data were then edited and categorized as per farm sizes (500, 600, 700, 800, 900 & 1000 farm sizes). Of the 90 farms, 23%, 20%, 16%, 17%, 14% and 11% farmers have 500,600,700,800, 900 and 1000 broilers, respectively which are treated as small and medium size broiler farmers.

3.2.7 Data processing and statistical analyses

Recorded data on socio-economic factors of broiler-producing farmers like age, education, land size, family size, family income, training on farming etc. were treated as independent variable. On the other hand, broiler performances like body weight, feed consumption, feed conversion ratio (FCR) and survivability were treated as dependent variable. Education of the broiler farmers was measured in terms of formal years of schooling. Land possession was determined by the area of land on which the farmers carried out the agricultural operations including homesteads, and was expressed in acre. The number of family members determined the working units of the farm. Annual family income was measured by the total yearly earnings from different sources by the members of a broiler farmer's family. FCR of different farm size was determined by dividing the average feed intake by the average live body weight of the broilers in each farm. Several factors both independent and or dependent variables, which were affecting in small-scale broiler production subsequently analysed possible and observed ranges, numbers and percentage, distribution, mean standard error (SE), ranking using a computer Statistical Package for Social Sciences (SPSS, 2003) which are presented in different tables.

3.2.8 Regression Analysis: Regression analysis was done to determine the relationship between some socio-economic factors of farmers and their broiler production performance on the basis of net return/ broiler. A regression analysis was performed using the following formula:

- Y= f (X1, X2, X3,X4,X5,X6,X7)
- Where:
- Y= Broiler production performance in terms of net return/broiler (BDT)
- X1= Age (years)
- X2= Education (years)
- X3= Family size (number of persons in the household)
- X4= Land size (acres)
- X5= Annual income (BDT in thousand)
- X6= Training received
- X7= Farm size

3.2.9 Problem Faces Index (PFI) of broiler farmers

To determine the severity of the problems faced by the farmers in broiler operation, a problem faces index (PFI) and rank order was used. PFI of each problem was determined by using the following formula (Ali, 2008):

$PFI = 3 \times fs + 2 \times fm + 1 fl + 0 \times fn$

Where,

fs = Number of broiler producing farmers faced severe problem

fm =Number of broiler producing farmers faced moderate problem

fl = Number of broiler producing farmers faced little problem

fn = Number of broiler producing farmers faced no problem

PFI was made with the 20 selected problems. PFI problems could range from 0 to 218, where 218 indicated severe problems and 0 indicated no problem. Rank order was made by the descending order of PFI of all the problems in order to compare the severity of problems.

PLATE 1
Data collection from broiler farmers

Photo 1: Researcher talking interview with small scale broiler farmer during data collection

Photo 2: Researcher talking interview with medium scale broiler farmer during data collection

Photo 3: Researcher talking interview with medium scale broiler farmer during data collection

Photo 4: Researcher talking interview with small scale broiler farmer during data collection

3.3 RESULTS

3.3.1 Socio-economic factors affect the potentiality of broiler production

The socio-economic factors like farmer's age, family size, land size, level of education, training exposure and family income were considered in sections:

3.3.1.1 Age of the farmers

The broiler farmers of the study area were grouped into three categories according to their ages as presented in Table 5. The age composition of owners of the sample broiler farms indicated that none of the owners had the age below 20 years. Of the total broiler farmers the highest number of owners (50%) was in the age group of 26-39 years, 32% farmers had the age group of 20-25 years and only 18% farmers were in the age group of 40 years and above. The average age of farmers in the study area was 33 years which indicate that majority of broiler producers were relatively young (Table 5).

Table 5. Socio- economic characteristics of the broiler producing farmers in study areas

	Farm size (no. of broiler)							
Variables	500	600	700	800	900	1000	All	Mean ± SE
No. of farms	21	18	14	15	12	10	90	
Farmer's age group (%)								
20-25 years	36	31	38	41	22	33	32	33.27
26-39 years	54	52	44	41	50	44	50	±
40 and above	10	17	18	28	28	23	18	1.98
Family size (%)								
Small up to 4	33	42	27	23	22	33	33	5.74
Medium 5-6	63	47	66	58	66	50	50	±
Large 7 and above	04	11	07	19	12	17	17	1.64

Framers education status (%)								
Can sign only	36	25	15	11	-	-	13	
Primary education level 1-5	30	31	35	35	04	10	25	
Junior school education level 6-8	08	11	10	14	06	06	10	6.71
Secondary education level 9-10	26	33	30	40	50	29	35	± 0.431
Higher secondary education level 11-12	-	-	10	-	20	35	10	
Graduation (above 12)	-	-	-	-	20	20	07	
Farmers training received (%)								
No training exposure	96	90	77	76	66	61	80	1.47
Training exposure	04	10	23	24	34	39	20	± 0.09
Land size (Acres)								
Land less (0-0.49)	28	20	15	06	05	01	11	2.67 ± 0.38
Small (0.50-2.49)	45	50	52	41	52	50	50	
Medium (2.50 – 7.49)	27	30	33	47	37	40	35	
Large (7 and above)	-	-	-	06	6	09	04	
Annual Income (%)								
Low income (BDT. 0-150,000)	20	47	38	29	06	-	23	235,000 ± 107.62
Medium income (BDT. 150,000-250,000)	40	21	11	41	44	50	36	
High income (BDT. 250,000 above)	40	31	51	30	50	50	41	
Total average annual income (BDT. Thousand)	125	150	175	190	200	225	-	-
Feed conversion ratio % (As per farm status)								
High performance (1.67-1.71)	10	14	25	25	18	26	19	1.78 ± 0.20
Medium performance(1.72-1.80)	49	35	35	59	30	26	39	
Low performance (1.81-1.87)	41	51	40	16	52	48	42	

3.3.1.2 Family size

The family size of small and medium size broiler farmers in selected areas was found three to nine members. The average number of members in the farmer's family size was 5.7. On the basis of family size the broiler farmers were classified into three categories as small (up to 4), medium (5-6) and large (7 and above). About 59 percent of the farmers were belonged to medium sized family, 30 percent small sized family and the rest of 11 percent had large sized family (Table 5).

3.3.1.3 Land size

The most of the broiler farmers (50%) were small land size farmers. Landless and medium farmers constituted 11% and 35% respectively shown in Table 5. Only 4% large size land was observed reaming of the broiler farmers. The average land size was 2.67 acres among all broiler farmers. Table 5 shows that the land holdings area was increased with an increase of broiler farm size.

3.3.1.4 Education

Farmers were classified into six categories based on their level of education (Table 5). The average year of schooling of the farmers was 7. Around 87% poultry farm owners were educated, and 13% could only sign their names. Of the farmers, about 25% farm owners had primary education, 10% had junior school education, 35% secondary, 10% higher secondary level education and 7% graduation. The 30, 31, 35, 35, 04 and 10% had primary level education of the farmers in 500, 600, 700, 800, 900 and 1000 broiler farm size respectively. Nobody had higher secondary and graduate level of education in 500 and 600 farm sizes. The results indicated that the size of the farm increased with increasing level of education *i.e.* comparatively small farm size had lower level of education than those of comparatively higher farm size.

3.3.1.5 Training of farmers

Table 5 showed that most of the broiler farmers (80%) were not trained on principles of broiler farming management. It was apparent that only 4% had training in 500 farm sizes, 10 % had in 600, 23% had in 700, 24% had in 800, 34% had in 900 and 39% had in 1000 farm sizes. The size of the farm increased with increasing the number trained farmers.

3.3.1.6 Annual income

Categories of annual income are as low, medium and high which depend on their annual income (Table 5). The average annual income of farmers in the study area was BDT 235,000 (BDT 78 = US$ 1.00). The low income was 23% and medium and high both were 77% farmers. According to table 5 average income contributions for 1000 broiler farm size is higher than 900 and followed by 800, 700, 600 and 500 farm sizes.

3.3.2 Existing small scale broiler production system

3.3.2.1 Housing

Farmers have been using open sided houses with wire-net partition in floor management system for flocks of different sizes. Most of the broiler houses at rural areas and semi urban areas were built in east-west direction to facilitate air movement in the house, and prevent entering direct sunshine in the shed at morning and at late afternoon. About 58% houses or sheds had a herring floor brick, 12% concrete made with brick and 30% soiled floor which was adjacent to the residence. In case of concrete floor and herring floor, the wall was made of brick with 1.5 feet height. Above the brick side walls, net wire stretched up to the roof level. The roof was usually made of corrugated *tin* (iron sheet). The house was 10 feet height in the centre and 7 feet height at the corner. In general, floor space of 1-1.5 sq. feet/bird was maintained. Rice husks were used as litter materials for broiler operations. But the majority of the broiler producers (65%) were found to use sawdust because of the availability and cost effective. During

the summer season, ambient temperatures are increased up to 42^{o}C with a high humidity. Therefore, to control heat stress, open- sided house is essential for broiler rearing in Bangladesh.

3.3.2.2 Broiler strain

The majority (74.5%) of the broiler producers used Cobb 500 strain and the 25% producers are rearing other strains such as Hubbard MPK, Arbor Acres, ISA 575 etc. The day old broiler chicks were procured from a local private hatchery. Generally, most of the small-scale broiler farm owners bought their day-old chicks through middlemen like dealers or agents by advance booking. The local hatcheries sometimes are not able to meet their demand for day- old chicks.

3.3.2.3 Brooding practices

The brooding of young chicks is very important to reduce early chick mortality as well as good returns. The main source of heating for brooding was electricity. But irregular supply of electricity was the common problem during brooding of DOCs. Chicks were brooded for a period of 2-3 weeks. The 3 electric bulbs of 100 watts or 1000 watts heater were used for brooding of 100 chicks. In absence of electricity, kerosene was used in hurricane or rice husk or sawdust was burnt in earthen pot or jars for brooding of chicks in rural area.

3.3.2.4 Feeding practices

The birds were fed a broiler starter diet for the first 2 weeks (1-14 days) and finisher diet during the remaining period (15-35 days).

3.3.2.5 Disease prevalence

The diseases those are frequently prevalent in broiler farms which were Newcastle Disease (ND), Infectious Barsal Disease (IBD), Mycoplasmosis, Salmonellosis, Colibacillosis etc. A majority of the producers (74%) reported Newcastle disease as a major concern of their farms. The majority of the small-scale broiler farmers (61%; n=55) followed treatment of diseases rather than

practicing vaccination from day-old to sell at village level. Some farmers followed vaccination schedule in their farms. Lack of quality control of vaccines during storage and transportation were major problems for failure of vaccines. A routine vaccination schedule is normally followed to prevent the common diseases. However, maintaining strict hygienic measures and bio-security can reduce the disease out -break in the farm and risks (Islam and Nabul 2003). 'Bio-security' is now a common word familiar to the most farmers. Nowadays avian influenza is called as a disaster to the poultry sector, resulted close down of the commercial broiler farms. This is a great loss for the nation.

3.3.3 Growth performances

The marketable live body weight, feed consumption, FCR and survivability were considered for broiler farming in study area presented in Table 6. Significant level was observed at 5 % and 1 % level of marketable body weight and FCR among the farm sizes. No significant difference was observed in case of feed consumption and survivability. The feed conversion efficiency was tended to be better with increasing the size of the farms. The marketable body weight was found higher trend with increasing the farm sizes.

Table 6. Performance parameters of broilers in small and medium farm size

Parameters	Farm size							P value and LS
	500	**600**	**700**	**800**	**900**	**1000**	**All**	
MBWT (kg/Broiler)	1.677± 0.158^{b}	1.722± 0.090^{ab}	1.707± 0.132^{ab}	1.726± 0.139^{ab}	1.785± 0.173^{a}	1.797.± 0.168^{a}	1.73± 0.151	0.029*
Ave. marketing age (days)	34.10	34.21	35.00	34.65	33.78	34.56	34.35	
FC (kg/Broiler)	3.12± 0.30	2.97± 0.13	3.11± 0.39	3.15± 0.32	3.03± 0.20	2.98± 0.27	3.06± 0.29	0.105^{NS}
FCR	1.87± 0.20^{a}	1.73± 0.08^{bc}	1.83± 0.24^{ab}	1.83± 0.23^{ab}	1.70± 0.14^{bc}	1.67± 0.18^{c}	1.78± 0.20	0.002**
Survivability (%)	95.44± 2.96	94.56± 3.72	95.21± 2.69	96.33 ±1.56	94.91± 1.94	93.57± 4.20	95.03± 3.05	0.211^{NS}

FC, Feed consumption; MBWT, Marketable body weight; Ave, Average; LS, Level of significance; FCR, Feed conversion ratio; Values indicate ± SD, Means having dissimilar superscript differ significantly, **, P<0.01; *, P<0.05; NS, Non-significant.

Results also showed that feed consumption had lower trends with increasing size of the farm and resulting lower FCR. The FCR of small-scale broiler units of 500, 600, 700, 800, 900 and 1000 under rural condition with traditional management was 1.87, 1.73, 1.83, 1.83, 1.70 and 1.67 respectively (Table 6). It has been found that small-scale broiler farms were comparatively low performer than those of higher farm size.

3.3.4 Economic performance (Cost and Return)

Data related to cost and return were evaluated and the results of cost benefit analyses for profit measurement of small & medium scale broiler farms of six farm sizes are shown in Table 7. Table 7 showed that size of the farm had a negative relationship with the cost of raising broiler on traditional management. The lower cost of production was observed in larger farm. The net return/broiler also had increasing trends with increasing size of the farm. It was found that benefit cost ratio of broiler farms under traditional management system at field level was 1.03, 1.08 and 1.09 in 500, 600 and 700 farm sizes respectively. Raising broilers small sized farms (500, 600 and 700) had smaller profit but the profitability may be increased if the farm size is increased. The total cost, BCR, net return/broiler and net return/kg were found significant difference among the farm sizes (P<0.01).

Table 7. Production cost and profitability in different sizes of broiler farm

Parameters	Farm size							SED	P value and LS
	500	600	700	800	900	1000	All		
Total cost	212.81± 13.09^{a}	209.03± 12.62^{a}	205.69± 16.65^{a}	203.78± 16.93^{a}	193.63± 14.70^{b}	187.99± 11.68^{b}	203.26± 16.52	1.66	0.0047**
Return/ broiler	218.01± 20.66	223.87± 11.82	221.94± 17.19	224.44± 18.18	232.05± 22.51	233.71± 21.96	224.90± 19.65	53.79	0.211 ^{NS}
Gross return/broiler	219.01± 20.73^{b}	225.15± 12.01^{ab}	223.22± 17.30^{ab}	225.55± 18.16^{ab}	233.65± 22.76^{a}	235.47± 22.19^{a}	226.21± 19.85	54.16	0.028*
Benefit cost ratio	1.03± 0.12^{b}	1.08± 0.07^{b}	1.09± 0.12^{b}	1.11± 0.11^{b}	1.21± 0.13^{a}	1.26± 0.13^{a}	1.12± 0.14	0.01	0.0034**
Net return/broiler	5.20± 25.70^{b}	14.85± 14.40^{b}	16.25± 25.85^{b}	20.66± 21.45^{b}	38.42± 24.14^{a}	45.72± 23.85^{a}	21.64± 26.92	2.70	0.0005**
Net return/Kg	1.95± 14.94^{c}	8.41± 8.21b^{c}	8.72± 15.26^{bc}	11.43± 11.65^{b}	20.69± 12.06^{a}	24.63± 11.34^{a}	11.54± 14.83	1.49	0.0010**

FS= Farm size, Values indicate ± SD, Means having dissimilar superscript differ significantly ** = P<0.01, * = <0.05, NS= Non-significant, LS= Level of significance

3.3.5 Factors influencing the performance of the broiler farmers

Regression models were used to determine the relationship between some socio-economic factors and broiler production performances considering net return. Broiler production performances were positively related with socio-economic factors in Table 8.

Table 8. Relationship between socio-economic factors and broiler production performances

Variable	Regression co-efficient	Standard error	t- value	Level of significance
Constant	-40.123	16.559	-2.423	.018
X1= Age	.297	.173	1.720	.089***
X2= Education	1.206	.448	2.694	.009**
X3= Family Size	-3.764	1.616	-2.330	.022*
X4= Land size	6.872	3.192	2.153	.034*
X5= Annual income	.011	.015	.746	.458 NS
X6= Training received	1.778	.862	2.064	.042*
X7= Farm size	.079	.013	6.066	.000**

R square = 0.556, Adjust R square= 0 .518, F= 14.654**, df= 89, *Significant at 5% level, ** Significant at 1% level, *** Significant at 0.1% level, NS Non- significant

Table 8 showed that broiler production performances were positively related with education, farm size, training, land size and age of the farmers except farmer's annual income (>0.05). Family size had negatively significant relationship with broiler production performance as well as profitability on the basis of net return in broiler production and showing the co-efficient (-3.764).

3.3.6 Problems faced by the farmers in broiler production

Among the constraints, lacking of quality chicks was the major constraint appeared to be a common complaint to the farmers. Fluctuating price of chicks & marketable live broiler, low price of finished broiler, risk of diseases including Avian Influenza (AI), bio-security of the farm and high feed cost ranked by turns second, third, fourth, fifth and sixth respectively. On the other hand, limited access to credit was appeared the lowest ranked according to farmers comment.

The other constraints reported by the farmers which were lacking of technical knowledge, variability in feed quality, influence of middlemen in the marketing channel, interruption of feed supply, lack of knowledge on disease out- break, heat stress affecting productivity & survivability, power failure and lack of technical support in farming.

Table 9. Major problems faced by small-scale broiler farmers ranked through index method

Categories of problems	Large	Moderate	Low	No	PFI	Ranking order
Lack of quality chicks	52	27	8	3	218	1
Fluctuate price of chicks & marketable live broiler	56	16	13	05	213	2
Low price of finished broiler	49	24	9	8	204	3
Risk of diseases including avian influenza	43	30	14	03	203	4
Bio-security of the farm	46	23	13	8	197	5
High feed cost	43	26	11	10	192	6
Lack of technical support	47	17	11	15	186	7
Problem temperature maintain in winter	41	23	15	11	184	8
Lack of technical knowledge	41	24	10	15	181	9
Effect of dealers, agents and middlemen	42	17	18	13	178	10
Lack of knowledge on disease outbreak	33	32	8	17	171	11
Interruption in power supply	34	23	18	15	166	12
Insufficient of training	32	21	25	12	163	13
Insufficient of government services	29	25	21	15	158	14
Heat stress affecting productivity & survivability	27	23	29	11	156	15
Lack of quality vaccine	23	32	15	20	148	16
Variability in feed quality	26	20	25	19	143	17
Interruption of feed supply	22	28	15	25	137	18
Unavailability of vaccine	22	18	27	23	129	19
Limited access to credit	9	28	18	35	101	20

PFI =Problem faces index

3.4 DISCUSSIONS

3.4.1 Socio-economic factors affect the potentiality of broiler production

The socio-economic conditions like age, family size, land size, level of education, training exposure and family income affecting profitability of broiler production are discussed below:

3.4.1.1 Age of the farmers

Age distribution of broiler farm owners is very important in maintaining profitable operation of a farm business. The average age of farmers in the study area was 33 years. None of the owners of the broiler farmer were below 20 years old. The highest number of owners (50%) was within the age group of 26-39 years which indicate that majority of broiler producers were relatively young (Table 5). Owners of the small scale broiler farms were relatively so young supported by Akteruzzaman *et al.,* 2009; Chowdhury *et al*., 2010; Ali *et al*., 2010; Islam *et al*., 2010. It is found that younger farmers able to provide more physical efforts in broiler farming and also create self- employment opportunity in this field.

3.4.1.2 Family size

The family size has been defined as the total number of persons living together and having meals in the same kitchen under the administration of one head of the family. According to Mcelven (1957) composition and the cultural level of farm family are important in any economic analysis of farm business. Small and medium size broiler farmers in selected areas were found range three to nine members. The average number of members in the farmer's family size was 5.7 which were higher than national average of 4.53 in the rural area of Bangladesh (BBS 2010) which agreed with Hossain *et al*., 2008; Islam *et al.*, 2010; Chowdhury *et al.,* 2010. About 50% of the farmers had medium sized family, 33% small sized and the remaining 17% large sized family. The family size had

a negative relationship with the farm size for broiler production. Hossain *et al*. (2008) reported that family size and occupation had no significant relationship with the broiler production. His findings partially supported to the current study.

3.4.1.3 Land size

In terms of land size, the farmers of the study area were categorized as landless, small, medium and large on the basis of total land holdings as stated in BBS (2011). Table 5 showed that most of the broiler farmers (50%) were small land size farmers, landless and medium farmers were 11% and 35% respectively. As per land size most of the farmers were under small category. Similar findings were reported by Akther *et al*. (2008). Also Islam *et al*. (2010) found that 26% broiler farmers were small land size. His result partially supported to the current study. Only remaining 4% large sized land was found among the broiler farmers. Similarly, Chowdhury *et al*. (2010) observed that most of the small-scale broiler farmers were resource poor having few sources of income and those who reared 100, 200 & 300 birds in a flock.

3.4.1.4 Education

The education level is generally considered as an index of social development of a community. It is also considered an important measuring bar for progressive attitude of the farm households in adopting modern and appropriate technology. Level of education has its own merits and it contributes to economic and social development. Level of education plays an important role in poultry sub-sector especially in broiler farming management. The average year of schooling of the farmers was 6.7. Table 5 showed that around 87% poultry farm owners were educated, and 13% could only sign their names. Of the farmers, about 25% poultry farm owners had primary education, 10% junior school education, 35% secondary, 10% higher secondary level education and 7% graduation. The others survey study showed 52% of the small-scale broiler farmers had only a primary level of education (Chowdhury *et al.,* 2010). Such a low level educational

background causes difficulty in understanding and applying scientific knowledge in practice, even to participate in training programme. Subsequently, productivity and profitability are suffered seriously and creates unhappiness among the farmers. Chowdhury (2011) and Miah (1990) also stated that education makes a men and women more capable of managing scarce resources and maximizing profit. While Mellor (1974) stated that education is not in itself a sufficient condition for development of poultry sub-sector of agriculture, it is certainly a necessary condition.

Chowdhury *et al*. (1993) clearly indicated that secondary level (class VI to X passed) is the appropriate level of education for trainees who were backyard poultry raisers. Chowdhury *et al.* (2011) advised that small and medium enterprise (SME) farmers must have at least Junior School Certificate (JSC) for taking trainings on commercial poultry farming. Michael *et al.* (1992) reported that education is not only an important factor for adopting an innovation but necessary tool for successful innovation of profitability.

3.4.1.5 Training of farmers

Training plays a vital role to contribute broiler production as well as profit. Training had an impact on the increased farm size. Similar results were found on the report of Akterruzzaman *et al.* (2009) who reported increased flock size, and land area to a greater extent as compared with non-trained farmers. The farmers received training on feeding, bio-security management and health care of poultry that reflection on productive performance. Most of the broiler farmers (80%) were not trained in broiler farming. Technical knowledge of farmers on broiler rearing was not satisfactory even it was poor reported by Bandara and Dassanyake (2006).

3.4.1.6 Annual income

The source of income and income level of the farmers are very important for socio-economic characteristics. The farmers had various sources of income. The average annual income of farmers was estimated by adding all income generating activities of the households. The total annual income added from different sources, i.e. income from agriculture, homestead gardening, livestock, small business, service and others. Table 5 showed that the average annual income of farmers in the study area was BDT 235,000 (BDT 78 = US$ 1.00). The low income 23% and both medium and high income level farmers were found 77% of the farmers. Farmers, who earned more profit they have the capacity to invest more on broiler production, consisted with the findings of Islam *et al.* (2009).

3.4.2 Growth performances

Small and medium scale broiler producers generally reared a number of birds that they could rear easily and sell within an appropriate time. The number of production cycles (or batches) per year depend on broiler marketing as well as the farm capacities. The number of production cycles in the farm was determined considering a number of factors including availability of day old chicks, feeds, and marketing opportunity. Farmers were sold their live broilers between at 33 and 35 days age with average marketable body weight1.73 kg/broiler in the study areas but it also depends on market price.

Among growth performances parameter, FCR was an important factor to increase the production performance as well as profitability of broiler farming. Marketable live body weight was found higher trend as the farms size increased (Table 6). Moreover, FCR was found tended to be better with an increase the size of the farm. FCR showed better trend with an increasing in the size of the farms as reported by Ali *et al.* (2014) and similar result was found in the present study. It is found that small-scale broiler farms were low performer than those

of comparatively higher farm size. The production performances of broiler farms including FCR were largely dependent on farmers' contribution but their technical knowledge, level of education, training, were not sufficient enough for achieving better performance. Poor resource base farmers, insufficient technical knowledge, low level education, little or no training might have resulted in poor management practices in small- medium size farms that might be the reasons of higher FCR.

3.4.3 Economic performance (Cost and Return)

In the present study, lower cost of production was observed in case of large farm size (Table 7). Greater economic efficiency, comparatively better management, comparatively more knowledge, training and experience were smaller counterparts which may have given this result. The Benefit cost ratio (BCR) also found higher trends with increasing farm size in accordance with earlier studies (Islam *et al*., 2010; Dwivedi *et al.,* 2010 and Kawsar *et al.,* 2013b). Chand, *et al.* (2009) also suggested that profitability is enhanced if farmers are properly trained to improve FCR value thereby reducing production cost and if bio-security is strengthened to reduce mortality under field condition. Therefore, the result of this study revealed that farmers may be advised to increase their farm size more than 600 capacity to earn profit. In addition, other factors related to performance and constraints might also have affected the present findings.

3.4.4 Factors influencing the performance of the broiler farmers

Broiler production performances were positively related with education, farm size, training, land size and age of the farmers in Table 8. It is logical that training exposure with higher education tend to be more efficient in broiler production. Within this study clearly observed that farm size is a factor to increase the production performance. Comparatively larger broiler farm size could improve their overall performance resulting profitability would be increased.

The family size had a negative significant relationship with broiler production performance as well as profitability on the basis of net return in broiler production. It was also found that family size to be a factor for impact on the production performance and sowing the co-efficient (-3.764). Low family size is an important factor leading to higher productive performance. This findings supported by Okike (2000) who reported that family size have negative influence on the production performance. His result partially supported to the present findings.

3.4.5 Constraints faced by the farmers in broiler production

Table 9 showed that among the constraints, lacking of quality chicks which is highest ranked and this constraint appeared to be a common complaint of the farmers. The findings of the present study agreed with the result of a previous survey of Chand *et al*. (2009) who concluded that chick quality occupied highest scoring among sixteen constraints of the farmers. Fluctuate price of chicks & marketable live broiler was annoying to the farmers which ranked second among the constraints. Fluctuation in market price of broilers affecting the profitability was also reported by some other researchers (Roy, 2000; Raha, 2007; Begum and Alam 2009). This might be due to the reason that the market is mostly controlled by the middlemen involved with the business. Risk of diseases including Avian Influenza (AI) was frustrating to the farmers in the study areas which ranked fourth among the constraints. The result of the present study agreed with the findings of a previous survey of Saleque and Saha (2013) reported that diseases affected the poultry and which was a major risk among the identified challenges. All these constraints should be addressed by the policy makers to ensure sustainability in the production system.

CHAPTER FOUR

Experiment 2: Production and economic performances of broiler farming with or without bio-security management intervention during summer

4.1 INTRODUCTION

Consumption of animal protein is much lower in Bangladesh than in some other countries of the world. According to Ali and Hossain (2012) with referring FAO statistics, the per capita availability of all meat is only 14.67-kg as against the requirement of 56 kg. The per capita poultry meat availability is approximately one-fifth of the consumed meat (3kg) which needs to be increased more than double to satisfy the current demand of 7.67kg (Begum *et al.*, 2010). So, there is a huge gap between requirement and availability of meat for human consumption. Statistics revealed that those are a big opportunity to increase the production through commercial broiler farming. Broiler farming has become a promising and dynamic industry with enormous potential for animal protein supply, income generation and poverty alleviation (Bhende 2006). Dolberg (2008) reported that 66% of all consumed poultry meat consumption came from commercial broiler sector. Due to short life cycle, low capital investment and quick return broiler farming plays a vital role in improving the livelihood as well as food security. Rahman *et al*. (2006) showed that commercial broiler farming provide employment opportunities for unemployed family members, improve socio-economic conditions and increase women empowerment among rural people in Bangladesh. Practicing of bio-security plays an important role for maximizing the profitability (Saleque and Rosen 2011).

Commercial poultry sector in Bangladesh grew by 20% annually up to 2007 and has supported livelihood of 6 million people directly and indirectly through 1,50,000 commercial farms. The total direct investment in this sector is about TK. 15000 crore (US$ 2.14 billion) (National Poultry Policy 2008). However, during 2007 and 2008 the recent outbreaks of avian influenza affected seriously both commercial and households poultry and caused a huge loss of TK. 4000

core (US$ 600 million) (BLRI 2008). HPAI and other diseases still remain due to various factors as multi age production practices, mixed farming, unstructured intensive poultry framing, contact with migratory and wild birds, large imports of poultry and poultry products, frequently cross border movement of people, high regional farm density and unregulated wet markets. Bio-security demands for policy intervention, building public and private partnership, enhanced practice and promotion by all stakeholders to protect poultry for maximizing the profit, producing safe food and also exploring the opportunity to enter into export market (Saleque and Rosen 2011).

According to National Committee for Protection of Poultry Industry in Bangladesh, there were about 1,14,000 small and medium enterprises (SMEs) in June 2010, 98000 in December 2010 and 74000 in March 2011 in the country of which 52% farm size between 500 and 5000 birds and the rest were very small with 100-500 birds which were treated as small-scale farms. The profitability of broiler farming is affected by various factors i.e. farm size, training, education, farming experience, bio-security etc. The large commercial broiler producers are able to overcome problems as they have high investment in this sector. On the other hand, small scale rural broiler producers, although take up poultry production as a means of self – employment to maintain livelihood, mostly fail to manage their farms efficiently due to their limited resources, lack of knowledge and very low investment. As a result, their profitability is not in a good condition. Sometimes, farmers could draw profit but at other times they incur loss. Due to high price of chick and feed and failure to obtain fair price of their products, if further aggravates the situation. Therefore, farmers are demotivated to continue farming. Besides, some farmers are illiterate and they do not have adequate knowledge about the nature of inputs to use and how to make profitability production. In addition, the size of farm also affects their management procedure and consequently their profit. The Government, NGOs and other organizations always encourage the rural farmers for poultry production but the minimum farms size for profitability production is yet to be determined. In view of current scenario in Bangladesh,

broiler can play a vital role in meeting the deficiency of people as well as improvement of rural livelihood but the number of farms has been decreasing trend in the recent years due to a number of factors (Chowdhury, 2013). It is therefore important to generate information on profitability from broiler farms in practicing under bio-secured and non-biosecured conditions. A baseline survey provided necessary information related to feed consumption, feed conversation ratio, survivability, cost items (recurring and non-recurring), income of broiler farm etc. that are currently practicing in the farms. The present study was conducted in Rajshahi, Pabna and Kishoregonj districts, where broiler farming is mostly concentrated. The present study was taken to determine the status of productive and profitability performances of bio-secured and non-biosecured broiler farming during summer season under field conditions reared in different locations of Bangladesh and to identify the constraints of small and medium scale broiler farming.

4.2 MATERIALS AND METHODS

4.2.1 Selection of the broiler farms

As per objectives of the study, Rajshahi, Pabna and Kishoregoanj districts were selected considering the concentration of broiler farms in those areas. Broiler raisers were selected with the help of officials of District Livestock Office (DLO), feed seller agent and local representative of different renowned company from the above mentioned districts. A total 41 broiler farms were selected in summer season (March-June) for the year of January 13 to June 2014 who reared broiler under bio-secured and non-biosecured condition. The broiler farms were categorized on the basis of bio-secured and non-biosecured management standard of 100 marks. According to bio-security standard, small scale broiler farm got above 60 marks treated as bio-secured farms, and below 60 marks treated as non-biosecured farms out of 100 marks (Table 10).

Table 10. Score card for bio-security standard applied in small scale broiler farm

Sl. No.	Measures	Total Marks	Marks obtained	Comments
	A. Conceptual			
1	Have clear idea about biosecurity and flock management	10		
2	Have collected information of poultry from neighbor	5		
	B. **Structural**			
	Environment for rearing poultry			
3	Poultry house constructed with minimum facilities (Air flow, light, floor space according to the recommendation)	10		
4	Presence of buffer zone and service room in poultry farm	5		
5.	Absence of native chicken, duck and pigeon within 100 meter from the farm	5		
6.	There is no poultry processing plant or wet market within 500 meter of the poultry farm	3		
7.	Poultry house is not very close to the main road (less than 50 meter)	2		
	Poultry farm characteristics			
8	Presence of entry guideline	3		
9	Provision of pure water for the poultry farm	2		
	Wild animal			
10	Presence of wild birds, predators and rodents protection system	5		
11	Presence of files, mosquito, cockroach and other insects protection system	2		
	C. **Operational**			
12	Farmer's/ employers do not work in other farms nor they have family poultry	3		
13	Visitors record maintained	2		
14	Vehicles kept 30 meter away from the farm	3		
	Management			
15	Practice all in all out system	7		
16	Interval between the batches minimum 14 days	5		
17.	Proper storage of feed	5		
18	Proper waste disposal system	8		
19	Removal of dead bird from the shed immediately after detection	5		
	Cleaning and disinfection			
20	Equipment are not brought from outside without proper cleaning and disinfection	5		
21	Regular cleaning and disinfection of the farm	5		
	Total Marks	100		

Standard= 80 and above; Good= 70-79; Moderate= 60-69 and Bad/ Non-biosecurity= Below 60 Overall Comments: Standard/ Good/ Moderate/Bad

Source: Third meeting (12 November, 2009) of PTDDP Biosecurity Standard Development Committee, Bangladesh Livestock Research Institute (BLRI), Savar.

4.2.2 Selection of sample size

The total sample sizes were 41 containing bio-secured and non-biosecured broilers farms that are using same feed and broiler strain at their farms. The farm sizes were 500, 600,700,800,900 and 1000 broilers in number. Of the 41 farms, 21 were selected as bio-secured and 20 taken as non-biosecured from the said three districts to carry out research (Table 11).

Table 11. Lay out of sample sizes according to farm category and location during summer season

Farm category	Farm location			Total
	Rajshahi	Pabna	Kishorgonj	
Bio-secured farm	7	7	7	21
Non-biosecured farm	7	7	6	20
Total	14	14	13	41

4.2.3 Preparation of the survey schedule

A draft survey schedule was prepared. Before finalization of the draft schedule, it was pre-tested in the study areas. After pre-testing, final survey schedule was developed through necessary corrections and modifications. The questions were arranged systematically, so that the respondent could provide information in a consistent and systematic manner. The survey schedule was then prepared and copied in its final form for the collection of data. The questionnaire contained the following major information's.

a. General information (Age, broiler farming experience, farm size, training on farming, education)
b. Feed conversion per broiler
c. Feed consumption according to age
d. Survivability
e. Cost items included the non- recurring and recurring costs of broiler farms. The following cost items are included
    i. Housing
    ii. Equipment
    iii. Chick

iv. Feed
v. Transportation
vi. Labour
vii. Vaccination and medication

f. Income from broiler and others
g. Adoption of bio-security measurement
h. Information on disease and prevention

4.2.4 Data collection and farm categorization

To achieve the objectives as stated above field level primary data were collected from a total of 41 broiler farmers of which 14 in Rajshahi, 14 in Pabna and 13 in Kishergonj district of Bangladesh. Before the collection of data, the objectives of the study were clearly explained to each of the farmers. All possible care was taken to obtain accurate and reliable data. Interview was done according to the convenience of the farmers. The collected data were then edited and categorized as per different farm sizes (500, 600, 700, 800, 900 & 1000 farm sizes). Among 41, 11 broiler farmers had 500 birds, 09 farmers had 600 birds, 06 farmers had 700 birds, 06 farmers had 800 birds, 05 farmers had 900 birds and 04 farmers had 1000 birds which were treated as small and medium scale broiler farms. According to farm size, data were summarized meaningfully and were processed by using master tabulation sheet. The author himself collected data during the month of January 13 to June 2014. Data collection was completed through several visits by the researcher.

4.2.5 Data Processing

The recorded data on production and profitability of broiler farming e.g. Body weight, Feed consumption, Feed conversion ratio (FCR) & survivability and total cost, return/broiler, gross return, net return and cost benefit ratio were determined as variable indicators under bio-secured and non-biosecured condition. FCR of different farm size was determined by dividing the average feed intake by the average live body weight of the broiler in each farm.

FCR= Total feed intake/average live body weight

Survivability was calculated by dividing the no. of harvested broiler by the no. of broiler bought in each farm and multiplies by one hundred. Survivability was also calculated by using following formula:

Survivability% = No. of broiler harvested/ No. of broiler bought ×100

On the other hand, total re-curing cost was determined by addition of different cost (feed, chick, transport, vaccine & medication, electricity, labour and operational cost) of the broiler in each farm. Besides, total non-recuring cost was determined by addition of different cost (depreciation cost for housing, equipment, land utilization and family labor). The total return of broiler produced was determined by multiplying the average total yield by the market price per kg and was expressed as Taka/batch. Net return was measured by deducting the total cost from the gross return. The benefit cost ratio (BCR) was determined by dividing the gross return by the total cost of the broiler of each farm.

BCR= Gross return/total cost

4.2.6 Statistical Analysis

The data were analysed using SPSS 11.5 (2003) program to compare broiler growth and profitability performances between bio-secured and non-biosecured farm in summer season at different locations.

4.2.7 Bio-security management intervention in summer

Table shows a comparison between bio security and non-biosecurity managed broiler farming during summer:

Table 12. Difference between with and without bio-security intervention in broiler farming

Factors	Without bio-security intervention	With bio-security intervention
Bio-security of the farms	Weak biosecurity. Farm owner, family members or even jointly reared their broiler farms.	Comparatively strong biosecurity. Foot bath, farm dress and sponge were strictly maintained during farm operation. Visitors and other than farm owners were restricted, disinfectant sprayed inside and outside the farm.
Vaccination	Somebody followed vaccination program.	Everybody followed vaccination schedule.
Use of antibiotic	Indiscriminate use in drinking water	Less application of antibiotics.
Training	Most of farmers were not trained	Most framers were trained about the principles of broiler farming.
Use of electrolyte	Seldom practiced electrolyte and vitamin supplementation.	Everybody practiced electrolyte and vitamin supplementation during hot weather.
Drinking water	Supplied water regularly but water temperature was not considered.	Most cases farmers supplied cold, clean and fresh water considering the environmental temperature.
Litter management	Somebody used reused litters and rarely practiced racking and stirring litters.	Everybody used fresh litters and 2-3 times racking and stirring were done in a day during cool hours.
Knowledge management on feed nutrient	Most of the farmers were not introduced	Most of the farmers were introduced

4.2.8 Problem faced during data collection

Although all possible attempts and precautions were taken, some difficulties were encountered during investigations that are given below:

1) The most of the farmers hesitated to give answer the questions since the researcher was unknown to them.

2) In fact, they hesitated to answer some questions relating to income and asset, because they were afraid of tax imposition or tax increase. Sometimes they provided misleading information that caused wide variation between the collected information and actual view. To overcome the problem a good deal of time was spent to build rapport with them.

3) It is difficult to convince the farmers on the importance of the study.

4) In some cases, selected farmers were not available at home because they remained busy with other outside activities. In that cases, more than two visits are conducted a single interview.

5) At the time of interview, the respondents asked the researcher on many cases that what benefits they would get from the researcher.

6) Another important limitation of the survey was that the researcher had to depend solely on the memory of the farm owners for collecting necessary information because they did not keep written records in many cases.

PLATE 2

Bio-security conditions between the two farm categories

Bio-secured and Non-biosecured farm

Photo 5: Environmentally clean Farm

Photo 6: Environmentally unclean Farm

Photo 7: Fence is found around the farm

Photo 8: No fence is found around the farm

Photo 9: Make option is found to keep both sides open shed

Photo 10: No make option is found to Keep both sides open sheds

Photo 11: Cleaning and use lime around the farm

Photo 12: No cleaning and no use lime around the farm

Photo 13: Moderate bio-secured farm

Photo 14: Poor bio-secured farm

4.3 Results

4.3.1 Bio-security level of broiler farms

The bio-security levels of broilers farm are shown in Table 13. In terms of bio-security levels of broiler farming, only 5% farms followed standard practice of bio-security, 16% farms followed good practices, 34% farms fell in moderate category and reaming 45% farms in poor category (non-biosecured farm) securing 80 and above, 70-79, 60-69 and below 60 marks, respectively.

Table 13. Summary of bio-security level of broiler farms in different farm sizes

Farm Size	No. of standard farms (80 and above)*	No. of good farms (70-79)*	No of moderate farm (60-69)*	No. of poor farms (non- biosecured farm -Bellow 60)*
500	0	03 (14%)	09 (42%)	09 (44%)
600	01 (05%)	03 (16%)	06 (33%)	08 (46%)
700	01 (7%)	02 (14%)	0 3 (21%)	08 (58%)
800	01 (06%)	0 1 (6%)	05 (33%)	08 (55%)
900	01 (08%)	03 (25%)	04 (33%)	04 (34%)
1000	01 (10%)	03 (30%)	04 (40%)	02 (20%)
Total	05 (5%)	15 (16%)	31 (34%)	39 (45%)

*= Mark range

4.3.2. Status of bio-security measures in broiler farming

The statues of bio-security measure are shown in table 14. In Table 14 observed that most of the measures were followed by the bio-security containing broiler farms than non-biosecured farms. The 91% bio-secured broiler farms were followed fully vaccination schedule where 40 % non-biosecured broiler farms fully followed the schedule. On the other hand, bio-secured broiler farmers followed 100% all in all out system where only 75% broiler farmers followed all in all out system in case of non-biosecured

managed farm. Besides, 33% bio-secured broiler farmers were made fence around shed where only 10% non-biosecured broiler farmers used this practice.

Table 14. Status of bio-security measures in different broiler farming

	Bio-secured farm			Non-biosecured farm		
Bio-security measures %	**Full**	**Partial**	**Not done**	**Full**	**Partial**	**Not done**
Keep environment clean	75	25	0	13	87	0
Shed clean and odor free	83	16	0	0	87	13
Make fence around shed	33	16	50	10	0	90
Make option to Keep both sides open of sheds	91	8	0	30	70	0
Use dry litter	83	16	0	20	80	0
Cleaning and use lime around the farm	83	16	0	60	20	20
Use footbath	25	16	58	0	10	90
Spray visitors before entering sheds	33	50	16	16	50	30
Clean at every day of feeding and watering pot	33	66	0	0	90	10
Follow all in all out system	100	0	0	75	25	0
burn or bury dead chicks	92	8	0	60	30	10
Follow vaccination schedule	91	9	0	40	60	0

4.3.3 Growth performances as per farm size

The performance of small and medium scale broiler units of 500, 600, 700, 800, 900 and 1000 broilers that were achieved under rural and semi-urban condition in Table 15. Table 15 shows that farm size had no significant effect

on feed consumption and survivability. But farm size was significantly different (P<0.05) on FCR and marketable body weight. The highest marketable body weight was seen in 1000 farm size with lower FCR. It was seen that feed consumption and FCR had tended to be better with increasing size of the farm. Poor live weight achieved in the smallest farm size in compression with other increasing farm sizes.

Table 15. Effect of farm size on the growth performances of broiler

Variable						
		Body weight				
Farm size	Rep	MBWT (kg/bird)	Marketing age (day)	FC (Kg/bird)	FCR	Survivability (%)
500	11	1.64[b]	33.64	3.20	1.96[a]	95.70
600	9	1.71[ab]	34.44	3.13	1.85[ab]	95.40
700	6	1.72[ab]	35.00	3.12	1.82[ab]	94.21
800	6	1.76[ab]	35.00	3.12	1.78[ab]	93.91
900	5	1.79[ab]	33.60	3.03	1.69[ab]	93.33
1000	4	1.88[a]	34.75	3.06	1.63[b]	92.67
SED	41	0.022	0.330	0.051	0.036	0.464
Level of significance		*	NS	NS	*	NS

Rep = Replication; MBWT= Marketable body weight; FC= Feed consumption; * = P<0.05; NS=Non- significant ; , Means having dissimilar superscript differ significantly

4.3.4 Growth performances as per farm category

The survivability was significantly (P<0.05) affected by the farm category (Table 16). No significant difference was observed between bio-secured and non-biosecured farms in marketable body weight, feed consumption and FCR. But marketable bodyweight was found higher in bio-secured farm in comparison with non-biosecured farm but no significantly difference was found. The FCR value of bio-secured managed farm at field level in the present study was 1.77, whereas it was 1.88 when bio-security management was

absent. The overall FCR was improved in bio-secured managed farm than those of non-biosecured managed farm. Interaction effects of farm size and farm category (FS× FC) on the growth performances showed significantly difference ($P<0.05$ and $P<0.01$) of feed consumption and FCR but marketable body weight and survivability showed non-significant result (Table 17). All interaction effect of farm size, farm category and farm location (FS × FC× FL) on growth performances showed non-significant results (Table 18).

Table 16. Effect of farm category on the growth performances of broiler

	Variables				
	Body weight		**FC Kg/bird**	**FCR**	**Survivability %**
Farm Category (FC)	MBWT (kg/broiler)	Marketing age (day)			
Bio-secured Managed Broiler Farm	1.797	34.739	3.180	1.773	95.455
Non- Biosecured Managed Broiler Farm	1.634	33.778	3.056	1.886	93.434
SED	0.033	0.508	0.055	0.055	0.742
Level of significance	NS	**	NS	NS	*

**, P<0.01; *, P<0.05; NS, Non- significant, MBWT= Marketable body weight

Table 17. Effect of interaction of farm size (FS) and farm category (FC) on the growth performance of broiler

Interaction (FS X FC)	Variables			
	MBWT (Kg/br)	FC (Kg/br)	FCR	Survivability(%)
FS_1 X FC1	1.80	2.92	1.63	97.18
FS_1 X FC2	1.65	3.13	1.90	93.95
FS_2 X FC1	1.86	2.97	1.60	92.22
FS_2 X FC2	1.74	2.92	1.68	94.96
FS_3 X FC1	1.93	3.15	1.64	96.99
FS_3 X FC2	1.77	2.77	1.57	93.72
FS_4X FC1	1.86	3.05	1.64	96.75
FS_4X FC2	1.73	3.13	1.82	96.75
FS_5 X FC1	1.99	3.11	1.56	95.44
FS_5 X FC2	1.70	2.81	1.66	94.07
FS_6X FC1	1.94	2.95	1.52	92.73
FS_6X FC2	1.75	3.05	1.74	91.83
SED	0.02	0.03	0.02	0.49
Level of significance	NS	*	**	NS

Br, Broiler; FC1, Bio-secured Farm; FC2, Non-biosecured farm; FS_1, Farm containing 500 birds; FS_2, Farm containing 600 birds; FS_3, Farm containing 700 birds; FS_4, Farm containing 800 birds; FS_5, Farm containing 900 birds; FS_6, Farm containing 1000 birds; SED, Standard error of difference; **, $P<0.01$; *, $P<0.05$; NS, Non-significant

Table 18. Interaction effect of farm size (FS), farm category (FC) and farm location (FL) on the growth performances of broiler

Interaction (FSX FC X FL)	Parameters			
	Body weight (kg/Br.)	Feed consumption (kg/Br.)	FCR	Survivability (%)
FS_1 XFC_1 X FL_a	1.79	3.4	1.91	97.57
FS_1X FC_1 X Fl_b	1.72	2.99	1.74	97.14
FS_1X FC_1 X Fl_c	1.74	3.03	1.74	97.11
FS_1X FC_2 X Fl_a	1.58	3.19	2.01	90.83
FS_1 X FC_2 X Fl_b	1.53	3.03	1.99	93
FS_1 X FC_2 X Fl_c	1.52	2.98	1.96	93.66
FS_2 XFC_1 X FL_a	1.75	2.95	1.69	92.67
FS_2X FC_1 X Fl_b	1.8	2.94	1.64	92.98
FS_2X FC_1 X Fl_c	1.72	3.02	1.76	96.85
FS_2X FC_2 X Fl_a	1.81	3.13	1.73	95.24
FS_2 X FC_2 X Fl_b	1.64	2.9	1.77	95.55
FS_2X FC_2 X Fl_c	1.61	2.94	1.83	95.49
FS_3 XFC_1 X FL_a	1.9	3.4	1.79	97.33
FS_3X FC_1 X Fl_b	1.78	3.11	1.75	97.13
FS_3X FC_1 X Fl_c	1.63	3.01	1.85	96.2
FS_3X FC_2 X Fl_a	1.65	3.3	2.03	91.66
FS_3 X FC_2 X Fl_b	1.66	2.88	1.74	93.81
FS_3X FC_2 X Fl_c	1.6	3	1.88	94.79
FS_4 XFC_1 X FL_a	1.8	3.83	2.13	96.9
FS_4X FC_1 X Fl_b	1.8	3	1.69	98.45
FS_4X FC_1 X Fl_c	1.83	3.05	1.67	95.83
FS_4X FC_2 X Fl_a	1.73	2.99	1.73	96.77
FS_4X FC_2 X Fl_b	1.52	3.01	1.99	94.54
FS_4X FC_2 X Fl_c	1.63	3.23	1.99	95.82
FS_5 XFC_1 X FL_a	1.91	3.26	1.71	94.14
FS_5X FC_1 X Fl_b	1.86	2.97	1.61	93.94
FS_5X FC_1 X Fl_c	1.68	2.97	1.79	95.85
FS_5X FC_2 X Fl_a	1.81	2.99	1.66	96.87
FS_5 X FC_2 X Fl_b	1.51	2.74	1.81	94.14
FS_5X FC_2 X Fl_c	1.84	2.97	1.61	95.25
FS_6 XFC_1 X FL_a	1.83	3.13	1.71	89.08
FS_6X FC_1 X Fl_b	1.82	2.95	1.62	97.07
FS_6X FC_1 X Fl_c	1.81	2.97	1.65	95.76
FS_6X FC_2 X Fl_a	1.95	3.25	1.69	89.78
FS_6 X FC_2 X Fl_b	1.8	2.62	1.47	96.18
FS_6X FC_2 X Fl_c	1.64	3	1.83	92.75
SED	0.109	0.156	0.105	1.529
Level of significance	NS	NS	NS	NS

NS, Non-significant; FS, Farm size; FC, farm category; FL, farm location; FS_1, Farm containing 500 broilers; FS_2, Farm containing 600 broiler; FS_3, Farm containing 700 broilers FS_4, Farm containing 800 broilers; FS_5, Farm containing 900 broilers; FS_6, Flock containing 1000 broilers; SED, Standard error of difference; FCR= Feed conversion ratio; FC_1, Bio-secured farm ; FC_2, Non bio-secured farm ; Fla, Rajshahi; FLb, Pabna; FLc, Kishoregoanj.

4.3.5 Cost of broiler production

The total costs of the broiler farming were categorized into non- recurring and recurring costs.

4.3.5.1 Non recurring cost and farm size

The findings indicate that the estimated non-recurring costs were statistically significant (P<0.01) among various farm sizes (Table 19). The highest non-recurring cost was found in the smallest size of the farm (500) and the lowest non-recurring cost was seen in comparatively higher of 900 farm size, whereas remaining farm size were differed each other. The labour cost covered ranging from 0.94 to 2.75 percent per bird of the total cost that shared the major portion of the fixed cost. The non-recurring cost was found BDT from 2.23 to 6.59 per bird of the total cost among different farm sizes (Appendix 2).

Table 19. Effect of farm size on non- recurring cost of broiler farming

		Cost per bird %				
Farm size	Rep	Depreciation cost for housing	Depreciation cost of equipment	Land utilization cost	Family labour	Non-recurring cost
500	10	0.140^{a}	0.087^{a}	0.084	2.759^{a}	3.07^{a}
600	9	0.085^{b}	0.074^{ab}	0.075	2.210^{a}	2.44^{a}
700	6	0.087^{b}	0.070^{ab}	0.074	2.367^{a}	2.59^{a}
800	6	0.051^{bc}	0.043^{ab}	0.053	1.205^{b}	1.35^{b}
900	5	0.071^{bc}	0.067^{ab}	0.085	0.941^{b}	1.16^{b}
1000	4	0.022^{c}	0.019^{b}	0.035	1.102^{b}	1.17^{b}
SED		0.018	0.087	0.013	0.349	0.369
Level of significance		**	*	NS	**	**

**, p<0.01; *, P<0.05 and NS, Non-significant; Means having dissimilar superscript differ significantly

4.3.5.2 Non-recurring cost and farm category

Table 20 showed that, average 2.45% non- recuring cost of per bird of the total cost was found in bio-secured farming condition. Besides, the 1.93 % non-recurring cost was observed per bird of the total cost in non-biosecured

managed farm. The non-recurring cost did not significantly differ (P>0.05) with farm category (Table 20). Interaction effects of farm size, farm location and farm category on non-recurring cost showed non- significant result (Appendix 5).

Table 20. Effect of farm category on non-recurring cost of broiler farming

	Cost per bird%				
Farm Category (FC)	Depreciation cost of housing	Depreciation cost of equipment	Land utilization cost	Family labour	Non-recurring cost
Bio-secured managed broiler farm	0.085	0.054	0.068	2.248	2.455
Non-Biosecured managed broiler farm	0.093	0.082	0.076	1.685	1.936
SED	0.018	0.016	0.013	0.349	0.369
Level of significance	NS	**	NS	NS	NS

**, P<0.01; NS, Non- significant

4.3.5.3 Recurring cost of broiler farming

Chick cost

The chick cost was not observed significantly difference (P>0.05) among the farm sizes and between the farm category (Table 21 & 22). The highest prices of chicks were found in 500 farm sizes where lowest price was seen in 1000 farm size in appendix 4. In this study, chick cost was found 20.00% of the total cost of broiler production for bio-secured managed farm and 20.43% were found of chick cost for non-biosecured managed farm (Table 22). No significant interaction effects (FS × FC × FL) was found in chick cost of small and medium scale broiler farming at rural Household levels (Appendix 5).

Feed cost

The feed cost was not observed significantly difference (P>0.05) among the farm sizes and between the farm category (Table 21 & 22). The feed cost accounted which was 66 to 70 % of the total cost of broiler production depending on variation in farm sizes. In bio-secured management condition,

68.49% feed cost was involved and in non-biosecured management condition it was 66.69% (Table 22). The highest & lowest feed cost were observed 70.27% and 65.96% per bird in 1000 & 900 farm sizes (Table 21) of the total cost. All interaction effects (FS × FC × FL) on recurring cost showed non- significant results (Appendix 5).

Vaccination &medication cost

Vaccination and medication cost was affected among the farm sizes and significant difference was found (P <0.01) but it was not significantly (P>0.05)) affected by the farm category (Table 21 and 22). The highest vaccination and medication cost (4.65%) per bird was found in non-biosecured managed farm whereas lowest vaccination and medication cost (4.41%) was found in bio-secured managed farm (Table 22). On the other hand, veterinary expenses were higher in non-biosecured managed farms in comparison with bio-secured managed farms. The highest & lowest vaccine & medication cost were observed 4.91% and 3.38% per bird in 600 & 1000 farm sizes respectively of the total cost (Table 21).

Table 21. Effect of farm size on recurring cost of broiler farming

Farm size	Rep	Cost per bird (%)					
		Chick cost	Feed cost	Vaccine & medication cost	Electrical Cost	Other operational cost (litter, lime transportation cost etc.)	Recurring cost
500	11	20.32	66.92	4.82^{a}	1.42^{a}	3.18	96.66
600	9	20.89	67.40	4.91^{ab}	1.20^{ab}	2.99	97.39
700	6	18.85	67.95	4.41^{c}	0.82^{c}	4.11	96.14
800	6	19.96	69.19	3.86^{bc}	0.95^{bc}	3.93	97.89
900	5	21.16	65.96	4.84^{ab}	1.28^{ab}	4.13	97.37
1000	4	19.38	70.27	3.38^{c}	0.88^{c}	4.16	98.07
SED	41	1.24	1.69	0.43	0.12	0.36	2.72
Level of significance		NS	NS	**	*	NS	NS

*, P<0.05; **, P<0.01; NS, Non-significant ; Means having dissimilar superscript differ significantly

Table 22. Effect of farm category on recurring cost of broiler farming

Farm Category (FC)	Cost per bird %					
	Chick cost	Feed cost	Vaccine & medication cost	Electrical cost	Others operational cost (litter, lime transportation cost etc.)	Recurring cost
Bio-secured managed broiler farm	20.00	68.49	4.41	1.22	3.39	97.51
Non-Biosecured managed broiler farm	20.43	66.69	4.65	1.06	3.82	96.65
SED	1.24	1.69	0.43	0.12	0.36	2.72
Level of significance	NS	NS	NS	NS	NS	NS

NS, Non-significant

Electrical cost: The electricity cost was differed significantly (P<0.05) among the farm sizes (Table 21). Electricity cost was lower trends with increasing in the size of the farm. The highest electricity cost (1.42%) per bird was incurred in 500 farm size and the lowest cost (0.82%) was found in 700 farm size. Electricity cost was found almost similar between bio & non bio-secured managed farm with non-significant difference (P>0.05) which is shown in Table 22.

Others operational cost: Others operational costs including litter, lime, transportation etc. were involved in broiler production. Others operational costs were not observed significantly difference (P>0.05) among the farm sizes as well as within the farm category (Table 21 &22).

4.3.6 Return from broiler farming

Table 23 shows that the highest and lowest total cost BDT 214.73 & 189.15 were observed per bird in 500 & 1000 farm sizes respectively. But no significant difference (P>0.05) was observed of total cost among the farm sizes. The total cost of broiler farming had lower trends as the farm size increased. In terms of return/broiler, no significant difference (P>0.05) was observed among the farm sizes. But significantly differences were observed

among the farm sizes in case of droppings ($P<0.05$), gross return ($P<0.01$), BCR ($P<0.01$), net return (BDT)/broiler ($P<0.01$) and net return (Kg) broiler ($P<0.05$) which is shown in table 23. The gross return (which picked up from the marketing of live broilers) indicated that it was increasing trend with increasing the size of the farm. About effect of farm category, bio-security management intervention had a significant ($P<0.01$) effect on gross return of broiler farming (Table 24). Overall net return/broiler was better in bio-secured managed farm than non-biosecured managed farm. BCR also found increasing trend with increasing size of the farms. The highest BCR (1.17) was found in bio-secured managed farm in comparison with non-biosecured managed farm (1.03). The net return/broiler and BCR values were positively related with the farm size and significant difference ($P<0.01$) was found among the farm sizes (Table 23). The benefit cost ratio had significant difference ($P<0.01$) between the bio-secured and non-bio-secured managed farm (Table 24).

Table 23 showed the net return was Tk. -1.69, 9.33, 7.18, 17.48, 18.08 and 29.10/kg in 500.600,700,800,900 and 1000 farm sizes, respectively. As table 23, large farm size was most profit efficient than that of other five smaller size farms. The highest net profit, Tk. 29.10/kg was found in 1000 farm size and lowest, Tk. -1.69/kg had in 500 farm size. It is indicated that if the farm size increased the net return also increased. Table 24 showed that net return (Tk)/Kg was found significantly difference ($P<0.01$) between the farm category. The net return (Tk)/Kg was found higher when bio-security management was practiced by the broiler farmers (Table 24). Overall, profitability was found to be higher in bio-secured managed farm compared to non-biosecured managed farm. Interaction effects of farm size and farm category (FS× FC) on the profitability showed significantly difference ($P<0.01$) of total cost and gross return but BCR and Net return (Tk./Kg) showed non-significant result (Table 25). All interaction effects (FS × FC × FL) on profitability performances showed non- significant results (Table 26).

Table 23. Effect of farm size on profitability of broiler farming

Farm Size	Rep	Parameters						
		Total cost Tk./broiler	Return (Tk./ broiler)	Droppings return (Tk./broiler)	Gross return (Tk./broiler)	Benefit Cost Ratio	Net return (Tk./broiler)	Net return (Tk./Kg)
500	11	214.73	213.67	1.20^{b}	214.87^{b}	1.01^{c}	-1.06^{c}	-1.69^{c}
600	9	205.30	221.87	1.53a^{b}	223.23^{b}	1.09b^{c}	16.57^{bc}	9.33^{bc}
700	6	208.50	222.95	1.09^{b}	223.86^{b}	1.09b^{c}	14.45^{bc}	7.18b^{c}
800	6	197.10	228.58	1.47^{ab}	229.81^{ab}	1.17^{ab}	31.49^{ab}	17.48^{ab}
900	5	199.43	232.96	1.99a	234.95^{ab}	1.18^{ab}	33.53^{ab}	18.08^{ab}
1000	4	189.15	244.08	2.04^{a}	246.11^{a}	1.30^{a}	54.92^{a}	29.10a
SED	41	2.76	2.92	0.09	2.93	0.02	4.57	2.60
LS		NS	NS	*	**	**	**	*

*, P<0.05; **, P<0.01; NS, Non-significant ; LS, level of significance

Table 24. Effect of farm category on profitability of broiler farming

Farm Category (FC)	Parameters						
	Total cost (Tk./broiler)	Return (Tk./broiler)	Droppings return (Tk./broiler)	Gross return (Tk./broiler)	Benefit Cost Ratio	Net return (Tk./broiler)	Net return (Tk./Kg)
Bio-secured managed broiler farm	201.85	233.66	1.67	235.11	1.17	31.81	17.19
Non-Biosecured managed broiler farm	208.59	212.41	1.27	213.68	1.03	3.82	1.37
SED	2.99	2.77	0.16	2.78	0.03	4.74	2.50
Level of significance	NS	**	**	**	**	**	**

**, P<0.01; NS, Non-significant

Table 25. Effect of interaction of farm size (FS) and farm category (FC) on profitability of broiler farming

Interaction (FS X FM)	Total cost (Tk./Br)	Broiler return (Tk./Br)	Droppings return (Tk./Br)	Gross return (Tk./Br)	Benefit cost ratio	Net return (Tk./Br)	Net Return (Tk./kg)
FS_1 X FC1	209.36	234.22	1.33	235.33	1.13	24.85	13.12
FS_1 X FC2	213.39	214.18	0.92	215.09	1.01	0.79	0.57
FS_2 X FC1	209.73	241.15	1.30	242.45	1.17	31.42	16.90
FS_2 X FC2	212.11	225.94	1.15	227.09	1.07	13.83	7.90
FS_3 X FC1	204.32	250.90	1.79	252.69	1.24	46.58	24.09
FS_3 X FC2	207.03	230.10	1.51	231.61	1.12	23.07	12.88
FS_4X FC1	197.79	241.48	1.17	242.35	1.23	43.69	23.26
FS_4X FC2	208.70	224.38	1.32	225.70	1.08	15.68	8.78
FS_5 X FC1	195.76	258.96	1.83	260.79	1.34	63.20	31.52
FS_5 X FC2	200.79	220.35	1.49	221.84	1.11	19.56	11.89
FS_6X FC1	183.08	252.20	2.02	253.81	1.40	69.12	35.57
FS_6X FC2	177.24	227.50	1.32	228.82	1.29	50.26	28.72
SED	2.29	2.61	0.08	2.65	0.02	3.61	1.82
Level of significance	**	*	NS	**	NS	NS	NS

FC1, Bio-secured Farm; FC2, Non-biosecured farm; FS_1, Farm containing 500 birds; FS_2, Farm containing 600 birds; FS_3, Farm containing 700 birds; FS_4, Farm containing 800 birds; FS_5, Farm containing 900 birds; FS_6, Farm containing 1000 birds; SED, Standard error of difference.

Table 26. Interaction effect of farm size (FS), farm category (FC) and farm location (FL) on the profitability of broiler farming

Interaction (FSX FC X FL)	Economic Parameters						
	Total cost (BDT)	Return broiler (BDT)	Droppings Return/broiler (BDT)	Gross return/ Broiler (BDT)	Benefit cost ratio	Net return/ Broiler (BDT)	Net return/Kg (BDT)
FS_1 XFC_1 X FL_a	219.56	226.85	1.26	228.11	1.05	7.29	3.30
FS_1X FC_1 X Fl_b	206.01	227.50	1.58	229.08	1.11	21.49	12.17
FS_1X FC_1 X Fl_c	208.23	222.95	1.00	223.95	1.08	14.73	8.06
FS_1X FC_2 X Fl_a	233.18	203.45	1.25	204.70	0.88	-29.73	-19.04
FS_1 X FC_2 X Fl_b	211.32	188.50	1.00	189.50	0.90	-22.82	-15.74
FS_1 X FC_2 X Fl_c	208.40	200.20	1.00	201.20	0.98	-8.20	-5.91
FS_2 XFC_1 X FL_a	201.42	214.50	1.23	214.50	1.06	13.08	7.93
FS_2X FC_1 X Fl_b	208.02	235.73	1.52	237.25	1.14	27.72	15.30
FS_2X FC_1 X Fl_c	198.65	224.90	1.42	226.32	1.14	26.26	15.18
FS_2X FC_2 X Fl_a	224.57	228.80	1.54	230.34	1.03	4.23	2.40
FS_2 X FC_2 X Fl_b	200.19	198.25	1.66	199.91	1.00	-1.94	-1.32
FS_2X FC_2 X Fl_c	208.23	187.70	1.00	188.70	1.10	-20.53	-12.75
FS_3 XFC_1 X FL_a	202.81	256.10	1.30	256.10	1.26	53.29	27.05
FS_3X FC_1 X Fl_b	211.32	200.50	1.00	189.50	1.05	-10.82	-6.07
FS_3X FC_1 X Fl_c	197.48	211.90	0.83	212.73	1.08	14.42	8.84
FS_3X FC_2 X Fl_a	251.92	200.20	1.33	201.53	0.80	-51.72	-33.59
FS_3 X FC_2 X Fl_b	186.09	224.25	1.01	225.26	1.21	38.17	22.05
FS_3X FC_2 X Fl_c	226.61	221.00	1.25	222.25	0.98	-5.61	-3.30
FS_4 XFC_1 X FL_a	234.09	240.50	3.00	243.50	1.04	6.41	3.46
FS_4X FC_1 X Fl_b	187.94	252.20	1.00	252.20	1.34	64.26	33.12
FS_4X FC_1 X Fl_c	193.82	247.00	1.00	248.00	1.28	53.18	27.99
FS_4X FC_2 X Fl_a	191.88	211.90	1.45	213.35	1.11	20.02	12.28
FS_4X FC_2 X Fl_b	175.64	198.90	0.95	199.85	1.14	23.26	15.20
FS_4X FC_2 X Fl_c	199.20	221.00	0.95	221.95	1.11	21.80	12.82
FS_5 XFC_1 X FL_a	185.72	253.50	2.15	255.65	1.38	67.78	34.76
FS_5X FC_1 X Fl_b	192.93	233.35	2.33	235.68	1.22	40.43	22.51
FS_5X FC_1 X Fl_c	193.82	247.00	1.00	248.00	1.28	53.18	27.99
FS_5X FC_2 X Fl_a	226.41	241.80	1.50	243.30	1.07	15.39	8.27
FS_5 X FC_2 X Fl_b	199.17	202.80	1.66	204.46	1.03	3.63	2.33
FS_5X FC_2 X Fl_c	199.20	221.00	0.95	221.95	1.11	21.80	12.82
FS_6 XFC_1 X FL_a	196.40	234.00	2.50	236.50	1.20	37.60	20.89
FS_6X FC_1 X Fl_b	193.35	240.50	2.00	242.50	1.25	47.15	25.49
FS_6X FC_1 X Fl_c	174.69	245.70	2.23	247.93	1.42	71.01	37.57
FS_6X FC_2 X Fl_a	226.41	241.80	1.50	243.30	1.07	15.39	8.27
FS_6 X FC_2 X Fl_b	199.17	202.80	1.66	204.46	1.03	3.63	2.33
FS_6X FC_2 X Fl_c	192.17	256.10	1.42	257.52	1.34	63.93	32.45
SED	2.25	0.00	0.59	0.59	0.01	2.25	1.30
Level of significance	NS	NS	NS	NS	NS	NS	NS

NS, Non-significant; FS, Farm size; FC, farm category; FL, farm location; FS_1, Farm containing 500 broilers; FS_2, Farm containing 600 broiler; FS_3, Farm containing 700 broilers FS_4, Farm containing 800 broilers; FS_5, Farm containing 900 broilers; FS_6, Flock containing 1000 broilers; SED, Standard error of difference; FC_1, Bio-secured farm ; FC_2, Non-biosecured farm ; Fla, Rajshahi; FLb, Pabna; FLc, Kishoregoanj.

4.4 DISCUSSION

4.4.1 Effect of farm size on growth performances of broiler

The farm size is the most important factor in terms of growth performances; body weight, feed consumption, survivability and Feed conversion ratio. Table 15 showed that FCR had 1.96, 1.85, 1.82, 1.78, 1.69 and 1.63 of 500, 600, 700, 800, 900 and 1000 farm sizes of medium and small scale broiler farms.

It was observed that FCR was the most important factor for broiler growth performance. FCR was found significantly ($P<0.05$) correlated among the farm sizes. It was seen that feed consumption and FCR had better trend with increasing size of the farm which is similar to the findings of Kawsar *et al.* (2013a). He reported that FCR was found decreasing trends with an increasing the size of the farms. Poor live weight achieved in smallest farm size compared to other increasing farm sizes. This low performance happened possibly due to inadequate technical knowledge on broiler farm management. Moreover, low level educational background causes difficulty to receive modern and appropriate technology. Chowdhury *et al.* (2010) stated that most of the small-scale broiler farmers had only primary level of education, which explained their difficulty in understanding the science and technology related to poultry production and their inability to apply scientific knowledge in practice during their farm operation which resulted low growth performance in terms of FCR. Present findings partially similar with the result of Fouzder (2006) and Farming System and Environment Study (FSES 1996) where no marked differences among farm categories in feed consumption, FCR and survivability of broilers were found. Higher body weight and lower FCR (improved) of broilers were found relatively in larger farms size in comparison with smaller farms size that were linked with farmer's knowledge. Previous study of Akteruzzaman *et al.* (2009) also showed that farmer's technical knowledge accelerated poultry production as well as increased their income with consequent expansion of

their farm size. Therefore, the farm size had effects on feed consumption and FCR of broilers in small and medium scale broiler farming at rural households.

4.4.2 Effect of farm category on growth performances

The average FCR value of the broiler farms with bio-secured condition was 1.77 which was almost similar to the earlier report (2.00) of Jaim and Islam (2008) and slightly higher than those of Chand *et al.* (2009) who reported the values of 1.93 to 1.94. Small scale broiler operation in Botswana field survey primary data also reported that the inferior feed efficiency values (2.72 Kg feed/kg broiler) was resulted due to poor managerial practices, feed wastage and variable quality of feed Badubi *et al. (*2004). FCR values of bio-secured managed farm in the present study were 1.77, whereas it was 1.88 when bio-security management was absent in table 16. Overall improved growth performances were found in bio-secured managed farm in comparison with non-biosecured managed farm in table 16. Sonaiya (2009) indicated low bio-security as being one of the technical factors contributing to productivity and profitability of smallholder family poultry. Lack of training facilities of farmers on various aspects of broiler farming was a major deficiency in feeding regime and management that greatly affected production efficiency. The results clearly indicated that farms managed by technical/trained person were better than those managed by rural farmers without technical support from any corner. This result was in agreement with Jabber *et al.* (2007) who reported that contract farmer was more performer than private farmer. In this study, the FCR values in both managements (bio and non-biosecured) were higher than that of standard value of the Cobb Breeding Company Limited, which may be due to high temperature (27^{o}C to 36^{o}C) that caused less feed utilization by the broiler and ultimately survivability decreased where bio-security management interventions were not provided. Okelo *et al.* (1998) reported that high ambient temperature greatly affected the production performance and mortality of broilers. They also observed that cool drinking water effectively relief heat

stress, enhanced greater intake of drinking water, cool roost and carbonated drinking caused highest survivability and FCR. Survivability was also significantly ($P<0.05$) higher in bio-secured farm due to practicing of bio-security management interventions. Comparatively better brooding, better feed management, addition of extra vitamins and electrolytes to cool drinking water in high temperature, standard biosecurity etc. might have been factor to achieve the result. Interaction effects of farm size and farm category (FS× FC) on the growth performances showed significantly difference ($P<0.05$ and $P<0.01$) of feed consumption and FCR in table 17. Interaction effects of farm size, farm category, farm location ((FS × FC× FL) did not have any significant influence on the productive performance of body weight, feed consumption, FCR and survivability of broilers in different farm sizes.

4.4.3 Cost of broiler production

4.4.3.1 Non-recurring cost and farm size

The highest and lowest non- recurring cost 3.07% and 1.16% was observed per bird of the total cost in 500 & 900 farm sizes respectively (Table 19) which supported partially of Rangareddy *et al. (*1997). They reported that non-recurring cost was 6.76% per bird of the total cost. Non -recurring cost gained from 1.16 to 3.07 percent per broiler of the total cost among different farm sizes that is also partially supported to that of Begum (2004) and Fouzder (2006). They showed that non-recurring cost ranged from 1.53 to 2.02 percent and 1.91 to 1.94 percent of the total cost of different farm sizes, respectively.

4.4.3.2 Non-recurring cost and farm category

The average 2.45% non- recurring cost was found per bird of the total cost in bio-secured condition. Moreover, 1.93 % non-re-curing cost was observed per bird of the total cost in non-biosecured cost (Table 20). It was concluded that higher non-recurring cost was found in bio-secured management condition than non-biosecured. Kawsar *et al*. (2013a) also found a fixed cost ranges 3.88 to

1.96% between the farm management which was almost similar to the present study. Non recurring cost did not significantly affect among farm size, farm category and farm location.

4.4.3.3 Recurring costs of broiler farming

The lowest & highest recurring cost was observed 96.14% & 98.07% per bird in 700 & 1000 farm sizes respectively of the total cost in table 21. Shanmugam *et al.* (1997) found that variable cost constituted 93.24% of the total cost of broiler production per bird which is almost similar to the present study.

Recurring costs were discussed in the following section

Chick cost

In this study, chick cost found 20.0% of the total cost of production of bio-secured management intervention and it was 20.43% for without bio-security management intervention in table 22. Jaim and Islam (2008) reported that chick cost computed 29% for small-scale broiler farmers who had no intervention in husbandry practices. The highest 21.16% of chicks cost was found in 900 farm sizes where lowest 18.86% was seen in 700 farm size. Karim (2000) reported considerable variations in the cost of broiler chicks of different batches. His results indicated that chick cost included 30.38% and 32.67% of total cost of production in small and large broiler flocks, respectively under contract farming system in Mymensingh. His result appeared to be higher to the present study.

Feed cost

Table 22 showed that in bio-security management condition, 68.49% feed cost per bird was involved and in without bio-security management it was 66.69%. The difference was not found significantly between the bio-security and non-biosecurity management condition. This might be happened because relatively higher survivability was found in bio-secured managed farm compared to non-

bio-secured managed farm. Those farmers received training and followed instructions properly resulting lowest feed wastage. The rate of sharing feed cost also depends on market price of chick cost. The reason was that, the cost of DOCs was relatively unstable. Chowdhury (2011) reported that chick cost varied from BDT minimum 18.00 to maximum 75.00 per DOC in the same year whether the price of feed cost is increasing gradually never decreases. The highest & lowest feed cost was observed 70.27% and 65.96% per bird in 1000 & 900 farm sizes of the total cost in table 21. Sarbiland *et al.* (2004) and Cobanoglu *et al.* (2002) also found that feed cost was 60% and 67.95% of the total cost which was partially agreed to the present study.

Vaccination &medication cost

The highest & lowest vaccine & medication cost was observed 4.91% and 3.38% per bird in 600 & 1000 farm sizes of the total cost (Table 21). On the other hand, the highest vaccination and medication cost was found (4.65%) per bird in non-biosecured managed farm and the lowest vaccination and medication cost (4.41%) was found in bio-secured managed farm (Table 22). It might be happened because comparatively better biosecurity and sanitation measures were strictly practiced in case of bio-secured managed farm. Begum (2000) found that vaccination & medication cost accounted for 3.97, 4.03 and 3.85 percent for small, medium and large farm respectively which is almost similar to the present study. Previous data were exceptionally higher (7.26 and 8.29 percent for vaccine and medication cost respectively) than the result of the present study with the observance of Uddin (1999) and Golap (2001).

Electrical cost

The highest electricity cost (1.42%) was incurred in 500 farm size and lowest cost (0.88%) in 1000 farm size (Table 21). This reason as discovered by Islam *et al.* (2010), who reported that increasing number of birds reared in a flock achieved higher economic efficiency due to better cost economy. Electricity

cost accounted for 1.22% and 1.06% in bio-security management and non-biosecurity management condition respectively which was supported partially that reported by Golap (2001) and Begum (2000). They reported that electrical cost ranged from 0.93 to 0.90 percent and 0.99-1.99, 1.00-1.47 percent of the total cost of different farm sizes, respectively.

Others operational cost

Others operational cost i.e. litter, lime, transportation etc. Others operational cost was found from 2.99 to 4.16% per bird of the total cost among in different farm sizes. Considering bio & non bio-secured management condition, it was 3.39 and 3.82 percent per bird of the total cost (Table 22). Comparatively higher cost was found in non-biosecured managed farm in comparison with bio-secured managed farm.

4.4.4 Return from broiler

Gross return is mainly affected by the market price of live broiler that is dependent on market demand and percentage of survivability. During summer (March to June), due to heat stress causing higher temperature, survivability percentage had slightly decreased that resulted gross return affected to the broiler farmers. Table 23 showed that gross return from the marketing of live broilers indicated that it had increasing trends with increasing the size of the farms with significance difference. In case of farm category, bio-security management intervention had also a significant ($P<0.01$) effect on gross return from broiler farming (Table 24). This was happened due to significantly higher live weight gain where intensive care was taken in bio-secured managed farm in comparison with non-biosecured managed farm. Receiving higher market price in bio-secured management group resulted higher gross return than those of without bio-security management group. Due to lack of training, resulting poor marketing knowledge and less awareness of market information which also deprived farmers. Mohsin *et al.* (2008) observed that small farmers had

losses due to poor marketing knowledge and less awareness of market situation which supported partially to the present study. Akteruzaman *et al*. (2009) also stated that trained farmers more capable about marketing knowledge and conditions of the products than non- trained small farmers.

Cost of raising broiler had lower trends with an increasing the size of the farm. So, in most cases lower production cost was observed in broiler farming in larger farm sizes. Benefit cost ratio had also higher trends with an increase in the size of the farm in accordance with Islam *et al.* (2010). They reported that BCR was increased with increasing the size of the farm which partially supported to the current study. Interaction effects of farm size and farm category (FS× FC) on the profitability showed significantly difference ($P<0.01$) of total cost and gross return. Profitability parameters like total cost, gross return, cost benefit ratio, net return were not affected by the interaction of farm size, farm category and farm location.

CHAPTER FIVE

Experiment 3: Production and economic performances of broiler farming with or without bio-security management intervention during winter

5.1 INTRODUCTION

Poultry farming is one of the major interventions in rural areas as it provides immense employment opportunities to the local communities especially for youth & women that helps in poverty reduction, ensures food security and improves the livelihood conditions. The poultry sub-sector is crucial in the context of agricultural growth and in improving diet for the people. It is an attractive economic activity especially for the people in rural areas by creating self-employment (Ahmed and Hamid, 1991). With a high population, increased income growth, urbanization and high-income elasticity of demand, the demand for poultry products is expected to increase appreciably in the future. In general, livestock, especially cattle, are considered assets to rich people. As such, poultry production is an essential element in connection with income generation for the rural unemployment people. Therefore, the development of poultry farming in both rural and urban areas of Bangladesh should be encouraged.

Bio-security increasingly gains importance for the health management of poultry flock. It reduces all measures to prevent pathogens from entering the flock and to reduce the spread of pathogens within flock in order to keep the birds healthy and also to limit the spread of pathogens to the environment. Bio-security can be divided into 3 different tires or levels: the conceptual, structural and operational bio-security. The conceptual bio-security mostly deals with planning, structural bio-security deals with measures which prevent pathogens entering the farms physically while operational bio-security is related to reduce the within farm spread of pathogens. Good structural bio-security provides good environment for the productivity (Chowdhury *et al.,* 2015). Improper

environment reduces the chicken defenses, making them more vulnerable to disease (Talukder *et al.*, 2010).

Low productivity, increased mortality and public health hazard associated with contamination of poultry products destined for human consumption resulting from enteric diseases have become an important concern to the poultry industry. With increasing risk of antibiotic resistance due to usage of antibiotics at sub-therapeutic level and consequent ban on such antibiotics in many countries, it has become imperative to find out alternatives to antibiotics for poultry production. Kawsar (2014) found that use of antibiotics indiscriminately with drinking water by the without improved management farmers compared to improved management farmers. Supplementation of probiotic improves body weight, FCR, mortality (Kabir, 2009) and it has shown positive effects on humoral and cellular immune responses (Kabir, 2009).

Commercial broiler farming, currently, has become a promising and dynamic industry with vast potential that serve as a tool for poverty reduction through self-employment and income generation for unemployed youth family members (Raha, 2007). Within the short life cycle and low capital investment, quick return is possible in broiler farming, may be a good source of income to the rural farmers throughout the year (Bhende, 2006). Therefore, a comparison of productive performance, costs and returns of small and medium scale broiler farming under field conditions with or without bio-security management intervention were maintained. Baseline survey activities were similar to the earlier experiment. Therefore, the experiment was conducted to i) assess the productive performance, costs and returns of small & medium scale broiler farming under field conditions with or without bio-security management intervention in winter ii) compare the seasonal impact of bio-security management intervention on productive and profitability performances. iii) determine minimum farm size for getting maximum profit.

5.2 MATERIALS AND METHODS

5.2.1 Selection of the broiler farms

As per objectives of the study, Rajshahi, Pabna and Kishoregonj districts were selected and data were collected above mentioned districts through direct interviewing from a total of 49 broiler farmers by using a semi-structured questionnaire considering in winter season (November- February). The 49 broiler farms were categorized on the basis of bio-secured and non-biosecured management standard of 100 marks. According to bio-security standard, small and medium scale broiler farms got above 60 marks treated as bio-secured farms, and below 60 marks treated as non-biosecured farms out of 100 marks (Table 10).

5.2.2 Sample size

The farm sizes were 500, 600,700,800,900 and 1000 broilers in number. Out of 49 farms, 25 were taken as bio-secured and 24 taken as non-biosecured from three districts to carry out research programme in Table 27.

Table 27. Lay out of sample sizes according to farm category and location during winter season

Farm category	**Farm location**			**Total**
	Rajshahi	**Pabna**	**Kishorgonj**	
Bio-secured farm	8	8	9	25
Non-biosecured farm	8	8	8	24
Total	16	16	17	49

5.2.3 Environmental conditions in winter season

During the survey period, the environmental temperature was observed which is shown in Table 28.

Table 28. Environmental conditions during data collection in winter season

Factor	Minimum	Maximum	Average
*Temperature (^{0}c)	10.00	28.37	12.07
*Humidity (%)	71.00	97.00	83.29
**Rainfall (mm)	No	No	No

Source: *, Collected from field record; **Records of climatological observation, Department of Irrigation and Water Management'2013

5.2.4 Preparation of the survey schedule

As per objectives of the study, a draft survey schedule was prepared. Before finalization of the draft schedule, it was pre-tested in the study areas. After pre-testing, a set of final survey schedule was developed after necessary corrections, changing and modifications. The questions were arranged systematically, so that the respondent could provide information in a consistent and systematic manner. The survey schedule was prepared and copied in its final form for the collection of data. The questionnaire information was similar as earlier experiment.

5.2.5 Data collection as per farm category

To achieve the objectives as stated above field level primary data were collected from a total of 49 broiler farmers of which 16 in Rajshahi, 16 in Pabna and 17 in Kishergonj districts of Bangladesh. Before the collection of data, the objectives of the study were clearly explained to each of the farmers.

All possible care was taken to obtain accurate and reliable data. Interview was done according to the convenience of the farmers. The collected data were then edited and categorized as per different farm sizes (500, 600, 700, 800, 900 & 1000 farm sizes). Among 49, 10 broiler farmers had 500 birds, 09 farmers had 600 birds, 08 farmers had 700 birds, 09 farmers had 800 birds, 07 farmers had 900 birds and 06 farmers had 1000 birds which were treated as small and medium scale broiler farms. According to farm size, data were summarized meaningfully and were processed by using master tabulation sheet. The author himself collected data during the month of January 13 to June 2014. Data collection was completed through several visits by the researcher.

5.2.6 Data Processing

All recorded data of production and profitability parameters of broiler farming in winter season e.g. body weight, feed consumption, feed conversion ratio (FCR) & survivability and total cost, return/broiler, gross return, net return and cost benefit ratio were determined as similar to the earlier experiment.

5.2.7 Statistical Analysis

The data were analysed using SPSS 11.5 (2003) program to compare broiler growth and profitability performances between bio-secured and non-biosecured in winter season at different locations.

5.2.8 Bio-security management intervention in winter

The following Table shows a comparison covering environmental situation in broiler farming of both bio-security management and non-biosecurity management categories during winter:

Table 29. Comparison between bio-secured and non-biosecured managed farm in winter season

Activity	Non- biosecured managed farm	Bio-secured managed farm
Ventilation	The farmers protected their broiler from cold, but they were not aware of proper ventilation system	The farmers protected their bird from cold and they were very much aware about ventilation system of their farm.
Litter management	Litter management was found poor	Litter management was found standard
Water management	Water management was found less care	Fresh deep tube-well water was frequently supplied, so that remains in normal temperature.
Heat management	Few farmers used extra heat source but most of the farmers did not do that.	Extra heat sources supplied to the houses to keep birds remain comfortable.

PLATE 3

Different levels of bio-secured managed farm

Photo 15: Good bio-security management farm

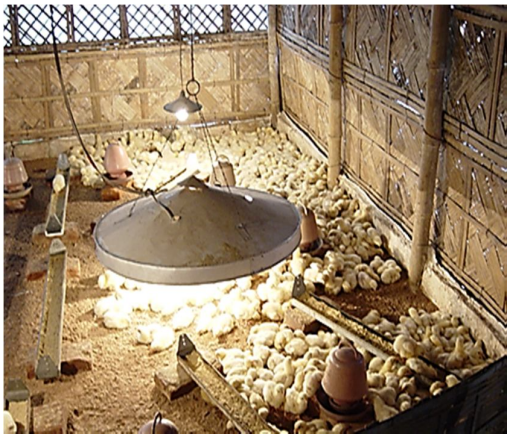

Photo 16 : Poor bio-security management farm

Plate 17: Moderate bio-secured farm

5.3 RESULTS

5.3.1 Growth performances as per farm size

The broiler farm size was not found any marked differences (P>0.05) in feed consumption and survivability but it had a significant (P<0.05) effect on marketable body weight and FCR (Table 30). The lowest feed consumption with the highest feed utilization was found in 1000 broiler farm size. FCR had better trend with increasing size of the farm. The highest marketable body weight was seen in1000 farm size and the lowest FCR was observed in the same farm size. Poor live weight achieved in smallest farm size in comparison with other increasing farm sizes.

Table 30. Effect of farm size on the growth performances of broiler

		Variables				
		Body weight				
Farm size	**Rep**	**MB WT (kg)/bird**	**Marketing age (day)**	**FC (Kg/bird)**	**FCR**	**Survivability (%)**
500	10	1.74^{b}	33.60	3.00	1.74^{a}	95.89
600	9	1.79^{ab}	34.00	2.94	1.65^{ab}	93.74
700	8	1.85^{ab}	35.00	2.96	1.60^{ab}	95.36
800	9	1.78^{ab}	34.33	3.09	1.74^{ab}	96.75
900	7	1.91^{a}	34.14	3.02	1.59^{bc}	95.04
1000	6	1.92^{a}	33.83	2.97	1.56^{c}	92.58
SED	49	0.04	0.94	0.09	0.03	0.67
Level of Significance		*	NS	NS	*	NS

Means having dissimilar superscript differ significantly; *, P<0.05; NS, Non- significant

5.3.2 Growth performances as per farm category

Bio-security management intervention during winter seasons had a significant effect on broiler growth performance (Table 31). The FCR and marketable body weight were found significantly (P<0.01) between the farm category (Table 31). No significant difference was observed between bio-secured and non- biosecured farms in feed consumption and survivability. But marketable bodyweight was found higher in bio-secured farm in comparison with non-biosecured farm. FCR value of bio-secured managed farm at field level in the present study was 1.60, whereas it was 1.74 when bio-security management intervention was absent. FCR tended to be better with increasing the size of the farm for both bio-secure and non-biosecure farms which are shown in figure 5&6. But overall improved FCR was observed in bio-secured farm than in non-biosecured managed farm (Table 31). Interaction effects between the farm size and farm category on the growth performances of broiler farming showed non-significant results which are shown in Table 32.

Table 31. Effect of farm category on the growth performances of broiler

	Variables				
	Body weight		**FC Kg/bird**	**FCR**	**Survivability %**
Farm Category (FC)	MB WT (kg)/broiler	Marketing age (Day)			
Bio-secured Managed Broiler Farm	1.89	34.21	3.02	1.60	95.28
Non-Biosecured Managed Broiler Farm	1.72	34.05	2.97	1.74	94.72
SED	0.02	0.30	0.05	0.04	0.37
Level of significance	**	NS	NS	**	NS

**, P<0.01; NS, Non-significant

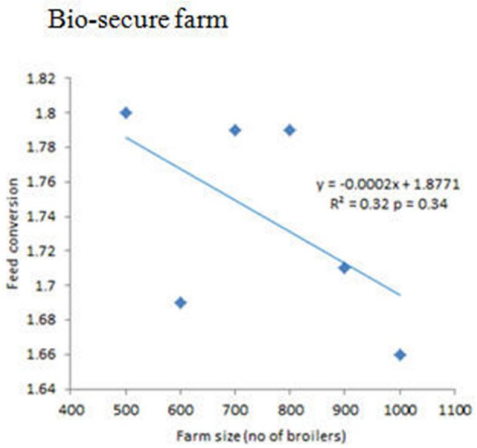

Figure 5- Trends to better feed conversion as farm size increase in bio-secure farm

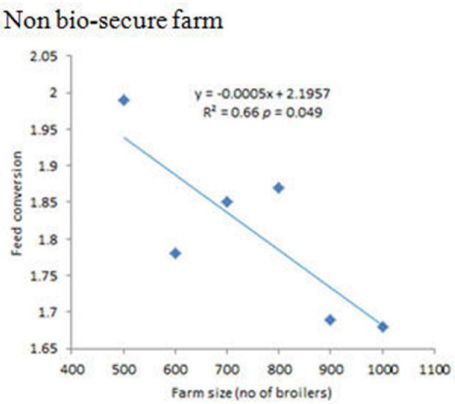

Figure 6- Trends to better feed conversion as farm size increase in non-biosecure farm

Table 32. Effect of interaction of farm size (FS) and farm category (FC) on the growth performances of broiler

Interaction (FS X FC)	MBWT (Kg)/broiler	FC	FCR	Survivability (%)
FS_1 X FC1	1.74	3.20	1.85	97.25
FS_1 X FC2	1.53	3.19	2.09	93.83
FS_2 X FC1	1.76	3.02	1.72	94.97
FS_2 X FC2	1.60	3.35	2.10	96.27
FS_3 X FC1	1.80	3.58	1.98	97.85
FS_3 X FC2	1.67	2.89	1.74	92.39
FS_4X FC1	1.90	3.35	1.77	96.52
FS_4X FC2	1.62	2.89	1.79	91.29
FS_5 X FC1	1.85	3.10	1.68	91.90
FS_5 X FC2	1.71	2.92	1.71	95.48
FS_6X FC1	1.85	3.09	1.67	93.73
FS_6X FC2	1.97	2.95	1.50	89.50
SED	0.022	0.051	0.036	0.46
Level of significance	NS	NS	NS	NS

FC1, Bio-secured Farm; FC2, Non-biosecured farm; FS_1, Farm containing 500 birds; FS_2, Farm containing 600 birds; FS_3, Farm containing 700 birds; FS_4, Farm containing 800 birds; FS_5, Farm containing 900 birds; FS_6, Farm containing 1000 birds; SED, Standard error of difference; NS, non-significant.

5.3.3 Seasonal effect on the growth performances of broiler

The significant seasonal effect was found in body weight, feed consumption and feed conversion ratio with no effect on survivability (Table 33). Between the two seasons, growth performances as body weight (P<0.01), FCR (P<0.01) and feed consumption (P<0.05) were found significant differences. Birds reared in winter gained more weight (1.82 kg/bird) than in summer (1.73 kg/bird). Improved FCR was observed during winter season in comparison with summer season. Besides, higher FC was in summer season whereas lower FC was found in winter season. Survivability was found higher in winter (95.04%) comparted to summer (94.57%).

Table 33. Effect of season on the growth performances of broiler

Parameters	Season		SED	Level of significance
	Summer	Winter		
Body weight (kg/bird)	1.73	1.82	0.016	**
Feed consumption (kg/bird)	3.13	3.00	0.028	*
Feed conversion ratio	1.82	1.66	0.022	**
Survivability (%)	94.57	95.04	0.339	NS

**, P<0.01; *, P<0.05; NS, Non-significant; SED, Standard error deviation.

5.3.4. Interaction effects of farm size, farm category and seasons on the growth performances of broiler

Interaction effects among the season, farm size and farm category are shown in table 34. All interaction effect (SE X FS X FC) on growth parameters showed non-significant results.

Table 34. Interaction effects of season (SE), farm category (FC) and farm size (FS) on the growth performances in broiler

Interaction (SE X FS X FC)	Parameters			
	Body weight (kg/Br.)	Feed consumption (kg/Br.)	FCR	Survivability (%)
S XF_1 X FC_1	1.80	2.92	1.63	97.18
SX F_2 X FC_1	1.86	2.97	1.60	92.22
SX F_3 X FC_1	1.93	3.15	1.64	96.99
SX F_4 X FC_1	1.86	3.05	1.64	96.75
S X F_5 X FC_1	1.99	3.11	1.56	95.44
S X F_6 X FC_1	1.94	2.95	1.52	92.73
S X F_1 X FC_2	1.65	3.13	1.90	93.95
SX F_2 X FC_2	1.74	2.92	1.68	94.96
SX F_3 X FC_2	1.77	2.77	1.57	93.72
S X F_4 X FC_2	1.73	3.13	1.82	96.75
SX F_5 X FC_2	1.70	2.81	1.66	94.07
SX F_6 X FC_2	1.75	3.05	1.74	91.83
W X F_1 X FC_1	1.74	3.20	1.85	97.25
W X F_2 X FC_1	1.76	3.02	1.72	94.97
W X F_3 X FC_1	1.80	3.58	1.98	97.85
WX F_4 X FC_1	1.90	3.35	1.77	96.52
W X F_5 X FC_1	1.85	3.10	1.68	95.90
W X F_6 X FC_1	1.85	3.09	1.67	93.73
W X F_1 X FC_2	1.53	3.19	2.09	93.83
W X F_2 X FC_2	1.60	3.35	2.10	96.27
W X F_3 X FC_2	1.67	2.89	1.74	92.39
WX F_4 X FC_2	1.62	2.89	1.79	91.29
W X F_5 X FC_2	1.71	2.92	1.71	95.48
W X F_6 X FC_2	1.97	2.95	1.50	89.50
SED	0.02	0.20	0.03	0.34
Level of significance	NS	NS	NS	NS

NS, Non-significant; S, Summer; W, Winter; F_1, Farm containing 500 broilers; F_2, Farm containing 600 broiler; F_3, Farm containing 700 broilers F_4, Farm containing 800 broilers; F_5, Farm containing 900 broilers; F_6, Farm containing 1000 broilers; SED, Standard error of difference; SE, Seasons; FS, Farm size; FC, Farm category; FC_1, Bio-secured farm ; FC_2, Non bio-secured farm

5.3.5 Cost of broiler production

The total costs of the broiler farming were categorized into non- recurring and recurring costs.

5.3.5.1 Non - recurring cost and farm size

The non- recurring cost accounted in different small & medium scale broiler farm size which is shown in Table 35. The non-recurring cost on broiler production was 3.29, 2.59, 1.89, 1.46, 1.14 and 1.04 % of the total cost in 500, 600, 700, 800, 900 and 1000 farm sizes respectively. Findings indicate that the estimated non-recurring costs were statistically significant ($P<0.01$) among in various farm sizes (Table 35). The highest non-recurring cost was found in the smallest size of the farm (500) and the lowest non-recurring cost was seen in comparatively higher of 1000 farm size. It is indicated that non- recurring cost was decreasing trends with increasing the size of the farm. The non-recurring cost was found BDT from 1.90 to 6.95 per bird of the total cost among in different farm sizes (Appendix 6). Some non-recurring costs are as follows:

Labour cost: The labour cost covered ranging from 2.91 to 0.96 percent per bird of the total cost that shared the major portion of the fixed cost.

Depreciation cost for housing: The depreciation cost for housing was ranging 0.151- 0.023% per bird of the total cost.

Land utilization cost: The land utilization cost covered ranging 0.120 -0.015% per bird of the total cost considering rural level households.

Depreciation cost of equipment: The depreciation cost of equipment was (0.109 -0.018%) per bird of the total cost.

Table 35. Effect of farm size on non- recurring cost of broiler farming

Farm size	Rep	Cost per bird %				
		Depreciation cost for housing	Depreciation cost of equipment	Land utilization cost	Family labour	Non-recurring cost
500	10	0.151[a]	0.109[a]	0.120[a]	2.915[a]	3.295[a]
600	9	0.100[b]	0.066[b]	0.103[ab]	2.330[ab]	2.599[a]
700	8	0.063[c]	0.029[c]	0.080[bc]	1.723[bc]	1.895[b]
800	9	0.051[d]	0.039[c]	0.050[cd]	1.323[cd]	1.463[bc]
900	7	0.048[cd]	0.032[c]	0.049[cd]	1.014[cd]	1.143[c]
1000	6	0.023[d]	0.018[c]	0.033[d]	0.967[d]	1.041[c]
SED	49	0.017	0.015	0.015	0.305	0.334
Level of significance		**	**	**	**	**

**, P<0.01; Means having dissimilar superscript differ significantly

5.3.5.2 Non- recurring cost and farm category

Table 36 showed that, the average 2.08% non- recurring cost of per bird of the total cost was found in bio-secured condition. Moreover, 2.00% non-recurring cost was observed per bird of the total cost in non-biosecured managed farm. Overall higher non- recurring cost was found in bio-secured managed farm in comparison with non-biosecured managed farm. The non-recurring cost was not found significantly difference (P>0.05) between the farm category.

Table 36. Effect of farm category on non-recurring cost of broiler farming

Farm Category (FC)	Cost per bird (%)				
	Depreciation cost of housing	Depreciation cost of equipment	Land utilization cost	Family labour	Non-recurring cost
Bio-secured managed broiler farm	0.069	0.043	0.079	1.894	2.085
Non-biosecured managed broiler farm	0.094	0.070	0.077	1.765	2.006
SED	0.019	0.012	0.012	0.459	0.485
Level of significance	NS	*	NS	NS	NS

*, P<0.05; NS, Non- Significant

5.3.5.3 Recurring cost of broiler farming

Chick cost

Within recurring costs, day-old chicks cost was found from18 to 20 percent of the total cost depending on farm sizes and showed significant differences ($P<0.05$) among the farm sizes (Table 37). The highest percentage for price of chicks (20.40%) was found in 900 farm sizes where the lowest percentage (18.38%) was seen in 1000 farm size in Table 37. In this study, chick cost accounted for 19.14% of the total cost of broiler production for bio-secured managed farm and 20.23% for non-biosecured managed farm (Table 38). Significant difference ($P<0.05$) was found between bio and non-biosecured managed farm of chick cost. Appendix 7 showed that non bio-security managed farmers purchased the DOCs with higher rate (BDT 42.06) than bio-security managed farmers.

Feed cost

The feed cost calculated from 67 to 70 % of the total cost which was the highest cost item in broiler production in Table 37. Feed cost was higher trends with an increasing the size of the farm and significant difference ($P<0.05$) was found among the farm sizes. In bio-secured management condition, 68.84% feed cost was involved and in non-biosecured management condition it was 65.92% in table 38. Comparatively higher feed cost was found in bio-secured managed farm in comparison with non-biosecured managed farm. The highest & lowest feed cost were observed 70.27% and 65.96% per bird in 1000 & 900 farm sizes (Table 37) of the total cost. No significant difference ($P>0.05$) was found of feed cost between the bio and non-biosecured managed farm (Table 38).

Vaccination & medication cost

The vaccination and medication cost was not affected among the farm sizes (Table 37). But it was also significantly (P<0.01)) affected between the farm category (Tables 38). Relatively higher vaccination and medication cost was found (5.28%) in non-biosecured managed farm whereas lower vaccination and medication cost (4.21%) was found in bio-secured managed farm. Veterinary expenses were higher in non-biosecured condition in comparison with bio-secured management condition. The highest & lowest vaccine & medication cost was observed 5.23% and 4.19% per bird in 600 & 1000 farm sizes (Table 37) of the total cost. Vaccination and medication cost were lower trend with increasing the size of the farm.

Table 37. Effect of farm size on recurring cost of broiler farming

Farm size	Rep	Cost per bird (%)					
		Chick cost	Feed cost	Vaccine & medication cost	Electrical Cost	Other operational cost (litter, lime transportation cost etc.)	Recurring cost
500	10	19.86^{a}	67.52^{a}	4.81	1.26^{ab}	3.06	96.51
600	9	20.39^{a}	67.03^{a}	4.86	1.34^{a}	3.54	97.16
700	8	18.81^{ab}	67.06^{ab}	5.23	1.15^{ab}	4.88	97.13
800	9	19.43^{ab}	67.66^{ab}	4.40	0.89^{c}	4.57	96.95
900	7	20.40^{a}	67.25^{ab}	4.31	1.06^{c}	4.94	97.96
1000	6	18.38^{b}	69.52^{b}	4.19	1.04^{c}	5.20	98.33
SED	49	0.88	1.62	0.42	0.10	0.52	2.19
LS		*	*	NS	**	NS	NS

*, P<0.05; ** P<0.01; NS, Non-significant; Means having dissimilar superscript differ significantly; LS, Level of significance

Table 38. Effect of farm category on recurring cost of broiler farming

Farm Category (FC)	Cost per bird (%)					
	Chick cost	Feed cost	Vaccine & medication cost	Electrical cost	Others operational cost (litter, lime transportation cost etc.)	Recurring cost
Bio-secured managed broiler farm	19.14	68.84	4.21	1.23	4.49	97.91
Non-biosecured managed broiler farm	20.23	65.92	5.28	1.02	3.89	96.34
SED	1.16	2.14	0.48	0.14	0.73	2.82
Level of significance	*	NS	**	NS	NS	NS

*, P<0.05; ** P<0.01, NS, Non-significant

Electrical cost

The electricity cost differed significantly (P<0.01) among the farm sizes (Table 37). The result indicated that electricity cost was decreasing trends with an increasing in the size of the farm. The highest electricity cost (1.34%) per bird was incurred in 600 farm size and the lowest cost (0.89%) in 800 farm size. Electricity cost accounted for 1.22% and 1.06% in bio-secured and non-biosecured managed farm respectively. No significantly difference (P>0.05) was found between the farm categories (Table 38).

Others operational cost

Other operational costs include as litter, lime, transportation etc. in broiler farming. Others operational cost were not observed significantly difference (P>0.05) among the farm sizes and between the farm category (Table 37& 38). The highest other operational cost was found in 1000 farm size where the lowest operational cost was found in 500 farm size. It was higher trends with an increasing the size of the farm. Other operational costs were found higher in

bio-secured managed farm (BDT 4.49) than non-bio-secured managed farm (3.89) in Table 38.

5.3.6 Return from broiler farming

Table 39 shows the highest and lowest total cost BDT 211.05 & 182.11 were observed per bird in 600 & 1000 farm sizes respectively. The significant difference ($P<0.01$) was observed of total cost among the farm sizes. Total cost of broiler farming was decreasing trend for both bio & non bio-security management conditions with an increasing the size of the in figure 7. In terms of return/broiler and gross return, no significant difference ($P>0.05$) was observed among the farm sizes. But in case of droppings ($P<0.05$), BCR ($P<0.01$), net return (BDT)/broiler ($P<0.01$) and net return (Kg)/ broiler ($P<0.01$) were found significantly differences among the farm sizes. Gross return and return/broiler from the marketing of live broilers indicated that it was increasing trends with an increasing the size of the farm for both bio-secured & non-biosecured management conditions which is shown in figure 8 & 9. Bio-security management intervention had a significant ($P<0.01$) effect on gross return from broiler farming (Table 40). Figure 10 showed that BCR was higher trends for both bio & non-biosecured managed farm with an increasing the size of the farm. Overall higher BCR (1.25) was found in bio-secured managed farm in comparison with non-biosecured managed farm (1.09) in table 40. Net return and BCR values were found positively significant ($P<0.01$) among the farm sizes (Table 39). Net return and BCR values were better trends with an increasing the size of the farm (Table 39). Figure 10 & 11 also showed that net return was increasing trends for both bio & non-biosecured managed farm with increasing the size of the farm. Overall higher net return was found in bio-secured managed farm than non-biosecured farm (Table 40). As per profitability analysis it has been found that small size (500, 600) farm had smaller profit in comparison with farm sizes of 700, 800, 900 and 1000 broilers.

Table 39 showed the net return on overall farms amounted to Tk. 8.10, 11.90, 18.48, 15.21, 25.91 and 34.43/kg in 500.600,700,800,900 and 1000 farm sizes, respectively. Thus, larger farm size was most profit efficient than that of smaller size farms. The highest net profit, Tk. 34.43/kg was found in large farm size (1000) and the lowest Tk. 8.10/kg had in 500 farm size. Table 40 indicated that significantly higher (P<0.01) of net return (Tk.)/Kg was found where bio-secured management was practiced by the broiler farmers. Overall, profitability was found to be improved in bio-secured managed farm compared to non-biosecured managed farm. Interaction effects between farm size and farm category (FS X FC) on the profitability parameters of broiler farming showed non-significant results except broiler return (P<0.05) in table 41.

Table 39. Effect of farm size on profitability of broiler farming

Farm Size	Rep	Parameters						
		Total cost (Tk./broiler)	Return (Tk./ broiler)	Droppings return (Tk./broiler)	Gross return (Tk./broiler)	Benefit cost ratio	Net return(Tk./ broiler)	Net return(Tk./Kg)
500	10	210.97^{a}	226.20	1.15^{c}	227.23	1.08^{c}	15.23^{c}	8.10^{c}
600	9	211.05^{a}	232.70	1.22b^{c}	233.92	1.11^{c}	21.65^{c}	11.90^{c}
700	8	205.67^{a}	240.50	1.65^{ab}	242.15	1.18^{bc}	34.83^{bc}	18.48^{bc}
800	9	203.85^{a}	231.98	1.26^{bc}	233.10	1.15^{c}	28.13^{c}	15.21^{bc}
900	7	197.20^{a}	247.93	1.74^{ab}	249.66	1.27^{ab}	50.73^{ab}	25.91^{ab}
1000	6	182.11^{b}	248.08	1.88^{a}	249.65	1.38^{a}	65.97^{a}	34.43^{a}
SED	49	2.29	2.61	0.08	2.65	0.02	3.61	1.82
LS		**	NS	*	NS	**	**	**

*, P<0.05; ** P<0.01, NS, Non-significant; Means having dissimilar superscript differ significantly; LS, Level of significance

Table 40. Effect of farm category on profitability of broiler farming

Farm Category (FC)	Parameters						
	Total cost (Tk./broiler)	Return (Tk./broiler)	Droppings return (Tk./broiler)	Gross return (Tk./broiler)	Benefit cost ratio	Net return (Tk./broiler)	Net return (Tk./Kg)
Bio-secured managed broiler farm	199.92	246.26	1.59	247.68	1.25	46.34	23.97
Non-biosecured managed broiler farm	207.84	223.66	1.26	224.92	1.09	15.82	9.03
SED	3.00	2.95	0.12	3.03	0.03	4.42	2.20
Level of significance	NS	**	*	**	**	**	**

*, P<0.05; ** P<0.01, NS, Non-significant

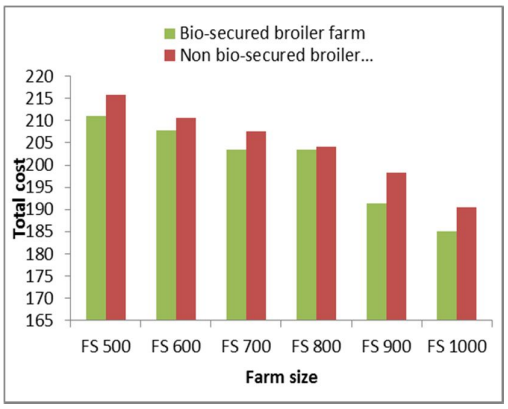

Fig 7: Trends of total cost in bio-secured and non-biosecured farm on different farm sizes

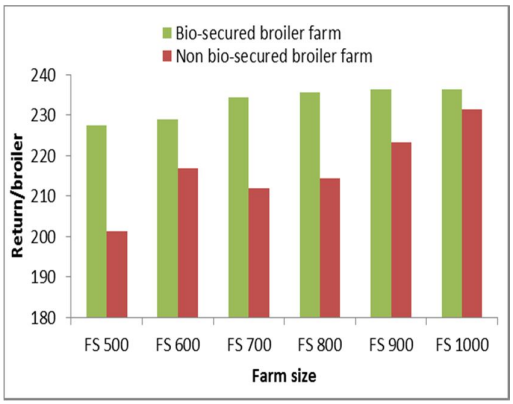

Fig 8: Trends of return /broiler in bio-secured & non-biosecured farm on different farm sizes

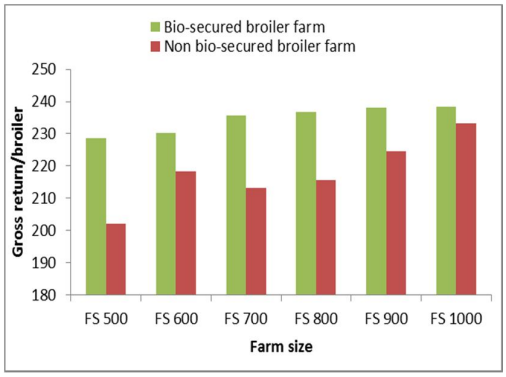

Fig 9: Trends of gross return/ broiler on different farm sizes in bio-secured & non-biosecured broiler farm

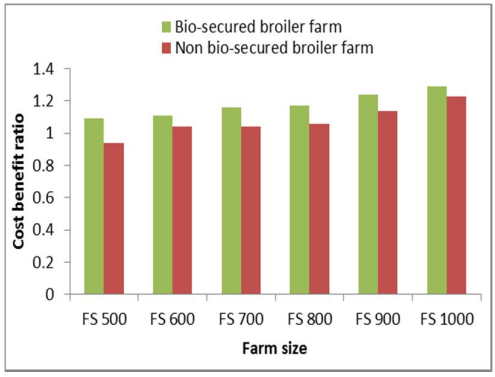

Fig 10: Trends of benefit cost ratio under bio-secured and non-biosecured on different farm sizes

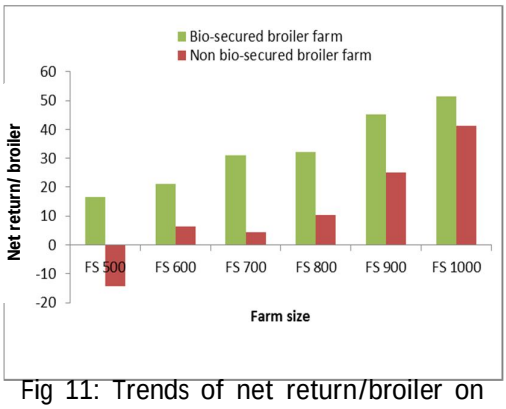

Fig 11: Trends of net return/broiler on different farm sizes in bio- secured and non-biosecured broiler farm

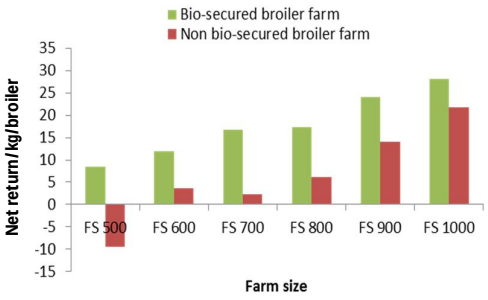

Fig 12: Trends of net return/kg broiler on different farm sizes in bio-secured and non-biosecured farm

Table 41. Effect of interaction of farm size (FS) and farm category (FC) on profitability of broiler farming

Interaction (FS X FC)	Total cost (Tk./Br)	Broiler return (Tk./Br)	Droppings return (Tk./Br)	Gross return (Tk./Br)	Benefit cost ratio	Net return (Tk./Br)	Net Return (Tk./kg)
FS_1 X FC1	211.27	225.77	1.28	227.05	1.08	14.50	7.84
FS_1 X FC2	218.90	199.16	1.10	200.26	0.92	-19.74	-13.13
FS_2 X FC1	203.79	228.58	1.48	229.82	1.13	24.79	14.03
FS_2 X FC2	208.31	208.43	1.62	210.05	1.01	0.12	-0.08
FS_3 X FC1	200.15	234.00	0.83	234.42	1.17	33.86	17.95
FS_3 X FC2	212.68	217.43	1.15	218.58	1.05	4.75	1.80
FS_4X FC1	205.28	246.57	2.00	247.90	1.22	41.28	21.52
FS_4X FC2	188.91	210.60	1.12	211.72	1.12	21.69	13.43
FS_5 X FC1	190.52	240.07	2.27	242.34	1.27	49.54	26.59
FS_5 X FC2	212.79	222.30	1.58	223.88	1.05	9.51	5.30
FS_6X FC1	188.15	240.07	2.24	242.31	1.29	51.92	27.98
FS_6X FC2	192.17	256.10	1.42	257.52	1.34	63.93	32.45
SED	2.76	2.92	0.09	2.93	0.02	4.57	2.60
Level of significance	NS	*	NS	NS	NS	NS	NS

FC1, Bio-secured Farm; FC2, Non-biosecured farm; FS_1, Farm containing 500 birds; FS_2, Farm containing 600 birds; FS_3, Farm containing 700 birds; FS_4, Farm containing 800 birds; FS_5, Farm containing 900 birds; FS_6, Farm containing 1000 birds; SED, Standard error of difference; *, (P<0.05); NS, non-significant.

5.3.7 Seasonal effect on the profitability of broiler farming

The significantly (P<0.01) higher gross return (Tk. 237.92) was found in winter season in comparison with summer season (Table 42). Moreover, body weight of broiler was also found higher in winter season (Table 33). Benefit cost ratio (BCR) was found significantly difference (P<0.05) between the seasons.

Table 42. Effect of season on the profitability of broilers reared in summer and winter

Parameters	Seasons		SED	Level of significance
	Summer	Winter		
Variable cost (Tk/bird)				
Total cost (Tk./br)	204.81	203.31	1.76	NS
Return (Tk./br)	224.33	236.57	2.04	**
Droppings return (Tk./br)	1.48	1.44	0.06	NS
Gross return (Tk./br)	225.70	237.92	2.06	**
Benefit cost ratio	1.11	1.18	0.02	*
Net return (Tk./br)	19.52	33.26	2.94	**
Net return (Tk./kg)	10.25	17.57	1.58	**

**, P<0.01; *, P<0.05; NS, Non-significant; SED, Standard error deviation; I US$ = BDT 78.00

Significantly higher net profit per broiler (kg) was also recorded in winter season in comparison with summer season. During winter, broiler farming achieved the highest performances in terms of body weight, FCR and also in survivability.

5.3.8 Interaction effects of season, farm size and farm category on profitability

Profitability parameters like total cost, gross return, cost benefit ratio and net return were not affected by the interaction among farm size, seasons and farm category (Table 43).

Table 43. Interaction effects of season (SE), farm size (FS) and farm category (FC) on the profitability of broiler farming

	Economic Parameters						
Interaction (SE X FS X FC)	**Total cost/ broiler (BDT)**	**Return/ broiler (BDT)**	**Droppings Return/broiler (BDT)**	**Gross return/ broiler (BDT)**	**Benefit cost ratio**	**Net return/ broiler (BDT)**	**Net return/Kg (BDT)**
S XF_1 X FC_1	209.36	234.22	1.33	235.33	1.13	24.85	13.12
SX F_2 X FC_1	209.73	241.15	1.30	242.45	1.17	31.42	16.90
SX F_3 X FC_1	204.32	250.90	1.79	252.69	1.24	46.58	24.09
SX F_4 X FC_1	197.79	241.48	1.17	242.35	1.23	43.69	23.26
S X F_5 X FC_1	195.76	258.96	1.83	260.79	1.34	63.20	31.52
S X F_6 X FC_1	183.08	258.20	2.01	253.81	1.40	69.12	35.57
S X F_1 X FC_2	213.39	214.18	0.92	215.09	1.01	0.79	0.57
SX F_2 X FC_2	212.11	225.94	1.15	227.09	1.07	13.83	7.90
SX F_3 X FC_2	207.03	230.10	1.51	231.61	1.12	23.07	12.88
S X F_4 X FC_2	208.70	224.38	1.32	225.70	1.08	15.68	8.78
SX F_5 X FC_2	200.79	220.35	1.49	221.84	1.11	19.56	11.89
SX F_6 X FC_2	177.24	227.50	1.32	228.82	1.29	50.26	28.72
W X F_1 X FC_1	211.27	225.77	1.28	227.05	1.08	14.50	7.84
W X F_2 X FC_1	203.79	228.58	1.48	229.82	1.13	24.79	14.04

W X F_3 X FC_1	200.15	234.00	0.83	234.42	1.17	33.86	17.95
WX F_4 X FC_1	205.28	246.57	2.00	247.90	1.22	41.28	21.52
W X F_5 X FC_1	190.52	240.07	2.27	242.34	1.27	49.54	26.59
W X F_6 X FC_1	188.15	240.07	2.24	242.31	1.29	51.92	27.98
W X F_1 X FC_2	218.90	199.16	1.10	200.26	0,92	-19.74	-13.13
W X F_2 X FC_2	208.31	208.43	1.62	210.05	1.01	0.12	-0.08
W X F_3 X FC_2	212.68	217.43	1.15	218.58	1.05	4.75	1.80
WX F_4 X FC_2	188.91	210.60	1.12	211.72	1.12	21.69	13.43
W X F_5 X FC_2	212.79	222.30	1.58	223.88	1.05	9.51	5.30
W X F_6 X FC_2	192.17	256.10	1.42	257.52	1.34	63.93	32.45
SED	1.76	2.04	0.06	2.06	0.02	2.94	1.58
Level of significance	NS	NS	NS	NS	NS	NS	NS

NS, Non-significant; S, Summer; W, Winter; F_1, Farm containing 500 broilers; F_2, Farm containing 600 broiler; F_3, Farm containing 700 broilers F_4, Farm containing 800 broilers; F_5, Farm containing 900 broilers; F_6, Flock containing 1000 broilers; SED, Standard error of difference; SE, Seasons; FS, Farm size; FC, Farm category; FC_1, Bio-secured farm ; FC_2, Non-biosecured farm

5.4 DISCUSSION

5.4.1 Effect of farm size on the growth performances of broiler

The broiler farm size was not found any marked differences ($P>0.05$) in feed consumption and survivability but it had a significant ($P<0.05$) effect on marketable body weight and FCR. Table 30 showed that lower feed consumption and higher feed utilization were found among the larger farm sizes than other smaller farms. FCR had tended to be better with increasing the size of the farm. Besides, feed consumption was lower trends as the farm size increased. This was happened, probably, due to poor managerial conditions (e.g. random entry in the flock with unhygienic situations, irregular feed and water supply, stagnant ammoniated environment, bad odors in flock), feed wastage, less vaccination, careless of quality control and poor resource base to smaller farm in comparison with larger farm size. Small farmers are those who had very small holdings or no land at all and had low access to resources, had some knowledge or even in many cases, was not in touch with modern technology to augment production as stated by several authors (Begum and Alam, 2009; Islam *et al.*, 2010; Chowdhury *et al.*, 2011) that might have reflected in the study results, as would be expected. Kawsar *et al*. (2011) stated that small broiler farmers who reared in small unit ranging from 100 to 300 flock sizes were low productive performer due to their insufficient technical knowledge, training and lack of technical assistance which partially supported in the current study.

5.4.2 Effect of farm category on the growth performances of broiler

Bio-security management intervention during winter seasons had a significant effect on broiler growth performance. The FCR and marketable body weight were found significantly ($P<0.01$) between the farm category in Table 31. It may be happened because bio-security management measures in broiler

farming followed more by the bio-secured farmers. Moreover, FCR had better trends for both bio-secured and non-biosecured farms with an increasing the size of the farm. But improve FCR was found in bio-secured farm than those of non bio-secured managed farms in table 31. Ali *et al.* (2014) reported that broilers reared with bio-security management intervention resulting consumed less feed with converted feed more efficiently therefore higher body weight gain than those of without intervention. These findings partially supported in the present results. Begum and Alam (2009) reported that the farmers, who got training, followed advice similar to contract growers and thus they were able to carry out their farming job more efficiently than those of traditional farmers. Begum and Alam (2009) concluded that contract farming played a significant role in small farmer development by technical assistance having opportunity to learn technical know-how which resulting improved productivity. All interaction effect (FS X FC) showed non-significant results.

5.4.3 Seasonal effect on the growth performances of broiler

Table 33 showed that significant seasonal effect was found in body weight, feed consumption and feed conversion ratio with no effect on survivability. Broiler reared in winter gained more weight (1.82 kg/bird) than in summer (1.73 kg/bird). The growth depression was recorded in summer compared to winter season which may be explained by the reduced feed intake regulated by raised environmental temperature and relative humidity (Scott *et al*., 1982, Sundararasu *et al.,* 1989). Ferket & Gernal (2006) reported that environmental stresses had the most profound effects on flock-to-flock variation for feed intake which influenced the body weight and feed conversion of meat type poultry. Due to comfortable housing condition and higher feed intake during winter, available nutrient synthesize body tissue is happened resulted in higher growth of broilers (Baghel and Pradhan 1989a). Arjona *et al.*(1988) and Fouzder (2006) found that heat stress mortality was increased in latter stage of growth of each batch broiler rearing during summer contributed to

comparatively lesser survival rate of broilers. Findings of these researcher's would be supported in the present study. All interaction effect (SE X FS X FC) on growth parameters showed non-significant results.

5.4.4 Cost of broiler production

5.4.4.1 Non-recurring cost and farm size

The non-recurring costs (i.e. depreciation cost for housing, depreciation cost of equipment, land utilization cost and family labour) were found in broiler farming. The non-recurring cost on broiler production was 3.29, 2.59, 1.89, 1.46, 1.14 and 1.04 % of the total cost in 500, 600, 700, 800, 900 and 1000 farm sizes respectively in table 35 and showed decreasing trend as the farm size increased. Singh (1994) found the decreasing trend for the fixed cost and it was 4.41% in small farms, 3.68% in medium farms and 3.66 % in large flocks of the total cost of production, respectively. His result appeared to be higher than the present study. Rajendran *et al.* (2008) also concluded that fixed cost reduced with an increase in flock size which supported in the present study. This might be due to the unit cost of broiler farming that is dependent on number of birds reared in a flock. If the number of birds reared in a flock increased, then unit price of inputs might be decreased.

Some non-recurring cost parameters are as follows:

Labour cost

The labour cost covered ranging from 2.91 to 0.96 percent per bird of the total cost that shared the major portion of the non-recurring cost. Table 35 revealed that non- recurring cost being influenced by the labour cost differed significantly with an increase in farm sizes. Begum (2004) and Fouzder (2006) found labour costs were approximately (3.73 - 2.07%) which partially agreed with the present study.

Depreciation cost for housing

The depreciation cost for housing was ranging 0.151- 0.023% per bird of the total cost. Chowdhury (2001) observed that housing cost for broiler production is 1.81%, 1.51%, 1.43% and 1.54% of the total cost in small, medium, large and all broiler farms respectively. His results appeared to be exceptionally higher with the present study.

Land utilization cost

The land utilization cost covered ranging 0.120 -0.015% per bird of the total cost considering rural level households. Kawsar (2014) found land utilization costs were approximately 0.037- 0.043 percent per bird of the total cost which was almost similar to the present study.

Depreciation cost of equipment

The depreciation cost of equipment was (0.109 -0.018%) per bird of the total cost. Chowdhury (2001) reported equipment costs were 0.29% 0.38% 0.41% and 0.37% of the total cost in small, medium, large and all broiler farms respectively. His results appeared to be higher with the present study.

5.4.4.2 Non-recurring cost and farm category

The average 2.08% non- recurring cost was found per bird of the total cost in bio-secured management condition (Table 36). Besides, 2.00 % non-recurring costs were observed per bird of the total cost in non-biosecured management condition. It was concluded that higher non-recurring cost was found in bio-secured condition farms than non-biosecured managed farms. It may happen, due to both lack of training and technical knowledge about the non-recurred costs of non-biosecured farmers. Shanmugam *et al.* (1997) found fixed costs constituted 6.76% of the total cost of broiler production. His findings appeared to be higher with the present study.

5.4.4.3 Recurring costs of broiler farming

Chick cost

In recurring cost, day-old chicks accounted from 18 to 20 percent of the total cost depending on farm sizes (Table 37). The highest percentage for price of chicks (20.40%) was found in 900 farm sizes where the lowest percentage (18.38%) was seen in 1000 farm size in table 37. In this study, chick cost calculated 19.14% of the total cost of production for bio-secured managed farm and 20.23% for non-biosecured managed farm. Cobanoglu *et al.* (2002) reported that chick cost computed 17.37% for small-scale broiler farmers who had no intervention in husbandry practices which was almost similar to the present study. The variable quality of chicks as indicated by so called grade 'A', 'B' and 'C' were the main causes for variation in price and even it varied batch to batch and also dealer to dealer. Bio-security intervention had a great influence on purchase of chicks. Intervened farmers were organized and they directly purchased their DOC at hatchery rate with the help of expert. But individual farmers were bound to buy their DOC from local dealers. In some cases, dealers charged higher rate in comparison with current market rate for DOCs due to absence of cash payment. Thus, farmers had no bargaining power and therefore had to accept it.

Feed cost

Table 37 showed that feed cost accounted from 67 to 70 % which was the highest cost item in broiler production. Feed cost was higher trends with an increasing the size of the farm and significant difference ($P<0.05$) was found among the farm sizes. In bio-secured management condition, 68.84% cost was involved and in non-biosecuried management condition it was 65.92% in table 38. Feed cost shared higher in this study due to a decrease in the price of chick. If the chick cost decreases, then share of feed cost increases. Therefore, the highest feed cost was observed in this study. Das *et al.* (2008) who stated

that feed cost is the prime input cost in commercial poultry production representing 65-70% of the total cost of production which is almost similar to the present study. Siddique (2004) found that broiler feed cost accounted approximately 60% in winter of the total cost of production. His result appeared to be lower with the present study. Major inputs of broiler production are feed and chicks that affected the profitability (Chand *et al.* 2009).

Vaccination &medication cost

The highest vaccination and medication cost was found (5.28%) in non-bio-secured managed farm whereas the lowest vaccination and medication cost (4.21%) was found in bio-secured managed farm in table 38. Veterinary expenses were higher in non-biosecured condition in comparison with bio-secured condition. The reasons were that the most of the broiler farmers randomly used medicine to protect their birds from diseases rather vaccination program and thus expenses are increased in non-biosecured managed farm in comparison with bio-secured managed farm. The highest & the lowest vaccine & medication cost was observed 5.23% and 4.19% per bird in 600 & 1000 farm sizes of the total cost. Vaccination and medication cost were lower trend with an increasing the size of the farm. Vaccination and medication costs showed significant variations in both farm categories (bio-secured and non-biosecured). Golap (2001) and Uddin (1999) accounted for 8.29% and 7.26% vaccination and medication cost of the total cost which were higher than the result of the present study. On the other hand, Bhuyan (1999) found medication cost only 3.97% for small farms which was almost similar with the present study.

Electrical cost

Higher electricity cost (1.23%) was accounted when bio-secured management was followed (Table 38). In bio-security management, farmers supplied additional bulb to protect broiler from excessive cold which increased some

electricity cost. On the other hand, lower (1.02%) electricity cost accounted where bio-security management was not practiced. Electricity cost was tended to be lower with an increasing the size of the farm. The result of the present study was in agreement with some previous findings (Karim, 2000; Begum, 2000; Golap, 2001) that electricity cost calculated ranged from 0.99 to 1.19 percent of total production cost in small flocks. Their findings appeared to be similar with the present study.

Others operational cost

Others operational cost includes as litter, lime, transportation etc. Other operational costs were not observed significantly difference ($P>0.05$) among the farm sizes and between the farm category. But operation costs were increasing trends as the farm size increase. Others cost were higher in bio-secured managed farm (BDT 4.49) than non-biosecured managed farm (3.89). It may be happened, because bio-security management interventions are practiced more by the bio-secured farmers compared to non-biosecured farmers. So, in case of bio-secured farms, some operational costs (litter, lime etc.) would be higher to protect the diseases of broiler farming. Uddin (1999) found that cost involvement for transportation of chicks, feed etc. including litter in small and large broiler farms were 2.22 and 2.37 percent of total cost, respectively. His results appeared to be lower than the present study.

5.4.5 Return from broiler

Price of live broiler varied from time to time and also due to seasons of the year. During winter season (November to February), most of the social and religious program are held in the society resulting price of broiler are increased in comparison with summer season. As a result, the demand of broiler is increased during winter and therefore gross return was increased. Farm size had a negative relationship with the cost of raising broiler in Table 39. Reduce the production cost was observed relatively in large farm size in compared to small

farm size. Benefit cost ratio was tended to be higher with increasing the size of the farm. Islam *et al.* (2010) found that benefit cost ratio was increased with the increase of farm which supported to the present study. BCR was found higher in bio-secured managed farm than those of non-biosecured farms which indicates that non bio-secured farming had smaller profit in table 40. Satisfactory profitability may be ensured when bio-security management is practiced. Begum *et al.* (2009) reported the net higher return per broiler was more and 1.4 times higher in scientifically managed farm than that of broiler farm managed without any scientific intervention. These results are also in agreement with the result of Badubi *et al.* (2004) who reported a better trained class of farmer, who could effectively seek out and process new information and who could keep accurate financial record, earned higher profit. Jaim and Islam (2008) studied the impact of technical intervention on profitability of village based medium-scaled broiler enterprise in Bangladesh. On the basis of comparative profitability analysis between with and without bio-security intervention, they suggested introduce technical intervention that makes a significant contribution to alleviate rural poverty having maximum profit. In the present study, the results showed that total production cost/ broiler decreasing trends with an increasing the size of the farm. Significant difference ($P<0.01$) was found of BCR between the two categories farm. Due to lack of training, absence of technical help and/or a low level technical knowledge reflected poor performances that caused poor return as well. The lowest BCR (1.08) was found in 500 farm sizes and the highest BCR was 1.38 in 1000 farm sizes in winter. As per profitability analysis it has been found that small size (500, 600) farm had small profit in comparison with farm sizes of 700, 800, 900 and 1000 broilers. During data collection it was found that most of the companies (Feed, chick and medicine suppliers) were provided training on broiler rearing of farm size more than 600 broilers for their business interest. Therefore, a broiler farm of 700 birds may be considered to be minimum farm size for rural farmers. Training had an impact with increasing farm size.

Similar results were found by Akterruzzaman *et al.* (2009). They reported that farmers with training increased farm size as compared with the farmers who had no training. If the farmers received training on feeding, management and health care of poultry that reflects on productive performances as well as profitability. A survey study showed that 52% of the small-scale broiler farmers reared flocks of 200, 300 & 400 birds who had only a primary level of education (Chowdhury *et al.*, 2010). Such a low level educational background causes difficulty in understanding and applying scientific knowledge in practice, even to participate in training programme. Consequently, productivity and profitability are being suffered resulting serious dissatisfaction to the farmers. Interaction effects between farm size and farm category (FS X FC) on the profitability parameters of broiler farming showed non-significant results except broiler return.

5.4.6 Seasonal effect on the profitability of broiler farming

The significantly ($P<0.01$) highest gross return (Tk. 237.92) was found in winter season in comparison with summer season. Moreover, body weight of broiler was also higher in winter season (Table 33). Market price of live broiler was the major contributing factor affected gross return in different seasons. During data collection, the average market price was BDT.129.00/kg in winter and BDT 109.00/kg in summer at producer level. Most of the religious programmes including get together ceremony are held in winter season. Additionally, during winter season, most of the ponds, canal and river are dried out due to unavailability of water resulting fish accessibility is reduced for rural people. So, people are depended more on broiler meat compared to fish. That is why broiler market price is found the higher in winter compare to summer season. In addition, during summer season, mortality rate is found to be slightly higher than winter due to heat stress. So, significantly higher net profit per broiler/ (kg) was recorded in winter season compare to summer season. During winter, broiler farming achieved the highest performances in terms of body

weight, FCR and also in survivability. Due to comfortable housing condition and higher feed intake during winter, available nutrient synthesize body tissue resulted in higher growth of broilers (Baghel and Pradhan 1989a) which partially supported to the current study. Sometimes farmers became disappointed, and left poultry production process. This happened due to the wide fluctuation of market price of live broiler and that was mostly controlled by the middle men. Roy (2000); Raha (2007) stated that fluctuation of market price of broilers affected the profitability which supported to the present findings. Tahura (2004) also reported unstable and undeveloped broiler market which as the top listed problem for broiler farming.

5.4.7 Interaction of season, farm size and farm category on profitability

Profitability parameters like total cost, gross return, cost benefit ratio, net return were not affected by the interaction of farm size, seasons and farm category which was partially similar to the study by Kawsar (2014) who reported that no interaction effect was found among the farm size, farm management and seasons on variable cost of broiler farming.

CHAPTER SIX

Experiment 4: Effect of bio-security management intervention on meat quality of different broiler farming in Bangladesh

6.1 INTRODUCTION

The poultry farming has now turned into one of the most important division of agriculture throughout the world. It is expanding rapidly as dynamic industry in South Asian countries. The tremendous role of commercial broilers is to meet the increasing demand of the population for protein by the meats. Poultry basically is a source of economical palatable and healthy food protein (Mahesar *et al*., 2010). In Bangladesh, poultry industry is playing a vital role in the economy of the country and providing employment for un-employment people. The poultry sub-sector has vigorous contribution in our economy in terms of income and employment generation and is likely to continue due to population growth and high income elasticity of the products. Different studies showed that this sector has been playing a significant role in income generating activities and employment creation particularly for the rural and semi-urban poor, landless laborers, small and marginal farmers and unemployment youth (Ahmed and Hamid, 1991; Alam *et al*., 1998; Miah, 2004 and Alam *et al*., 2012).

Food derived from animal products is important source of nutrients in the human diet and play and increasing role in the most valuable form of animal protein for human consumption. Protein in animal tissues is also associated with some saturated fat. Poultry birds are leaner than other livestock. Still they hold variable amounts of protein, fat and cholesterol according to species, age, weight and sex (Howlider, 1988). Poultry processing technologies and production have become rapidly accessible and are being implemented on a worldwide basis, which will allow continued expansion and competitiveness in the poultry meat sector (Aho, 2001). Therefore, the quality meat may strongly relate to farm management and feed quality considering proximate

components. The quality of the meat is also influenced by genotype of animals and its environment. Recently, there is a tremendous increase in poultry production in our country with consequent increase in poultry meat consumption. The protein consumption from animal origin in Bangladesh is significantly lower than other countries. Usually, an adult person requires 150 gms of meat per day, but he/she only gets 12.61 gms. Moreover, an adult person requires two eggs a week but per capita availability per week is 045% only (DLS, 2007). To meet the growing consumer demand of meat and eggs mostly for urban, semi urban and municipal population a good number of poultry farms are emerging in rural areas.

With poultry farm, currently, broiler farming has become promising and dynamic industry with enormous potential for animal protein supply, income generation and poverty alleviation (Bhende, 2006). Broiler meat is the most desirable source of animal protein and highly accepted by most of the people of Bangladesh irrespective caste and religion. It can efficiently and rapidly fill in the shortage of body requirement. The quality of meat in general and hence poultry meat is an extremely complex notion that can be assessed from different points of view. Poultry meat is a valuable source of proteins, minerals, and has relatively low fat cholesterol content. In this respect, the chemical composition of muscle tissue of major primal cuts is an important element of broiler meat quality reported by Demby and Cunningham, 1980; Grashorn and Closterman 2002. Therefore, meat quality of broiler was analysed reared with or without bio-security management intervention. Proximate analysis was done to determine the meat quality of broiler. So, the experiment was conducted to the following purposes i) to determine the broiler meat quality through proximate analysis reared under bio-secured & non-biosecured management conditions in different locations ii) to compare the seasonal impact of bio-security management intervention on meat quality.

6.2 MATERIALS AND METHODS

6.2.1 Meat Samples collection

Field level meat samples of Rajshahi, Pabna and Kishoregonj were collected through direct communicating and having 12 meat samples each location (Table 45). A total of 36 broiler meat samples were collected from broiler farmers to determine the quality of meat through proximate analysis who reared broilers under bio-secured and non-biosecured managed farm. The total 36 samples were collected from bio and non-biosecured managed farm from three locations during summer and winter. Categories of farm (bio-secured & non bio-secured) were identified by using measures of bio-security standard which were based on marks. As per bio-security standard of broiler farm, the farms those got above 60 marks treated as bio-secured farms and below 60 marks treated as non-biosecured farms (out of 100 marks) in Table 10.

6.2.2 Selection of sample size

Samples were collected from 36 broiler farmers as purposeful during from June 13 to December 2014. Within total 36 broiler farms, 18 meat samples were bio-secured farm and 18 samples were non-biosecured farm considering medium and small scale broiler farming (broiler farm size between 500-1000). Two seasons; summer (March-June) and winter (November- February) were considered during data collection and having 18 meat samples in each season (Table 44).

Table 44. Total broiler meat sample sizes were detailed out according to farm category and season

Farm category	Seasons		Total
	Winter	Summer	
Bio-security farm	9	9	18
Non-biosecured farm	9	9	18
Total	18	18	36

Table 45. Total broiler meat sample sizes were detailed out according to farm location and seasons

Type of seasons	Farm locations			Total
	Rajshahi	Pabna	Kshorgonj	
Summer	6	6	6	18
Winter	6	6	6	18
Total	12	12	12	36

6.2.3 Preparation and preservation of meat samples

Collected broilers were slaughtered with the help of farm owners in a specific place with aiming to collect breast and thigh muscle of broiler meat. After complete bleeding, the feathers were removed from the slaughtered bird for collection of meat considering purposely. The skins also removed from the carcass by traditional method with the assistance of broiler farmers. After collection the samples, samples were placed in polyethylene bag with

indicating farm location, category and seasons. Then samples were frozen and held -4 degree Celsius to send laboratory later for proximate analysis.

6.2.4 Proximate analyses procedure of broiler meat

The frozen samples were submitted to the Animal Nutrition Laboratory, Department of Livestock Services (DLS), Dhaka for proximate analysis (moisture, protein, ash, crude fiber and ether extract). Moisture, Crude protein (CP), Crude fiber (CF), Either extract (EE) and Total ash were analyzed according to the procedure of AOAC (Association of official Analytical Chemist), 7^{th} edition, 2000.

Moisture

1. Accurately weighted a moisture dish of appropriate size.
2. Add approximately 10 g of the comminuted broiler meat sample and reweighted.
3. Placed the container in a vacuum oven at 100^{o}C and less than 100 mm Hg for approximately 5 hours.
4. Removed dish from the oven, cover, cool in desiccator, and weighted.
5. Re dry 1 hour and repeated process until constant weight has been achieved,

Calculate the percentage moisture (fresh weight basis) as follows:

$$\text{percent moisture} = \frac{100\ (P-a)}{P}\ \%$$

P = weight in g of sample
a = weight in g of dried sample

Protein

The micro kjeldahl method was used for the nitrogen (N) determination and crude protein determined by multiplied with a protein factor (N × 6.25). Detail procedure of kjeldahl method is given below:

1. Accurately weighted a suitable quantity of fine-grained material (ca 1.2 g for meat sample, ca 2.5 g for solubles or homogenized meat) and place in digestion flask.
2. Added sequentially a mixture of K_2SO_4:$CuSO_4$= 5:1 (aprrox. 8 gm), one or two selenized boiling granules and 25 mL of conc H_2SO_4 to the flask.
3. Digested until solution is almost colour less or light green (2 hrs for inorganic material) and then at least a further 30 minutes. Do not heat any part of the Kjeldahl flask above the level of the digestion mixture.
4. Cooled (do not allow to solidify), and cautiously add 200 mL water. Add additional boiling granules (if necessary) to prevent bumping.
5. Pipette 100 mL 0.1 N HCl into a 500 mL erlenmeyer flask, add 1 mL Conway's indicator and place the flask under the condenser ensuring that the condenser tip is immersed in the acid solution. (Volume of standardized HCl) used in distillation may be varied according to the expected nitrogen content of the sample).
6. Tilt the Kjeldahl flask containing the digested sample and add 100 mL of 50% NaOH solution slowly down the side of the Kjeldahl flask so that it forms a layer underneath the digestion mixture. Immediately connect the flask to the distilling bulb of the distillation apparatus. Rotate flask to thoroughly mix contents.
7. Heat until all ammonia has passed over into the standard acid. Collect approximately 150 mL. Caution, flask will bump. Removed immediately (prolonged boiling and too rapid distillation of acid during digestion should be avoided as loss of ammonia may occur).
8. Washed tip of condenser and titrate excess standard HCl in distillate with NaOH standard solution

Calculation

Calculate the percentage nitrogen (wet weight basis) as follows:

$$\% \text{ Nitrogen (wet)} = \frac{(A - B) \times 1.4007}{\text{weight (g) of sample}} \times 100$$

where:

- A = vol. (mL) std. HCl x normality of std. HCl
- B = vol. (mL) std. NaOH x normality of std. NaOH

Calculate nitrogen content on dry basis (when moisture content is known) as follows:

$$\% \text{ Nitrogen (dry)} = \frac{\% \text{ Nitrogen (wet)}}{(100 - \% \text{ moisture})} \times 100$$

Calculate the percentage protein (wet or dry basis) as follows:

- % PROTEIN = % nitrogen x 6.25 (where 6.25 is the protein-nitrogen conversion factor for meat sample).

Ash

1. Accurately weighted sample 2 g each was placed in a ceramic crucible
2. Placed crucible in drying oven at 100^{o}C for 24 hours.
3. Transferred to cool muffle furnace and increase the temperature step wise to 550^{o}C ± 5^{o}C.
4. Maintained temperature for 8 hours or until a white ash is obtained.
5. If white ash is not obtained after 8 hours, moisten ash with distilled water, slowly dry on a hot plate, and re-ash at 550^{o}C to constant weight. Repeat if necessary.
6. Removed crucible to a desiccator and weight soon after cool.

Calculation

Calculate the percentage ash content (wet weight basis) as follows:

$$\% \text{ ASH (wet)} = \frac{(\text{wt. crucible and ash} - \text{wt. crucible})}{(\text{wt. crucible and sample} - \text{wt. crucible})} \times 100$$

Calculation of ash content on dry basis (when moisture content is known) as follows:

$$\% \text{ ASH (dry)} = \frac{\% \text{ ash (wet)}}{(100 - \% \text{ moisture})} \times 100$$

Either extracts (Fat content)

For the fat extraction approximately 20 g meat sample was placed in a cellulose thimble paper and fat extraction was carried out using hexane in a 250 ml. Soxhlet extractor for 6 hours.

Calculation:

Percent Crude Fat (Ether Extract), DM basis:

$$\% \text{ Crude fat (wet)} = \frac{(AWres - Wta)}{\text{weight (g) of sample}} \times \text{DM (\%)}$$

- Wta = tare weight of beaker in grams
- Wres = weight of beaker and fat residue in grams

Crude fiber

1. Determined separately the sample moisture by heating in an oven at 105°C to constant weight. Cool in a desiccator.
2. Weighted accurately 1 g about of grinded sample (1 mm about) approximately with 1 mg. ==> W1
3. Added 1.25% sulfuric acid up to the 150 ml notch, after preheating by the hot plate in order to reduce the time required for boiling.
4. Added 3-5 drops of n-octanol as antifoam agent.
5. Boiled 30 minutes exactly from the onset of boiling.
6. Connected to vacuum for draining sulfuric acid.
7. Washed three times with 30 ml (crucible filled up to the top) of hot deionized water, connecting each time to compressed air for stirring the content of crucible.

8. After draining the last wash, add 150 ml of preheated potassium hydroxide (NaOH) 1.25% and 3-5 drops of antifoam.
9. Boil 30 minutes.
10. Filter and wash as point 7.
11. Perform a last washing with cold deionized water aimed to cool the crucibles and then wash three times the crucible content with 25 ml of acetone, stirring each time by compressed air.
12. Remove the crucibles and determine the dry weight after drying in an oven at 105°C for an hour or up to constant weight. Let cool in a desiccator. This weight (W2) represents the crude fiber plus ash content in comparison to initial weight.

Calculation

Calculate the percentage crude fiber (wet weight basis) as follows:

$$\% \text{ Crude fiber (wet)} = \frac{(W2 - W1)}{W1} \times 100$$

6.2.5 Statistical analysis

The data were processed using percentage and standard error mean. Data were analyzed using SPSS 11.5 (2003) program and comparisons of results were made between farms with & without bio-secured intervention.

PLATE 4

Photograph of sample collection

Photo 18: Sample collection from bio-secured farm

Photo 19: Sample collection from bio-secured farm

Photo 20: Sample collection from non-biosecured farm

Photo 21: Sample collection from non-biosecured farm

PLATE 5

Photograph of broiler meat sample analysis

Photo 22: Regent combination for CP determination of broiler meat

Photo 23: Titration for Crude protein determination of broiler meat

Photo 24: Determination of EE of broiler meat

Photo 25: Determination of Ash of broiler meat

6.3 RESULTS

6.3.1 Meat quality as per farm location considering in both seasons

The five (05) proximate parameters like as moisture, CP, ash, CF and EE were considered to determine of broiler meat quality in the study which are presented in Table 46. Significant difference (P<0.05) was found of moisture among the locations. Moreover, CP, ash, CF and EE were not affected significantly among the farm locations. The average moisture, CP, ash, CF and EE was found 76.09, 20.07, 1.02, 0.033 and 1.05% respectively as fresh basis considering in both seasons in table 46. The highest & lowest CP were found 20.38% & 19.49% in Pabna and Kishoregonj respectively. Besides, the highest & lowest EE were found 1.07 & 1.03 in Rajshahi and Pabna locations respectively.

Table 46. Effect of farm location on meat quality in different broiler farming in both seasons

Farm location	Variable % (fresh basis)				
	Moisture	CP	Ash	CF	EE
Rajshahi	75.58	20.35	1.07	.037	1.07
Pabna	75.87	20.38	1.00	.021	1.03
Mean	76.09	20.07	1.02	.033	1.05
SEM	0.051	0.047	0.039	0.005	0.005
P value/Level of significance	0.001**	0.521^{NS}	0.125^{NS}	0.133^{NS}	0.162^{NS}

**, P<0.01; NS, Non-significant

6.3.2 Meat quality as per farm category considering in both seasons

Bio-security management intervention had significant difference (P<0.01) in moisture, CP and ash. On the other hand, CF and EE were not found any significantly difference (P>0.05) between the two farm categories. The crude protein (21.26%), ash (1.10%) and EE (1.08%) were found higher in bio-secured managed farm compared to non-bio-secured managed farm of CP

(18.93%), ash (0.93%) and EE (1.03%) in Table 47. The average moisture, CP, ash, CF and EE showed 75.94%, 20.09 %, 1.01%, 0 .033% and 1.05% respectively between the farm categories.

Table 47. Effect of farm category on meat quality in different broiler farming in both seasons

	Variables % (Fresh basis)				
Farm Category (FC)	**Moisture**	**CP**	**Ash**	**CF**	**EE**
Bio-secured Managed Broiler Farm	75.47	21.26	1.10	.041	1.08
Non Bio-secured Managed Broiler Farm	76.42	18.93	0.93	.026	1.03
Mean	75.94	20.09	1.01	.033	1.05
SEM	0.049	0.041	0.042	0.004	0.003
P value/Level of significance	0.001**	0.002 **	0.004 **	0.215 ^{NS}	0.166 ^{NS}

**, P<0.01; NS, Non-significant

6.3.3 Meat quality as per farm locations during summer

The broiler farm location was not found any significant differences (P>0.05) in moisture, crude protein, ash, crude fiber and either extract (Table 48). The lowest crude protein% was found in Rajshahi and the highest was in Pabna. The average CP, ash and EE was found 19.07%, 0.94% and 1.01% respectively among the three farm locations.

Table 48. Effect of farm location on meat quality in different broiler farming during summer season

Farm locations	Variables % (fresh basis)				
	Moisture	CP	Ash	CF	EE
Rajshahi	78.64	18.04	0.88	.028	1.02
Pabna	76.61	19.61	0.96	.042	1.01
Kishoregonj	76.38	19.58	1.00	.032	1.02
Mean	77.21	19.07	0.94	0.03	1.01
SEM	0.048	0.045	0.047	0.003	0.004
P value/Level of significance	0.132^{NS}	0.174^{NS}	0.103^{NS}	0.115^{NS}	0.129^{NS}

NS, Non- significant

6.3.4 Meat quality as per farm category during summer

Bio-security management intervention during summer season had a significant effect on proximate parameters (Table 49). The crude protein was found significantly (P<0.001) between the bio-secured and non-biosecured managed farm. The crude protein (20.13%) and ash (1.02%) were found higher in bio-secured managed farms compared to non bio-secured managed farms of CP (18.06%), ash (0.88). The average 19.09%, 0.95% & 1.01% of CP, ash & EE was found between the farm categories.

Table 49. Effect of farm category on meat quality in different broiler farming during summer season

Farm Category (FC)	Variables % (fresh basis)				
	Moisture	CP	Ash	CF	EE
Bio-secured Managed Broiler Farm	76.68	20.13	1.02	.039	0.99
Non Bio-secured Managed Broiler Farm	77.74	18.06	0.88	.029	1.04
Mean	77.21	19.09	0.95	0.033	1.01
SEM	0.052	0.047	0.033	0.007	0.005
P value/Level of significance	0.211^{NS}	0.0741***	0.231^{NS}	0.109^{NS}	0.122^{NS}

NS, Non- significant; ***, P<0.001

6.3.5 Meat quality as per farm locations during winter season

Among three farm locations, no significant differences (P>0.05) were observed of proximate parameters (moisture, CP, ash, CF and EE) in Table 50. The average 74.98, 21.14, 1.08, 0.033 and 1.09% was observed of moisture, CP, ash, CF and EE respectively. The highest & lowest CP were found 21.15% & 20.94% in Pabna and Rajshahi respectively. Besides, the highest & lowest EE were found 1.12 & 1.05 in Kshoregonj and Pabna locations respectively.

Table 50. Effect of farm location on meat quality in different broiler farming during winter season

	Variable % (fresh basis)				
Farm locations	**Moisture**	**CP**	**Ash**	**CF**	**EE**
Rajshahi	75.02	20.94	1.08	.058	1.10
Pabna	75.14	21.15	1.01	.000	1.05
Kishoregonj	74.78	21.14	1.15	.042	1.12
Mean	74.98	21.07	1.08	0.033	1.09
SEM	0.046	0.052	0.044	0.002	0.003
P value/Level of significance	0.270^{NS}	0.150^{NS}	0.101^{NS}	0.157^{NS}	0.201^{NS}

NS, Non- significant

6.3.6 Meat quality as per farm category during winter season

The results of proximate parameters; moisture, CP, ash, CF and EE are shown in table 51. Bio-security management intervention had significant difference in moisture (P<0.01), CP (P<0.001), ash (P<0.05) and EE (P<0.01). On the other hand, CF was not found any significantly difference (P>0.05) between the two farm categories. The crude protein (22.39%), ash (1.18%) and EE (1.16%) were found higher in bio-secured managed farm compared to non bio-secured

managed farm of CP (19.81%), ash (0.98%) and EE (1.02%) in Table 51. The average moisture, CP, ash, CF and EE showed 74.97%, 21.1 %, 1.08%, .033% and 1.09% respectively between the farm categories. Overall improve meat quality was found in bio-secured managed farm compared to non bio-secured managed farms.

Table 51. Effect of farm category on meat quality in different broiler farming during winter season

	Variable % (fresh basis)				
Farm Category (FC)	**Moisture**	**CP**	**Ash**	**CF**	**EE**
Bio-secured managed Broiler Farm	74.26	22.39	1.18	.043	1.16
Non-Biosecured managed Broiler Farm	75.69	19.81	0.98	.023	1.02
Mean	74.97	21.1	1.08	0.033	1.09
SEM	0.053	0.043	0.048	0.004	0.006
P value/Level of significance	0.001**	0.067***	0.041*	0.122^{NS}	0.003**

**, P<0.01; ***, P<0.001; *, P<0.05; NS, Non-significant

6.3.7 Seasonal effect on the quality of broiler meat

The significant seasonal effect was found in moisture (P<0.001) and EE (P<0.05) with no effect on CP, Ash and CF (Table 52). The average moisture, CP, ash, CF and EE was found 76.09, 20.07, 1.01, .033 and 1.05% respectively between the two seasons. The crude protein (21.07%), ash (1.08%) and either extract (1.09%) were found higher in winter season compared to summer season of CP (19.08%), ash (0.95%) and EE (1.01%) in Table 52.

Table 52. Effect of season on the quality of broiler meat

Parameter%	Season (SE)		Mean	SEM	P value/Level of significance
	Summer	Winter			
Moisture	77.21	74.98	76.09	0.054	0.089***
CP	19.08	21.07	20.07	0.050	0.152^{NS}
Ash	0.95	1.08	1.01	0.045	0.134^{NS}
CF	.034	.033	.033	0.005	0.129^{NS}
EE	1.01	1.09	1.05	0.008	0.002**

NS, Non-significant; **, P<0.01, ***, P<0.001

6.3.8 Interaction effects of season, farm location and farm category on broiler meat quality in different farming

The interaction effects among the season, farm location and farm category are shown in Table 53. All interaction effects (SE X Fl X FC) on meat quality showed non-significant results except moisture (P<0.01).

Table 53. Effect of interaction of season (SE), farm location (Fl) and farm category on broiler meat quality

Interaction	Parameters (%) (fresh basis)				
(SE X Fl X FC)	Moisture	CP	Ash	CF	EE
SXRaj X FC1	79.99	17.28	0.86	.030	1.00
SX RajX FC2	77.93	18.22	0.87	.027	1.03
SX PabX FC1	73.74	23.21	1.12	.047	1.00
SX PabX FC2	79.47	16.27	0.81	.037	1.02
SX KisX FC1	76.31	19.96	1.07	.040	.977
SX KisX FC2	76.44	19.21	1.00	.042	1.06
WXRajXFC1	74.28	22.01	1.19	.077	1.16

WXRajXFC2	75.75	19.90	1.00	.040	1.04
WXPabXFC1	74.43	22.57	1.07	.000	1.12
WXPabXFC2	75.84	19.79	1.00	.000	.993
WXKisXFC1	74.06	22.59	1.28	.053	1.21
WXKisXFC2	75.49	19.74	1.02	.030	1.04
Mean	76.14	20.06	1.02	0.03	1.05
SEM	0.058	0.047	0.044	0.005	0.007
P value/Level of significance	0.005**	0.125^{NS}	0.142^{NS}	0.312^{NS}	0.133^{NS}

Raj, Rajshahi; Pab, Pabna; Kis, Kishoregonj; S, Summer; W, Winter. FC; Farm category; FC1; Bio-secured; FC2; Non bio-secured farm; **, P<0.01; NS, Non-significant

6.4 DISCUSSIONS

6.4.1 Effect of farm location on meat quality in both seasons

The major nutrient value as moisture, crude protein, crude fiber, ash, and either extracts were considered to determine the quality of broiler meat. The results of the present study indicate the average chemical composition of broiler meat was found moisture (76.09%), CP (20.07), ash (1.02%), CF (.033%) and EE (1.05%) among the three farm locations (Table 46). The highest & lowest CP were found 20.38% & 19.49% in Pabna and Kishoregonj respectively. Okarini *et al*. (2013) reported the chemical composition of broiler meat was moisture (73.85%), protein (18,94%), fat (4.70) and ash (1.78%) respectively. His result was found to be lower than the present study except fat and ash. Gu *et al.* (2008) also found moisture, CP, fat and ash were 72%, 24.9%, 1.5% and 1.4% respectively which are almost similar to the present study. CP, Ash, CF and EE were not affected significantly among the farm locations. It may be happened because major environmental factors (i.e. increase in temperature, humidity and rainfall) in relation with broiler meat quality of three locations are found likely to be identical. Therefore, no significance difference was found among the locations. Lara *et al*. (2013) found that heat stress is one of the most important environmental factors challenging poultry production worldwide. They also reported that harmful effects of heat stress on broilers and laying hens range from reduced growth and egg production to decreased poultry products quality and safety. Exposure to high ambient temperatures has been recognized as one of the main environmental factors that influence meat quality negatively (Aksit *et al.*, 2006; Lu *et al.*, 2007). Gu *et al.* (2008) stated that the protein contents of both breast and thigh meat were reduced by hot environment.

6.4.2 Effect of farm category on meat quality in both seasons

The Table 47 is evident that bio-security management intervention had significant difference in moisture, CP and ash. The crude protein (21.26%), ash (1.10%) and either extract (1.08%) were found higher in bio-secured managed farm compared to non-biosecured managed farm of CP (18.93%), ash (0.93%) and EE (1.03%) respectively in Table 47. However, improve meat quality was found in bio-secured managed farms in comparison with non-biosecured managed farms. This may be happened because during sample collection it was found that bio-security management issues i.e. litter & water management, use of disinfectant ,vaccination, use of nutrient feed, heat management, use of foot bath, good ventilation etc. which are usually practiced more by the bio-secured managed farmers compared to non-biosecured managed farmers. As a result, improve meat quality considering proximate parameters (moisture, CP, ash, fat and CF) was found in bio-secured managed farms than those of non-biosecured managed farms. If the farmers are practiced improve management issues in the broiler farming collectively that may reflect on productive performances as well as meat quality as reported by Akteruzzaman *et al.* (2009). Bogosavljevic-Boskovic Snezana *et al.* (2006b, 2008) the effect of rearing system on protein and fat content of breast and leg muscles was reported. They also found that high protein and fat content were in improving management system compare to low level management. Almost similar findings were found in the current study. Additionally, it was also found that bio-secured broiler farmers were trained much more compared to non-bio-secured farmers. These bio-secured farmers received training from the feed, chick, medicine suppliers companies and other organizations where farmers learnt about bio-security measures on broiler farming, feeding management, housing and health management etc. Due to receiving training more by the bio-secured farmers, improve meat quality was found in bio-secured managed farms. Training had a positive impact on poultry farming management that returns on productive performances as well

as poultry products quality as reported by Akterruzaman *et al.* (2009). In this study, CP was found 21.26 % in case of bio-secured managed farm. Castellini (2006) who stated that protein of Ross broiler at 1 days of age under improve rearing system was 22.77. His result appeared to be higher than the present study.

6.4.3 Effect of farm locations on meat quality during summer

The broiler farm locations were not found any significant differences in moisture, crude protein, ash, crude fiber and either extracts (Table 48). It may be happened, because during summer season, temperature is found likely to be same into the three locations of the study areas and other environmental factors were also same (detail stated earlier). So, in terms of meat quality, no significant differences were found into three locations. Sogunleet *et al.* (2010) found that environmental factor like hot temperature was influenced the quality of broiler meat. In terms of nutritional composition, average moisture, CP, EE, ash and crude fiber was found 77.21, 19.07, 1.01, 0.94 and 0.033% respectively among the three farm locations. Adeniyi *et al.* (2011) reported that moisture, crude protein, fat, ash and crude fibre of broiler meat were 80.21, 18.82, 2.39, 0.50 and 0%, respectively and partially agree with the current study.

6.4.4 Effect of farm category on meat quality during summer

Bio-security management intervention during summer season had a significant effect on proximate parameters (Table 49). The crude protein (20.13%) and ash (1,02%) were found higher in bio-secured managed farms compared to non-biosecured managed farms of CP (18.06%), ash (0.88) respectively. Comparatively improve meat quality was found in bio-secured managed farm compared to non-biosecured farm. This may be happened because biosecurity management issues (detail stated earlier) are practiced more by the bio-secured managed farmers compared to non-bio-secured managed farmers. Sonaiya (2009) indicated that low bio-security as being one of the technical factors

contributing to productivity and poultry product quality of small scale farm. Castellini *et al.* (2002) found that the effect of conventional and improve broiler rearing management system on the chemical composition of broiler meat. They observed minimum differences in protein content and substantial differences in fat content in different muscle groups between two rearing management systems. They also reported that higher protein and significant fat were found in improving management system compared to conventional rearing system which is partly supported to the present study. The average 19.09% CP and 1.01% EE was found between the two farm categories. Souza *et al.* (2011) who reported that proximate composition (protein and EE) of broiler strain (reared in different production systems) was 22.61% and 0.95 respectively. His result seems to be higher except fat than the present study.

6.4.5 Effect of farm location on meat quality during winter

Among the three farm locations, no significant differences were observed of proximate parameters (moisture, CP, ash, CF and EE) during winter in Table 50. It may be happened, because during winter season, environmental factors like temperature and humidity percentage are found likely to be same among the three locations of the study areas. In terms of nutritional composition of broiler meat, the average 74.98, 21.14, 1.08, 1.09 and 0.033% was observed in case of moisture, CP, ash, EE and CF respectively among the three farm locations. This result partially agrees with Cobos *et al.* (2000) who found that the protein and fat content were 20.08 and 3.39% respectively in breast meat of wild ducks. Another researcher Kabir (2010) also reported that proximate compositions of breast meat of broiler were found 74.25%, 22.10%, 1.37% and 1.07% of moisture, protein, ash and fat respectively provided different level of dilatory protein of broiler feed which is almost similar to the present study.

6.4.6 Effect of farm category on meat quality during winter

The results (moisture, CP, ash, CF and EE) of proximate parameters of broiler meat are shown in table 51. Bio-security management intervention had significant difference on proximate parameters. The crude protein (22.39%), ash (1.18%) and either extract (1.16%) were found higher in bio-secured managed farm compared to non-biosecured managed farm of CP (19.81%), ash (0.98%) and EE (1.02%) respectively in Table 51. This result may happen due to use of growth promoters, antibiotic and toxin binder indiscriminately to have maximum growth and survivability, less use of vaccine, less use of nutrient feed, little or no use of disinfectant, no use of foot bath by the non-bio-secured broiler farmers. These irregular practices might be reflected on broiler production performance as well as meat quality. In addition to that during sample collection it was also found that non bio-secured broiler farmers were not followed improve feeding management in broiler rearing system as they had insufficient training on nutrition management including feeding system on broiler farming. As a result, improve meat quality was found in bio-secured managed farms compared to non-biosecured farms. Bogosavljević-Bošković1 Snežana *et al*. (2010) reported that nutrition feed, as one of the most important external factors in broiler production, can have a crucial effect on the chemical composition of broiler meat which is partly supported to the present study. The feeding mode is very important factor of meat quality since the feed composition can affect or change strongly the characteristics of chicken meat (Jaturasitha *et al*., 2004 and 2008a) which is also supported to the present study. The average CP was found 21.01 % between the two farm categories which was almost similar to the earlier study by Qiao *et al.* (2001) who observed that protein was 23.05% in some selected broiler breast meat.

6.4.7 Seasonal effects on the quality of broiler meat

The significant seasonal effects were found in moisture and EE with no effect on CP, ash and CF (Table 52). The average moisture, CP, Ash, CF and EE was found 76.09, 20.07, 1.01, .033 and 1.05% respectively between the seasons. The crude protein (21.07%), ash (1.08%) and either extract (1.09%) were found higher in winter season compared to summer season of CP (19.08%), ash (0.95%) and EE (1.01%) respectively in Table 52. It might be occurred due to in-house comfortable condition resulting higher feed intake during winter and available nutrient synthesize in body tissue in winter is happened. Besides, in winter season nutrient absorption is occurred much more than summer season. As a result, CP and EE were found higher of broilers meat for the period of winter in comparison with summer season. Raphulu *et al. (*2015) found that the crude protein of the grower chickens breast muscles and fat content of the adult chicken leg muscles differed with season. They found that the highest fat content of the leg muscle was obtained in autumn which is partially supported in the present study. Gu *et al.* (2008) reported that hot environment had significant effect on average daily feed intake (ADFI), average daily gain (ADG) and feed conversion ratio (FCR). They also found that the protein contents of both breast and thigh meat were reduced by hot environment which also supported in this study. This result partially agrees by Baghel and Pradhan 1989a who reported due to outside temperature adjustment, higher feed intake occurred during winter resulted higher growth of broilers. All interaction effect (SE X Fl X FC) on meat quality showed non-significant results except in moisture.

CHAPTER SEVEN

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

7.1 SUMMARY

Experiment 1: Impact of socio-economic factors on production performances of small and medium size broiler framing in Bangladesh

A survey study was carried out to assess the broiler production performances reared in different locations; Pabna, Rajshahi and Kishorgonj having 30 broiler farmers in each. Data were collected from a total of 90 broiler farmers by direct interviewing using a semi-structured questionnaire between January 13 and June 2014. Data were edited and categorized as per farm sizes, such as 23% farmers of 500 broilers, 20% of 600, 16% of 700, 17% of 800, 14% of 900 and 11% farmers of 1000 broilers. The data were processed using mean, percentage and master tabulation sheet. Regression models were used to determine the relationship between some socio economic factors and broiler production performances considering net return. Broiler production performances were positively related with education, farm size, training, land size and age of the farmers and significant differences of education & farm size ($P<0.01$), training & land size ($P<0.05$) and age ($P<0.001$) were found. On the other hand, in case of farmer's annual income had no significant relationship with the broiler performance. In terms of production performance, feed conversion efficiency was tended to be better with an increasing in the size of the farms and significant difference ($P<0.01$) was found among the farm sizes. The article also focuses on broiler production constraints, production systems for the improvement of broilers farming in Bangladesh. The major constraints are chick quality, fluctuate price of chicks & live broiler, low price of finished broiler, risk of diseases including avian influenza, bio-security of the farm and high feed cost, marketing system, interruption of feed supply, heat stress

affecting productivity and survivability, lack of knowledge in disease outbreak and limited access to credit. Among the major constraints, lacking of quality chicks was the major constraint appeared to be a common complaint to the farmers. Fluctuating price of chicks & marketable live broiler, low price of finished broiler, risk of diseases including Avian Influenza (AI), bio-security of the farm and high feed cost ranked by turns second, third, fourth, fifth and sixth respectively. The present study revealed that the socio-economic status of the broiler farmers affect broiler production as well as profitability.

Experiment 2: Production and economic performances of broiler farming with or without bio-security management intervention during summer

A survey study was undertaken to determine the productive and economic performances of broiler farming with or without bio-security management conditions during summer season reared in different locations; Pabna, Rajshahi and Kishoregonj districts of Bangladesh. Total 41farms were selected into three locations considering bio and non bio-secured managed farms of which 14 in Rajshahi, 14 in Pabna and 13 in Kishoregonj. Data were collected from a total 41 broiler farms by using semi structured questionnaire. As per bio-security standard of broiler farm, the farms those got above 60 marks treated as bio-secured farms and below 60 marks treated as non-bio-secured farms (out of 100 marks). Of the 41 farms, 27%, 21%, 15%, 15%, 12% and 10% farms have 500,600,700,800 900 and 1000 broilers respectively. During summer, a significant difference was found on marketable body weight and FCR among the farm sizes. FCR was better trend with increasing the size of the farm. Overall FCR was improved in bio-secured managed farm than those of non bio-secured managed farm. Bio-security managed groups showed FCR (1.77) that was lower than without bio-security management groups (1.88). Results indicated that farm category and farm size had clear impact on broiler productivity. Total cost of production was lower trend with increasing the size of the farm resulting higher BCR trend was found among the farm sizes. The

highest BCR was found in 1000 farm sizes (1.30) and the lowest was in 500 farm sizes (1.01). The lowest cost of broiler production was found when bio-security management was practiced. Therefore, significantly higher BCR value was found in bio-secured managed farms (1.17) than those of non bio-secured managed farms (1.03). High temperature, excessive load shedding in rural areas during summer, lack of technical knowledge of farmer, heat stress affecting productivity & survivability and high feed cost were the major challenges for the farmers to explore higher productivity and profitability.

Experiment 3: Production and economic performances of broiler farming with or without bio-security management intervention during winter

A total of 49 farms were selected into three locations in Bangladesh of which 16 in Rajshahi, 16 in Pabna and 17 in Kishorgonj. Data were collected from broiler farms by using semi structured questionnaire in winter season considering bio and non bio-secured managed farms. Of the 49 farms, 25 were bio-secured farms and 24 were non bio-secured farms. According to bio-security standard of small scale broiler farm, those farms that got above 60 marks were treated bio-secured farms and below 60 treated as non-bio-secured farms (out of 100). Of 49 farms, 20% farms of 500 broilers, 19% of 600, 16% of 700, 18% of 800, 14% of 900 and 13% farms of 1000 broilers. In case of productive performances, body weight and FCR showed better trend as the farm size increased and significant differences were found among the farm sizes. When farms of similar sizes were maintained with bio-secured conditions, overall, FCR tended to be better than non bio-secured managed farm. The lowest FCR (1.56) was found for 1000 farm size. On the other hand, the highest FCR (1.74) was found in 500 farm size. With bio-security management intervention in broiler farming during winter was found higher body weight (1.89kg /bird) with lower FCR (1.60) than who were not bio-security intervened groups. Survivability was also higher in farms practicing bio-security management (95.28%) than those of non bio-secured managed

farms (94.72%). In terms of profitability parameters, the highest BCR (1.38) was found in 1000 farm size and very poor BCR (1.08) was found in 500 farm sizes. BCR was found higher trends with increasing the size of the farm. Moreover, higher BCR value (1.25) was observed in bio-secured managed farm than those of non bio-secured managed farm (1.09).

The growth performances were found higher to winter in comparison with summer season. Profitability also was found to be higher in winter compared with summer season. Excessive cold, risk of diseases including Avian Influenza (AI), insufficient marketing knowledge, high chick cost and lack of technical support were the main constraints of the farmers to rearing broilers during winter.

Experiment 4: Effect of bio-security management intervention on meat quality of different broiler farming in Bangladesh

A total of 36 broiler meat samples were collected from broiler farmers to determine the quality of meat through proximate analysis who reared broilers under bio-secured and non bio-secured management conditions in different locations; Rajshahi, Pabna and Kishoregonj districts of Bangladesh. Categories of farm (bio-secured & non bio-secured) were identified by using measures of bio-security standard which were based on marks. As per bio-security standard of broiler farm, the farms those got above 60 marks treated as bio-secured farms and below 60 marks treated as non-bio-secured farms (out of 100 marks). Within total 36 broiler farms, 18 meat samples were bio-secured farm and 18 samples were non bio-secured farm. Two seasons; summer and winter were considered during data collection and having 18 meat samples in each season. The data were processed using percentage and standard error mean. Broiler farm locations were not found any significant differences in moisture, crude protein, ash, crude fiber and either extracts in both seasons. However, bio-security management intervention during summer and winter seasons had a

significant effect on proximate parameters. CP, moisture, Ash, EE and CF were found higher in bio-secured managed farm in comparison with non bio-secured managed farm in both seasons. The proximate analysis of broiler meat samples of both seasons average showed the following composition: moisture 76.09%, CP 20.07%, Ash 1.07%, CF 0 .033% and EE 1.05% respectively. Overall improve meat quality was found in bio-secured managed farm than those of non bio-secured managed farm. Finally, between the two seasons, in terms of meat quality, CP, ash and EE were found higher in winter season in comparison with summer season.

7.2 CONCLUSIONS

The following conclusions may be drawn on the basis of the results of this study:

1. Broiler production performances were positively influenced with education, farm size, training, land size and age of the farmers while family size had negative influence;
2. Farmers with poor academic background who are unemployed usually engage themselves in small and medium scale broiler farming. Lack of both training and technical knowledge that affects broiler productivity and profitability;
3. Lacking of quality chicks by ranked highest among the constraints faced by the broiler farmers, and this constraint appeared to be a common complaint of the farmers. Excessive colds, lack of knowledge on disease outbreak, poor management due to insufficient technical knowledge of the farmers, risk of diseases including Avian Influenza (AI), high temperature, frequent power break in rural areas, improper marketing facilities and lack of biosecurity of the farm were the major constraints of broiler farming in both seasons;

4 Bio-security management issues of broiler rearing were found higher to be practiced in bio-secured managed farmers in comparison with non bio-secured managed farmers. As a result, improve FCR, higher survivability and BCR were found in bio-secured managed farm compared to non bio-secured farms. Therefore, bio-security management intervention had a positive impact on broiler growth and profitability;

5 Production performances along with profitability were higher in winter season compared to summer due to seasonal variability of factors affecting performances;

6 Considering moisture, CP, ash and fat, overall improve meat quality was found in bio-secured management condition in comparison with non bio-secured management condition. Between the two seasons, overall meat quality was found higher in winter season compared to summer saeson.

In general, bio-security management issues are neglected in broiler farming in most cases than layer farming. The current study shows in terms of production performances and profitability, improve FCR and higher BCR were found in bio–secured managed farm compared to non bio-secured managed farm. Moreover, over all FCR was tended to be better with an increasing the size of the farm. BCR also found higher trend with increasing the size of the farm. As per profitability analysis it has been found that small size (500, 600) farm had small profit in comparison with farm sizes of 700, 800, 900 and 1000 broilers. So, a broiler farm of 700 birds may be considered to be minimum farm size for rural farmers. Production and economic performances were found satisfactory including better profit in winter season in comparison with summer season. The current study also shows that around 80% farmers were not trained up on broiler farming management resulting low production as well as less profitability in broiler farming. In terms of meat quality, bio-security intervention had significant effect on proximate components of broiler meat. It is, therefore, concluded that training of the broiler farmers, introduction of bio-security management practices, regular monitoring with adequate poultry extension services are the key elements to get satisfactory result from the broiler farming.

7.3 SUGGESTIONS AND RECOMMENDATIONS

The following suggestions and recommendations are made for the policy makers to explore productivity and ensure profitability in a sustainable manner:

1. Small & Medium Enterprise farmers must have at least Junior School Certificate (JSC) for poultry husbandry practices. Farmers should be trained periodically on various aspects of husbandry and disease control so that they can apply their knowledge for the operation of broiler farming successfully. Non trained farmers should not be registered for farming;
2. The poultry dealers and agents are the representatives of broiler farmers for providing feeds and chicks. Their contribution in commercial poultry production is essential. Training of such dealers and agents need be taken for maintaining the quality of inputs. Their educational level must be at least JSC level;
3. The minimum farm size should be 700 to have optimum profit. This should be followed strictly to ensure sustainability by minimizing cost of production for favor of maximum profit;
4. Smallholder farmers should come forward to form “market group” for the intervention of marketing channel that will ensure price of their products;
5. Extension support to broiler farmers should be ensured and regular monitoring of services on management, vaccination, bio-security, etc. need to be strengthened to enhance productivity and maximize profitability especially for small and medium scale broiler farmers. Bio-security program must be regularly reviewed, updated and monitored in individual operation;
6. A policy should be developed by the government to remove unexpected growth promoters and antibiotics in case of poultry production. Awareness should be developed against the use of such Antibiotics /Antibiotics growth promoters.

REFERENCES

Ahmed, M.F., Nishibori, M. and Islam, M.A. 2012. Production and price of indigenous nacked and full feathered chicken reared under rural scavenging system in Bangladesh. *Journal of Agricultural Extension and Rural Development*, **4**: 92-97.

Adeniyi, O. R., Ademosun, A. A. and Alabi, O. M. 2011. Proximate composition and economic values of four common sources of animal protein in South-western Nigeria. *Zootecnia Tropical*., **29(2):** 231-234.

Ahmed and Islam, 1985. Backyard Poultry Development project in 100 villages, sponsored by Bangladesh Agricultural University and assisted by UNICEF, Bangladesh. In: *Proceedings of the 1st conference of Bangladesh Animal Husbandry Association*, BRAC, Dhaka, Bangladesh.

Ahmed, A. 1997. Broiler farming in different seasons of the year. *Bangladesh Agricultural University Research Progress*, **11**:82-83.

Abdullah-Al Amin, M., Rahman, M. S., Howlider, M. A. R. and Ahammed, M. M. 2009. Disposal of layer droppings reared in case and impact on environmental pollution. *Journal of the Bangladesh Agricultural University*, **7(2):** 281-290.

Ahmed, S.U., Ali, M.S. and Begum, A. 1995. An economic study on the performance of broiler and layer round the years. Bangladesh Agricultural University *Research Progress*, **9:** 315-320.

Ahmed, S. and Hamid, M.A. 1991. Status of poultry production and development strategy in Bangladesh. In: *Proceedings of the workshop on*

livestock development in Bangladesh, held on July 16 to 18, 1991 at Bangladesh Livestock Research Institute, Savar, Dhaka.

Akter, A. and Uddin, S. 2009. "Bangladesh Poultry Industry" *Journal of business and technology* (Dhaka), **4 (2)** : 97-112.

Akteruzzaman, M., Miah, M.A.M., Hossain, M.M., Nahar, J. and Fattah, K. 2009. Impact of training on poultry farming for improving livelihood of the smallholders in rural Bangladesh. In: *Proceedings of the* 6^{th} *International Poultry Show and Seminar*, World's Poultry Science Association, Bangladesh Branch, Dhaka, Bangladesh. p.35-43.

Alam, G.M.M., Khatun, Most. N. and Kamruzzaman, M. 2012.Factors affecting poultry production: Empirical insights from areas of Bangladesh, Annals of Bangladesh Agriculture 16 (forthcoming).

Akther, S., Harun-Ar Rashid and Manzur Morshed, M.M. 2008. Broiler farming under Aftab Bhaumukhi Farm Limited supervision and farmers own management: A comparative efficiency analyses. *M.S. Thesis*, submitted to the Department of Agricultural Economics. Bangladesh Agricultural University, Mymensingh, Bangladesh.

Alam, J. 1995. Livestock researches in Bangladesh: Present Status and Future Potential. University Press Limited, Dhaka, Bangladesh.

Alam, J. 1996. Socio-economic Impact of Smallholder Livestock Development Project Bangladesh. Bangladesh Livestock Research Institute, Savar, Dhaka, Bangladesh.

Alam, J. 1997. Impact of Smallholder Livestock Development Project in some selected areas of rural Bangladesh. *Livestock for Rural Development* 9: (http;//www.cipav.org.co/irrd/irrd9/3/bang 932.htm).

Alam, J., Sayeed, A., Rahman, A., Yasmin, F. and Begum, J., (1998). An economic study on poultry farms in Bangladesh. *Bangladesh Journal of Livestock Research*, **2(1-5):** 61-174.

Aho, P. 2001. *Subject Poultry Elite*, Watt poultry, USA

Ali, A. 1993. An economic analysis of poultry farming in some selected area of Dhaka city. *M.S. Thesis* submitted to the Department of Agricultural Economics, Bangladesh Agricultural University, Mymensingh, Bangladesh.

Ali, M. J. 1996. Current status of Veterinary Biologic Production in Bangladesh and their quality control. Proceedings of the BSVER symposium held on July 28, 1994 at NIPSO Mauditorium, Mohakhali, Dhaka, Bangladesh.

Ali, M. Y., Jahan, S. S., Begum, M. I. A. and Islam, A. 2014. Impact of bio-security management intervention on growth performance and profitability of broiler farming in Bangladesh. *Livestock Research for Rural Development* **26 (11).**

Ali, M.A. 2004. Performance and cost benefit analyses of commercial broilers. *Bangladesh Agricultural University Research Progress*, **14**: 96-97.

Ali, M.M. and Hossain, M.M. 2012. Problems and prospects of Poultry Industry in Bangladesh: An analysis. AIUB Bus Econ working paper. Series, 2012-01 htpp://orp.aiub.edu/Working paper/aspx? Year=2012.

Ali, M.S. 2008. Adoption of ecological agricultural practices. Ph D dissertation, Department of Agronomy, Bangladesh Agricultural University, Mymensingh, Bangladesh.

Ali, M.S. and Hossain, M.M. 2010. Factor influencing the performance of farmers in broiler production of Faridpur District in Bangladesh. *World's Poultry Science Journal,* **66**: 123-131.

Al-Rawi, B.A. and Vetera-Alvarez, H. 1983. Strain and energy level effects in broiler chicken in Saudi Arabia. *Tropic Agriculture,* Triniad, **60**: 168-289.

Ansarey, F.H. 2012. Prospects of poultry industry in Bangladesh. Published in Seminar and Reception of Bangladesh Animal Husbandry Association proceedings; Animal Husbandry and Profession in Bamgladesh-A journey of 50 Years. pp. 62-63.

AOAC, 2000. Official Methods of Analysis. Association of Official Analytical Chemist. 7th ed., Washington DC, USA.

Arjona, A.A., Denbow, D.M. and Jr Weaver. W.D. 1988. Effect of heat stress in early life on mortality of broilers exposed to high environmental temperature just prior to marketing. *Poultry Science*, **67:**226-231.

Aksit, M., Yalcin, S., Ozkan, S., Metin, K. and Ozdemir, D. 2006. Effects of temperature during rearing and crating on stress parameters and meat quality of broilers. *Poultry Science*, **85**: 1867-1874.

Badubi, S.S., Ravindran, V. and Reid, J. 2004. A survey of small scale broiler production systems in Botswana. *Tropical Animal Health and Production* **36**:823-834.

Biswas, S., Goswami, Al., Jana, C., Das, A. K. and Pal, R. N. 2003. A study on broiler chicken production and marketing situation in coastal belt of west Bengal, *Indian Journal of Animal Health,* **42 (1**): 51-57.

Baghel, R.P.S. and Pradhan, K. 1989a. Seasonal effect on carcass traits organ weight and processing loss in broilers. *Indian Journal Animal Science*, **59**: 476-478.

Baghel, R.P.S. and Pradhan, K. 1989b. Performance of the broiler influenced by the phase of growth and seasons. *Indian Veterinary Journal*, **66**: 1176-1178.

Bandara, R.M.A.S. and Dassanyake, D.M.W.K. 2006. A quantitative analysis on factors affecting profitability of small-scale broiler production. *The Journal of Agricultural Science*, **2(3):** 45-50.

Bangladesh Economic Review 2006. Ministry of Finance. Government of the People's Republic of Bangladesh, Dhaka, Bangladesh.

Barua, A. and Yoshimura, Y. 1997. Rural poultry keeping in Bangladesh. *World's Poultry Science Journal*, **53:** 387-395.

BBS, 2010. Statistical Year Book of Bangladesh. Bangladesh Bureau of Statistics, Statistics Division, Ministry of Planning, Government of the People's of Bangladesh, Dhaka, Bangladesh. p. 96.

BBS, 2011. Statistical Year Book of Bangladesh Bureau of Statistics, Statistics Division, Ministry of Planning, Government of the People's of Bangladesh, Dhaka, Bangladesh p. 195.

BBS, 2012. Statistical Pocket Year Book of Bangladesh Bureau of Statistics, Statistics Division, Ministry of Planning, Government of the People's of Bangladesh, Dhaka, Bangladesh p. 190.

Begum, D. 2004. Analyses of cost and returns in poultry farming at small holder production units. *M.S. Thesis* submitted to the Department of

Poultry Science. Bangladesh Agricultural University, Mymensingh, Bangladesh.

Begum, I. and Alam, M.J. 2009. Is vertically integrated poultry farming system pave the way of small scale poultry farmers in Bangladesh? *Revue Africanie De Sante de Productions Animales*.http://www.eismv.refer.sn

Begum, I.A. 2005. Vertically Integrated Contract and Independent Poultry Farming System in Bangladesh: a Profitability Analysis. Livestock Research for Rural Development, **17 (8)**.

Begum, I.A. 2006. Potentiality of Vertically Integrated Poultry Contract Farming System in Bangladesh: Profitability and Productivity Analysis, *Bangladesh Journal of Agricultural Economics*, ***29*****(1&2):** 107-117.

Begum, I.A. 2008. Prospects and potentialities of vertically integrated contact farming in Bangladesh poultry sector development. Submitted *Ph D thesis*. Hokkaido University, Japan.

Begum, I.A., Buysse, J., Alam, M.J. and Vanhuylenbrooec, K.G. 2010. Technical allocative and economic efficiency of commercial poultry farms in Bangladesh. *World's Poultry Science Journal*, **66**:465-475.

Begum, S. 2000. A comparative analyses of broiler and layer production in some selected area of Mymensingh District. *M.S. Thesis* submitted to the Department of Agricultural Economics. Bangladesh Agricultural University, Mymensingh, Bangladesh.

Bhende, M.J. 2006. Production and cost of broiler meat: A case study. Karnataka Agricultural Development and Rural Transformation Center, *Research Report 9/ADRT/118*. Institute for Social and Economic Change, Bangalore, India.

Banerjee, G.C. 2004. Poultry, Oxford & ONH Publishing Co. Pvt. Ltd., New Delhi, 3rd edition.

Bhuiyan, M.U. 1999. An economic analysis of small-scale poultry farming of Kotwali Thana in Mymensingh District. *M.S in Agricultural Economics Thesis*. Department of Agricultural Economics. Bangladesh Agricultural University, Mymensingh, Bangladesh.

BLRI (Bangladesh Livestock Research Institute), 2005. Poultry Utpadon Projukti Nirdeshika (Livestock and poultry production technology manual). Bangladesh Livestock Research Institute, Savar, Dhaka, Bangladesh. p. 76-79.

BLRI (Bangladesh Livestock Research Institute), 2008. A study report on Highly Pathogenic avian influenza in Bangladesh.

BRAC (Bangladesh Rural Advancement committee) 2005. Report on poultry farms, 2005.

Bogosavljevic-Boskovic Snezana, Kurcubic, V., Petrovic, M. and Doskovic, V. 2006b. The Effect of Season and Rearing System on Meat QualityTraits. *Czech Journal of Animal Science*, **51(8):** 369-374.

Boškošković-Bogosavljević Snežana, Mitrović, S., Radović, Vera., Dosković, V. and Dermanović, V. 2008. Chemical Composition of Chicken Meat in Extensive Indoor and Free Range Rearing System. 18th Symposium on Innovation in Animal Science and Production 27-28 November, Belgrade-Serbia. *Biotechnology Animal Husbandry*, **24**: 213-223.

Bogosavljević-Bošković Snežana, Zlatica Pavlovski, Milun, D. Petrović Vladimir Dosković1 and Simeon Rakonjac 2010. Broiler meat quality:

Proteins and lipids of muscle tissue. *African Journal of Biotechnology*, **9: 54**, 9177-9182.

Castellini, C., Bosco, A.D., Mugnai, C. and Pedrazzoli, M. 2006. Comparison of two chicken genotypes organically reared: oxidative stability and other qualitative traits of the meat. *Italian Journal of Animal Science,* **5**: 29-42.

Castellini, C., Muginai, C. and Bosco, A. D. 2002. Effect of organic production system on broiler carcass and meat quality. *Meat Science*, **60**: 219-225

Chand,V., Chowdhury, S.D., Saha, M.K. and Hossain, M.K. 2009. IFC-SEDF sector studies a baseline surveys in poultry in Bangladesh. *Final report.* Associates for Development Services Limited, Dhaka, Bangladesh.

Chowdhury, E.H., Das, P.M., Islam, M.R. and Yamage, M. 2015. Quantification of bio-security statuses in commercial poultry farms using a scoring system. In: *Proceedings of the 9th International Poultry Show and Seminar*, World's Poultry Science Association, Bangladesh Branch, Dhaka, Bangladesh. P. 173-184.

Chowdhury, S.D. Latif, M.A. and Debnath, S.C. 1993**.** Appropriate level of education for trainees in backyard poultry raiser's training programme as determined by their performance. *International Journal of Animal Science*, (India), ***8*:**23-26.

Chowdhury, 2013. Opportunities & challenges facing commercial poultry production in Bangladesh. *Proceedings of Eighth International Poultry Show and Seminar*, WPSA-BB, 28 February-02 March 2013, Dhaka, Bangladesh.

Chowdhury, M.S.J. 2001. Economic analyses of broiler rearing farms under Aftab Bhamukhi Farm Limited in Bajeetpur Upzilla of Kishorgonj

District. *M.S thesis*, submitted to the Department of Agricultural economics, Bangladesh Agricultural University, Mymensingh, Bangladesh.

Chowdhury, S.D, Kawsar M.H., Islam, M.N., Raha, S.K., Hossain, M.M. and Huque, E. 2010. Profitability of small scale broiler farming to support rural livelihood In Bangladesh. In: *Proceedings of the Annual Research Review workshop 2009-2010,* Bangladesh Livestock Research Institute, Saver, Dhaka, pp. 241-247.

Chowdhury, S.D., 2011. Reported that commercial poultry farming in Bnagladesh: the rolling tears of farmers and its consequences. *Proceedings Seventh International Poultry Show and Seminar*, WPSA-BB, 25 -27 March 2011, Dhaka, Bangladesh.

Cobanoglu, F., Konak, K. and Bozkurt, M. 2002. Marketing and Economic Analysis of broiler farms in Aydn province, *Ziraat Fakultesi Dergisi Akdeniz Universitesi*, **15 (1)** : 27-36.

Cobos, A.; Veiga, A. and DIaz, O. 2000. Chemical and fatty acid composition of meat and liver of wild ducks (Anasplatyrhynchos). Food Chemistry, **68:** 77-79.

Costa and KilpmUiek, I.J. 2001. The ideal levels of crude protein for Ross broiler chickens from 1 to 21 and 22 to 42 days of age in both sexes. *Journal of China Agricultural University*, **11(6):** 96-102.

Daghir, N.J. 1991. Broiler feeding and management in hot climates. *Zootechnica International,* **10(32 & 34):** 36-37.

Das, S.C., Chowdhury, S.D., Khatun, M.A., Nishibori, M. N., Losbe and Yoshimura, Y. 2008. Poultry production profile and expected future projection in Bangladesh. *World's Poultry Science Journal***, 64:** 99-117.

Demby, J.H. and Cunningham, F.E. 1980. Factors affecting composition of chicken meat-literature review. *World's Poultry Science Journal,***36**: 25-37.

Dolberg, F. 2008. Poultry sector country review: Bangladesh FAO animal production and health division emergency centre for trans-boundary animal diseases: socio- economics, production and biodiversity unit. Rome, Italy.

Dwivedi, S., Sarma, P.K. and Sehar, H. 2010. Investment and Income Pattern in Poultry Production: A Case Study a Baramulla District of Jammu and Kashmir. *Research Journal of Agricultural Science,* **1(3):** 262-265.

DLS, 2007. Directorate of Livestock Services, Farmgate, Khamarbari, Dhaka.

Ergin, S. 2006. Avian Influenza as an emerging infection. Veteriner-Fakultesi-Dergisi-Istanbul, **32**: 1-11.

Ersad, S.M.E., Islam, S.S., Mondal, S.C. and Sarkar, B. 2004. Efficiency of trained farmers of the productivity of broilers in selected Area of Bangladesh. *International Journal of Poultry Science,* **3**: 503-506.

Fairoze, M.N., Achoth, L., Rashmi, P.K.K., Tiongco, M.M., Delgado, C.L., Narrod, C., Chengappa, G.C. and Padinjarada 2006. Equitable intensification of market oriented smallholder poultry production in India through contract farming. An IFRI-FAO project entitled contract farming of milk and poultry in India: Partnerships to promote the environmentally friendly and equitable intensification of smallholder market oriented Livestock production, Washington DC. USA.

Farooq, M., Mian, M. A. and Asghar, A. 1999. Factors affecting cost of production and net profit per broiler. *Poultry Advisor,* **19:** 26-30.

Ferket, P.R. and Gernat, A.G. 2006. Factors that affect feed intake of meat birds: A review. *International Journal of Poultry Science,* **5:** 905-911.

Fouzder, S.K. 2006. Broiler rearing at subsistent farms and its implication on income generation, gender efficiency and family nutrition. *Ph D Thesis,* Department of Poultry Science, Bangladesh Agricultural University, Mymensingh, Bangladesh. p. 125.

FSES 1996. Poverty alleviation through integrated farming. Fact Searching and Intervention 1990-91. Farming system and Environmental Studies, Bangladesh Agricultural University, Mymensingh, Bangladesh p.120-122.

Ghosh, S.C., Hossain, M. and Saleque, M.A. 2009. Practices of biosecurity in wet market of Bangladesh in response to highly pathogenic avian influenza, *proceedings of the 6th International Poultry Show and Seminar of WPSA-BB*, Dhaka, Bangladesh.

Gokhan, E.E. and Aken, A. 2000. The effect of seasonal conditions on fattening performance and production cost in broiler production in Elazig. *Poultry Abstracts,* **8:** 2-3.

Golap, A.K.M. 2001. A comparative economic analyses of broiler and layer production in some selected areas of Mymensingh district. *M.S thesis* submitted to the Department of Agricultural Economics, Bangladesh Agricultural University, Mymensingh, Bangladesh.

Gracas, A.S., Fonseca, DAS, P.R. Soares, J.B. and Silva, DE.AE M. 1990. Housing density of broilers at different times of the year. *Revista de SociedadeBrasileira de Zootechnia,* **19:** 186-196.

Grashorn, M.A. and Closterman, G. 2002. Mast-und Schlachtleistung von Broilerherkunften fur die extensivmast. Arch. Geflugelk. **66(4):** 173-181.

Grashorn, M.A. and Brose, K. 1997. Quality assurance in label progras forchicken meat. Proceedings of XIII European Symposium on the Quality of Poultry Meat, 21-26 September, Poznan, Poland: p. 619-624.

Guèye, E.F. 2000a. Woman and family poultry production in Africa. *Development practice,* **10:** 98-102.

Guèye, E.F. 2000b. The family poultry in poverty alleviation, food security and the promotion of gender equity in rural Africa. *Outlook Agriculture,* **29:** 129-136.

Guèye, E.F. 2002. Employment and income generation through family poultry. *World's Poultry Science Journal*, **58:** 541-557.

Guèye, E.F. and Bessei, W. 1996. Gefluegelhaltung in Afrika: Bedeutung and Perspektiven. Deutsche Gefluegelwirtschaft and Schweineproduktion Magazin, Woche, **31:** 38-40.

Gu, X.H., Li, S.S. and Lin, H. 2008. Effects of Hot Environment and Dietary Protein Level on Growth Performance and Meat Quality of Broiler Chickens. *Asian Australian Journal of Animal Science,* **21(11):** 1616-1623.

Gopalkrishnan, C.A. Mohanlal and Morley, G. 2007. Livestock and poultry enterprise for rural development. Conference proceedings : Poultry in the 21st Centry- Avian Influenza and Beyond, FAO, Bangkok, November 5-7.

Hossain, M.A., Suvo, K.B. and Islam, M.M. 2011. Performance and economic suitability of three fast growing broiler strains raised under farming

condition in Bangladesh. *International Journal of Agricultural Research. Innovation & Technology,* **1**:37-43.

Hossain, M.R., Ali, A., Rahman, A.H.M.S. and Apu, M. S. 2008. Analyses of Economic loss of flood victim broiler farms. *Bangladesh Journal of Animal Science,* **37 (1):** 23-31.

Hossain, S.A. 1999. Marketing of eggs and broiler in Bangladesh. In: *Proceedings of the 1st International Poultry Show and Seminar.* World's Poultry Science Association, Bangladesh Branch, Dhaka. pp.59-69.

Howlider M.A.R. 1988. Rearing temperatures at the meat yield in broilers. *PhD thesis,* Aberdeen University. UK.

Ike, P.C. and Ugwumba, C.O.A. 2011. Profitability of Small Scale Broiler Production in Onitsha North Local Government Area of Anambra State, Nigeria. *International Journal of Poultry Science,* **10 (2):** 106-109.

Islam, M.A., Nishibori, M. and Islam, S. 2011. Organoleptic panel taste of cooked meat of broiler, indigenous naked neck and full feathered chicken from Bangladesh. Proceeding of 7th International Poultry Show and Seminar. World's Poultry Science Association –Bangladesh Branch, 25-27 March, Dhaka, Bangladesh, pp. 278-282.

Islam, M.N. and Howlider, M.A.R. 1990. Season effect of broiler performance in Bangladesh. *Bangladesh Journal of Training and Development,* **3:** 35-38.

Islam, M.N., Khatun, H., Khatun, R., Rashid, M.A. and Rahman, M. 2011. Biosecurity status and products quality of small scale commercial poultry farms in Bangladesh. *Proceedings of Seventh International Poultry Show and seminar,* 25-27 March, 2011, WPSA-BB, Dhaka, Bangladesh.

Islam, M.S., Takashi, S. and Chabbi, K.Q.N. 2009. Socio-economic development of small scale broiler farmers in rural areas of Bangladesh. A case Study of Mymensingh district. *Journal Rural problems*, **45:**88-93.

Islam, M.S., Takashi, S. and Chabbi, K.Q.N. 2010. Current scenario of the small scale broiler farming in Bangladesh: Potential for the future projection. *International Journal of Poultry Science*, **9:** 440-445.

Islam and Nabul, 2003. Demand projection for poultry products and poultry feed in Bangladesh. No 54. MSSD discussion paper from International Food Policy Research Institute (IFPRI).

Ibrahim, K.A. and Osman, M. 2005. Effects of different protein level on compensatory growth, Carcass characteristics and Some blood parameters of broiler chicks. *Annals of Agricultural Science Moshtohor*, **43(1):** 149-169.

Jaturasitha, S., Khiaosaard, R., Pongpaew, A., Leowtharakul, A., Saitong, S., Apichatsarangkul, T. and Leaungwunta, V. 2004**.** Carcass and indirect meat quality of native and Kai Baan Thai chickens with different sex and slaughter weight, in: *Proceedings of the 42nd Annual Conference.* Kasetsart University, Bangkok, Thailand, p.116-126.

Jaturasitha, S., Srikanchai, T., Kreuzer, M. and Wicke, M. 2008a**.** Differences in carcass and meat characteristics between chicken indigenous to Northern Thailand (Blackboned and Thai native) and improved extensive breeds (Bresse and Rhode Island Red). *Poultry Science*, **87**, 160-169.

Jabbar, M.A. and Green, D.A.G. 1983. The Status and Potential of Livestock within the Context of Agricultural Development Policy in Bangladesh, Aberystwyth, The University College of Wales, U. K.

Jabbar, M.A., Islam, S.M.F., Delgado, C. S., Ehui, M.A.I., Akanada, M.I., Khan and Kamruzzaman, M. 2005. Policy and scale factors influencing efficiency in dairy and poultry production in Bangladesh. International Livestock Research Institute, Nairobi, Kenya.

Jabbar, M.A., Rahman, M.A., Talukder, R.K. and Raha, S.K. 2007. Alternative institutional Arrangements for contract farming in poultry production in Bangladesh and their impacts on equity. Research Report. International Livestock Research Institute (ILRI), Nairobi, Kenya. p.98.

Jaim, J. and Islam, M.N. 2008. Impact of technical intervention on profitability of village based medium scaled broiler enterprise in Bangladesh. *Progressive Agriculture*, **19:** 143-153.

Kabir, S.K. 2005. Poultry in Bangladesh: Awaiting and awakening. *In: Proceedings of the 4th International Poultry Show and Seminar*, World's Poultry Science Association Bangladesh Branch, Dhaka. p. 8-15.

Kassim, H. and Suwanpradit, S. 1996. The effects of dietary protein levels on the carcass composition of starter and grower broiler. *Asian Australasian Journal of Animal Science,* **9(3):** 211-266.

Katla, N., Saikia, P., Baruah, N. and Talukder, J.K. 2004. Economic housing design and stocking dencities for rural poultry production in India. *World's Poultry Science Journal* **60**: 357-365.

Kalla, D.J.U., Barrier, G., Haruna, U., Abubakar, M., Hamidu, B.M. and Murtala N., 2000. Economic analysis of broiler production at Miango Plateau State, Nigeria. Paper prepared for presentation at the Farm Management Association of Nigria Conference, Ayetoro, Nigeria, September 4-6.

Kamruzzaman, M., Islam, S.M.F. and Raha, S.K. 1999. Broiler farming in Gazipur District: Prouctivity, profitability and variability in supply. *The Bangladesh Journal of Agricultural Economics*, **22**: 77-88.

Karim, M.R. 2000. An economic analysis of broiler enterprise under contract farming system in area of Bangladesh. M.S thesis, submitted to the Department of Agricultural Economics. Bangladesh Agricultural University, Mymensingh, Bangladesh.

Karim M.R. 1999. An economic analysis of broiler enterprise under contract farming system in area of Bangladesh. M.S theses, submitted to the Department of Agricultural Economics. Bangladesh Agricultural University, Mymensingh.

Kabir, S.M.L. 2009. The role of probiotics in the poultry industry. *International Journal of Molecular Sciences*, **10**: 3531-3546.

Kawasr, M.H. 2014. Management interventions on productivity and profitability of small-scale broiler farming in Bangladesh. *PhD thesis*, submitted to the Department of Poultry Science. Bangladesh Agricultural University, Mymensingh, Bangladesh.

Kawsar, M.H., Chowdhury, S.D., Raha, S.K. and Hossain, M.M. 2013a. Impact of management intervention on productive performance and profitability of small-scale broiler farming in Bangladesh. *Livestock Research for Rural Development* **25 (5).**

Kawsar, M.H., Chowdhury, S.D., Islam, M.N., Raha, S.K., Hossain, M.M. and Huque, E. 2011. Impact of scientific intervention on productive performance and profitability of small scale broiler farming at rural households. In: *Proceedings of the 7th International Poultry Show and Seminar,* WPSA Bangladesh Branch. p. 57-62.

Kawsar, M.H., Chowdhury, S.D., Raha, S.K. and Hossain, M.M. 2013b. An analysis of factors affecting the profitability of small-scale broiler farming in Bangladesh. *World's Poultry Science Journal*, **69**: 676-686.

Kabir, S.M. 2010. Effect of dietary protein and energy levels on growth performance, carcass traits and value of broiler meat after cooking, *MS thesis* submitted to the Department of Poultry Science, Bangladesh Agricultural University, Myemsingh.

Khalifa, A.H. and Nassar, A.M. 2001. Nutritional and bacteriological properties of some game duck carcasses. Nahrung, **45**: 286-292.

Khan, A.G. 1998. Woman as a resource target for rural poultry production in India. In: *Proceedings of 10th European Poultry Congress*, Jerusalem, Israel, **2**: 604-605.

Kolic, C. J. 1994. Profitability of contracting out to private farms for chicken fattening and its effect upon the co-operatives of farmers and farms in the socialistic sector engaged in poultry. *World Agricultural Economics and Rural Sociology*, **20**: 30-31.

Kumar, V.P. and Mahalati, S. 1998. Cost analysis of layer farm in South- West Madhya Pradesh. Indian Journal of Poultry Science, **33(1):** 110-112.

Landes, M. S. Persaud and Dyck, J. 2004. "India's Poultry Sector: Development and Prospects". ERS, USDA, Agricultural and Trade Report WRS-04-03.

Latif, M.A. 2007. Development of Strategies of Livestock and Poultry in Bangladesh. In: *Proceedings of the 5th International Poultry Show and Seminar*, WPSA Bangladesh Branch, Dhaka Bangladesh.

Lara, Lucas J. and Rostagno, Marcos H. 2013. Impact of Heat Stress on Poultry Production, *Animals, **3*:** 356-369; doi:10.3390/ani3020356.

Lu, Q., Wen, J. and Zhang, H. 2007. Effect of chronic heat exposure on fat deposition and meat quality in two genetic types of chicken. *Poultry Science*, **86**: 1059-1064.

Lee, S.J., Kim, S.S., Lee, K.H. and Kwack, C.H. 1990. Effects of dietary protein levels on broiler performance. *Livestock,* **32(3):** 28-34.

Mazanowski, A.; Kisiel, T. and Gornowiez, E. 2003. Carcass quality, meat traits and chemical composition of meat in ducks of paternal strains A44 and A55. Animal Science Papers and Reports, Institute of Genetics and Animal Breeding, Poland, **21**:251-263.

McElven, J.V. 1957. Family farm is a changing economy. USDA Agricultural Research service, Agricultural information Bulletin, 171. USA.

Mellor, 1974.The economics of Agril. Department Vora and Co. Bombay, India.

Miah, M.T.H. 1990. Economics of commercial poultry farming in Bangladesh. Report no. 21 *Burro of Socio-economic. Resident and Training,* Bangladesh Agricultural University, Mymensingh, Bangladesh. p. 17.

Miah, M.A.M. 2004. Production and marketing of livestock and livestock products in pre-urban areas of Bangladesh. *PhD thesis* submitted to the Department of Agricultural Economics, Bangladesh Agricultural University, Mymensingh, Bangladesh.

Michael, C.A., Hughes, B.O. and Elson, H.A. 1992**.** Poultry Production System, Behaviour, Management and welfare. Redwood Press Ltd. Melkshan, Great Britain.

Mohsin, A.Q., Riaz, R., Asad, S. and Mushtaq, A. 2008. Profitability of broiler production In Rawalpindi district. *Pakistan Journal of Agricultural Science,* **45**: 514-519.

Monira, K.N., Howlider, M.A.R., Miah, G. and Hassanuzzaman, M. 2004. Performance of broiler reared on different litter materials in Late autumn season under Bangladesh condition. M.S thesis, Department of Poultry Science, Bangladesh Agricultural University, Mymensingh, Bangladesh.

Mozumder, M., Farid, K.S., Ahmed, J.U. and Rahman, M.W. 2009. Broiler farming: An approach to improve rural livelihood. *Journal Bangladesh Agricultural University,* **7(2):** 395-402.

Muhammad, M. Muhammad, L.U., Amball, A.G. and Mani, A.U. 2010. A Survey of Early Chick Mortality on Small-Scale Poultry Farms in Jos, Central Nigeria. *International Journal of Poultry Science,* **9:** 446-449.

Mulla, N.I. 1995. Marketing of poultry products with special reference to India. *Poultry Adviser,* p.28.

Mahesar, S.A., Sherazi, S.T.H., Abdul Niaz, Bhanger, M.I. Sirajuddin, Abdul Rauf. 2010. Simultaneous assessment of the zinc, calcium, lead and copper in poultry feeds by differential pulse anodic striping voltammetry. *Food and Chemical Toxicology*, doi: 10.1016/j.fct.2010.05.071.

Mishra, M., Sahoo, G., Pattnaik, S.N. and Mohanty, S.C. 1988. Economic efficiency of poultry broiler farms of different sizes under hot humid conditions. *Indian Journal of Animal Production and Management,* **4(2):** 87-91.

Moorti, T.V., Oberoi, R.C. and Dogra, R. 1990. Economic rationale of poultry farming in Himachal Pradesh. *Indian Journal of Poultry Science,* **24(4):** 287-292.

Nelson, T.M. and Tablante, N.L. 2004. Bio-security for poultry

National Livestock Development Policy (2007). Ministry of Fisheries and Livestock, Government of Bangladesh.

National Poultry Development Policy 2008**.** Ministry of Fisheries and Livestock, Government of Bangladesh.

Nworgu, F.C., Egbunike, G.N., Ogundota, F.L., Salako, R.A. and Rakeye, O.E. 2001. Effects of different dietary protein levels on the performance and carcass characteristics of broilers. *Agriculture and Environment* **1(2)**: 75-87.

Ochieng, O., Owour, G., Bebe, B.O. and Ocheing, D.O. 2011. Effect of Managemental Interventions on Productive Performance Of Indigenous Chicken in Western Kenya. *Livestock Research for Rural Development,* **23**: 56-62.

Ogunmola, O. O., Taiwo, O .F. and Ayankoso, A. S. 2013. The Nutritive Value of the Meat Quality of Locally Breed Chicken, Exotic Chicken and Turkey. *IOSR Journal of Applied Chemistry (IOSR-JAC) e-ISSN: 2278-5736.* **3 (6):.**46-50.

Okarini, Ida. Ayu., Purnomo, Hari., Aulanni,'am and Radiati, Liliek. Eka. 2013. Proximate, Total Phenolic, Antioxidant Activity and Amino Acids Profile of BaliIndigenous Chicken, Spent Laying Hen and Broiler Breast Fillet. *International Journal of Poultry Science,* **12 (7):** 415-420.

Okelo, P.O., Carr, L.E., Schreuders, P.D., Wheatonand, P.W. and Donglan, L.W. 1998. Effectiveness of using cool and roost broilers. ASAE Annual international meeting, Orlando, USA, held on 13-16 July. p.21.

Oluyemi, J.A. and Roberts, F.A. (1979). Poultry production in warm climatic. Macmillan Press Ltd.,London, p. 197.

Okike, I. 2000**.** Crop-livestock interactions and economic efficiency of farmers in the savannah zones of Nigeria. Unpublished *PhD thesis*, University of Ibadan, Ibadan, Nigeria, p. 155.

Patel G. S. 1999. Economics of broiler production in India. *Poultry Advisor*, **2**: 12-17.

Patil H. N. 1985. Economics of broilers in India. *Poultry Advisor* **17:** 21-25

Paul, D.C., Huque, Q.M.E. and Rahaman, T. 1997. Unconventional geese raising and women in farm economy in rural Bangladesh In: Proceedings. 11th European Symposium. Waterfowl, Nantes. p. 523-526.

Prodhan, S.K. 1995. Broiler farming: A self- employment program in Tripura, India. Indian farming, p.39-49.

Qiao, M. Fletcher, D. L., Northcutt, J. K., and Smith, D. P. 2001. Relationship Between Raw Broiler Breast Meat Color and Composition. Poultry Science Association, Inc. p. 422-427.

Quentin, M., Bouvarel, I. and Picard, M. 2005. Effect of crude protein and lysine contents of the diet on growth and body composition of slow-growing commercial broilers from 42 to 77 days of age. *Animal Research*, **54(2):** 113-122.

Raha, S.K. 2005. Export broiler possibilities of Broiler farm: some issues. *In: Proceedings of the 4th International Poultry Show and Seminar.* World's Poultry Science Association, Bangladesh Branch, Dhaka, Bangladesh. p.54-59.

Raha, S.K. 2007. Broiler industry in Bangladesh: some issues. *In: Proceedings of the 5th International Poultry Show and Seminar.* World's Poultry Science Association, Bangladesh Branch, Dhaka, Bangladesh. p.1-9.

Raha, S.K. 2013. Poultry industry in Bangladesh: ample opportunities for improvement. *Proceedings of Eighth International Poultry Show and Seminar*, WPSA-BB, 28 Feb-02 March 2013, Dhaka, Bangladesh.

Rahaman, S.M.A., Sayeed, M.A., Sarkar, N.R. and Alam, J. 2006. Impact of improved poultry management technique on socio-economic condition of broiler beneficiaries. *Journal of Bangladesh Agricultural University,* **4**: 401-411.

Rahman, M.H., Howlider, M.A.R. and Rahman, M.S. 2001. The parasitism and productivity of Poultry in rural area of Bangladesh. First report, Participatory Livestock Development Project (PLDP) of Bangladesh, sponsored by DANIDA.

Rajendran, K., Mohan, B. K., Visawanathan and Edwin, S.C. 2008. A study on cost of production of broiler at market age at Palladamarea. *Tamilnadu Journal Veterinary & Animal Sciences***, 4(2):** 69-70.

Rajini, Thanabalan, R.A., Narahari, S. D. and Kumararaj, R. 1998. Influence of season, form of feed and dietary energy levels on broiler performance. *Indian Journal of Poultry Science,* **33(1):** 36-41.

Rangareddy, P., Shanmugam, T.R. and Mohan B. 1997. Economic and Financial analyses of Broiler Production at Kamarajar District of Tamil Nadu.Department, of Poultry Science, Veterinary College and Research Institute. *Indian Journal of Animal Science,* **33**: 36-41.

Roy, B.C. 2000. Identification of constraints to broiler farming.*MS in Poultry Science Thesis.* Department of Poultry Science, Bangladesh Agricultural University, Mymensingh, Bangladesh.

Riaz, A.H. and Syed, M. T. C. 2000. Economics of broiler farming in Kamrup district of Assam .*Journal of Interacademicia*, **4 (2)** : 294-303.

Rezaei, M., Moghaddam, H. N., Reza, J. P. and Classen, H. L. 2004. Effects of diTerent levels of crude protein and dietary electrolyte balance on the performance and body composition of broiler chicks. *Agricultural Sciences and Technology*, **18(2):** 69-78.

Raihan, S. and Mahmud, N. 2005. Trade and Poverty Linkages: *A Case Study of the Poultry Industry in Bangladesh*. Published by Cuts International, Jaipur, India. P. 1-20.

Rahman, T.K. 2004. Marketing system and consumer performance for broiler with emphasis on impact of bird flue rumor in an area of Bangladesh. M S Thesis, Department of Agricultural Marketing, Bangladesh Agricultural University, Mymensingh.

Raphulu, T., Jansen van, C., Roelof, R. and Coertze, J. 2015. Carcass composition of Venda indigenous scavenging chicken sunder village management. *Journal of Agriculture and Rural Development in the Tropics and Subtropics,* **116(1):** 27–35.

Saleque, M. A. 2007. Poultry industry in Bangladesh: Current status and its challenges and opportunity in the emerging market environment. Poultry Business Directory 2007, Dhaka, Bangladesh.

Saleque, M. A. 2009. Poultry industry in Bangladesh: Current status and its challenges and opportunities in the emerging market environment, Published poultry director.

Saleque, M.A. 2010. Livestock and Livelihood - The role of BRAC in Livestock Development in Bangladesh, Paper for Workshop on “Review

of Livestock Research Programs and Preparation of Future Research" Organized by BRAC.

Saleque, M.A. and Rozen, S.M. 2011. Biosecurity: demand for policy, partnership, practice and promotion to protect poultry. *Proceedings of Seventh International Poultry Show and seminar*, WPSA-BB, Dhaka, Bangladesh. p.96-102.

Saleque, M.A. and Saha, A.A. 2013. Production and economic performance of small scale Sonali bird farming for meat production in Bangladesh. *Proceedings of eighth International Poultry Show and seminar*, WPSA-BB, Dhaka, Bangladesh. p.20-24.

Saleque, M.A. and Mustafa, S. 1996. Landless women and poultry: The BRAC Model in Bangladesh. Integrated Farming in Human Development. *In: proceedings ARDAF, work, 25-29 March, Tune Landboskole, Denmark* (http.//www.husdyr.kvl.dk/htm/php/tune96/4askovjrnsen.htm).

Sarbiland, Khan.,Farooq, M., Durrani, F. R., Naveed, R. and Hamayun Khan, 2004. Economic Analysis of broiler farms in Arid zone, *Sarhad Journal of Agriculture*, **20 (3):** 337-341.

Sarker, M.T. 2012. Bangladesh Poultry Shilpo Bikashe Prostabona, *Poultry Khamar Bichitra*, 20 (9).

Sonaiya, E.B. 1990c. Poultry husbandry in small rural farms. Entwicklung +landlicher raum **4:** 3-6.

Scott, M.L., Neshiem, M.C. and Young, R.J. 1982. Nutrition of the chicken. 3rd Edn., M.L. Scott and associates Publishers, Ithaca, New York.

Sarker, M.S.K., Islam, M.A., Ahmed, S.U. and Alam J. 1999. Profitability and meat yield traits fast growing broiler strains in winter. *Online Journal of Biological Sciences* **2(6):** 361-363.

Shaikh, A.S. and. Zala, Y.C., 2005. Production Performance and Economic Appraisal of BroilerFarms in Anand District of Gujarat. *Agricultural Economics Research Review,* 24 July-December 2011, pp. 317-323.

Shane, S. 2003. "Thai Broiler Integrators Committed to Export". Poultry International, June, p.16-19.

Shanmugam, J.k. and Mian, A. 1997. Economic Analysis of broiler production in Kamarrayar district of Tamil Nadu. *Poultry Advisor*, **15**: 16-19.

Siddique, J.H. 2004. Effect of season and flock size on cost benefit ratio of broiler production. *M.S. Thesis* submitted to the Department of Poultry Science, Bangladesh Agricultural University, Mymensingh, Bangladesh.

Singh, S. 1994. Economics of broiler poultry farming in Haryana. *Poultry Adviser*, **27 (4):** 29-39.

Sirohi, A.S. 1982. Role of dairy and poultry enterprises for increasing income and employment of farmers in the Union Territory of Delhi. *Indian Journals of Economics,* **35**: 120-125.

Smith, D.P.; Fletcher, D.L.; Buhr, R.J. and Beyer, R.S. 1993. Pekin ducklings and broiler chicken pectoralis muscle structure and composition. *Poultry Science*, **72:**202-208.

Sokoowicz, Z. and Krawczyk, J. 2004 a. Profitability of broiler chicken production in 2001-2003, *Roczniki Naukowe Zootechniki*; **31 (1)** :133-141.

Sonaiya, E.B. 2009. Some technical and socio-economic factor affecting productivity and profitability of smallholder family poultry. *World Poultry Science Journal*, **65**:132-138.

Sonaiya, E.B. 1990. Poultry husbandry in rural small farms. *Entwicklunglandicherraum,* **4:** 3-6.

Souza, X.R., Faria, P.B. and Bressan, M.C. 2011. Proximate composition and meat quality of broilers reared under different production system. Rev. Bras. Cienc. Avic. vol.13 no.1 Campinas Jan./Mar. 2011**.** http://dx.doi.org/10.1590/S1516-635X2011000100003

SPSS, INC. 2003. SYSTAT Statistics.Version 11.5. SPSS Inc. Chicago, NL.

Sultana, F., Khatun, H. and Islam, A. 2012. Conducted a research on Small scale broiler farming at Santhia upazilla of Pabna District of Bangladesh. Bangladesh Animal Husbandry Bnagladesh. *Journal of Animal Science,* **41(2):**116-119.

Sundarasu, V. R and Prabakaran, X.X. 1989. A study on the effects of strains and seasons on commercial broiler production- an economic approach. *Indian Journal of Poultry Science*, **24:** 12-14.

Sogunle, O.M., Egbeyale, L.T., Alajo, O.A., Adeleye, O.O., Fafiolu, A.O.,Onunkwor, O.B., Adegbite, J.A. and Fanimo, A.O. 2010. Comparison of meat composition and sensory valuesof two different strains of broiler chickens. *Arch. Zootec.* **59 (226):** 311-314.

Soliman, A.Z.M., Ghazalan, A.A., El Abbady, M.R. and Elsamee, A.M.O. 1999. Broiler performance as affected by crude protein, metabolizable energy and fat during hot summer season. *Egyptian Journal of Nutrtion and Feeds*, **2**: 621-631.

Taha, F.A. 2003. "The Poultry Sector in Middle-income Countries and its Feed Requirements: The Case of Egypt". Outlook Report No. WRS03-02. Economic Research Service, USDA.Http://www.ers.usda.gov/publications/WRS03/dec03/ wrs0302.

Tohura, S. 2004. Economices scale of commercial broiler farming in sadar upazila of Rangpur district. *M S Thesis,* Department of Agricultural economics, Bangladesh Agricultural University Mymensingh, Bangladesh.

Talukder, S., Islam, Sarker, T.S. and Islam, M.M. 2010. Effects of environment on layer performance. *Journal of Bangladesh Agricultural University,* **8**: 253-258.

Trujillo, E. 1998. Performance of broiler in Cuba according to season and district. *Revistaevicultura*, **32**: 29-35 (Cited from poultry Abstract 1989, 15:251).

Uddin, M.A. 1999. A comparative economic analysis of broiler and layer production in some selected areas of sadder Thana in Mymensingh district. *M.S. Thesis* submitted to the Department of Agricultural Economics, Bangladesh Agricultural University, Mymensingh, Bangladesh.

Verma, A.R. and Pillai, A.G.R. 1998. Economics of layer and broiler farming. *Poultry guide,* **26**: 7-10.

Verma, L.C. and Singh, K.S. 1997. Cost and returns structure in layer farming. *Indian Journal of Poultry Science,* **32(2):** 152-158.

WHO, 2005. Avian influenza A (H5N1) infection in humans. *New England Journal of Medicine*. **353**: 1374-85.

Yousef Al-Ribdawai and Singh, R.A. 1989. Effect of protein level and stocking density on broiler performance in different seasons. *Indian Journal of Poultry Science,* **24:** 40-45.

APPENDICES

Appendix 1. Questionnaire for Household Survey (bio-secured - standard/moderate/good and Non bio-secured farm)

(Standard= 80 and above; Good= 70-79; Moderate= 60-69 and Bad (non-biosecured)= Below 60)

N. B. As per bio-security standard of broiler farm, the farms those got above 60 marks treated as bio-secured farms and below 60 marks treated as non-biosecured farms (out of 100 marks).

Small and medium -scale broiler farming (Farm sizes are considered 500-1000) to support rural livelihood

1. Name of the farmer: …… ……

2. Name of the father : ……
3. Name of mother : ……..

4. Present address : ……

Village/ Road No……..Upazilla ……..

District……..Mobile No……..
5. Age of the farmer ……Year .....

6. Family information

Sl. No.	Name and family relation with head	Age (yr)	Sex	Education	Marital status		Occupation	
					Married	Unmarried	Main	Others
01								
02								
03								
04								
05								
06								
07								
08								
09								
10								

7. Farm size and land utilization

Sl. No.	Land type	Area of land (ha)		Total land (ha)
		Cultivable	Fallow	
01	Homestead			
02	Cultivable land			
	Own			
	Rented in			
	Rented out			
	Mortgaged in			
	Mortgaged out			
03	Pond			
04	Fallow			
			Total land	

8. Asset of ownership of farm families

Sl No.	Household asset	Quantity (No.)	Type /constructing material	Value
01	House			
02	Cot			
03	Choky			
04	Alna			
05	Chair			
06	Furniture			
07	Table			
08	Jewellery			
09	Radio/cassette			
10	Television			
11	Tube well			
12	Latrine			
13	Fridge			
14	Digging instruments			
15	Cutting instruments			
16	Agricultural implement			
17	Irrigation implement			

9. Information on livestock

Species	Quantity (No.)	Local/exotic /crossbred	Price	Production @ amount						Total value (Tk)
				Milk (Litter)	Value (Tk)	Meat (kg)	Value (Tk)	Egg (No.)	Value (Tk)	
Cattle										
Cow										
Bull										
Bullock										
Buffalo										
Goat										
Sheep										
Chicken										
Duck										

10. Information on credit

Source		Amount received (Tk.)	Interest rate (%)	Duration of credit (Month)	Purpose of credit	Farmers attitude about source	Constraints
Institutional	**1**						
	2						
	3						
Non-institutional	**1**						
	2						
	3						

11. Annual income and expenditure

Income (Tk. year^{1})			Expenditure (Tk. year^{1})		Savings (Tk. year^{1})
Sector of income	**Amount (Tk. year^{1})**		**Expenditure item**	**Amount (Tk. year^{1})**	
Field crop			Food		
Backyard livestock rearing			Clothing		
Fisheries			Housing rent		
Timber/Fruit trees			Traveling		
Poultry keeper			Education		
Service			Medicare		
Business			Fuel		
Broiler farming			Recreation		
Others			**Others**		
Total			**Total**		

Farming related information (Bio-secured/ non bio-secured)

1. **How long have you been rearing broiler?** ..... Year ..... Month ..... Batch/Year

2. **What is the name of broiler strain and farm size?** Name --------- No. --------

3. **What is the other strains you rearing?** Cobb-500/ Hubbard Classic / Hybro /--------

4. **Whether broiler farming rearing profitable or not?** Yes / No

5. **What are the main reasons for profitability?**

a)
b)
c)

6. From where you used to purchase chick? Place……
Person/Institution/Company….. Value……Tk

7. What are the problems you face in purchasing DOC?

a) Higher price of DOC
b) Lack of availability of quality chick
c) Lack of timely delivery of DOC
d) Influence of Middlemen
e) Influence of dealers and agents

8. What are the problems you face in broiler rearing?

a) Lack of technical knowledge
b) Load-shedding
c) Problem in maintaining temperature in winter
d) Lack of vaccine
e) Lack of quality feed
(f) Risk of diseases including AI
(g) Lack of knowledge on disease outbreak
h) Lack of availability quality chicks
i) Others (mention)

9. Do you face lack of technical knowledge in rearing broilers? Yes / No?
If yes, what are those?

a) DOC brooding management

b) Technique of balanced feed preparation

c) Technique of maintaining brooding temperature

d) Biosecurity

10. Have you got any technical assistance/ training from any organization? Yes / No
If yes, which organization?
Government employee / Medical representative / Feed seller / Agent or dealer

11. What are the technical assistance have you got?

a) DOC brooding management

b) Technique of balanced feed preparation

c) Technique of maintaining brooding temperature

d) Biosecurity
e) Vaccination technique etc.

12. Do you vaccinate in broiler birds against any disease? Yes / No
If yes, what are those vaccines?

a) Baby Chick Ranikheth Disease Vaccine (BCRDV)

b) Fowl pox vaccine

c) Gumboro vaccine

d) Others (mention)

13. Do you face any problem in vaccination program?
If yes, what are those vaccines?

a) Baby Chick Ranikheth Disease Vaccine (BCRDV)

b) Fowl pox vaccine

c) Gumboro vaccine

d) Others (mention)

14. What are the steps you take to maintain bio-security in broiler farm?

a) Use of disinfectant in foot-bath

b) Restricted entrance in farm area

c) Spraying of disinfectant inside and outside of the farms

d) Use of separated clothing, shoes while working in farm

e) Broiler is reared in farm according to strain, age and stage of production

f) Use of fence around the farm

g) Follow all in and all out system

15. What type of feed you fed to broiler? Commercial feed / Hand mixed feed

a) How much it costs per k g feed for hand mix feed

b) How much it costs per k g feed Commercial feed or feed mill feed

16. What are the problems in using hand mix feed?

a) Higher wastage
b) Improper mixing of micronutrients
c) In appetite
d) Uniformity of broiler growth
e) If any others

17. Do you face any problem in using commercial feed? Yes / No
If yes, pls. mention the points

18. What are the problems in using commercial feed/Feed mill feed?

a) Quality of feed does not persist for long time.
b) Growth of broiler is not uniform
c) Higher price of feed
d) Availability of feed due time
e) If any others

19. Which seasons are more suitable for broiler rearing?

i	April-May	iv	July-August	vii	October-November	x	January-February
ii	May-June	v	August-September	viii	November-December	xi	February-March
iii	June-July	vi	September-October	ix	December-January	xii	March-April

20. What are the steps you take to maintain the production of broilers in summer?

21. What are the steps you take to maintain the production of broilers in winter?

22. What steps have you taken during failure of electricity/ loadsheding
23. What are the areas of Poultry house?

Size	**Long x Width**		
Floor type	**Katchha**	**Paved**	**Slated**
Faces of the house	**North - South**	**East - West**	**Exception**

24. How long you rear broiler birds? 25-30/ 30-35 / 35-40 / ---------- Day

25. What is the average body weight of broilers during the harvesting period? --------- g.

26. What is the number of dead birds in farm? ---------- No. percentage of survivability of broiler ----------

27. What are the problems in marketing broilers?

a) Influence of middlemen

b) Unsustainable of market

c) Real price is not obtain against production cost

d) Others (mention**)**

28. What is the selling price of per kg live broiler? Mention selling price of three batches

a) …… Tk./kg

b) ……..Tk./kg

c) ……..Tk./kg

29. What are your suggestions for the profitability of broiler farming?

a. Training of broiler rearing management

b. Preparation and use of least cost balanced feed

c. Training on biosecurity techniques

d. Others (mention)

30. Cost related information on small scale broiler farming

a) Housing cost

Item	Size of the farm	Primary cost	Present Cost	Durability	Repairing cost (year)
Poultry house (Sq.feet)					
Land (Yearly rented cost)					
Poultry house (Monthly rented cost)					

b) Cost of equipment's

Item	Unit price	Amount	Total value	Source of items		Durability
				Self	Purchased	
Feeder						
Waterer						
Brooder						
Chick guard						
Thermometer						
Hygrometer						
Electric bulb						
Electric fan						
Pail/Bucket						
Mug						
Polythene						
Others (mention)						
Total						

d) Labour cost

Kind of labour		Number	Day labour wage	Monthly salary	Yearly salary	Total cost
Permanent labour	Male					
	Female					
	Child					
Family labour	Male					
	Female					
	Child					
Contact labour	Male					
	Female					

e) Litter cost

Item	Unit price (Taka/Sac)	Amount	Total value	Sources of item	
				Self	buy
Rice husk					
Saw dust					
Other					
Sac					
Polithin					
Diesel					

f) Feed & other cost

Item	Unit price	Amount	Total value	Sources of item		Limitations
				Self	Purchased	
Broiler chick cost (per piece)						
Feed cost (kg/taka/sac)						
Vaccine						
Medicine						
Electricity						
Transport						
Other						
Total						

g) Bank interest (Operating cost)

h) Total income from broiler

Item	Unit price	Amount	Total value	Limitations
Price of live broiler (kg/taka)				
Used litre price (kg/taka/sac)				
Used sac (Piece/Taka)				
Other				

_____

Signature of researcher

Appendix 2. Effect of farm size on non- recurring cost of broiler farming during summer

Farm size	Rep	Cost per bird				
		Depreciation cost for housing	Depreciation cost of equipment	Land utilization cost	Family labour	Non- recurring cost
500	11	0.302a	0.187a	0.181	5.926a	6.595a
600	9	0.176b	0.152ab	0.154	4.539a	5.020a
700	6	0.182b	0.147ab	0.156	4.937a	5.422a
800	6	0.102bc	0.085ab	0.105	2.376b	2.667b
900	5	0.143bc	0.134ab	0.171	1.878b	2.326b
1000	4	0.042c	0.037b	0.068	2.086b	2.233b
SED		0.018	0.016	0.013	0.349	0.369
Level of significance	41	**	*	NS	**	**

**, p<0.01; *, P<0.05 and NS, Non-significant; Means having dissimilar superscript differ significantly

Appendix 3. Effect of farm category on non-recurring cost of broiler farming during summer

Farm Category (FC)	Cost per bird				
	Depreciation cost of housing	Depreciation cost of equipment	Land utilization cost	Family labour	Non-recurring cost
Bio-secured managed broiler farm	0.173	0.110	0.139	4.538	4.959
Non-Biosecured managed broiler farm	0.195	0.173	0.159	3.516	4.043
SED	0.018	0.016	0.013	0.349	0.369
Level of significance	NS	**	NS	NS	NS

**, P<0.01; NS, Non- significant

Appendix 4. Effect of farm size on recurring cost of broiler farming during summer

Farm size	Rep	Cost per bird					
		Chick cost	Feed cost	Vaccine & medication cost	Electrical Cost	Other operational cost (litter, lime transportation cost etc.)	Recurring cost
500	11	43.65	143.70	10.37^{a}	3.05^{a}	6.84	208.14
600	9	42.90	138.39	10.09^{a}	2.47^{ab}	6.15	200.28
700	6	39.32	141.68	9.20^{ab}	1.71^{c}	8.57	203.08
800	6	39.35	136.39	7.62^{ab}	1.89^{bc}	7.75	194.43
900	5	42.20	131.56	9.66^{ab}	2.57^{ab}	8.25	197.11
1000	4	36.67	132.93	6.40^{b}	1.67^{c}	7.87	186.92
SED	41	1.24	1.69	0.43	0.12	0.36	2.72
Level of significance		NS	NS	**	*	NS	NS

*, P<0.05; **, P<0.01; NS, Non-significant

Appendix 5. Interaction effect of farm size (FS), farm category (FC) and farm location (FL) on recurring cost of broiler farming during summer

Interaction	Cost per bird					
(FSX FC X FL)	Chick cost (BDT)	Feed cost (BDT)	Vaccine and medication cost (BDT)	Electric cost (BDT)	Other operational cost (Lime, litter & transportation cost)	Recurring cost (BDT)
FS_1 XFC_1 X FL_a	45.50	148.40	10.87	2.77	7.17	214.71
FS_1X FC_1 X Fl_b	45.17	133.50	11.27	2.93	6.70	199.57
FS_1X FC_1 X Fl_c	35.28	143.81	9.66	3.86	7.13	199.73
FS_1X FC_2 X Fl_a	57.66	148.23	8.66	3.13	8.20	227.08

FS_1 X FC_2 X Fl_b	37.33	148.52	8.53	2.53	6.46	204.43
FS_1 X FC_2 X Fl_c	37.79	142.14	12.33	2.80	5.20	201.46
FS_2 XFC_1 X FL_a	35.00	143.20	9.62	1.63	5.87	195.32
FS_2X FC_1 X Fl_b	44.36	138.42	10.92	2.39	6.14	202.23
FS_2X FC_1 X Fl_c	38.00	136.83	11.56	2.49	5.90	194.77
FS_2X FC_2 X Fl_a	49.66	151.34	9.16	2.49	5.88	219.52
FS_2 X FC_2 X Fl_b	46.17	131.03	8.11	2.99	6.67	195.74
FS_2X FC_2 X Fl_c	38.79	142.14	12.33	2.80	6.20	203.46
FS_3 XFC_1 X FL_a	40.00	136.25	8.61	3.33	6.47	194.66
FS_3X FC_1 X Fl_b	45.17	133.50	11.27	2.93	7.70	200.57
FS_3X FC_1 X Fl_c	32.00	136.94	9.33	1.00	9.13	188.40
FS_3X FC_2 X Fl_a	63.33	157.50	10.66	1.36	9.13	247.88
FS_3 X FC_2 X Fl_b	34.81	128.57	8.40	1.78	7.92	182.48
FS_3X FC_2 X Fl_c	31.00	162.25	9.79	0.99	10.83	222.57
FS_4 XFC_1 X FL_a	54.00	162.80	6.66	2.20	6.95	232.61
FS_4X FC_1 X Fl_b	35.66	134.81	4.58	2.49	5.24	182.78
FS_4X FC_1 X Fl_c	35.50	133.49	9.33	1.37	11.24	190.93
FS_4X FC_2 X Fl_a	43.33	132.00	7.66	1.83	4.61	190.17
FS_4X FC_2 X Fl_b	32.61	120.25	7.52	1.85	8.37	171.59
FS_4X FC_2 X Fl_c	35.00	134.99	9.99	1.58	10.07	198.49
FS_5 XFC_1 X FL_a	42.33	129.07	5.55	2.22	4.02	183.19
FS_5X FC_1 X Fl_b	40.83	132.11	7.24	2.77	6.65	189.58
FS_5X FC_1 X Fl_c	35.50	133.49	9.33	2.37	11.24	191.93
FS_5X FC_2 X Fl_a	42.00	132.00	18.75	1.87	17.79	225.70
FS_5 X FC_2 X Fl_b	45.00	132.50	9.55	3.22	6.16	197.48
FS_5X FC_2 X Fl_c	35.00	134.99	9.99	1.58	11.07	199.49
FS_6 XFC_1 X FL_a	40.66	135.64	9.66	1.63	7.33	194.92
FS_6X FC_1 X Fl_b	39.00	136.80	4.80	3.26	6.60	190.46
FS_6X FC_1 X Fl_c	32.00	126.54	3.13	1.00	9.13	171.80

$FS_6X\ FC_2\ X\ Fl_a$	43.00	132.00	18.75	1.87	16.79	225.70
$FS_6\ X\ FC_2\ X\ Fl_b$	45.00	132.50	9.55	3.22	7.16	198.48
$FS_6X\ FC_2\ X\ Fl_c$	35.00	132.75	8.00	0.78	8.41	190.50
SED	0.83	1.65	1.30	0.30	0.16	0.73
Level of significance	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

NS, Non-significant; FS, Farm size; FC, farm category; FL, farm location; FS_1, Farm containing 500 broilers; FS_2, Farm containing 600 broiler; FS_3, Farm containing 700 broilers FS_4, Farm containing 800 broilers; FS_5, Farm containing 900 broilers; FS_6, Flock containing 1000 broilers; SED, Standard error of difference; FC_1, Bio-secured farm ; FC_2, Non-biosecured farm ; Fla, Rajshahi; FLb, Pabna; FLc, Kishoregoanj.

Appendix 6. **Effect of farm size on non- recurring cost of broiler farming during winter**

Farm size	Rep	Cost per bird				
		Depreciation cost for housing	Depreciation cost of equipment	Land utilization cost	Family labour	Non- recurring cost
500	10	0.319^{a}	0.232^{a}	0.255^{a}	6.151^{a}	6.958^{a}
600	9	0.213^{b}	0.141^{b}	0.219^{ab}	4.918^{ab}	5.492^{a}
700	8	0.130^{c}	$0.061b^{c}$	0.165^{bc}	3.558^{bc}	3.914^{b}
800	9	$0.104c^{d}$	$0.081b^{c}$	0.103^{cd}	2.697^{cd}	2.985^{bc}
900	7	0.096^{cd}	$0.065b^{c}$	0.097^{cd}	2.000^{cd}	2.258^{c}
1000	6	0.042^{d}	0.034^{c}	0.061^{d}	1.762d	1.900^{c}
SED	49	0.017	0.015	0.015	0.305	0.334
Level of significance		**	**	**	**	**

**, P<0.01; Means having dissimilar superscript differ significantly

Appendix 7. Effect of farm category on recurring cost of broiler farming during winter

Farm Category (FC)	Cost per bird					
	Chick cost	Feed cost	Vaccine & medication cost	Electrical cost	Others operational cost (litter, lime transportation cost etc.)	Recurring cost
Bio-secured managed broiler farm	38.28	137.63	8.42	2.46	8.98	195.75
Non Bio-secured managed broiler farm	42.06	137.01	10.98	2.13	8.10	203.67
SED	1.16	2.14	0.48	0.14	0.73	2.82
Level of significance	*	NS	**	NS	NS	NS

*, P<0.05; ** P<0.01, NS, Non-significant