COMPARATIVE PROFITABILITY ANALYSIS AND RESOURCE USE EFFICIENCY OF BEEKEEPING USING WOODEN AND POLY HIVE IN SOME SELECTED AREAS OF BANGLADESH

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CERTIFICATE

This is to certify that the thesis entitled ***"COMPARATIVE PROFITABILITY ANALYSIS AND RESOURCE USE EFFICIENCY OF BEEKEEPING USING WOODEN AND POLY HIVE IN SOME SELECTED AREAS OF BANGLADESH"*** *submitted to the Department of Agricultural Economics, Faculty of Agribusiness Management, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfilment of the requirements for the degree of* ***MASTER OF SCIENCE IN AGRICULTURAL ECONOMICS****, embodies the result of a piece of bona fide research work carried out by* ***FATEMA TUS SADIA,*** *bearing Registration No.* ***11-04311*** *under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

I further certify that such help or source of information, as has been availed of during the course of this investigation has duly been acknowledged.

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THIS THESIS IS LOVINGLY DEDICATED TO

MY PARENTS

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CONTENTS

CHAPTER	TITLE	PAGE NO.
	ABSTRACT	I
	ACKNOWLEDGEMENT	II
	CONTENTS	III
	LIST OF TABLES	VI
	LIST OF FIGURES	VI
	ABBREVIATIONS	VII
CHAPTER I	**INTRODUCTION**	**1-7**
1.1	General Background of the Study	1
1.2	History of Beekeeping in Bangladesh	2
1.3	Apiculture (Bee-keeping), Beehives and poly hive	2
1.4	About Honeybees, Bee forages and Bee-products	3-4
1.5	Production area and market condition of honey in Bangladesh	5
1.6	Economics importance of beekeeping in Bangladesh	5
1.7	Justification of the Study	6
1.8	Objectives	7
1.9	Organization of the Study	7
CHAPTER II	**REVIEW OF LITERATURE**	**8-16**
CHAPTER III	**METHODOLOGY**	**17-25**
3.1	Introduction	17
3.2	Sources and Methods of data collection	17
3.3	Sampling Technique	17
3.4	Location and duration of data collection	18
3.5	Analytical Technique	18
3.6	Profitability Analysis	19
3.7	Descriptions and measurement techniques of cost items	19-21
3.8	Calculation of Returns	21
3.9	Cobb-Douglas Production Function	23
3.10	Resource use efficiency	24
3.11	Measurement of constraints	24-25

CONTENTS (Continued)

CHAPTER IV	**SOCIO-DEMOGRAPHIC CHARACTERISTICS OF THE BEEKEEPERS**	**26-31**
4.1	Introduction	26
4.2	Age Distribution	26
4.3	Educational level	26
4.4	Marital status	27
4.5	Gender	27
4.6	Occupational status	28
4.7	Family size	28
4.8	Income level	29
4.9	Experience of beekeeping	29
4.10	Training on beekeeping	30
4.11	Farm size according to number of hives	30
4.12	Extension contact	31
4.13	Concluding remarks	31
CHAPTER V	**PROFITABILITY OF BEEKEEPING**	**32-39**
5.1	Introduction	32
5.2	Profitability of beekeeping	32
5.2.1	Variable Costs	32
5.2.2	Fixed Cost	33
5.2.3	Return of beekeeping	35
5.3	Benefit Cost Ratio (undiscounted)	35
5.4	Concluding remarks	35
CHAPTER VI	**FACTORS AFFECTING THE RETURNS AND RESOURCE USE EFFICIENCY OF BEEKEEPING**	**36-40**
6.1	Introduction	36
6.2	Factors affecting the return	36
6.3	Interpretation of Result	36-38
6.4	Performance of the Model	38
6.5	Returns to Scale of beekeeping	38
6.6	Resource use efficiency in bee production	39
6.7	Concluding remarks	40

CONTENTS (Continued)

CHAPTER VII	**CONSTRAINTS OF BEEKEEPING**	**41-43**
7.1	Introduction	41
7.2	Higher cost of modern hives and accessories	41
7.3	Lack of skilled labor	41
7.4	Lack of capital	42
7.5	Marketing problem	42
7.6	Disease, pest and predators	42
7.7	Lack of extension support Shortage of bee forages	42
7.8	Transportation problem	42
7.9	Lack of training	43
7.10	Death/Reduction of colony	43
7.11	Poisoning of agro-chemicals	43
7.12	Concluding remarks	43
CHAPTER VIII	**SUMMARY, CONCLUSION AND RECOMMENDATIONS**	**44-48**
8.1	Summary	44-46
8.2	Conclusion	46
8.3	Recommendations	47
8.4	Limitations of the study	48
	REFERENCES	**49—53**
	APPENDICES	**54-62**

LIST OF TABLES

TABLE	TITLE	PAGE NO.
3.1	Distribution of the beekeepers	18
4.1	Family size of beekeepers	28
4.2	Distribution of the beekeepers according to their experience	29
4.3	Training received by the beekeepers	30
4.4	Farm size of beekeepers according to their number of boxes.	30
4.5	Extension contact in last one year	31
5.1	Per hive cost of beekeeping	33
5.2	Gross return of beekeeping from wooden and poly box	34
5.3	Per hive cost and return of beekeeping	35
6.1	Estimated Values of Coefficients and Related Statistics of Regression Analysis	38
6.2	Resource use efficiency of different inputs in beekeeping	39
7.1	Constraints Faced Index with rank order	41

LIST OF FIGURES

FIGURE	TITLE	PAGE NO.
4.1	Age distribution of the beekeepers	26
4.2	Level of education of the beekeepers	27
4.3	Gender of the beekeepers	27
4.4	Occupational status of the beekeepers	28
4.6	Annual household income of the beekeepers	29

ABBREVIATIONS AND ACRONYMS

ACI	:Advanced Chemical Industries
AP	:Ayurvedia Pharma
BBS	:Bangladesh Bureau of Statistic
BDT	: Bangladeshi Taka
BCR	:Benefit Cost Ratio
BIA	:Bangladesh Institute of Apiculture
BSCIC	:Bangladesh Small and Cottage Industries Corporation
CD	:Cobb-Douglas
CFI	:Constraint Faced Index
DAE	:Department of Agricultural Extension
et al.	: and others (at elli)
EU	:European Union
FAO	:Food and Agricultural Organization
FC	:Fixed cost
GDP	:Gross Domestic Product
GOs	:Government Organizations
GM	:Geometric Mean
GLM	:General linear model
GR	:Gross returns
IBRA	:International Bee Research Association
IOC	: Interest on Operating Capital
Kg	: Kilogram
KGF	:Krishi Gobeshona Foundation
KTBH	:Kenya Top Bar Hive
MOARD	:Ministry of Agriculture and Rural Development
MVP	:Marginal Value Product
MFC	:Marginal Factor Cost
MT	:Metric Ton
MUS	:Mouchas Unnayan Sangstha
N	:Naira (Nigerian currency)
NGOs	:Non-Governmental Organizations
PROSHIKA	:Proshikkhan Shikkha Karmo
RUE	: Resource Use Efficiency
SAS	:Statistical Analysis System
SPSS	:Statistical Package For Social Sciences
SR	:Saudi Riyal
TC	:Total cost
TVC	:Total variable costs
US $	: United States Dollar

COMPARATIVE PROFITABILITY ANALYSIS AND RESOURCE USE EFFICIENCY OF BEEKEEPING USING WOODEN AND POLY HIVE IN SOME SELECTED AREAS OF BANGLADESH

ABSTRACT

Poly hive provides a superior environment to raise and keep the honeybee population vigorous due to its high-tech internal facilities and sanitary system. Information on the profitability of poly hive is needed to encourage beekeepers to adopt it. The study was conducted to examine the profitability of beekeeping using wooden hive and modern poly hive technology and resource use efficiency of beekeeping in some selected areas Sirajganj, Gazipur and Satkhira districts of Bangladesh. Besides, socio-demographic profile and the major problems of beekeeping in the study area were also investigated. The study area was selected purposively on the basis of intensive cultivation of bee plants. A total of 60 beekeepers were selected using stratified random sampling technique to conduct farm level survey with pre-tested questionnaire. After analysing the data, gross return, net return and gross margin were found to be Tk. 11019.26 **,** Tk. 4082.45 and Tk. 8660.5 per hive per year respectively for wooden hive, and Tk. 27373.34, Tk. 19838.42, and Tk. 24736.14per hive per year respectively for poly hive. Total cost of beekeeping was Tk. 6936.81 and Tk. 7534.92 per hive for wooden and poly hive respectively. Undiscounted BCR were 1.59 and 3.63 for wooden and poly hive. Thus, it was found that beekeeping was profitable and it was very efficient and suitable in poly hive in comparison to traditional wooden hives. From production function analysis, it was observed that labor cost, transportation cost, insecticide cost, equipment cost, hive cost, rent cost and poly hive have significant effect on return. Resource use efficiency analysis indicated that labor cost, medicine cost, equipment cost, and extraction cost were under used in the study area. Higher cost of modern hives and accessories was found as their most severe (first ranked) constraint followed by some other constraints like lack of skilled labor, lack of capital, marketing problem etc.

CHAPTER I
INTRODUCTION

1.1 Background of the study

Honeybees can be kept as pet and recently beekeeping has turned out to be a profitable business. A beekeeper is called an apiarist who enjoys working with such unusual kind of pet, the honeybees. Beekeepers or apiarists keep bees in order to collect honey and other byproducts. Keeping honeybees is very much essential for man's benefit regarding health, pollination in agricultural production, natural biodiversity etc. Aside from its value as a high-energy food source, honey also has natural antiseptic, antibiotic and antimycotic characteristics (Lee and Lee, 1995). It can, in addition, relieve nervous disorders, stimulate effective immunity against known and unknown health problems; promote sharp intellect in children; improve digestion; heal wounds, burns and skin rashes; prevents and cures Diabetes mellitus (Olagunju, 2000). Traditionally, honey bees are kept in many countries where they are used for many purposes. In Bangladesh, about 75 % natural honey is produced in Sundarban forest areas by Giant bees *Apis dorsata* (Paul, 1996). Natural honey production declined at the rate of six percent per year during the period 1982-83 to 1993-94 (Paul, 1996). To balance this situation, production of honey by apiculture is needed to be emphasized. Apiculture industry provides the much needed diversification in the agriculture production base **(**Adgaba *et al*, 2012). At present, the new method of honey farming using artificial boxes is gaining huge popularity among a section of young farmers in different districts including sirajgonj, gajipur, tangail, sunderban area, hill tracts area etc in our country **(**Fazlullah, 2018). Honeybees have its role in economic return through pollinating and increasing agricultural crops, yield, quality of seed and fruits. It increases resource without changing environmental balance (Klatt, 2014). The contribution of bee-products is probably one of the most important small scale income generating activities and could be an effective business for the marginal farmers (Islam *et al.*, 2016). In a family based activity it is very easy, acceptable and less expensive than any other income generating activity. **(**Moniruzzaman and Rahman, 2009).

1.2 History of Beekeeping in Bangladesh

Beekeeping was started in some developed countries of the world in the 17th century. But in Bangladesh beekeeping has been started during the self reliant movement of Mahatma Gandhi in 1940 (Hossain *et al*., 2017). Efforts were very limited till 1977 due to lack of technical knowledge. However, in 1977 BSCIC started beekeeping in modern and scientific way and got success with *Apis cerana*. In 1990, European bee Apis mellifera was introduced in Bangladesh by two beekeepers named "Ayub" and "Sunil" (Hossain *et al*., 2017). Since 1977 BSCIC has trained out or sponsored about 25 thousand beekeepers in the country but only 1551 active beekeepers are present in the country (Hossain *et al*., 2017). Bangladesh government and many NGOs like, Bangladesh Institute of Apiculture (BIA), Proshikkhan Shikkha Karmo (PROSHIKA), Mouchas Unnayan Sangstha (MUS) have taken various schemes to provide technological support such as training, marketing facilities and supply of necessary equipment for beekeeping to increase the production of honey in the country (Annual progress report PROSHIKA, 2000). PROSHIKA has innovated and introduced a number of new technologies to modernize apiculture practice in Bangladesh (Islam *et al.,* 2016). In recent years, the Government and many NGO's including Bangladesh Institute of Apiculture (BIA), BSCIC, Proshikkhan Shikkha Karmo (Proshika), Mouchas Unnayan Sangstha (MUS), and Krishi Gobeshona Foundation (KGF) have implemented various plans to provide technological support, training, marketing, and the supply of necessary equipment to beekeepers (Islam *et al.,* 2016). Director General of the Department of Agricultural Extension (DAE), Tushar Kanti, informed that, "country's total honey production is estimated at 6000-7000 tonnes a year currently. DAE has imparted training on honey cultivation to 18,900 farmers till 2016-17 and 660 farmers in 2017-18 FY. They are planning to expand the training programme to create a total of 4,500 bee farmers at Union and 13,000 bee farmers at Ward level across the country."

1.3 Apiculture (Bee-keeping), Beehive and Poly hive

In apiculture, care, maintenance, management and domestication of colonies of honeybees (Apis species) in artificial boxes are done so as to enable them to produce and store a quantity of honey exceeding their own requirements for commercial production of honey and other by-products (Morse, 1989). Apiculture most likely began with the realization that it was better to safeguard future colonies rather than to

destroy them in the process of gathering honey. This substitute nesting sites or man-made hives facilitate the removal of honey without injuring the bees.

The most important tool for commercial beekeeping is the artificial boxes known as **Beehive**. A beehive is an enclosed, man-made structure to house a honey bee nest, in which some honey bee species live and raise their young. Gidey and Mekonen (2010) mentioned three types of beehives named as traditional, intermediate, and frame beehives while Awraris *et al*. (2015) mentioned four beehive types namely: improved frame hive, Kenya Top Bar hive (KTB), Ethio-ribrab and Traditional log bee hives. In Bangladesh, traditionally people use bark, log and calabash hives. In modern beekeeping practices the basket, Kenyan top bar (KTB) hives, and Langstroth hives are used (Hossain *et al.*,2017). Apiculture practice in wooden box encourages pest and disease of honey bee, while using poly hive box is convenient and helps in reducing pest and disease of bee (Fazlullah, 2018).

Poly hive is a very improved type of beehive which was first introduced in Europe in 1970s and then the design is being modified till date. In 2015 this box won gold medal in World Apimondia Congress. After that in 2016, Krishi Gobeshona Foundation (KGF) brought it here from Netherlands (Hossain M. S., unpublished). It's a very strong and robust box, made of high density polystyrene and durable for more than 30 years. Polyhives offer superior insolation benefits for the bees, helping them keep warm in the colder months and cooler in the hotter months. In poly hives bees produce larger amount of honey than bees kept in wooden hives (Fazlullah, 2018). Bee colonies can be kept in it very conveniently in any environment of the world from tropical to temperate zone. Pollen, propolis, wax, royal jelly, bee venom etc can also be exploited through this poly box. Using traditional wooden box we can harvest maximum 36-38 kg of inferior quality honey containing 24-26 or more percentage of moisture. Whereas from poly box we can harvest nearly 100 kg of superior quality honeys containing 20-21 percent moisture (Hossain M.S., unpublished).

1.4 About Honeybees, Beeforages and Beeproducts

Honeybees and bumblebees are examples of social bees. There are three different kinds of bees in the hive: queen, several hundred drones, and thousands of worker bees; each form is structurally and physiologically different from the others (Crane,

1990). Bangladesh has 4 species of honeybee: *Apis cerana indica, Apis dorsata, Apis florea,* and *Apis mellifera* (Saha, 2002). In Bangladesh, important honeybee species from the commercial point of view, are *Apis cerana indica* and *Apis mellifera* (Saha, 2002; Islam *et al.*, 2016). ***Apis dorsata*** is a wild species, largest amongst all the honey bees but produce inferior quality of honey (Saha, 2002). ***Apis cerana indica*** is medium sized, golden color and comparatively quiet in nature. Quality of honey is superior. ***Apis florea*** is the smallest bee and their honey yielding capacity is very low only 0.5 kg. Origin of ***Apis mellifera*** is in Europe and Africa but now cultivated worldwide. They are medium sized, golden color and quiet in nature. Yielding capacity is about five times more than that of *Apis cerana*. (Saha, 2002).

There are more than sixty semi-major and at least ten major bee plant species are found in different areas of Bangladesh (Saha, 2002; Islam *et al.* 2016). **Products of Honey Bee** are: **Honey,** a sweet liquid made by bees using the nectar from flowers. It is graded by color, with the clear, golden amber honey often fetching a higher retail price than the darker varieties. The flavor of a particular type of honey will vary based on the types of flower from which the nectar was harvested. The use and benefit of honey is huge (Mutsaers et al., 2005). **Beewax:** Beewax is collected from the combs of wild hives, frame hives and cappings. IBRA, (1991) reported that pure wax was in strong demand and that 90% of beeswax in the world market is used in both the pharmaceuticals and for church candles while the remaining 10% is used in dentistry, electronics, food industry, printing, metallurgy, paper and textile manufacture; and in preparation of varnishes and polishes. **Bee pollen** is approximately 40% protein. Bee-gathered pollen is rich in vitamins including B-complex and folic acid has anticancer qualities (Arefin, 2018). **Propolis** or bee glue, is a mixture of beeswax and resins which are collected from leaf bugs and twigs, used to line nest cavities and brood combs, seal cracks. It is also used to reduce the size of the hive entrance. Propolis has antibacterial and antifungal properties (Hossain *et al.*,2017). **Royal jelly** is a protein rich substance which is fed to larvae. More is given to the queen larva, causing her to grow larger than the other bees. It is made from digested pollen and honey (Mutsaers et al., 2005). **Bee venom** comes from bee stings is a complex mixture of proteins, which has been used in the treatment of rheumatoid arthritis and snake bite (Mutsaers et al., 2005; Arefin, 2018).

1.5 Production area and market condition of honey in Bangladesh

Most of the honey is produced in the Gazipur, Tangail, Mymensingh, Sherpur, Savar, Sirajgonj, Dinajpur, Rajshahi, Shariotpur, Barguna, and Sundarban areas of Bangladesh. The Sundarbans are a leading honey producing area in Bangladesh, with about 75% natural honey coming from the region **(**Paul, 1996; Moniruzzaman and Rahman, 2009). Most of the honey is collected from mustard flowers. Through personal communication BSCIC Project Director Aminuzzaman informed that, Mustard seeds are cultivated on around 5,500 hectares of land, of which 10 percent is used for honey production. Around 20 local brands of honey are sold in the domestic market of Bangladesh, including Ayurvedia Pharma (AP) Honey, Litchi Honey, Tropica Honey, Pran, Bengal Honey, Moti Modhu, Nahol Honey, and Amber Honey. Various foreign brands including Al Shafi Honey from Dubai; Acacia, Lume di Miel, and Royal Jelly from France, Dabur Honey from India etc are doing business here. Local honey has penetrated only 30% of the domestic market, while imported honey has captured 70% of the market (Abdullah, march 4, 2019). BSCIC Project Director Md. Aminuzzaman informed that "Every year, local brands of honey worth Tk 35-40 crore are sold in Bangladesh. Honey produced in Bangladesh is recently highly sought in foreign markets, with main export destinations being India, Japan, Slovenia, the Middle East, and the European Union (EU)". According to the Bangladesh Small and Cottage Industries Corporation (BSCIC), "Around 6,000 tons of honey was produced in 2017, of which 500–700 tons were exported to India. Tropica Honey have already received recognition in the European market for export quality honey. Another brand, Ayurvedia Pharmacy, exports honey to Japan. If proper steps are taken, every year it is possible to produce 1–1.5 million tons of honey in Bangladesh." (Abdullah, march 4, 2019)

1.6 Economic importance of beekeeping in Bangladesh

Beekeeping is an economically sustainable occupation, offering attractive opportunities for self-employment with multiple benefits (Moniruzzaman and Rahman, 2009). Participation of rural women and youth in beekeeping activities may provide a unique opportunity to improve rural livelihood and also poverty reduction. Most valuable return of the industry is the honey, wax and pollination service rendered by bees which increase yield of many of the agricultural and horticultural crops (Veer and Jitender, 2017). Beekeeping is a proven technology as a good

profitable venture requiring small investment of capital, skilled labor and little time, promises a high return in comparison to other poverty reduction activities. In the Nigerian context, Ayansola (2012), observed that beekeeping helps eradicate poverty especially in the rural communities. To alleviate the problem of poverty in rural areas, looking for alternative technologies that are environment friendly are crucial. So, introduction of improved beekeeping practices as an alternative income generating activities can be appropriate solution for sustainable development (Vaziritabar & Esmaeilzade, 2016). It is unbelievable but true that the required technical labor per day for management 5 colonies may be about only thirty-five minutes in average. Whereas a beekeeper having 5 colonies can earn about Tk.1000 per month in an average. It may be mentioned here that in most of the 86 thousand villages in Bangladesh beekeeping is more or less feasible on the basis of existing natural bee plants (Saha, 2002). There's no need of extra land for beekeeping. It's not a high technological matter. Honey is not a perishable good. It remains fresh one year in normal condition, so farmers can easily store it. Variable cost is also very low. On an average the beekeepers can earn net return of Tk. 5,682.92 per year per hive without considering the size of hives (Moniruzzaman and Rahman, 2009). Honeybee pollination increases weight and commercial grade of crops. Some people provide bees on a rental basis to farmers and orchardists for pollination. The pollination service delivered by the bees to our ecosystem is 20 to 117 times more valuable than the financial worth of all beekeeping production (Verma, 1990). To all pollination done by insects, bees contribute by 70-80 percent. The bee enhances yield of crops up to 30 – 40 percent by increasing pollination (Klatt, 2014). Through the scientific and proper implementation, beekeeping can play a vital role in increasing rural income as well as contributing to reduce import cost and increased export earnings and in bio-diversity conservation.

1.7 Justification of the Study

Bee keeping has a great scope in broadening its base in Bangladesh. Bangladesh possesses enormous potential to transform bee keeping into a productive industry. The Poly hive box has many amenities. Current study will be helpful to make all the beekeepers and other stakeholders familiar with the specialty and profitability of the poly hive technology. So that they can adopt it blithely. The findings will also be helpful for the related Government body and policy makers.

1.8 Objectives

- To examine the socio-demographic characteristics of beekeepers in the study area.
- To determine the cost and returns of beekeeping using poly hive and traditional wooden hive in understanding profitability of the enterprise.
- To measure the resource use efficiency of beekeeping in the study area.
- To identify the constraints faced by the beekeepers in the study area and recommending some solution.

1.9 Organization of the Study

The thesis is organized in eight chapters including the first chapter as "Introduction" Chapter 2 presents review of literature on honeybee, apiculture, profitability and resource use efficiency, constraints of apiculture. Chapter 3 represents methodology of the study. Socio-demographic profile of beekeepers presented in chapter 4. Profitability of beekeeping using wooden and poly hive is presented in chapter 5. Factors affecting the return and the resource use efficiency of beekeeping is presented in chapter 6. Constraints faced by the beekeepers in the study area is presented in chapter 7. The chapter 8 represents summary, conclusion and recommendations.

CHAPTER II
REVIEW OF LITERATURE

This chapter presents the review of relevant literature with a view to understand the past and present research work on Comparative Profitability Analysis of Honey Production using wooden and Poly Hive Technology. Review of literature is essential for research works as it provides a scope for reviewing the stock of knowledge and information relevant to the proposed research. A very few studies have so far conducted related to the present research topic. Again, some of these studies may not entirely relevant to the present study, but their findings, methodology of analysis and suggestions have a great influence on it. Review of some research works relevant to the present studies, which have been conducted in the recent past, are discussed below.

Abdullahi *et al*. (2014) examined the comparative economic analysis of modern and traditional bee-keeping business in selected local government areas of Kaduna state, in Northern Nigeria during 2010 production season. The findings of this study revealed that modern bee-keeping is more profitable with an estimated gross margin of 5,264.2 naira while traditional beekeeping is more technically feasible with an estimated gross margin of 1,391.925 naira and the net farm income of modern bee keeping is 56,154.67 naira while the traditional beekeepers has 37, 73.95 naira their difference in gross margin were attributed to the difference in quality price of the two methods. The results of the exponential function showed that feed, cost of storage and labor had significant effect on honey production. Some of the problems encountered by both categories of farmers in the study areas include; low bee swarm, expensive technology, inadequate market opportunities, inadequate finance, high cost of equipment, and hive vandalization.

Al-Ghamdi *et. al.* (2017) examined the comparative analysis of profitability of honey production using traditional and box hives. The study revealed that supplementary bee feeds, labor and medication were statistically significant for both box and traditional hives. The study indicated that productivity of box hives were 72% higher than traditional hives. The incremental net benefit of box hives over traditional hives was nearly double. Box hive owners have relatively small families and were more

educated. Approximately 62.64 percent of the respondents were entirely engaged in traditional beekeeping practices. The remaining 37.36 percent of respondents were using box hives. Across all hive owners, the contribution of neighbors in sharing beekeeping experience was high (41.3 percent). Approximately 59.2 percent and 59.7 percent of traditional and box hive owners respectively supplied their honey to consumers.

Adgaba *et al*. (2012) conducted a study to analyse the Socio-economic characteristics of beekeeping and determinants of box hive technology adoption in the Kingdom of Saudi Arabia. The study revealed that about 71.1 percent of the honeybee colonies in the country are kept in traditional hives and the adoption of box hives have been observed to be significantly influenced by the beekeeper's socio-demographic profiles. Education level had positively influenced the adoption of box hive. The less acceptance of box hive was also implicated with its unsuitability to the biology and ecology of the local bees. The average annual productivities of colonies were 6.6±5.6kg and 3.7±2.6 kg honey per colony per annum for box and traditional hives, respectively. The average price of locally produced honey is high and varies from $58.9 to $77.9 and this has contributed to attract and sustain many people in the beekeeping business. The average annual earnings from beekeeping is relatively high ($58,937.6), and contributes to an average of 29.7 ±29 percent of the total annual income of beekeepers which show that beekeeping plays a significant role in increasing and diversifying the incomes of rural communities.

Alemu *et al.* (2013) conducted a research to characterize honey produced in Sekota district in northern Ethiopia and to assess the effects of location (lowland, midland and highland) and hive type (modern zander-frame and traditional tube basket) on the quality of honey produced in the area. A total of 20 honey samples were collected from four locations in Sekota district. Reducing sugars, apparent sucrose, pH, moisture, ash, hydroxymethylfurfural, acidity and water-insoluble solids contents of the honey samples were analyzed. The pH of honey samples collected from the midland of the district was significantly higher than the pH of honey samples collected from lowland areas. Hive type significantly influenced the reducing sugars contents of the honey samples. The water-insoluble solids content of the honey

samples analyzed in his study was above the maximum limit set by national and international standards for water-insoluble solids content of honey.

Beyene *et al.* (2015) conducted an experiment in Adami Tulu and Arsi Negelle districts of Ethiopia from September 2009 to June 2012 to evaluate the productivity performance of transitional and modern bee hives. The study found that, average honey yield per hive per year from transitional hive was 13.88 kg, 13.21 kg and 10. 45 kg at Asebo, Adami Tulu Research station and Ashoka Lepis site, respectively. Significantly higher and lower honey yield from transitional hive was recorded at Asebo and Ashoka Lepis site respectively. The average honey yield per hive/year from modern hive was 23.18 kg, 21.61 kg and 18.45 kg at Adami Tulu Research center, Asebo and Ashoka Lepis site respectively. The mean yield obtained from modern hive at all study sites was statistically higher when compared to transitional and traditional hives. There was no ($P < 0.05$) variation between all study sites in terms of honey yield from traditional hives. Generally, there was highly significant difference between the three types of hives in terms of honey yield per hive per year. It was concluded that using improved bee hives with improved management practices can improve honey yield and ensure better quality.

Cebotari and Buzu (2012) carried out an experiment on comparative study of maintaining bee colonies in different types of hives : horizontal and vertical, both with Dadant frames. It was found that the types of hives, all other equal conditions of maintenance and exploitation, have not had any impact on the biological process of bees overwinter, but had a significant influence on reproduction process and development of bee colonies in high beekeeping season. Economic effect obtained at exploitation of vertical hives only from honey production is 23.8 euro per bee colony. Maintenance of bee colonies in vertical hives ensures an increase of queens laying 3.5 percent and on average annual strengthens of the bee colony with 6.0 percent. Use of vertical hives contributes to increasing of honey production with 19.1 percent. Bee colonies exploitation in vertical hives ensures economic efficiency at least 23.8 euro per bee colony.

Fazlullah (2018) conducted a study on honey production by using wooden and poly hive in different seasons in Bangladesh and found that, there was a significant difference of honey production in traditional hives and the poly hive super boxes. The

production of honey is very efficient and suitable in poly hive with super bee boxes in comparison to wooden traditional hives. The study also reveals that, polyhive with super boxes provides bees a good environment to raise and to keep their population strong due to its high-tech internal facilities and sanitary system.

Famuyide *et al.* (2014) examined the socio-demographic characteristics of honey producers and economic contribution and level of honey production in Iseyin-Ogbomoso Local Government Areas of Oyo State. The result revealed that, honey production in Oyo State, South West Nigeria was male dominated, and these people were still in their active working age. Average number of the sampled population took honey production as a primary occupation while substantial part of them took it as a secondary work. Education was found to be a significant factor that promotes the productivity level of honey production. Honey business was however found to be lucrative as it was revealed in the study that for every one naira spent in the process of production and marketing, not less than fifteen and half kobo was realized as profit.

Gebremedhn and Estifanos (2013) designed a study to familiarize alternative new technology, Kenyan top bar hive (KTBH) and to evaluate its honey productivity under farmers' condition. There was significant difference between modern and Kenyan top bar hive for honey yield. The potential productivity of the modern hive (22.8 kg per hive) was higher than the KTBH (17.8 kg per hive). In Begasheka, honey yield from the modern hive was significantly higher than the Kenyan top bar hive, While in Debrekidan there was no significant difference between the hives.

Getachew *et al.* (2015) conducted a study on comparative analysis of colony performance and profit from different beehive types in southwest ethiopia and found that the overall average annual honey yield performance clearly revealed both improved frame hive (30.09 ± 2.69 kg per hive) and Ethio-ribrab hive (29.22 ± 2.69 kg per hive) were significantly higher ($p < 0.0001$) than KTB hive (15.71 ± 2.22 kg per hive) and traditional log hive (15.36 ± 0.86 kg per hive).

Guyo and Legesse (2015) were undertaken a study in different parts of the Ethiopia to identify the opportunities and challenges of beekeeping systems in the country and to suggest possible intervention measures for the identified problems. Based on the review indication in most part of the country only two types of honeybee production

systems were identified, namely traditional and transitional honeybee production systems. Honeybee production system in the country is predominantly traditional and transitional (90.3 percent) and very few (9.7 percent) were practiced with modern beekeeping systems. Most of the beekeepers (92 percent) have started beekeeping by trapping swarms and some (7 percent) received from their parents as gifts. Perennial crops, cultivated crops, annual herbs, and some natural trees have significant contribution for beekeeping. The major challenges were drought, pests and diseases, pesticide poisoning, low hive occupation rate, absconding, lack of modern beekeeping equipment and materials, lack of honey storage facilities, poor extension service etc. On the other hand the opportunities for beekeeping in the country were the abundance of honeybee, availability of flowering plants, ample sources of water for bees except in drought prone area, experience of beekeepers' and socio-economic value of honey.

Islam *et al.* (2016) conducted a study in Tangail district of Bangladesh, to examine the profitability of apiculture practice by using financial analysis of investment costs and benefits. The study suggested that, beekeeping is a profitable business for marginal farmers. The socio-economic status of beekeepers indicates that most of the beekeeper were young, lower educated, obtain basic beekeeping training from NGO and considered beekeeping as a part-time job. The sensitivity analysis shows that *Apis mellifera* bee species have a higher IRR than *Apis cerana* for a particular size of a beehive. The larger beehive obtains larger IRR, ROI, and B/C ratio. However, the average IRR is higher for *Apis cerana* (185.60), the bigger number of large beehive of *Apis cerana* contributing larger outcome. The correlation of beekeeping benefits and cost factors suggest that, overall profit is highly correlated with beehive colony, wooden box, labor and transportation cost. Proper beekeeping training and effective marketing of honey and other beekeeping byproducts is highly desired by the beekeepers.

Kinati *et al.* (2013) conducted an experiment in Gomma district of Jimma Zone, south western Ethiopia to assess honey production and marketing systems. Results of their study showed that the mean age of the respondents was 40.47 years, indicating an active and productive age. The beekeepers had an average experience of 5.66 years where most of them are male (92.8 %). The average honey yield per year/colony was 7.20 ±0.23, 14.70 ±0.62 and 23.38±0.73kg for traditional, transitional and moveable

frame hives, respectively. There was no difference in price of crude honey between study locations (P>0.05), while significant difference was observed for table honey. Honey yield per hive per year was found to be low from traditional and transitional hives as compared to moveable frame hive. Thus, strong extension and technical intervention was felt important for farmers to use the moveable frame hives to increase honey production and income of beekeepers in that study area.

Kiros and Tsegay (2017) conducted study in two purposively selected zones of Oromiya Regional State, namely Jimma and Illubabor in Ethiopia to analyse the honey-bee production and to assess hive technology preferences. From the study it was found that, the average age of the beekeepers was 40.2 ± 8.13 years with an average of 13.5 ± 6.58 years of experience. Three hive types (traditional, transitional, and frame hive) were found in the study area. Compared to frame and transitional hives, a much lower amount of honey was harvested from traditional hives. Half of the respondents' preferred transitional hive followed by frame hive (37.2 percent). Factors which affect the use of frame hives were lack of equipment followed by wax quality and availability problems.

Kumsa and Takele (2014) conducted a study in Jimma Zone where modern beekeeping has been practiced since 40 years. For their study three districts (Kersa, Goma and Gera) were purposively selected depending upon the existence of large number of modern beekeeping. The result revealed that 62.7 percent modern beekeeping in the study area was based on inappropriate colony management practices. Inappropriate bee management practices, colony absconding, poor design of modern beehives, low honey yield and bee pests were the main problems that impede the full use of apiculture resources. They recommended interventions of modern beekeeping focused on empowering beekeepers with skills, through ensuring availability of improved beekeeping technologies with standard seasonal bee management practices.

Mohammed *et al.* (2017) revealed vital information on the demography of the Apiculturists and the traditional honey beekeeping. Young, married, business persons, secondary level educated person, farmers with large family size (16 persons and above), and more experienced persons (9 years and above), were mostly involved in Apicultural practices. The majority of the Beekeepers in Biu and its environs sale

their honey at retails price (41 percent) and sales were done in the rural market (47 percent) inclusively. Youths were urging to engage and participate in this sector of farming, it adds more beauty to the agro-ecosystem-ecology and economic value systems. They also revealed that most of the Apiculturists in the study area use grass hives for the traditional method, honey bee wax as attractant for new colonies formation, wild honey harvesting and traditional methods of honey production and crude method of honey processing. Theft of the honey was the most serious problems they encountered.

Moniruzzaman and Rahman (2009) conducted a research in Tangail and Gopalgonj districts of Bangladesh, to examine the costs and return and to assess the scope of beekeeping in Bangladesh. The study found that, 46 percent of the total beekeepers had own land of 0.5-1.5 acres and 37 per cent of them were young beekeepers in the age group of 15-30 years. Most of the beekeepers took it as main occupation. The benefit cost ratio of beekeeping was 1.59 which showed that this business was profitable. They found a great prospect of beekeeping in Bangladesh on the basis of the socio-economic context of the country and some special features of the enterprise. Most of the beekeepers reported credit unavailability as major beekeeping problem followed by restriction of farmers to set up hives in their field, training unavailability, lower farmgate prices of honey, hive being stolen in different region etc.

Onwumere *et al*. (2012), conducted a research in Abia State, Nigeria, on comparative analyses of modern and traditional bee keeping entrepreneurships. The result shows that modern bee keeping generates more income than traditional bee farming despite its production cost. The total production cost of modern bee keeping was 10,590,400 naira while that of traditional bee keeping was 7,185,620 naira. The bee keepers earned an average of 7,160,760 naira for modern bee keeping and 4,742,880 naira for traditional bee keeping. Age and membership of cooperative societies has negative relationship with efficiency whereas, education status, household size, and expenditure on apiaries were positively related to efficiency in both modern and traditional bee keeping practices. The largest proportion of traditional and modern bee keepers respectively has fairly large family and has 6–10 years of experience. Most of them (75 percent modern bee keeper and 57 percent traditional bee keepers) depended on personal savings especially for initial capital.

Pocol and Popa (2012) evaluated the comparison of different production practices : stationary beekeeping versus pastoral beekeeping ; conventional beekeeping versus organic beekeeping. They identified : stationary beekeeping generates primarily for use in the household or within the close network of friends, does not require significant resources, but the productivity of the hives is lower. By practicing pastoral beekeeping instead, a higher productivity was obtained, but the expenses for the travel are high and the risks associated to moving the hives were significant. In terms of the comparison between the economic efficiency of conventional versus organic beekeeping, although 82% of the respondents agree at the declaratory level with the principles of organic beekeeping, this type of beekeeping is not yet sufficiently attractive for several reasons : bureaucracy, the difficulty of selling the products within the country, very expensive periodic inspections, higher costs and greater risks.

Vaziritabar & Esmaeilzade (2016) conducted a study on profitability and socio-economic analysis of beekeeping and honey production in Karaj state, Iran. The study found that credit, knowledge, education level of household head, perception and visits to demonstrations positively and significantly influenced adoption of box hive. The average annual productivity of colonies of modern hives is more than double of that of traditional hives. The study shows that about 11 percent of the beekeepers used the log hive, and they preferred it the most, whilst 20 percent, 33 percent, 32 percent, and 4 percent of the respondent preferred the Iranian top-bar hive, Iranian longstroth hive, wooden open floor hive and polystyrene open floor hive respectively. Here, higher honey yield (45.09 kg/hive/annum) was obtained from polystyrene open floor hive type than the other hives. Annual honey yield obtained from wooden open floor hive was 40.71 kg/hive. The annual average share of income from beekeeping in relation to beekeepers' total annual income indicates that beekeeping plays a significant role in increasing and diversifying the incomes of rural communities and provides a means of self-employment opportunities.

Wodajo (2011) conducted a study to examine the financial benefits of box hive and the determinants of its adoption in selected district of Ethiopia. The study found that credit, knowledge, education level of household head, perception and visits to demonstrations positively and significantly influenced adoption of box hive. 90 percent of the total variation for the adoption of improved box hive is explained by

binary logit model. In the study area, improved box hive was perceived as being costly by the beekeepers. The mean annual honey yield from improved box hive in the study area is above the national honey yield average. The partial budgeting done in this study reveals that adoption of improved box hive does result in additional income to the extent of 489.11 Birr in the study area, the income being almost three times than that of traditional hive.

Weldemariam (2015) demonstrated a survey to develop information on the quality and productivity of modern (framed) hives. His study included four districts of central zone of Tigray where beekeeping has significant role in the livelihoods of smallholder farmers. The study indicated that only 63.4 percent of the respondents received technical support and 75.1 percent exercise replacing of old combs. The productivity of colonies in the framed hive was almost similar across year except the first two. The highest honey yield (31.5kg/hive) was recorded during the early years while the minimum (19.59kg/hive) was in 2009. Pests and predators, lack of management, poor skill, improper use of agrochemicals and feed shortages were affecting beekeeping most in the areas. About 60.3 percent of the beekeepers had full trust and confidence on the framed beehive while about 89.7 percent of them reflected their interest to use the hive in an increasing way for the future.

Concluding remark

Beekeeping is practiced in different regions of Bangladesh using different types of hives. Improved poly hive technology is a new concept in beekeeping in Bangladesh. However, to date, no adequate comparative study has been conducted on the profitability and productivity of wooden box hive and poly hive in this region. Thus the current study is conducted to analyze and compare the profitability of wooden box hive and modern poly hive considering annual operating costs and returns and also to measure the resource use efficiency of beekeeping for both type of hive in the context of Bangladesh.

CHAPTER III
METHODOLOGY

3.1 Introduction

Methodology is an important part of any study. A profitability analysis usually involves collection of information about cost and return from individual beekeepers. For the present study, farm survey method was adopted for collecting data. Since the beekeepers of Bangladesh do not usually maintain records and accounts of their farm operations, interviewing the respondent's method was used to collect data. This chapter discusses about the source and methods of data collection, study area, period of survey, sampling technique and sample size, preparation of the survey schedule and data processing and analysis.

3.2 Sources and Methods of data collection

Data for the study were obtained from a combination of primary and secondary sources but mainly through the former. Primary data had been collected by survey method with the help of pre-designed and pretested interview schedule. Questions had been designed to raise basic issues on the assessment. Personal observations and personal interviews with beekeepers, extension workers and honey-bee experts were also done. Using the feedback obtained during the pretest, the questionnaire was customized in a way that was comprehensible to enumerators and respondents. Information was collected on: households' socio-demographic characteristics, input and output price, average yield per each type of hive per annum, constraints faced by beekeepers etc. Moreover, data on the major expenditures for producing bee products, quantity of inputs and the average prices of bee products and costs and returns from both hive types etc were used for analysis and comparison. Besides, secondary data were collected from different sources such as books, research publications, journals, office reports, organizations (DAE, KGF, BSCIC, proshika, etc) Internet etc.

3.3 Sampling Technique

Sampling is an important part of survey work. Stratified simple random sampling technique was used for collecting cross sectional data and information from a total of 60 beekeepers. Among them all are owner of traditional wooden hives and 15 have modern poly hives.

3.4 Location and duration of data collection

For collecting data Sirajganj, Gazipur and Shatkhira districts were purposively selected as study area on the basis of intensive cultivation of beeplants. Interviewed apiarists moved these areas with their apiary year round based on the seasons as they were doing migratory beekeeping. Sirajganj district was selected for collecting data at the flowering period of mustard. Gazipur district was selected for collecting data at litchi season. And Shatkhira district was selected for collecting data at the end season of sunderban mangrove forages. Three upazilla i.e. Ullapara, Shahzadpur and Tarash were selected in Sirajganj district. From Gazipur district, Gazipur Sadar, Kapasia and Kaligonj upazilla were selected. Satkhira Sadar, Kaligonj and Tala upazilla were selected in sundarban areas of Satkhira district. The regions have high concentration of bee forages and beekeepers were available in these areas at the time of flowering periods of those plants. All the sampled beekeepers rear *Apis mellifera* species in their apiary. The survey was conducted on 01 November 2017 to 30 May 2018. Peak mustard flower blooming period, litchi blooming period and mangrove plants blooming period were selected for data recording.

Table 3.1. Distribution of the beekeepers

Districts	Upazila	Number of Beekeeprts	Poly hive users
Shirajganj	Ullapara	10	5
	Shahzadpur	6	
	Tarash	4	
Gazipur	GazipurSadar	8	5
	Kapasia	7	
	Kaligonj	5	
Sathkhira	SatkhiraSadar	9	5
	Kaligonj	7	
	Tala	4	
Total		**60**	**15**

3.5 Analytical Technique

Data were analyzed with a view to achieving the objectives of the study. Descriptive statistics like sum, mean, average, percentage etc. were followed to analyze the data to achieve the objectives of the study. For examining the socio-demographic characteristics of beekeepers (objective 1) and in understanding the profitability of the enterprise (objective 2), descriptive statistics was used here. For measuring the factor effects on return and the resource use efficiency of beekeeping (objective 3), Cobb-

Douglas (CD) production function was used. And to identify the major problems faced by the beekeepers (objective 4) the Constraints Faced index (CFI) was calculated using established formula.

3.6 Profitability Analysis

The return was estimated using the set of financial prices. The financial prices were market prices actually received by farmers for outputs and paid for purchased inputs during the period under consideration in this study. The cost items identified for the study were Labor cost, Feed cost, Transportation cost, Medicine cost, Hive cost, Colony cost, Equipment cost, Honey extraction cost, Packaging and marketing cost, Rent and Interest on operating capital. The return from beekeeping was estimated based on the value of main products and by-products. The return items identified for the study were Honey, Wax, Pollen, Propolis, Colony and Queen bee.

3.7 Description and measurement techniques of cost items

Variable cost (TVC) included labor cost, feed cost, transportation cost, insecticide cost, equipments cost, honey extraction cost, packaging and marketing cost. Fixed cost (FC) included hive cost, colony cost, interest on operating capital and rent cost. Total cost (TC) included total variable cost and total fixed cost.

3.7.1 Human labor cost

Labor cost was required for different operations such as swarm catching, box transferring, inspection of apiary, feeding bees in derth period, honey harvesting and extraction, cleaning, packaging, transportation, marketing etc. In order to calculate human labour cost, the recorded man-days per hive were multiplied by the wage per man-day for a particular season.

3.7.2 Feed Cost

Beekeepers need to feed the honeybees in the derth period when there is not enough food in the nature available for them. Cost of feed included ready feed, such as sugar solution, barley flour, pules mash, pollen, etc. Feed cost was calculated on the basis of required taka per colony.

3.7.3 Transportation Cost

Transportation cost included expenses on transportation from region to region at different seasons. As the flowering stages of beeplants (from where bees collect honey) are different and also all the forages are not available in one region, apiarist needs to keep moving with their boxes and colonies from one district to another based on availability of beeplants for the entire harvesting period. There are also some transportation costs for purchasing hive, medicine, marketing, collection of feed etc.

3.7.4 Cost of Insecticide/medicine

Cost of insecticide is another important cost item of beekeeping. This cost incurred for controlling varroa mites, ants, different species of spiders etc. There are different types of diseases of honeybees and various insecticides and medicines are also needs to be used for cure. But in Bangladesh normally those type of major diseases of honey bees are very rare. Cost of insecticides was calculated based on the market price of the insecticides which were used by the apiarists.

3.7.5 Cost of Hive

Bee hives were made of woods and polystyrene. In the present study, hive cost was calculated by applying straight line depreciation method. In this method, the depreciation during each period is same.

3.7.6 Colony cost

Apiarist purchases colonies at the beginning of their beekeeping activity. For each hive one colony is needed. A honey bee colony is comprised of a queen bee, hundreds of drones, and thousands of worker bees. Farmers purchase colony from other beekeepers at conventional prices.

3.7.7 Cost of Tools and Equipment

Tools and equipment are necessary for successful bee cultivation. The bee farmers generally used hand gloves, veil, knife, brush, buckets, smokers, hive tools etc. Cost of tools and equipment were determined by applying straight line depreciation method.

3.7.8 Rent /land use cost

For beekeeping there's no need of large amount of land, farmers only need to place the boxes by the side of a flowering crop land. It can be done even on the aisled of the

crop land or any unused open field. Moreover, now-a-days crop farmers are interested in placing beehives near their crop field as honeybees improve the production. So the amount of rent costs for land use was calculated on the basis of number of boxes placed on field during the flowering period of those crops.

3.7.9 Honey extraction cost

To extract the honey from the hive frames farmers, need honey extractor. Some of the large farmers have their own honey extractor. But those who don't have it, need to contact with someone who has honey extractor.

3.7.10 Packaging and marketing cost

Beekeepers need to pour the honey in small containers to deliver it to the customers. Sometimes some companies purchase honey in large amount. In that case farmers need to buy some containers of 30-40 kg capacity and sell honey in those containers. The market prices of those things were calculated here.

3.7.11 Interest on Operating Capital

Interest on operating capital was charged on taking all variable costs incurred for various operations in bee farming such as labor cost, feed cost, transportation, insecticide cost and equipment cost. As the variable cost items were short time investments, interest rate (IR) on these items was charged at the rate of 10 percent per annum based on thumb rules. Interest on operating capital (IOC) was computed by the following formula (Miah and Hardekar, 1988).

$$IOC = OC \times IR \times \text{Total time period of cycle}$$

Where,

IOC =Interest on operating capital

OC = Operating capital;

IR=Interest rate

3.8 Calculation of Returns

3.8.1 Gross Return

Per hive gross return was calculated by multiplying the total amount of product and by-product by their respective per unit prices.

Gross Return= Quantity of the product* Average price of the product

+ Value of by- product.

3.8.2 Gross Margin

Gross margin is defined as the difference between gross return and variable costs. Generally, farmers want maximum return over variable cost of production. The argument for using the gross margin analysis is that the farmers are interested to get returns over variable cost. Per hive gross margin was obtained by subtracting variable costs from gross return.

That is, Gross margin = Gross return – Variable cost

3.8.3 Net Return

Net return or profit was calculated by deducting the total cost from the gross return.

That is, Net return = Gross return – Total cost

The following profit equation was used to assess the profitability of beekeeping

$$\prod = P_1Q_1 + \sum P_iQ_i - \sum WjXj - TFC$$

Where,

$\prod$= Profit per hive from beekeeping;

P_1 = Per unit price of the output;

Q_1 = Quantity of output obtained (per hive);

P_i = Per unit price of by-products;

Q_i = Quantity of by-products obtained (per hive);

Wj = Per unit price of input used;

Xj = Quantity of the input used; and

TFC = Total fixed cost

3.8.4 Undiscounted Benefit Cost Ratio (BCR)

Average return to each taka spent is an important criterion for measuring profitability. Undiscounted BCR was estimated as the ratio of total return to total cost per hive.

$$BCR = \frac{Gross\ return}{Total\ cost}$$

3.9 Cobb-Douglas Production Function

For functional analysis of the data Cobb-Douglas production function is used. To determine the contribution of the most important variables in the return, the following type of function was used in the study.

$Y = \alpha X1^{\beta 1} X2^{\beta 2}$ ---------- $Xn^{\beta n} e^{ui}$

The production function was converted to logarithmic form so that it could be solved by Ordinary Least Square (OLS) method, that is,

$lnY = \alpha + \beta 1\ lnX1 + \beta 2\ lnX2 + \ldots\ldots\ldots\ldots\ldots + \beta n\ lnXn + Ui$

The empirical production function is the following:

$lnY = \alpha + \beta 1\ lnX1 + \beta 2\ lnX2 + \beta 3\ lnX3 + \beta 4\ lnX4 + \beta 5\ lnX5 + \beta 6\ lnX6 + \beta 7\ lnX7 + \beta 8\ lnX8 + \beta 9\ lnX9 + \beta 10\ lnX10 + \beta 11\ D + Ui.$

Where,

ln= Natural logarithm

Y= Gross return (Tk/hive)

X_1= Labor cost (Tk/hive)

X_2= Feed cost (Tk/hive)

X_3= Transportation cost (Tk/hive)

X_4= Insecticide/Medicine cost (Tk/hive)

X_5= Equipment cost (Tk/hive)

X_6= Marketing cost (Tk/hive)

X_7= Hive cost (Tk/hive)

X_8= Colony cost (Tk /hive)

X_9= Rent cost (Tk/hive)

X_{10}= Extraction cost (Tk/hive)

D = 1, If the beekeeper use poly hive

= 0, otherwise

α = Intercept

$\beta 1, \beta 2$ ---- $\beta 11$ = Coefficients of the respective variables to be estimated; and

Ui = Error term.

3.10 Resource use efficiency

In order to investigate the resource use efficiency, the ratio of marginal value product (MVP) to the marginal factor cost (MFC) for each input was computed and tested for its equality to 1,

$$\text{That is, } \frac{MVP}{MFC} = r$$

Where, r = Efficiency ratio MVP = The change in gross return in value term resulting from a unit change of a resource. MFC = price paid for use of an extra unit of that resource.

Under this method, the decision rules are that, when: r >1, the level of resource use is below the optimum level, implying under-utilization of resources. Increasing the rate of use of that resource will help increase productivity. When r <1, the level of resources use is above the optimum level, implying over utilization of resources. Reducing the rate of use of that resource will help improve productivity. r = 1, the level of resource use is at optimum implying efficient resource utilization.

The most reliable, perhaps the most useful estimate of MVP is obtained by taking all input items (Xi) and gross return (Y) at their geometric means (Dhawan and Bansal, 1977). All the variables of the fitted model were calculated in monetary value. As a result, the slope co-efficient of those independent variables in the model represent the MVPs, which were estimated by multiplying the production co-efficient of given resources with the ratio of geometric mean (GM) of gross return to the geometric mean (GM) of the given resources, that is,

$$\text{MVP (Xi)} = \beta i \frac{Y(GM)}{Xi(GM)}$$

Where, $\bar{Y}$ (GM) = Geometric mean of gross return (BDT)

$\ddot{X}$i (GM) = Geometric mean of different independent variables (BDT)

β_i = Co-efficient of parameters i = 1, 2……...n

3.11 Measurement of constraints

Constraints faced by the farmers in beekeeping were measured on the basis of ten constraints. Each of the sample farmers was asked to indicate the degree of constraints faced by him/her against each of 10 selected constraints. The alternative responses were ‘high’, ‘medium’, ‘low’ and ‘not at all’. The score of 3, 2, 1 and 0 were assigned

to these alternative responses respectively. Finally, constraint's score of a respondent was determined summing up the weights of his/her responses to all the ten constraints. Thus, constraint faced score of a single respondent was ranged from zero (0) to 30, where '0' indicating no constraints and '30' indicating highest constraints of beekeeping. The Constraints Faced index (CFI) was calculated with the following formula (Akter *et al.*, 2016).

$$CFI = C_h \times 3 + C_m \times 2 + C_l \times 1 + C_0 \times 0$$

Where, CFI= Constraint Faced Index

C_h = No. of beekeepers faced high constraints

C_m = No. of beekeepers faced medium constraints

C_l= No. of beekeepers faced low constraints

C_0 = No. of beekeepers faced no constraints

Thus, the possible CFI of constraints items could range from 0–180. To compare the severity of the constraints, rank order was made by the descending order of the CFI.

CHAPTER IV
SOCIO-DEMOGRAPHIC CHARACTERISTICS OF THE BEEKEEPERS

4.1 Introduction

This chapter provides a brief description of the socio-demographic characteristics of beekeepers in the study area. Decision making behavior of an individual is determined to a large extent by his socio-demographic characteristics. The characteristics considered in the present study were age, education, gender, occupation, marital status, family size, income level, experience, training received, etc.

4.2 Age Distribution of beekeepers

The beekeepers were grouped into three categories according to their ages. The different age groups of the beekeepers are presented in Figure 4.1. The age of the selected beekeepers was observed to be ranging from a minimum of 31 to a maximum of 55 years.

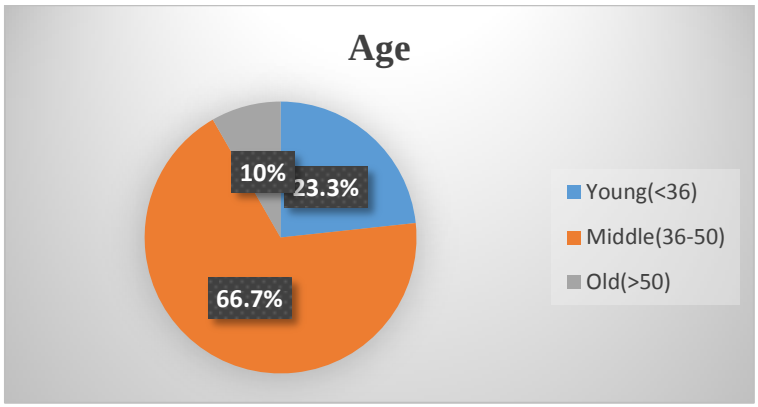

Figure 4.1: Age distribution of the beekeepers

The result reveals that farmers between 31-35 years of age accounted for 23.3 percent of the total sampled farmers while farmers of middle age in 36-50 years constituted 66.7 percent. There are only 10 percent farmers aged 50 years and more. Figure 4.1 revealed that, beekeepers were of mostly middle aged group.

4.3 Education level

Education enables to be capable of managing scarce resources and hence to earn maximum profit. The years of schooling of the sampled beekeepers ranges from 3 to 11 years. To examine the education level three categories were made here including

Primary (1-5 years of schooling), Secondary (6-10 years of schooling) and above Secondary (above 10 years of schooling).

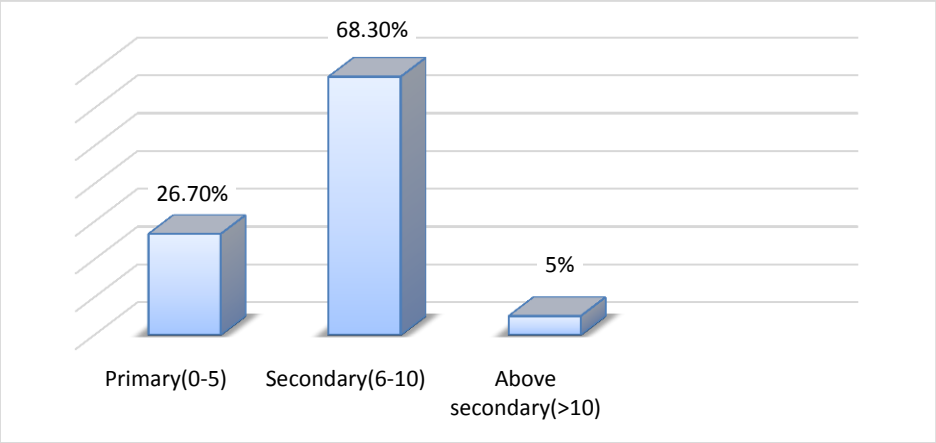

Figure 4.2: Level of education of the Beekeepers

Figure 4.2 reveals that, 26.7 percent of the respondents attained primary education. Farmers who are of secondary and above secondary level educated, constituted 68.3 percent and 5 percent, respectively. Their average years of schooling is 6.6 years. It is evident from the figure that most of the beekeepers are secondary level educated.

4.4 Marital status

In the study area, all the respondent beekeepers are found to be married.

4.5 Gender

About 95 percent of the beekeepers were male and only 5 percent of them were female. So, apiculture is a male dominating sector in the study area.

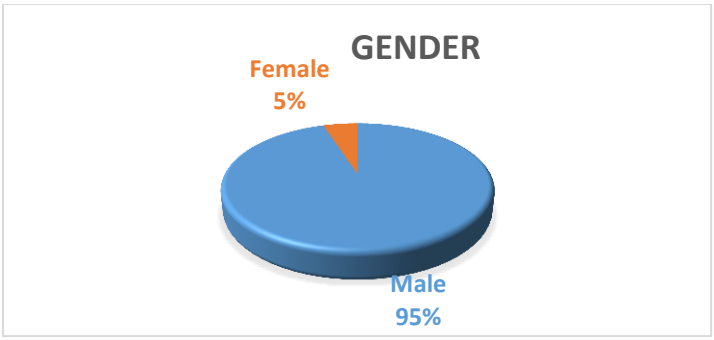

Figure 4.3: Gender of the beekeepers

4.6 Occupation

The work in which a man is engaged throughout the year is known as his main occupation. In Bangladesh, rural people's occupations are increasingly diversified. In the selected area, among the respondents, 100 percent are engaged in beekeeping as their main occupation. But they have other subsidiary occupations like crop (38.3%), livestock (18.30%), non-farm businesses (20%), and others (23.4%) (Figure 5.5).

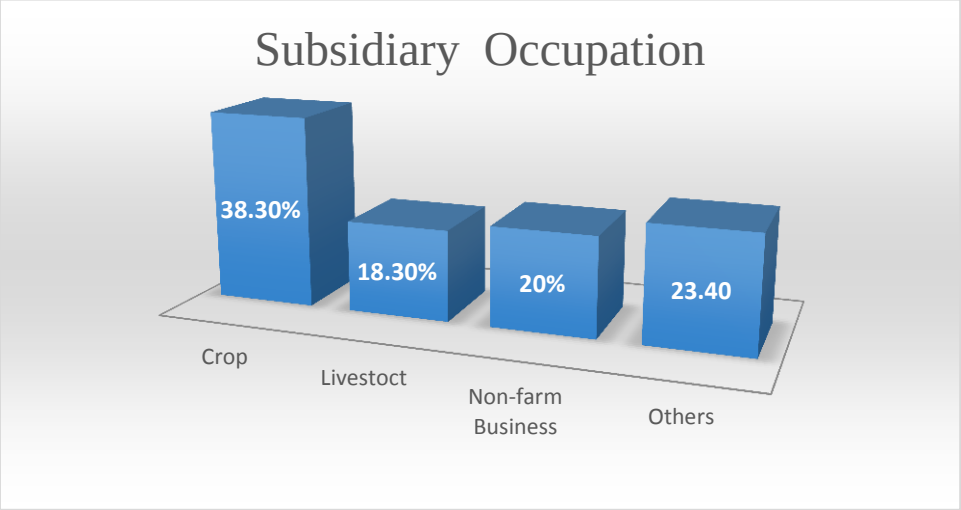

Figure 4.4: Occupational status of the beekeepers

4.7 Family size

Family size has been considered as the total number of people living together with the same head of the family. The family member includes wife, sons, unmarried daughter, father, mother and brother. Beekeeper's families were divided into three categories according to their number of family members.

Table 4.1: Family size of beekeepers

No. of family members group	No. of farm family	Percent	Average family size
1-3	7	11.7	4.67
4-5	41	68.3	
Above 5	12	20	
Total	60	100	

Table 4.1 indicates that 11.7 percent families of beekeepers consisted of 1-3 members, 68.3 percent families consisted of 4-5 members, 20 percent families consisted of

above 5 members. The average family size of our country is 4.5 (BBS, 2018). But in the study area it was found 4.67 for beekeepers, which is larger than average family size of the country.

4.8 Income level

Family income of the apiarists comprises different sources. Annual family income of beekeepers comes from beekeeping, business, agriculture, livestock, service, and others. Annual income of the respondents ranges from 110,000 to 440,000 taka.

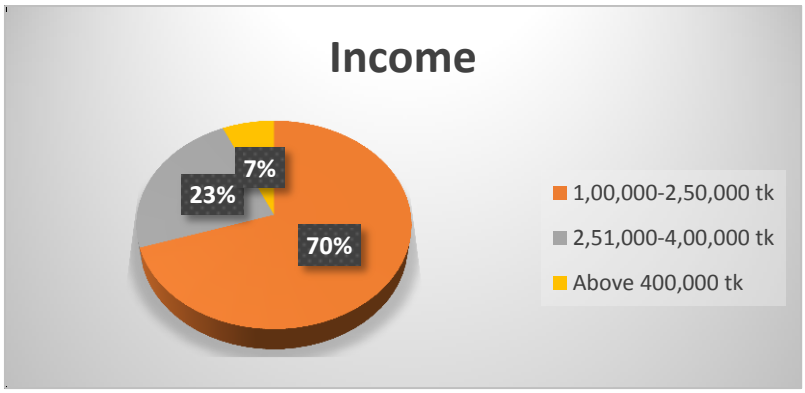

Figure 4.6: Annual household Income of the beekeepers.

Figure 4.6 indicates that, 70 percent families of beekeepers have annual income of Tk 100,000-250,000, 23 percent have income of Tk 251000-400000 and 7 percent have income above Tk 400000. Their average income is 227,866.7 tk. The figure indicates that, most of the beekeepers are of lower income group.

4.9 Experience of beekeeping

The selected beekeepers were grouped into three categories according to their years of experience in beekeeping. Their experience was observed to be ranging from a minimum of 5 to a maximum of 19 years.

Table 4.2 Distribution of the beekeepers according to their experience

Beekeeping Experience (Years)	No. of farmers	Percent	Poly hive user	Percent
5-8	15	25	4	26.7
9-12	26	43.3	5	33.3
Above 12	19	31.7	6	40
Total	60	100	15	100

It is clear from the table that; 25 percent of the sampled beekeepers have an experience of 5-8 years in this profession. While the majority (43.3%) have 9-12 years of experience. And 31.7 percent farmers have experience above 12 years. Table 4.2 also revealed that more experienced beekeepers are more likely to have poly hive.

4.10 Training on beekeeping

Training on beekeeping of the farmers ranges from 15 to 40 days. Data contained in Table 4.3 indicates that 36.7 percent of the apiarists had 15-20 days of training; while 50 percent had 21-30 days training and 13.3 percent had above 30 days training. The beekeepers received training mostly from KGF (Krishi Gobeshona Foundation) and DAE (Department of Agricultural Extension).

Table 4.3 Training received by beekeepers.

Training on beekeeping (Days)	No. of farmers	Percent	Poly hive user	Percent
15-20	22	36.7	**3**	20
21-30	30	50	**9**	60
Above 30	8	13.3	**3**	20
Total	60	100	**15**	100

4.11 Farm size according to number of hives.

Here, farm size of beekeepers is categorized based on the number of hives which ranges from 70 to 280. Table 4.4 indicates that 21.7 percent beekeepers have small farm size with 70-120 hives; while 61.6 percent have medium farm size with 121-200 hives and 16.7 percent have large farm size with above 220 hives. Table 4.4 also indicates that medium farm size holder beekeepers are the highest (53.3%) poly hive adopters in the study area.

Table 4.4 Farm size of beekeepers according to their number of boxes.

Farm size (Number of boxes)	No. of farmers	Percent	Poly user	Percent
Small(70-120)	13	21.7	3	20
Medium(121-200)	30	61.6	8	53.3
Large(Above 200)	8	16.7	4	26.7
Total	60	100	15	100

4.12 Extension contact

Extension contact of the beekeepers ranges from 3-15 days in last one year. According to their observed scores, Extension contact of the farmers classified into three groups as shown in Table 4.6.

Table 4.5 Extension contact in last one year

Extension contact (days)	No. of farmers	Percent	Poly hive user	Percent
3-5	22	36.7	0	0
6-10	27	45	4	26.7
Above 10	11	18.3	**11**	**73.3**
Total	60	100	15	100

Data contained in Table 4.6 indicates that 36.7 percent of the beekeepers had 3-5 days of extension contact in last one year; while 45 percent had 6-10 days of extension contact and 18.3 percent had above 10 days of extension contact. The table also indicates that the more the beekeepers came in extension contact the more they adopt poly hive.

4.13 Concluding remarks

The demographic characteristics of the beekeepers indicates the dominance of middle aged beekeepers in the study area, mostly secondary level educated and lower income group. Largest group of them consists of 4-5 family members and it is a male dominating enterprise here. Most of them have medium sized farm with 120-200 boxes. All the sampled beekeepers taken apiculture as their main occupation and most of them do rice cultivation as their subsidiary occupation. Majority are highly experienced beekeepers and all of them received training time to time. Though they didn’t receive much training on modern beekeeping technologies.

CHAPTER V
PROFITABILITY OF BEEKEEPING

5.1 Introduction

Financial profitability can be measured based on net return, gross margin and ratio of return to total cost. The costs of all items were calculated to identify the total cost of production. The returns from beekeeping have been estimated based on the value of main products and by-products.

5.2 Financial profitability of beekeeping

5.2.1 Variable Costs

For determining the cost of beekeeping practices, all the variable costs like feed cost, human labour cost, transportation cost, marketing cost, insecticide cost, equipment cost, honey extraction cost were calculated per box basis. In order to calculate labor cost, the recorded man-days per hive were multiplied by the wage per man-day for a particular season. It is revealed from Table 5.1 that the cost of labor per hive per year was Tk. 615.53 for traditional and Tk. 499.80 for modern poly hive which covered 8.87 and 6.63 percent of the total cost, respectively. In the selected areas sugar solution, barley flour, pules mash, pollen, etc. were used as feed. The average feed cost per hive per year amounted to Tk. 1347.73 and Tk. 1764 for traditional and modern poly hive which was 19.43 and 23.41 percent of the total cost, respectively. Transportation cost per hive per year stood at Tk. 204.04 for traditional and 205.83 for modern poly hive, which covered 2.94 and 2.73 percent of total cost, respectively. Marketing cost per hive per year stood at Tk. 98.00 for traditional and 99.30 for poly hive, which covered 1.41 and 1.32 percent of total cost, respectively. The average insecticide cost per hive was Tk. 64.96 and Tk. 39.06 for wooden and poly hive, respectively which covered 0.94 and 0.52 percent of the total cost. The tools and equipment cost per hive per year was Tk. 22 for both wooden and poly hive which covered 0.32 and 0.29 percent of the total cost. A honey extractor is required for beekeepers to extract honey from hive frame. Table 5.1 shows that total extractor cost per hive per year was Tk. 6.5 and Tk. 7.21 for wooden and poly hive representing 0.09 and 0.10 percent of the total cost. The total variable cost of beekeeping was Tk. 2358.76 and Tk.2637.20 per hive for wooden and poly hive, respectively which was 34 and 35 percent of the total cost (Table 5.1).

Table 5.1: Per hive cost of beekeeping

Cost items	Cost/hive/year (wooden box)		Cost/hive/year (Modern poly box)	
	Cost (Tk.)	Percent of total cost (%)	Cost (Tk.)	Percent of total cost (%)
Labor cost	615.53	8.87	499.80	6.63
Feed cost	1347.73	19.43	1764.00	23.41
Transportation cost	204.04	2.94	205.83	2.73
Marketing cost	98.00	1.41	99.30	1.32
Insecticide/Medicine cost	64.96	0.94	39.06	0.52
Tools and equipment cost	22.00	0.32	22.00	0.29
Honey extraction cost	6.50	0.09	7.21	0.10
A. Total variable cost	2358.76	34.00	2637.20	35.00
Interest on Operation capital	235.87	3.40	263.72	3.50
Hive cost	382.18	5.51	834.67	11.08
Colony cost	3880.00	55.93	3719.33	49.36
Rent cost	80.00	1.15	80.00	1.06
B. Total Fixed Costs	**4578.05**	66.00	**4897.72**	65.00
Total cost (A+B)	**6936.81**	100.00	**7534.92**	100.00

5.2.2 Fixed Cost

The fixed cost included hive cost, rent cost, colony cost and interest on operating capital. In the present study, hive cost was calculated by applying straight line depreciation method. In this method, the depreciation during each period is same. Cost of hive was Tk. 382.18 and 834.67 for wooden and poly hive, respectively which was 5.51 and 11.08 percent of total cost (Table 5.1). Colony cost was the most crucial cost item for beekeeping. The apiarists of the study areas mainly collected colony from honey producers through their local agents. The local honey producers imported parent stock from breeder farm and produced colony for local commercial farms. The cost of colony per hive was calculated at Tk.3880 and Tk. 3719.33 for wooden and poly hive respectively which covered 55.93 and 49.36 percent of the total cost. Table 5.1 shows that total rent cost per hive per year was Tk. 80 for both wooden and poly hive representing 1.15 and 1.06 percent of the total cost. Interest on operating capital

was estimated Tk. 235.87 and Tk. 263.72 for both wooden and poly hive respectively which covered 3.40 and 3.50 percent of the total cost (Table 5.1).

Total cost was calculated by adding all the cost of variable and fixed inputs. Per hive total cost per years was found to be Tk. 6936.81 and Tk. 7534.92 for beekeeping in wooden and modern poly hive respectively (Table 5.1).

5.2.3 Return

5.2.3.1 Gross Return

Return of beekeeping is shown in Table 5.2. Per hive gross return was calculated by multiplying the total amount of product with respective per unit price and then adding the value of by-products. Therefore, the gross return was found to be Tk. 11019.26 per hive for wooden box and Tk. 27373.34 per hive for poly box.

Table 5.2: Gross return of beekeeping from wooden and poly box.

Return items	**Wooden hive**			**Poly hive**		
	Quantity/ box/year	Price (Tk)/unit	Return (Tk)	Quantity/ box/year	Price (Tk)/ unit	Return (Tk)
Honey	36 kg	150	5400	57 kg	200	11400
Wax	.39 kg	300	119.26	.78 kg	350	273.34
Pollen	0	2000	0	.6 kg	2000	1200
Propolis	0	1000	0	.6 kg	1000	600
Colony	1 nos	3000	3000	3 nos	3000	9000
Queen bee	5 nos	500	2500	7 nos	700	4900
Total			11019.26			27373.34

5.2.3.2 Gross Margin

Gross margin was calculated by deducting the total variable cost from the gross return. On the basis of the data, gross margin was found to be Tk. 8660.5 and Tk. 24736.14 per hive for wooden and poly hive respectively (Table 5.3).

5.2.3.3 Net Return

Net return or profit was calculated by deducting the total cost from the gross return. On the basis of the data the net return was estimated as Tk. 4082.45 and Tk. 19838.42 per hive for wooden and poly hive respectively (Table 5.3).

5.3 Benefit Cost Ratio (undiscounted)

Benefit cost ratio (BCR) was found to be 1.59 and 3.63 for wooden and poly hive respectively which implies that one-taka investment in beekeeping generated Tk. 1.59 in wooden hive and Tk. 3.63 in poly hive (Table 5.3). From the above calculation it was found that beekeeping in poly hive is more profitable. And the results are compatible with the findings of Moniruzzaman and Rahman, (2009), Islam *et al.,* (2016), Abdullahi *et al*. (2014) and Al-Ghamdi *et al*. (2017).

Table 5.3: Per hive cost and return of beekeeping

Sl. No.	**Items**	**Traditional wooden Amount (Tk./hive)**	**Modern poly Amount (Tk./hive)**	**t-test**
A.	Gross return (GR)	11019.26	27373.34	0.047266**
B.	Total variable costs (TVC)	2358.76	2637.20	
C.	Total costs (TVC+TFC)	6936.81	7534.92	
D.	Net return (GR-TC)	4082.45	19838.42	
E.	Gross margin (GR-TVC)	8660.50	24736.14	
F.	Benefit-cost ratio (BCR) = GR/TC	1.59	3.63	

Note: **Significant at 5% level

From the t-test we found that, there are significant difference in Gross return, Net return, Gross margin, Total cost and Benefit cost ratio between wooden and poly hive.

5.4 Concluding remarks

From the profitability analysis, it is observed that, beekeeping in poly hive is highly profitable compared to wooden hive. Total cost is found nearly similar but return is almost double in case of poly hive. Benefit cost ratio is also higher (3.63) for poly hive than wooden hive (1.59). So it can be concluded that beekeeping in modern poly hive is highly profitable.

CHAPTER VI

FACTORS AFFECTING THE RETURNS AND RESOURCE USE EFFICIENCY OF BEEKEEPING

6.1 Introduction

This chapter is designed to estimate the contribution of the individual key variables to the return from beekeeping.

6.2 Factors affecting return

For beekeeping different kinds of inputs, such as labor, feed, transportation, insecticide/medicine, hive, colony etc. were employed which were considered as priori explanatory variables responsible for variation in return. Multiple regression analysis was employed to understand the possible relationships between the return and the cost items used. Interpretations of the estimated co-efficient and related statistics have been shown in Table 6.1.

6.3 Interpretation of result

6.3.1 Human labor cost (X_1)

The regression coefficient of labor cost was 0.077 and the result is significant at 5 percent level, which indicated that, keeping other factors constant, a 1 percent increase in labor cost would increase the return by .077 percent (Table 6.1).

6.3.2 Feed cost (X_2)

The co-efficient of feed cost was 0.008 which was found insignificant (Table 6.1).

6.3.3 Transportation cost (X_3)

The estimated co-efficient of transportation cost was -0.107 which was negative but significant at 5 percent level (Table:6.1). This indicates that 1 percent increase in transportation cost, keeping other factors constant would result in a decrease in return by .107 percent.

6.3.4 Insecticide/Medicine cost (X_4)

The estimated coefficient of insecticide/medicine cost was 0.084 (table 6.1) which was significant at 10 percent level. That means, 1 percent increase in insecticide cost would increase the return by 0.084 percent while other factors were kept constant.

6.3.5 Equipment cost (X_5)

The regression coefficient of equipment cost was .293 and the result was significant at 5 percent level (Table 6.1), which indicates that, 1 percent increase in equipment cost would increase the return by .293 percent.

6.3.6 Marketing cost (X_6)

The estimated value of the co-efficient of marketing cost was 0.001 which was found to be positive but insignificant (Table 6.1).

6.3.7 Hive cost (X_7)

The regression co-efficient of hive cost was -0.128 and significant at 10 percent level (Table 6.1). Which implies that, keeping other factors constant, 1 percent increase in hive cost would decrease the return by 0.128 percent.

6.3.8 Colony cost (X_8)

The estimated value of the co-efficient of colony cost was 0.112 which was found insignificant (Table 6.1).

6.3.9 Rent cost (X_9)

The estimated co-efficient of rent cost was -0.115 which was negative and significant at 10 percent level (Table:6.1). This indicates that 1 percent increase in rent cost, keeping other factors constant would result in a decrease in return by .115 percent.

6.3.10 Extraction cost(X_{10})

The estimated value of the co-efficient of extraction cost was 0.001 which was found insignificant (Table 6.1).

6.3.11 Poly hive (D)

The estimated co-efficient of poly hive was .317 which was significant at 1 percent level (Table:6.1). The result indicates that the average return for using poly hive in beekeeping is about .317 percent higher than the return from wooden hive.

Table 6.1 Estimated Values of Coefficients and Related Statistics of Regression analysis.

Explanatory variables	Coefficient	Standard error	p- value
Intercept	8.441	1.57	0.0000
Labor cost(X_1)	0.077**	0.04	0.0540
Feed cost(X_2)	0.008	0.06	0.9000
Transportation cost (X_3)	-0.107**	0.05	0.0375
Insecticide/medicine cost(X_4)	0.084*	0.04	0.0666
Equipment cost(X_5)	0.293**	0.14	0.0460
Marketing cost(X_6)	0.001	0.02	0.9505
Hive cost(X_7)	-0.128*	0.07	0.0601
Colony cost (X_8)	0.112	0.12	0.3681
Rent cost (X_9)	-0.115*	0.07	0.1064
Extraction cost (X_{10})	0.001	0.02	0.9450
Poly hive(D)	0.317***	0.07	0.0001
R^2	0.85		
Return to scale	.54		
F-value	24.80***		

Note: *** Significant at 1 percent level;

** Significant at 5 percent level;

* Significant at 10 % level.

6.4 Performance of the Model

The value of R^2 were found to be 0.85 and which implied that about 85 percent of the total variation in return could be explained by the independent variables included in the model (Table 6.1). Other 15 percent variations depend on the factors which were not included in the regression model.

The F-values was about 24.8, and significant at one percent level which implied good fit of the model. Highly significant F-value implied that the included variables collectively were important for explaining the variations in return from beekeeping.

6.5 Returns to Scale of beekeeping

The result from the summation of all the regression coefficients of the estimated regression function was .54, which implies that the function exhibits decreasing

returns to scale. If all the inputs specified in the function were increased by 1 percent, then the return would increase by .54 percent.

6.6 Resource use efficiency of beekeeping in wooden and poly hive

In order to identify the status of resource use efficiency, it was considered that a ratio equal to unity indicated the optimum use of that factor, a ratio more than unity indicated that the return could be increased by using more of that input. A value of less than unity indicated the unprofitable level of input use, which should be decreased to minimize the losses because farmers are over using the resource.

Table 6.2 Resource use efficiency of different inputs in beekeeping

Variable	Geometric mean(GM)	Co-efficient	MVP (Xi)	MVP/ MFC	Decision rule
Return (Tk)	11450.41				
Labor cost(X_1)	614.70	0.008	1.43	1.43	Under-utilized
Feed cost(X_2)	1344.17	-0.107	0.06	0.06	Over-utilized
Transportation cost(X_3)	301.78	0.084	-4.05	-4.05	Over-utilized
Insecticide/medicine cost(X_4)	63.94	0.293	15.04	15.04	Under-utilized
Equipment cost(X_5)	22.64	0.001	148.29	148.29	Under-utilized
Marketing cost(X_6)	701.19	-0.128	0.02	0.02	Over-utilized
Hive cost(X_7)	489.26	0.112	-3.01	-3.01	Over-utilized
Colony cost (X_8)	3342.88	-0.115	0.38	0.38	Over-utilized
Rent cost (X_9)	75.39	0.001	-17.51	-17.51	Over-utilized
Extraction cost (X_{10})	6.11	0.077	2.69	2.69	Under-utilized

Note: MFC= BDT 1.

From Table 6.2 it is evident that, the ratio of MVP and MFC of labor cost (1.43), Medicine cost (15.04), equipment cost (148.29), and extraction cost (2.69) was positive and greater than unity. This indicates that, labor cost, medicine cost, equipment cost, and extraction cost were under used. So, the beekeepers needed to increase the use of these inputs to attain the efficient level of return.

On the other hand, the ratio of MVP and MFC of transportation cost (-4.05), marketing cost (.02), hive cost (-3.01), colony cost (0.38), and rent cost (-17.51) were

less than unity indicated that these factors were over used. So, the beekeepers needed to decrease the use of these inputs to attain efficiency.

6.7 Concluding remarks

The relative contribution of individual key variables affecting return of beekeeping can be seen from the estimates of regression equation. The results showed that, among the explanatory variables labor cost, transportation cost, insecticide cost, equipment cost, hive cost, rent and poly hive were found to have significant effect on return. From analysing resource use efficiency, it was found that, labor cost, medicine cost, equipment cost, and extraction cost were under utilized in the study area. So beekeepers can increase the use of these inputs to attain efficiency.

CHAPTER VII

CONSTRAINTS OF BEEKEEPING IN THE STUDY AREA

7.1 Introduction

Though beekeeping was found as a profitable enterprise, there were some problems too which were reported by the beekeepers. The constraints of beekeeping are presented with rank order in Table 7.1. Each respondent describes the problems based on the severity they faced during their beekeeping practices.

Table 7.1 Constraints Faced Index (CFI) with rank order

No.	Problems	Frequency out of 180	Percent	Rank
1.	Higher cost of modern hives and accessories	172	91.7%	1st
2.	Lack of skilled labor	156	81.7%	2nd
3	Lack of capital	142	68.3%	3rd
4.	Marketing problem	135	58.3%	4th
5.	Disease, Pest and predator attack	121	48.3%	5th
6.	Shortage of bee forages	112	30.0%	6th
7.	Transportation problem	102	26.7%	7th
8.	Lack of training	92	21.7%	8th
9.	Death of colony	83	20.0 %	9th
10	Poisoning of agro-chemicals	66	18.3%	10th

7.2 Higher cost of modern hives and accessories

Among the constraints, higher cost of modern hives and accessories was the major problem of beekeepers. They said that, higher prices of modern hives make initial cost high which reduces the profit. About 91.7% apiarist claimed it as their major problem.

7.3 Lack of skilled labor

There is a shortage of skilled labor in the study area. Beekeeping requires some specific skills which are not common with other agricultural practices. To operate modern types of beehives, laborers need specific skills. Due to lack of trained and

skilled labor beekeepers face problems in harvesting time. For the study area it stands as 2nd most important constraint in the problem rank order(Table7.1).

7.4 Lack of capital

Availability of cash capital is necessary for establishing and operating apiary. Institutional credit was hardly available and it required complicated procedure. It appears from Table 7.1 that 68.3% beekeepers mentioned this as a problem. It stands 3rd in the problem rank order.

7.5 Marketing problem

Bee-products like honey, wax, pollen, propolis, queen bees, etc have high market demand. But all the beekeepers cann't manage proper channel to market their valuable products. They have to sell their honey to the wholesaler/ organization at lower farmgate prices. It's a mojor problem for beekeepers. 58.3% farmers claimed it as a high problem in the study area (Table 7.1). It stands 4th in the problem rank order.

7.6 Disease, pest and predators

In the monsoon bee farmers face challenges of some bee diseases. A number of insects including ants and wax moth, birds, mice, and some other mammals often destroy combs. When disease attract in the hives, it damaged large portion of colony. It is a big loss for the beekeepers. 48.3% apiarist claimed it as their major problem, and it stands 5th In the problem rank order (Table 7.1).

7.7 Shortage of bee forages

Availability of bee forages is a crucial need for operating apiary. It appears from Table 7.1 that 30% farmers mentioned it as a high problem. Shortage of bee forage was 6th in rank order. Due to the non availability of bee forages in a single region beekeepers need to keep moving from one district to another with their hives. It increases their transportation cost and reduce profit.

7.8 Transportation problem

Beekeepers need to transport region to region at different seasons with their apiary in search of forages. Sometimes they loss some of their colonies, as honeybees die at the time of transportation. Sometimes accidentally they loss their boxes. 26.7% apiarist

claimed it as their major problem, and it stands 7th in the problem rank order (Table 7.1).

7.9 Lack of training

Respondents claimed about the shortage of trained manpower to handle newer technologies, commercial activities such as production, post-harvest handling etc. Availability of training facilities about modern technology is rare. The beekeepers don't have proper knowledge about pesticides and bee disease. Beekeepers think that lack of training facility is a problem to expand this enterprise. 21.7% beekeepers mentioned it as a constraint. (Table 7.1).

7.10 Death/Reduction of colony: Sometimes honeybees (queenbee/worker bee) flee from their boxes leaving their colony which effect the condition adversely. These syndrome is known in many names such as Disappearing disease, Autumn collapse, colony collapse disorder etc. Death/reduction of colony causes significant financial losses of beekeepers. 20% beekeepers suffered from this problem. And it ranked at 9th position in the order.

7.11 Poisoning of agro-chemicals

Poisoning of agro-chemicals is an important problem not only for apiculture but also for agricultural crops and the environment as well. Though all the farmers are not well aware of this pollution but Table 7.1 shows that 18.3% of the beekeepers reported it as a high problem.

7.12 Concluding remarks

Apiarists of the study area claimed that, higher cost of modern hives and accessories (91.7%), lack of skilled labor (81.7%), lack of capital (68.3%), marketing problem (58.3%), pest and predator attack (48.3%), shortage of bee forages (30.0%), transportation problem (26.7%), lack of training (21.7%), death of colony (20.0%), poisoning of agro-chemicals (18.3%) were some major constraints against undertaking improved beekeeping practices in the study area.

CHAPTER VIII
SUMMARY, CONCLUSION AND RECOMMENDATIONS

In this chapter a brief summary and conclusion has been drawn based on the previous discussions. In conclusion, the main points can be found out easily. Some policy recommendations are also proposed to draws the attention of the respective authority to improve the situation of beekeepers.

8. 1 Summary

Beekeeping is a vast scientific subject, related to agriculture, food, nutrition, medicine, industrial products and environment. And honey is a much sought-after food item with a high demand in the local and foreign markets. At present modern poly hive is becoming popular in some areas of the country. Three districts namely Sirajganj, Gazipur and Shatkhira were selected purposively as the locale of the study for high concentration of bee forages.

A total of 60 samples were selected by stratified random sampling method for primary data collection. A structured interview schedule was developed based on the background information, expert's appraisal and pre-test questionnaire. Data obtained by administering interviews with the respondents were coded appropriately and entered into a database system using Microsoft Excel. Finally, obtained dataset were analyzed using MS Excel and STATA 14 statistical software.

Descriptive statistics like sum, mean, average, percentage etc. were used to analyze the data to achieve the objectives of the study. Functional analysis was also done in some cases to arrive at expected findings. Cobb-Dauglus production functions models was used to analyze the resource use efficiency.

The general socio-demographic characteristics of the sample farmers, such as age, education, gender, farming experiences, family size, income level, etc. were investigated. It was found that, the highest proportion of beekeepers (68.4 percent) were in the middle aged group (36-50). According to the field survey, it was found that 26.7 percent farmers attained primary level of education, 68.3 percent had secondary level of education and 5 percent had above secondary level of education. All the beekeepers were married in the study area and it was also found as a male dominating (95 percent male) enterprise here. From the field survey, it was indicated

that family size of the beekeepers was not very big. Largest group (68.3 percent) of them consists of 4-5 members. Data indicated that 70 percent families of beekeepers have annual income of Tk 100,000-250,000, 23 percent families have income of Tk 251000-400000 and 7 percent families have income above Tk 400000.

Majority group of 43.3 percent have 9-12 years of experience. And 31.7 percent farmers have experience above 12 years. Data also revealed that more experienced beekeepers are more likely to have poly hive. 36.7 percent of the apiarists had 15-20 days training; while 50 percent had 21-30 days training and 13.3 percent had above 30 days training. 21.7 percent beekeepers had small farm size with 70-120 hives; while 61.6 percent of them had medium farm size with 121-200 hives and 16.7 percent of the beekeepers had large farm size with above 220 hives. It was also found that, medium farm size holder beekeepers are the highest (53.3%) poly hive adopters.

In the study area the beekeepers were found to have good contact with extension agents. 36.7 percent of the beekeepers had 3-5 days of extension contact in last one year; while 45 percent had 6-10 days of extension contact and 18.3 percent had above 10 days of extension contact. Data also indicates that the more the beekeepers came in extension contact the more they adopt poly hive.

The performance of modern poly hive in beekeeping was superior in terms of profitability in comparison with the traditional wooden hive. The cost items were cost of human labor, feed cost, transportation cost, medicine cost, marketing cost, tools and equipment's cost, hive cost, colony cost, honey extractor cost and rent cost. The total cost of production was Tk 6936.81 and Tk 7534.92 for beekeeping in wooden and poly hive respectively. Per hive gross return was Tk 11019.26 and Tk 27373.34; gross margin was Tk. 8660.5 and Tk. 24736.14; and net return was Tk. 4083.09 and Tk. 19839.15 for wooden and poly hive, respectively. Undiscounted BCR was also higher for poly hive (3.63) than wooden hive (1.59). And the differences are statistically significant at 5% level.

From regression analysis, it was observed that among the explanatory variables labor cost (X1), transportation cost (X_3), insecticide cost(X_4), equipment cost (X5), hive cost (X7), rent cost (X9) and poly hive (D) were found to have significant effect on return. The value of R^2 was 0.85, which implied that about 85 percent of the total

variation in the gross return could be explained by the included explanatory variables of the model (Table 6.1). The F-statistics was found to be highly significant at one percent level which implies good fit of the model. Therefore, all the explanatory variables included in the model were important for explaining the variation in return. The returns to scale exhibits a decreasing return (0.54). Resource use efficiency indicated that labor cost, insecticide/medicine cost, equipment cost, and extraction cost were under used for beekeeping except overutilization of remaining six variables (Table 6.2).

Respondents replied that among the constraints, higher cost of modern hives and accessories was the major problem of beekeepers. About 91.7% apiarist claimed this problem. Due to lack of trained and skilled labor beekeepers face problems in harvesting time. For the study area it ranked second (81.7%) in the problem rank order. Institutional credit was hardly available and it required complicated procedure, so farmers borrowed money from other people or depend on their own savings which may not always be available. About 68.3 % respondent claimed it. Besides these problems Marketing problem (58.3%), pest and predator attack (48.3%), shortage of bee forages (30.0%), transportation problem (26.7%), lack of training (21.7%), death of colony (20.0%), poisoning of agro-chemicals (18.3%) were some other constraints mentioned by the beekeepers in the study area (Table 7.1).

8.2 Conclusion

Beekeeping contributes positively to local biodiversity. It is an enterprise of possibility for many self-dependent, freedom loving youths. Although beekeeping in modern poly hive was more profitable, the farmers were not so much interested to use it, because of higher initial cost of the modern poly hive. The demographic characteristics of the beekeepers indicates the dominance of middle aged beekeepers in the study area, mostly secondary level educated and lower income group. Largest group of them consists of 4-5 family members and it is a male dominating enterprise here. All the sampled beekeepers taken apiculture as their main occupation and most of them do rice cultivation as their subsidiary occupation. Majority are highly experienced beekeepers and all of them received training time to time. Though they didn’t receive much training on modern beekeeping technologies.

The cost items were human labor cost, feed cost, transportation cost, insecticide cost, tools and equipment cost, marketing cost, hive cost, colony cost, honey extraction cost and rent cost. The total cost of production was higher for poly hive compared to wooden hive while per hive gross return and net return were also higher for poly hive. Benefit cost ratio indicates a handsome return received by beekeepers in both wooden and poly hive. Labor cost, transportation cost, insecticide cost, equipment cost, hive cost, rent, and poly hive have significant effect on return but labor cost, insecticide cost, equipment cost, and honey extraction cost were under utilized. Higher cost of modern hives and accessories, lack of skilled labor, lack of capital, marketing problem, pest and predator attack, shortage of bee forages, transportation problem, lack of training, death of colony, poisoning of agro-chemicals were some constraints mentioned by the beekeepers in the study area.

8.3 Recommendations

The following recommendations are drawn on the basis of findings of the study for the policy makers and researchers in order to adopt all sort of potential measures to improve the present situation of beekeeping sector:

1. Most of the beekeepers of the study area use wooden hive for commercial beekeeping. Therefore, awareness should be created among them regarding the huge profitability of modern poly hive. At the same time price of poly hive needs to bring in the purchasing power of most of the beekeepers.
2. Awareness should be created and appropriate steps should be taken by the authority, GOs and NGOs for proper, planned and scientific use of insecticides and pesticides; farmers should be encouraged to use balanced dose of fertilizers and allocate their resources optimally, which would reduce the chemical poisoning and death of bees.
3. Lower price of bee products was observed at the harvesting period in the study areas. Compatible and steady market price should be ensured by the concerned authority. Government should take necessary steps to explore the possibility of export of bee products in different countries. In this regard government can purchase bee products from the farmers at the harvesting period and export to the recipient countries as per their demand.

4. Special incentive should be given to the beekeepers including institutional credit, insurance, infrastructural development etc. Investment should be made in public education and formal training on beekeeping technology which would be effective to improve farmers' efficiency in this regard.
5. All authorities should pay their highest attention for restoration and expansion of bee plants community throughout the country.

8.4 Limitations of the study

In conducting the present study, following problems and difficulties were aroused

1. Most of the beekeepers in the selected areas hesitated to give actual information about their income.
2. In most cases it was needed to depend solely on the memory of the respondents because they did not keep any written record of their production data.
3. Respondents of the study area rarely have knowledge about research study. They did not find any benefit to give information. It was therefore difficult to explain the purpose of this research to convince them.
4. On many occasions respondents were not available at home and in such cases extra effort and time had needed to collect the information from them.
5. There was constraints of time and resources, that’s why in-depth study was hampered in some extent.

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Appendix 1

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Interview Schedule on

COMPARATIVE PROFITABILITY ANALYSIS AND RESOURCE USE EFFICIENCY OF BEEKEEPING USING WOODEN AND POLY HIVE IN SOME SELECTED AREAS OF BANGLADESH

1. Personal Information **Sample No.**

Name: _____ Fathers Name: _____

Village: _____ Upazila/Thana: _____ District: _____

Age(years): _____ Gender (Code: Male=1, Female=2): _____

Years of education: _____ Marital status: _____ Family size: _____

2. Major occupation: _____

Code: Beekeeping=1; Crop=2; Livestock=3; Nonfarm Business=4; Others=5

2.1 Subsidiary occupation:

Code: Beekeeping=1; Crop=2; Livestock=3; Nonfarm Business=4; Others=5

3. Information about land area(acre):

Own cultivable land: _____ Rented in: _____ Mortgaged in: _____

Rented out: _____ Mortgaged out: _____ Total: _____

Land used for apiary: _____ Other crop area: _____

4. Beekeeping extension

4.1 Do you have contact with extension agent? 1. Yes 2. No

4.2. If yes, how many times in last one year? _____

4.3. Which extension media helped you to learn about poly hive?

1 Extension agent 2.NGO 3. Radio

4. Field day 5. Television 6. Printing materials

4.4. Do you have any societal membership: Yes/No?

4.5. If yes, please mention the name of the organization. _____

4.6. Did you ever get beekeeping training? 1.Yes 2. No

4.7. If yes, from where did you got the training

1. Research center 2. Agricultural and rural development 3. Beekeeping societies

3. Non Governmental Organization (NGO) 4. Any other (specify)_____

4.8. Have you ever used credit for beekeeping? 1.Yes 2. No

4.9. If yes, from where did you get the credit?

5. Beekeeping

5.1. Do you keep bees? 1.Yes 2. No

5.2. When did you start beekeeping? _____Years

5.3. Which bee Species do you rear:

1.*Apis mellifera* 2. *Apis cerena* 3. Others 4. Both

5.4. Size of Apiary (no. of box): _____

5.5. Where do you keep your honeybees?

1. Backyard 2. In forest 3. Under the roof

4. In the house 5. Any other (specify)_____

5.6. Are you aware of improved poly hive? 1.Yes 2. No

5.6.1. If yes, from whom you hear about it?

1. Extension agent 2.NGO 3. Radio 4. Field day 5. Neighbor

6. leaflet 7. Any other (specify)_____

5.6.2. If yes, are you using improved poly hive? 1.Yes 2. No

5.6.3. If yes, when did you start utilizing poly hive? _____

5.6.4. If no, why did you not use improved poly hive?

1. It is expensive 2. It is not available 3. It needs skill

4. Lack of awareness 5. Any other (specify)_____

5.7. Can you buy improved poly hive whenever you want to buy? 1.Yes 2. No

5.8. Do you get accessories (honey extractor etc) to hire in your vicinity? 1.Yes 2. No

6.1. Do you provide supplementary feed to your honeybee during dearth period?

1. Yes 2. No

6.2. If yes, what do you feed your honeybees?

1. Sugar 2. Barley flour 3. Pulse mesh 4. Honey 5. Any other_____

6.3. Are there any pests of honeybees in your apiary? 1.Yes 2. No

6.4. If yes, what are the major pests found in your apiary?

1 Ant 2 Wax moth 3 Spider 4 Lizard 5 Birds 6. any other (specify)

6.5. what types of insect/pest protection methods you use? _____

6.6. Do you practice colony multiplication? 1.Yes 2. No

6.7. How do you handle your honey?

1. By storing in the recommended equipment (plastic jar)

2. By storing in moisture free area

3. By extracting and purifying properly

4. By using all the methods mentioned above

5. Any other (specify)_____

7.1. Is there any absconding from your box hive? 1.Yes 2. No

7.2. If yes, what are the reasons for absconding?

1.Lack of feed 2. Honeybee enemies 3. Honeybee disease

4. Application of agrochemicals 5. Any other (specify)_____

7.3. How many honeybee colonies (hives with bees) do you own?

1. Wooden _____ nos 2. Poly_____ nos 3. Total_____ nos

7.4. How many times do you harvest honey per annum? _____

7.5. When is the peak honey production period? _____, _____, _____ month

7.6. What kind of hive products do you produce after using poly hive?

1. Pure Honey 2. Pure Beeswax 3. Queen rearing 4. Pollen

5. Propolis 6.royal jelly 7. All products mentioned above

8. **Cost Determination**

8.1. Depreciation cost

Description	Purchase price	Useful Life	residual value	Depreciation cost
Box(wooden/poly)				
Honey extractor				
Vail				
Hive tools				
Smoker				

8.2 Feed cost (traditional/poly/both)

Item	Unit	Price/unit	Total value
Sugar syrup			
Barley flour			
Pulse mash			
Others			

8.3. Labor cost (traditional/poly/both)

Season	No. of labor	Wage rate	Total value
Season 1 (Mustard)			
Season 2 (coriander,fennel flower)			
Season 3 (litchi)			
Season 4 (vegetables/sundarban/others)			
Derth period			

8.4. Transportation cost(traditional/poly/both)

Places of transportation	types of vehicles	Fare per trip	Total value

8.5. Cost of insecticide(traditional/poly/both)

Insect/Disease	Insecticide/drug/other remedy	Price/unit	Total cost

8.6. Other cost items

Descriptions	Traditional			Modern poly hive		
	Quantity	Price(Tk/unit)	Total value	Quantity	Price	Total value
Colony						
Honey Extraction						
Gloves						
Knife/Fork						

Brush						
Buckets						
Pure wax						
Packaging						
Marketing						
Rent						
Miscellaneous						
Total						

9. Returns

9.1. What is the amount of products you get from your apiary?

	Wooden hive				Modern Poly Hive			
	Qty/ box /year	Total pdn/ year	Price Tk/ unit	Total Income	Qty/ box /year	Total pdn/ year	Price Tk/ unit	Total Income
Honey(kg)								
Wax(kg)								
Pollen(kg)								
Propolis(gm)								
Colony								
Queen bee								
Total								

9.2 Is there ready market for your hive products? 1.Yes 2. No

9.3. If yes, where do you sell your honey?

1. At market found in nearby town 2. At farm gate 3. Cooperative

4. Super shops 5.Any other (specify)_____

9.4. What is the distance of your apiary from the nearest market: _____?

9.5. If yes, can the market absorb all the quantity you need to sell? 1. Yes 2. No

10.1. Indicate the relative advantages of using improved poly hives (√)

Advantages	Very low	Low	Medium	High	Very high
1.High yield					
2.Easy for inspection					
3.Easy for harvesting					
4.Produce quality honey					
5. More than 2/3 product					
6.Fewer disease infestation					
7.Easy for transportation					

10.2. Indicate the disadvantages of using improved poly hives (√)

Disadvantages	Very low	Low	Medium	High	Very high
High cost					
Needs high skill					
Needs accessories					
Unavailable					
Others: _____					

11. What are the major problems for undertaking improved beekeeping practices?

No	Problems	Rank
1.	Lack of beekeeping materials	
2.	Disease, pest and predators	
3.	Reduction of number of honeybee colonies	
4.	Shortage of bee forage	
5.	Indiscriminate application of agro chemicals	
6.	Lack of extension support	
7.	Absconding	
8.	Death of colony	
9.	Drought	
10.	Marketing problem	
11.	Beekeeping skill	
12.	Transportation problems	

12. Give some suggestions to overcome these problems:

a)
b)
c)

Thank you for kind co-operation.

Date: Signature of the Interviewer

Appendix 2

Table 5.1: Per hive cost of beekeeping

Cost items	Cost/hive/year (wooden box)		Cost/hive/year (Modern poly box)	
	Cost (Tk.)	Percent of total cost (%)	Cost (Tk.)	Percent of total cost (%)
Labor cost	615.53	8.87	499.80	6.63
Feed cost	1347.73	19.43	1764.00	23.41
Transportation cost	204.04	2.94	205.83	2.73
Marketing cost	98.00	1.41	99.30	1.32
Insecticide/Medicine cost	64.96	0.94	39.06	0.52
Tools and equipment cost	22.00	0.32	22.00	0.29
Honey extraction cost	6.50	0.09	7.21	0.10
A. Total variable cost	2358.76	34.00	2637.20	35.00
Interest on Operation capital	235.87	3.40	263.72	3.50
Hive cost	382.18	5.51	834.67	11.08
Colony cost	3880.00	55.93	3719.33	49.36
Rent cost	80.00	1.15	80.00	1.06
B. Total Fixed Costs	**4578.05**	66.00	**4897.72**	65.00
Total cost (A+B)	**6936.81**	100.00	**7534.92**	100.00

Table 5.3: Per hive cost and return of beekeeping

Sl. No.	Items	Traditional wooden Amount (Tk./hive)	Modern poly Amount (Tk./hive)	t-test
A.	Gross return (GR)	11019.26	27373.34	0.047266**
B.	Total variable costs (TVC)	2358.76	2637.20	
C.	Total costs (TVC+TFC)	6936.81	7534.92	
D.	Net return (GR-TC)	4082.45	19838.42	
E.	Gross margin (GR-TVC)	8660.50	24736.14	
F.	Benefit-cost ratio (BCR) = GR/TC	1.59	3.63	

Note: **Significant at 5% level

Table 6.1 Results of Regression analysis.

Explanatory variables	Coefficient	Standard error	p- value
Intercept	8.441	1.57	0.0000
Labor cost(X_1)	0.077**	0.04	0.0540
Feed cost(X_2)	0.008	0.06	0.9000
Transportation cost (X_3)	-0.107**	0.05	0.0375
Insecticide/medicine cost(X_4)	0.084*	0.04	0.0666
Equipment cost(X_5)	0.293**	0.14	0.0460
Marketng cst(X_6)	0.001	0.02	0.9505
Hive cost(X_7)	-0.128*	0.07	0.0601
Colony cost (X_8)	0.112	0.12	0.3681
Rent cost (X_9)	-0.115*	0.07	0.1064
Extraction cost (X_{10})	0.001	0.02	0.9450
Poly hive(D)	0.317***	0.07	0.0001
R^2	0.85		
Return to scale	.54		
F-value	24.80***		

Note:*** Significant at 1% level; **Significant at 5% level;*Significant at 10% level.

Table 6.2 Resource use efficiency of different inputs in beekeeping

Variable	Geometric mean(GM)	Co-efficient	MVP (Xi)	MVP/ MFC	Decision rule
Return (Tk)	11450.41				
Labor cost(X_1)	614.70	0.008	1.43	1.43	Under-utilized
Feed cost(X_2)	1344.17	-0.107	0.06	0.06	Over-utilized
Transportation cost (X_3)	301.78	0.084	-4.05	-4.05	Over-utilized
Insecticide cost(X_4)	63.94	0.293	15.04	15.04	Under-utilized
Equipment cost(X_5)	22.64	0.001	148.29	148.29	Under-utilized
Marketng cst(X_6)	701.19	-0.128	0.02	0.02	Over-utilized
Hive cost(X_7)	489.26	0.112	-3.01	-3.01	Over-utilized
Colony cost (X_8)	3342.88	-0.115	0.38	0.38	Over-utilized
Rent cost (X_9)	75.39	0.001	-17.51	-17.51	Over-utilized
Extraction cost (X_{10})	6.11	0.077	2.69	2.69	Under-utilized

Table 7.1 Constraints Faced Index (CFI) with rank order

No.	Problems	Frequency out of 180	Percent	Rank
1.	Higher cost of modern hives and accessories	172	91.7%	1st
2.	Lack of skilled labor	156	81.7%	2nd
3	Lack of capital	142	68.3%	3rd
4.	Marketing problem	135	58.3%	4th
5.	Disease, Pest and predator attack	121	48.3%	5th
6.	Shortage of bee forages	112	30.0%	6th
7.	Transportation problem	102	26.7%	7th
8.	Lack of training	92	21.7%	8th
9.	Death of colony	83	20.0 %	9th
10	Poisoning of agro-chemicals	66	18.3%	10th