BEEKEEPING IN LALMAI HILL AREAS OF CUMILLA: POTENTALS AND PROBLEMS

MIM NURJAHAN

DEPARTMENT OF ENTOMOLOGY

SHER-E-BANGLA AGRICULTURAL UNIVERSITY

SHER- E-BANGLA NAGAR, DHAKA -1207,

BANGLADESH

JUNE, 2020

BEEKEEPING IN LALMAI- HILL AREAS OF CUMILLA: POTENTALS AND PROBLEMS

BY

MIM NURJAHAN

REGISTRATION NO:13-05646

A Thesis
Submitted to the Faculty of Agriculture,
Sher- e-Bangla Agricultural University,
Dhaka, In Partial fulfillment of the
requirements
for the degree of

MASTER OF SCIENCE (M.S.)
IN
ENTOMOLOGY
SEMESTER: JANUARY- JUNE, 2020
Approved By:

Prof. Dr. Mohammed Sakhawat Hossain Professor Department of Entomology Sher-e-Bangla Agricultural University **Supervisor**	**Prof. Dr. Md. Mizanur Rahman** Professor Department of Entomology Sher-e-Bangla AgriculturalUniversity **Co-Supervisor**

Prof. Dr. S. M. Mizanur Rahman
Professor
Department of Entomology
Sher-e-Bangla Agricultural University
Chairman

DEPARTMENT OFENTOMOLOGY
Sher-e-Bangla AgriculturalUniversity
Sher-e-Bangla Nagar, Dhaka-1207

CERTIFICATE

This is to certify that thesis entitled, "**BEEKEEPING IN LALMAI- HILL AREAS OF CUMILLA: POTENTALS AND PROBLEMS**" submitted to the **Faculty of Agriculture**, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE IN ENTOMOLOGY**, embodies the result of a piece of bona fide research work carried out by **MIM NURJAHAN, Registration No. 13-05646** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

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

Dated:

Dhaka, Bangladesh

Dr. Mohammed Sakhawat Hossain
Professor
Department of Entomology
Sher-e-Bangla Agricultural University
Dhaka

Dedicated

To

Almighty to bless me ever with the best of all
the choices

&

My loving parents
and teachers
who has laid the foundation of my success.

ACKNOWLEDGEMENT

All praises and thanks are due to the supreme ruler of the universe, the almighty Allah for His grace bestowed upon the author for accomplishment of this research study.

The author expresses the deepest sense of respect and heartiest gratitude to her respectable supervisor ***Prof. Dr. Mohammed Sakhawat Hossain****, Department of Entomology, Sher-e- Bangla Agricultural University for her efficient and scholastic guidance, constructive criticism, valuable suggestions and immense help to carry out the research work toward successful completion and preparation of the thesis by necessary corrections and modification through reviewing the text.*

She wishes to express her sincere appreciation and heartfelt gratitude to her Co-supervisor ***Prof. Dr. Dr. Md. Mizanur Rahman****, Professor, Department of Entomology, Sher-e-Bangla Agricultural University, for her valuable suggestions, constant cooperation, inspiration and sincere advice to improve the quality of the thesis.*

Special thanks from endocardium to ***Prof. Dr. S. M. Mizanur Rahman****, Chairman, Department of Entomology and all respected teachers of the Department of Entomology, Sher-e-Bangla Agricultural University for their help and co-operation during the study and research.*

The study was funded by ***Bangladesh Academy for Rural Development (BARD)*** *through Sher-e- Bangla Agricultural University under Lalmai-Moynamoti project.*

Last but not the least, the author expresses her immense indebtedness and the deepest senses of gratitude to her beloved parents, university senior and junior brothers and a sister, my uncles named ***Md. Abubakar Siddique, Md. Mohiuddin Fazlullah, Md. Obaidul Khan, Md. Sahadat Hossain, Md. Ismail Hossain, Sunanda Sarkar, Nazim Hossain and Dr. Shafiqul Islam and*** *who sacrificed all their valuable time during the whole study period. The author is grateful to* ***Abdullah AL Mamun*** *the joint director of* ***Bangladesh Academy for Rural Development (BARD)*** *and all the respondents in the study area for their co-operation and help in accomplishing the objectives of this research work and all the staff of the department of Entomology for their cooperation. Finally, she wishes to extend her unfeigned thanks and recognition to* ***BARD*** *for their inspiration, blessing and encouragement that opened the gate of her higher study.*

The Author

Date: June, 2020

ABSTRACT

The purpose of the study was to explore the biology of honey bee diversity and Beekeeping potentials and problems of the Lalmai-Moynamoti Hill area of Cumilla. Data were collected from 200 beekeepers by performing a questionnaire survey, key informant interview, focused group discussion, and case study from November 2018 to May 2020. The findings revealed that there were 98% cultivated *Apis mellifera* and only 2% explored as wild honeybees. About 93.5% of the farmers stated that beekeeping is profitable whereas other 6.5 % said it is not profitable,76% provided artificial food support to their bee box in the offseason and 22% did not provide any artificial food and 100% of the beekeepers didn't face any bee disease but 22% beekeepers lost their bees due to poor management and scarcity of food supply during dearth period. The study revealed a piece of astonishing information about the potentials of beekeeping in the terms of yield increment of corps and homestead plants of the farmers due to bee-keeping as most of them acknowledged that they got two to three times more yield of homestead fruit plants and crops after starting beekeeping.

LIST OF ABBREVIATIONS AND ACRONYMS

ABBREVIATION	FULL MEANING
BARD	Bangladesh Academy for Rural Development
BBS	Bangladesh Bureau of Statistics
BCPC	British Crop Production Council
FAO	Food and Agriculture Organization
CV	Coefficient of variation
^{o}C	Degree Celsius
g	Gram
ml	Mili gram
Kg	Kilogram
HFRS	High Fructose Rice Syrup
SAU	Sher-e-Bangla Agricultural University

TABLE OF CONTENT

TABLE OF CONTENT(CONT'D)

TABLE OF CONTENT(CONT'D)

LIST OF TABLES

LIST OF PLATES

LIST OF FIGURES

CHAPTER-I

INTRODUCTION

Honeybees offer human being with a wide range of benefits from honey, other bee products, food crop pollination, and ecological services. Beekeeping is practiced around the world and can give a valuable source of income to people with relatively little investment in developing regions. Honey and wax are the best-known primary beekeeping products, but pollen, propolis, royal jelly, poison, queens, bees, and their larvae are also primary bee products that are marketable. Many of these things can be eaten as the bees grow them. Where bee products are a component of another product, there are extra uses. The addition of other products typically increases the perceived value or efficiency of these secondary products due to the quality and often almost magical popularity and characteristics of the bee products. This can increase the profitability of many beekeeping operations. The major bee products used for human consumption and use are: **Honey**-Honey bees suck the nectar from the flowers and store it in a honey crop called a stomach-like organ. Once the bee returns to the hive, the nectar is collected by another bee and spread over the wax honey comb to help water evaporate. Even the second bee adds an enzyme called invertase to help break down the molecules in sugar. When it gets dense it is sealed in a wax cap chamber. **Pollen**-Pollen grains are small, male reproductive units (gametophytes) produced in the higher flowering plant anthers. **Propolis**-Propolis, or bee glue, is a combination of beeswax and resins from bugs and twigs from the trees. It is used to line cavities of nests and brood combs, close cracks and reduce the size of the entrance to the hive. Propolis possesses both antibacterial and antifungal properties. **Royal jelly**-Royal jelly is a material rich in proteins which is fed to larvae. The queen larva gets more, which allows her to grow larger than the other bees. It is made from digested pollen and honey

and contains sugars, fats, amino acids, vitamins, minerals and protein. **Venom** -Venom used in the bee sting is made up of a complex mixture of protein.

Like other (Abrol, 2011) honeybee species *A. mellifera* has a high flight range for foraging (maximum 2-3 km away from its colony) (Abrol, 1997). So, the study was planned to focused on the potential yield of the homestead plants in term of income per box of honeybee colony after introduction of bee rearing in 3 upazilla of Lalmai-Moynamoti Hill area of Cumilla and the astonishing biology of the found honey bee species *Apis mellifera* and *and Apis cerana*. In Bangladesh beekeeping is done in traditional single boxes where broods of honey bee and honey remain in same box. In rural areas of Bangladesh bee boxes are fixed near the mustard, sesame, black cumin fields or fruit gardens like Litchi, Mangos, Ber etc. Honey bees are of great economic importance because they not only produce honey and bee wax but also act as primary pollinating agents of many agricultural and horticultural crops since pollination of crop increases yield, quality of seed and fruit improves and heterosis can be exploited. Beekeeping can play a vital role in sustainable agricultural development as it increases resource without changing environmental balance. As a cottage industry, it is a source of income of the rural people. Beekeeping is one of the important components of integrated rural development programs (Verma, 1990). There is a general agreement that introduction of the exotic *A. mellifera*, in Northern India, Bangladesh, Pakistan and Thailand now the basis of flourishing apiculture industries. Similarly, nectar substitute should be provided to the colonies if good quality natural nectar is rarely available. For successful management and rearing of honey bees in dearth period, it is imperative to adapt beekeeping measures for colony development. The annual cycle of colony development of European honey bee (*A. mellifera*) is described in detail in many independent studies in temperate climates from North America (Farrar, 1937; Avitabile,

1978). Limited brood rearing may be initiated during winter months and brood rearing leading to colony expansion is often initiated before nectar and pollen become available. Furthermore, queen rearing is essential for improving existing stock, but has not been practiced successfully with *A. mellifera* in spite of many attempts. This species is new in Bangladesh and the information in this country regarding this species are also scanty. *A. mellifera* carries heavier pollen, less aggressive and produce more honey than the native bee *A. cerana*. It is less prone to swarming for beekeepers who naturally hope to lose their colonies as rarely as possible. Like other honey bee species *A. mellifera* has a high flight range for foraging. A worker of this species may fly maximum 2-3 km away from its colony (Abrol, 2006).. In rural areas of Bangladesh bee boxes are fixed near the mustard, sesame, black cumin fields or fruit gardens like Litchi, Mangos, Ber etc. The study is done in 3 upazillas of Lalmai Hill areas under Cumilla district namely Adarsha sadar, Sadar dakkhin and Burichong upazilla the study is done in 7 unions of the aforementioned upazillas from November, 2018 to May 2020. This study was planned to explore the potentials of apiculture and where the beekeepers are facing problems and how they treat with it which can open a gate of socio economic as well as the environmental benefits of the area. This study is first in the study area which will play significant role to beekeeping in a new area and it revealed important information for further research in beekeeping.

Objectives:

- To study the biology of found honeybee of Lalmai hill area.
- To find out the potentials and problems of bee keeping of the study area.
- The effect of beekeeping in socio-economic development of the study area and to develop a floral chart of the study area.

CHAPTER II
REVIEW OF LITERATURE

2.1 Worldwide Beekeeping Potentials and Problems:

Beekeeping (apiculture) is the management of bee colonies for the manufacture of honey and other hive items as well as for crop pollination. Holding honeybees and stinging fewer bees (Melliponiculture) is an art and science (URT, 1998). At the beginning of the 21st century, the United States maintained an estimated 2.5 million colonies of honey bees, producing approximately 78 million kg of honey equivalent to 31 kg (68 lb) of honey per colony, and 9 to 18 kg (20 to 40 lb) of beeswax per ton of honey harvested in 171 million pounds per annum. Germany, the United Kingdom, and Russia are the leading honey producing countries in the world and leading European exporters (William, 2007). In Africa, beekeeping is also popular in countries such as Ethiopia, where beekeepers can produce between 10-600 colonies each producing between 12 and 18 kg of honey and 1 kg of beeswax, and this amount of beeswax is part of the criterion used to assess the social status of beekeepers in the group (Amssalu, 2002). However, the actually produced volume is 4,800 tons and 324 tons per year respectively, which is just around 3.5 percent of the projected production (URT, 1998). While an ordinary beekeeper typically owns at least 150 hives in potential beekeeping areas like Tabora and Rukwa and produces an average of 10 and 0.5 kg of honey and beeswax per year per hive that is equal to a total of 1,500 kgs. Honey and 75 Kg Beeswax respectively which is equivalent to Tshs, 2000/= 2.25 million (URT, 2001). Honey and beeswax production in Hanang 's district in 1995 was 92,426 Kgs and 3,111 Kgs respectively, compared to expected 150,000kgs of honey and 5,000kgs of beeswax. For this 68 percent equal to 62,849.70 kgs for honey and 2,115.50 kgs of beeswax were from Balang'dalalu Ward. The baseline survey conducted by the Njiro

Beekeeping Research (IBC) center in 1992 shows that Balang'dalalu Ward had a greater potential for high production of bee products at 15 and 1 kg per hive per annum. Besides, another survey carried out by Boniface (1992) showed that the production of bee products was still as small as 3 and 0.5 kgs of honey and beeswax respectively. A study was also conducted in 2009 by the Tanzania Wildlife Research Institute (TAWIRI), which reported that productivity was still below the recommended level and found to be 6.6 kg of honey and 0.5 kg of beeswax compared to the average 15 kg annual production and 1 kg of honey and beeswax respectively (Mumbi and Silas 2009). To improve efficiency, the Arusha Beekeepers Association undertook a feasibility study in partnership with the Danish Beekeepers Federation (DBF) and launched a project to help beekeepers' groups for modern beekeeping for1995-1997. Also, the National Income Generation Program (NIGP) under the Poverty Reduction Division in the office of the Vice President conducted a three-year beekeeping project aimed at increasing the production of bee products for household use and income sales and ultimately reducing poverty. The intervention also focused on empowering groups of beekeepers, particularly women and young people, with expectations of scaling up to other villagers (AGR, 1997 and UNDP, 1999). Despite those efforts, the status of manufacturing bee goods is uncertain. The degree to which beekeepers currently experience honey and beeswax in uncertain, current challenges facing beekeepers in Balang'dalalu Ward are not well known, so this study aims to generate knowledge on the status of development of bee products and critical challenges facing the beekeeping industry in Balang'dalalu Ward. A study was conducted in 2013 by Baltazar *et al* in-Beekeeping Industry in Balang'dalalu Ward, Hanang' District in Manyara, Tanzania. in this study 94 beekeepers and 5 key informants involved. Questionnaires and on-site visit obtained primary data from the subjects. The data was analyzed in (SPSS 11.5). Results show that 34.0 percent of respondents produce less than 100 kgs

of honey and 29.8 percent produce 1-10 kgs of beeswax per year. On the other hand, 62.8 percent and 30.9

percent of beekeepers have honey and beeswax productivity ranging from 11-20 kgs to 0.6-1 kgs respectively. 29.8 percent and 1.5 percent of respondents have productivity between 21-30 kgs and 0.6-2 kgs of honey and beeswax respectively. This is higher than the projected national production potential of 15 kg honey and 1 kg bee wax per hive per annum. The major challenges in the honey and beeswax business include unreliable markets, low knowledge/skills in production, lack of value-adding mechanisms, and lack of capital to improve quality and expand the market. Hence, this study recommends providing adequate capacity building and financial support to beekeepers to increase the development of bee products in the study area.

Beekeeping is a profitable enterprise (Syngkon, 2017). All living species of Apis have had their honey gathered by indigenous peoples for consumption. (Baranitharan *et al.*,2020). There is no negative impact of beekeeping on the environment. Therefore, beekeeping should be encouraged and good honey marketing facilities should be promoted by the government and non-government organizations; so that no individuals middle man or private firms can take advantage of the beekeepers. The union should link themselves to different agencies for accessing resources and supports like the block department, Khadi commission, forest department, banks, and other agencies (Syngkon, 2017). Honey represents an interesting source of natural macro and micro-nutrients, saturated solution of sugar (fructose and glucose), and also a wide range of minor constituents like phenolic compounds (Bogdanov *et al*.2008 and Bertoli *et al*.,2018). It contains antioxidant, bacteriostatic, anti-inflammatory, antimicrobial properties, including wound and sunburn healing effects (Battino *et al*., 2018).

A study aimed to investigate the practice of apitherapy by (Hellner *et al*., 2008)- using bee products such as honey, pollen, propolis, royal jelly, and bee venom to prevent or treat illness and promote healing - among German beekeepers and to evaluate their experiences with these therapies.

A questionnaire was published in three German beekeeping journals which included two instruments on the physical and mental health and working practice of beekeepers, and readers were asked to complete it. The instrument contained questions about the use of apitherapy. The data were analyzed using simple descriptive methods, bivariate correlation, cross-tabulation, and one-way ANOVA. It received a total of 1059 completed questionnaires. The most successful and favorable therapeutic effects with honey were recorded by the beekeepers followed by propolis, pollen, and royal jelly. The factors associated with productive experiences were: age tended the number of hives, health consciousness, positive one-product encounters, and treatment self-administration. Beekeepers have been asked which condition they would use propolis and pollen for. They reported that the most frequently used propolis to treat colds, wounds, and burns, sore throats, gum disorders, and also as a general prophylactic, whereas pollen was most commonly used as a general prophylactic and less commonly used to treat prostate diseases. No adverse events have been reported. The possible advantage of bee products is backed by a broad number of beekeepers' positive experiences, who use some of these products to treat a wide variety of conditions. Royal jelly can be also useful due to its biostimulant effect given by its special nutrients. Royal jelly is considered a micro-food with important effects in the body, helping to maintain the health and stamina of the beekeeper (Topal *et al.*, 2019).

A study was undertaken during the period 1 November 2017 to 17 April 2018 to assess the entrepreneurial potential, scope, and opportunities of beekeeping in districts

Panchagarh, Thakurgaon, and Dinajpur under the Dinajpur region by Fuad & Nurse. Therefore, a pre-tested interview schedule, a sample of 230 respondents from 23 Upazilas was selected using simple random sampling for data collection. The study focused mainly on basic concepts of beekeeping entrepreneurship, entrepreneurship skills, and the needs of developing beekeeping entrepreneurship in Bangladesh, along with major reasons for promoting the country's development of beekeeping entrepreneurship.

According to (Fuad & Nurhasan, 2019) Beekeeping, entrepreneurship needs some initiatives to building beekeeping entrepreneurship for expanding the honey market, conserve biodiversity, and finally getting judicial price.

Chanie *et al.* (2019) conducted a study in Amhara region Maksegnit town north Gondar Ethiopia to investigate honey bee products marketing practice; opportunities and constraints. The data was collected using a pre-tested semi-structured questionnaire from 40 households of four PAs. The data gathered revealed that honey bee's main products are honey (67.5 percent) and the rest (32.5 percent) are colony itself. The key reason that bees are kept in the area of research is for a source of income. The value obtained through the ranking index revealed that middlemen, tej houses (a mead or honey wine), and retailers are the three major honey buyers with index values of 0.30, 0.24, and 0.21, respectively. Honey prices are largely governed by the honey quality and color with 0.4 and 0.3 index values, respectively. The highest and lowest honey prices for white and black honey in the study region were found to be 133.50 ± 6.222 and 69.25 ± 12.483 Ethiopian birr (ETB), respectively. The three key constraints of honey marketing with the index value of 0.16 of 0.143 and 0.141, respectively, were found to be road scarcity, lack of materials for calculating the quantity of honey, and

variability in the color of the honey. The big challenge for bee colony marketing is the lack of an organized marketing place. The rise in the number of unemployed youths, the rise in honey and colony prices, and the high demand for honey and colony in the area are the three main opportunities in the study area for beekeeping. The government should provide essential inputs to mitigate the challenges of bee product and colony marketing and awareness should be generated for the farmers.

2.2 Bee-loving Plants:

According to (Saha, 2005) a large number of year-round bee plants species are found in plenty throughout the country. They are: *Brassica napus* L., *Litchi chinensis* Camb., *Zizyphus jujuba Lamk., Moringa oleifera Lam., Cocos nucifera,* Helianthus *annus L., Eugenia jambolana Lamk., Coriandrum sativum L., Citrus sp., Sesamum indicum Dc*. Of course, there must be more than sixty semimajor bee plants found in different areas of Bangladesh. Such as: *Raphanus sativus L., Brassica sp., Mimosa pudica L., Mimusops elengi L., Mikania scandens L., Musa balbisiana Colla., Mangifera indica L., Leucas aspera Spreng., Linum usitatissimum L., Glycosmis pentaphylla Correa., Foeniculum vulgare Gaertn., Eugenia Jambos L., Dolichos lablab L., Cucumis sativus L., Crotalaria juncea L., Cajanus cajan Mill., Borassus flabellifer L., Bombax malabaricum Dc., Azadirachta indica Juss., Averrhoa carambola L., Albizzia sp. Benth., Allium sp. L., Hibiscus esculentus L., Ipomoea alba L., Lagerstroemia frox-reginme Rez., Marmardica charantia L., Ocimum sanctum L., Psidium guava L., Pisum sativum L., Solanum melongena L., Solanum lycospersicum Mill., Trachyspermum amni Spreng., Celosia cristata, Cosmos bipinnatus, Alstonia scholaris, Anthocephalus cadamba, Barringtonia acutangula., Eucalyptus sp., Saraca indica., Mesua ferrea., Melia sempervirens., Cassia siamea, Callistemon lanceolatus, Ficus elastica, Cucurbita moschata, Mormordica dioica, Zea mays var. saccharata, Vigna*

sesquipedalis, Tamarindus indica, Aegle marmelos, Annona sp., Acacia sp., Areca catechu, Camellia sinensis, Elaeocarpus floribundus, Phyllanthus emblica, Manilkara achrus, Phoenix sylvatris, Spondias mangifera, Syzygium jambos, Syzygium Samarangense. Honey flow for six months: December to May.

Narottam *et al.* (2015) stated that in the case of a big apiary having more than fifty honey bee colonies required artificial feeding in a large amount. In other cases, a little amount of artificial feeding is to be supplied as and when necessary. To utilize properly the six months honey flow and the other three months less honey flow for getting a large amount of honey production and to minimize the artificial food supplement migratory beekeeping is a must for all the bee-keepers around the year in Bangladesh. A large population of insects visits several seed spices and other crops right from the initiation of flowering to the harvesting of crops for foraging in seed spices coriander and fennel normally received by 25 and 24 floral visitors, respectively in semiarid and arid conditions of Rajasthan and honeybees are to be considered as primary pollinators of all seed spice crops. *Apis florea* contributed the greatest percentage among honeybee species followed by *Apis mellifera*, *A. Pollination dorsa*. To beekeeping with *Apis mellifera* is profitable due to the huge bee flora available in the Indian continent all year round, providing the honeybees with nectar and pollen. Manmade honeybee pollination, adequate knowledge of bee flora, bee management, pollinator management, and managed pollination are common practices for enhancing yield and quality in seed spices (highly cross-pollinated) and promoting beekeeping to produce good quality, honey. Because of the great role of honey bees in pollination of cross-pollinated crops especially seed spices, there is a need to popularize bee-cultivation with *Apis mellifera* in the country.

2.3 Effect of Beekeeping on pollination:

Pollination is a biotic process that has both commercial and ecological value. In the context of agriculture, pollination provides a wide range of benefits to a broad diversity of commodities across the world. In some cases, the production of the commodity itself results directly from the act of pollination (for example, fruit production).

In other cases, although pollination does not result in the production of the commodity itself, the process contributes to crop propagation (for example, production of seeds used to grow a root crop such as carrots) or quality (for example, the size of tomatoes has been linked to repeated pollination). There are indirect benefits as well, through food-chain relationships. Alfalfa seed, a bee-pollinated crop with an annual value of $109 million (direct effect), is used to produce hay for livestock forage that is valued at $4.6 billion per year (indirect effect) (Morse and Calderone 2000). In Germany, beekeeping is used to encourage the use of royal jelly, honey, pollen, and propolis – as apitherapy - because of their healing properties (Topal *et al.*, 2019). Although these indirect effects tend to exaggerate the economic value of pollination, they have been used in several widely cited studies. The annual value of honey bee pollination to U.S. agriculture has been variously estimated at $150 million (Rucker et al. 2005), $1.6–5.7 billion (Southwick and Southwick 1992), $9 billion (Robinson et al. 1989a, b), $14.6 billion (Morse and Calderone 2000), and $18.9 billion (Levin 1983). The contributions of *Apis mellifera* are not unique because alfalfa leafcutting bees and bumblebees also pollinate crops. An estimated $2 billion to $3 billion value in annual crop pollination can be attributed to the activities of native bees and other insects (Losey and Vaughan 2006; Prescott-Allen and Prescott-Allen 1986; Southwick and Southwick 1992). Some vertebrates also operate as pollinators of ecologically and economically important plants. Tropical trees of the family Bombacaceae, which includes species used for timber, silk cotton, balsa wood, and other products, rely primarily on bats for

pollination (Bawa 1990; Watson and Dallwitz 1992). Many columnar cacti and agaves, which are important sources of alcoholic beverages (tequila, mescal) and other products (sisal fibers), also depend on bats and birds for pollination (Arizaga and Ezcurra 2002; Arizaga et al. 2002; Fleming et al. 2001a, b; Grant and Grant 1979; Rocha et al. 2005; Valiente-Banuet et al. 1996; but see also Slauson 2000, 2001). Globally, pollinators are fundamentally important for the production of roughly 30% of the human diet and most fibers (cotton and flax), edible oils, alcoholic beverages, nutraceuticals, and medicines created from plants (Buchmann and Nabhan 1996; McGregor 1976; Roubik 1995). Estimating the value of pollinators and pollination in natural ecosystems and predicting the consequences of their losses are considerably more challenging than 16 1 Introduction estimating their economic value in agriculture. Such estimates are complicated by both the number of species involved (globally, more than 400,000) and the relative paucity of information available for most of those species. For example, in their effort to calculate the economic value of ecological services provided by insects, Losey and Vaughan (2006) did not attempt to place a dollar value on the contributions of pollinators to the maintenance of natural plant communities, although it is reasonable to assume that a significant proportion of plants in uncultivated terrestrial communities rely upon pollinators. These plants, in turn, contribute to many ecosystem services of value to humans, such as water filtration, carbon sequestration, and flood and erosion control (Daily et al. 1997). An added complication is that insect pollinators may contribute ecosystem services other than pollination in their larval stages. The value of these services is equally difficult to calculate, particularly without a complete understanding of all aspects of pollinators' life histories. 1.7 Pollination Crisis The concept of a pollinator "crisis"—localized extinctions and possibly a global decline in the number and viability of pollinating species contributing to trophic collapse (Dobson et al. 2006)—began to gain recognition as a critical issue in the early 1990s. The

publication of The Forgotten Pollinators (Buchmann and Nabhan 1996), which extended the concern to non managed species and placed the issue within the greater context of biodiversity decline, galvanized the ecological community. Buchmann and Nabhan's book concluded with a call for a U.S. national policy on pollination and pollinators. The subsequent emphasis of pollination as a fundamental "ecosystem service" (Daily et al. 1997) led to an explosion of interest in the international policy arena (Allen et al. 1998; Costanza et al. 1997; Eardley et al. 2006). The science of pollination ecology and floral biology has, however, now been mainstreamed in biodiversity conservation. In the mid-1990s, scientists and agriculturists around the world were concerned that a worldwide decline of pollinator diversity was occurring, and this prompted policymakers at the Fifth Meeting of the Conference of Parties (COP) of the Convention on Biological Diversity (CBD) to establish an International Initiative for the Conservation and Sustainable use of pollinators (also referred to as the International Pollinators Initiative, or IPI) in 2000. Fifth Meeting of the Conference of Parties (COP) considered this to be a cross-cutting initiative within the program of work on agricultural biodiversity to promote coordinated action worldwide, and so requested the development of a Plan of Action for the IPI. Subsequently, the Executive Secretary of the CBD requested the Food and Agriculture Organization of the United Nations (FAO), in collaboration with key experts, to develop a Plan of Action for the IPI. This Plan of Action, which was built on recommendations from the São Paulo Declaration on Pollinators, was adopted 1.7 Pollination Crisis 17 at COP 6 (decision VI/5) in 2002.

2.4 Potentials and Problems of beekeeping in rural areas of Bangladesh:

According to (Arefin, 2019) Bangladesh, Small & Cottage Industries Corporation (BSCIC) began beekeeping in wooden hives under Khulna at Jatrapur in the 1960s.

Due to inadequate equipment, the outcome at that time was also unsatisfactory and ultimately the operations were halted in the same decade. In 1977 BSCIC beekeeping again began in a modern and scientific manner. Since 1977 BSCIC has been launching successful efforts to promote and expand beekeeping activities throughout the world. Now, on realizing the value and usefulness of honey, other bee products, and beekeeping, several other organizations have started and supported the country's modern beekeeping. In the past, however, no attempt was made to introduce modern, scientific, and systematic beekeeping in Bangladesh before BSCIC. Now for the period 1990-2005, BSCIC is implementing the beekeeping Plan.

Saha,2005 stated that beekeeping is more or less possible based on existing natural bee plants in most of the 86 thousand villages in Bangladesh. So, it is to be expected that if there were an average of at least 5 beekeeping in each village then more than 0.4 million people would be engaged in beekeeping activities. He also stated that 0.4 million people to be engaged in keeping bees and when each bee-keeper on average will produce 10 kg of honey then there would be a total honey production of about 4,000 metric tons which is worth TK. 800 (US$ 14 million) millions per year and on the other hand, additional crop, vegetable, and fruit production as per scientific records are to be worth Tk. 8000 (US$140 million) millions by way of pollination through bee-keeping activities in the country. So it is to be appreciated that there will be a good amount of honey production with the increased crop, vegetable, and fruit production through the scientific and proper implementation and expansion of beekeeping through research and demonstration in the country. Subsequently, a significant number of job formation will also ensue.

2.5 A comparison of bees and other pollinators:

Nearly 200 000 animal species play roles in pollinating the 250 000 species of wild

flowering plants on our planet (Ingram *et al.*,1996). Among them, about 1500 species of vertebrates such as birds (e.g. hummingbirds) and mammals (e.g. bats, lemurs) serve as pollinators (Ingram *et al.*,1996). However, the main pollinators are insects: they include bees, wasps, moths, butterflies, beetles, and so on. Bees are the most efficient and the only dependable pollinators because they visit flowers methodically to collect nectar and pollen and do not destroy the flower of the plant in the process. However, concerning agricultural ecosystems, it is important to stress that only 15 percent of the 100 or so crops that feed the world are serviced by domestic honey bees, while at least 80 percent are pollinated by wild bees and other wildlife (Ingram *et al.*,1996). Unfortunately, both wild bees and domestic honey bees are in decline. Thus, for example, the number of commercial US bee colonies plummeted from 5.9 million in the late 1940s to 4.3 million in 1985, and 2.7 million in 1995. The loss of one-quarter of all managed honey bee colonies since 1990 signals one of the most severe declines US agriculture has ever experienced in such a short period. There are fewer beehives in the US today than at any time in the past 50 years (Ingram *et al.*,1996). This demise has been brought about by the spread of diseases and parasitic mites, invasion of Africanized honey bees (Ingram *et al.*,1996), climatic fluctuations, industrialization, and exposure to pesticides and other chemicals. Two dozen geographic races of the Western honey bee, *Apis mellifera*, have been recognized, adapted to a range of environments from the cold continental climate of Eastern Europe, through the moist temperate climate of the Atlantic seaboard, the warmth of the Mediterranean, and the heat of the tropics and semi-deserts. Only four of these races need be considered for apiculture in Europe, namely *A. m. mellifera, A. m. ligustica, A. m. carnica, and A. m. caucasica* which present different morphological and behavioral characteristics (Milner, A. ,1996 and Pham-Delègue, M.H. ,1998).

Honey bees (*Apis mellifera L.*) are the main pollinating agents for numerous plants and

fruit trees and, hence, play a key role in agriculture and more generally in the maintenance of ecological biodiversity (Devillers & Pham-Delègue, 2003). The main activity of the queen is to lay eggs and to keep the workers uninterested in reproduction through pheromonal control (Devillers & Pham-Delègue, 2003). If the queen stops producing pheromone or laying eggs, one of her most recent eggs will be moved to a specially prepared queen cell to produce a new queen (Devillers & Pham-Delègue, 2003).

2.6 Biology of honey Bees:

The drones are the largest bees in the colony. The drone's head is much larger than that of either the queen's or the workers. Drones have no sting, pollen baskets, or wax glands since they are designed for mating only (Devillers & Pham-Delègue, 2003). Drones take their first flights at about 8 days old and are sexually mature at 12 days old (Devillers & Pham-Delègue, 2003). Only a few of them are tolerated in the hive in spring and fall, more in the summer, but none in the winter. The workers keep them out of the hive to starve to death in the autumn. Their normal lifespan is 8 weeks or less (Koning, R.E. ,1994).

The workers are the smallest and the most numerous individuals in the colony (Devillers & Pham-Delègue, 2003). They are sexually undeveloped females and under normal hive conditions, they do not lay eggs (Devillers & Pham-Delègue, 2003). Worker bees have specialized structures, such as brood food glands, scent glands, wax glands, and pollen baskets, which allow them to perform all the tasks of the hive (Devillers & Pham-Delègue, 2003).

From Encyclopedia Britannica an article was published in 2017 on beekeeping and it

stated that “Most kinds of honey are sold by floral type; that is, when they accumulated the honey, they are given the name of the predominant flowers which the bees visited. The beekeeper has no way of guiding the bees to a specific source of food but knows from experience the plants are the main sources of honey. Various flowers produce different honey colors and flavors. It may be heavy-bodied or thin-bodied, dark or white, mild-flavored, or aromatic. The beekeeper has mixed most honey to a standard grade that can be delivered and marketed year after year.”

Chanie *et al.* conducted a study in 2019 in Amhara region Maksegnit town north Gondar Ethiopia intending to investigate honey bee products marketing practice; opportunities and constraints. The data was collected using a pre-tested semi-structured questionnaire from 40 households of four PAs. The data gathered revealed that honey bee's main products are honey (67.5 percent) and the rest (32.5 percent) are colony itself. The key reason that bees are kept in the area of research is for a source of income. The value obtained through the ranking index revealed that middlemen, tej houses (a mead or honey wine), and retailers are the three major honey buyers with index values of 0.30, 0.24, and 0.21, respectively. Honey prices are largely governed by the honey quality and color with 0.4 and 0.3 index values, respectively. The highest and lowest honey prices for white and black honey in the study region were found to be 133.50 ± 6.222 and 69.25 ± 12.483 Ethiopian birrs (ETB), respectively. The three key constraints of honey marketing with the index value of 0.16 of 0.143 and 0.141, respectively, were found to be road scarcity, lack of materials for calculating the quantity of honey, and variability in the color of the honey. The big challenge for bee colony marketing is the lack of an organized marketing place. The rise in the number of unemployed youths, the rise in honey and colony prices, and the high demand for honey and colony in the area are the three main opportunities in the study area for beekeeping. The government should provide essential inputs to mitigate the challenges of bee product and colony

marketing and awareness should be generated for the farmers.

The honeybee is an incredibly sophisticated insect that has developed over millions of years. The earliest recorded Bee was found in Myanmar (Baranitharan *et al.*,2020). Bees today live worldwide and there are about 20,000 species. Baranitharan *et al.*,2020 stated them as eusocial animals; they fly insects within the Apis genus. They are well known colonial insects for their surplus production and storage of honey. Species of honey bees are found worldwide and can be seen in many different places, including Europe and the USA. Honey is the complex material that is formed when the bees eat nectar, process it, and store it in honeycombs. They use the wax to shape the walls of the comb and its tips. As with honey, beeswax is gathered by humans for various purposes such as candle making, waterproofing, producing soap and cosmetics, pharmaceuticals, painting, furniture polishing, and more. In myths and folk medicine, honey has been used both orally and topically to treat various ailments including gastric disturbances, ulcers, skin wounds, and burns by ancient Greeks and Egyptians, and in Ayurveda and traditional Chinese medicine. Proposed for treating wounds and burns, honey may have antimicrobial properties as first reported in 1892 and be useful as a safe, improvisational wound treatment (Baranitharan *et al.*,2020). Although it may be caused by high osmolarity even when diluted with water, it is more effective than plain sugar water with similar viscosity.

Beekeeping activity is increasingly dependent on flora but it is a different model of production than the general agricultural model. A study made in Romania found that current beekeeping difficulties were constituted by factors that did not affect beginners; while the desire to pursue a passion and to be autonomous was the basis for starting beekeeping (Popa *et al.*, 2011). The beekeepers are mostly challenged and exposed to environmental factors. Variable environmental conditions become a stress source for

the beekeeper. The fact that agricultural production is flora-orientated is proof of the difference when compared to other production models (Crane, 1990). In Europe, beekeepers are migrating 2 times per year, while in Turkey, beekeepers might do it 4-5 times per year (Topal *et al.*, 2019).

Beekeeping is carried out after a migration model and the beekeeper may be forced to spend 5-6 months apart from their family. In some cases, this place is close to home, but most of the time it is far away (Günbey, 2007). In warm climate countries such as Turkey, beekeepers can confront with scorpion's bites that can also be life-threatening. Education must be encouraged to increase the use of protective equipment to decrease the incidence of Lyme borreliosis and other problems caused by various insects (Topal *et al.*, 2019). Beekeepers should be also educated in first aid measures, especially when they confront poisonous insects and they are far away from hospitals (Strant and Topal, 2017).

A 2012 research by circulating questionnaires (based on numerous earlier investigations) to 732 beekeepers in Austria, Germany, Luxembourg, and Switzerland found that Lyme borreliosis had been diagnosed for 31.1 percent of respondents. Only a minority of responders (11.4%) used protection against tick bites. As a conclusion of the study, beekeepers should be considered as a high-risk group for Lyme borreliosis when compared to the general population and even forest workers (Münstedt and Thienel, 2012). Beekeepers should be constantly aware of the weather forecast, considering meteorological conditions can change fast (Peterson, 2017). The level of education is very important for a right and quick decision during the beekeeping activity. Generally, the level of education of beekeepers is low throughout in some countries (Soysal and Gürcan, 2005).

As the educational level and awareness increase, the view and decision making of risk factors are changing (Westaby and Lee, 2003). As the level of education increases, attention to health is also increasing. Income level and access to facilities are directly linked. If the economic income of the beekeeper is good, it reflects in the use of new tools and types of equipment and raises the quality of life in the vicinity (Günbey, 2007). Due to the unconscious and inadequate use of drugs used to fight diseases and harmful substances used in their hive, beekeepers have reduced their immunity and harmed their health (Topal *et al.*, 2019).

Another issue for beekeepers may be the proximity to smoke. Exposure to smoke is well known to be one of the main causes of chronic bronchitis and chronic obstructive pulmonary disease (COPD) in rural village non-smokers. The smoke is used by beekeepers to calm bees and to reduce stings. An investigation has been made by Polatlı *et al*. in 2002. Research factors among beekeepers about obstructive airway diseases. The findings of the pulmonary function tests were not substantially different in beekeepers relative to control subjects for each smoking and non-smoking category ($P > 0,05$) for all forms of respiratory symptoms such as coughing, sputum, and trouble breathing. Nonetheless, both beekeepers and control subjects demonstrated reduced lung capacity in cigarette smokers and increased respiratory symptoms relative to non-smokers ($P < 0.05$). It was suggested that less intense and short working periods in addition to outdoor exposure to biomass smoke in beekeepers might be a factor of lower risk for chronic bronchitis (Polatlı *et al*., 2002).

2.7 Dearth period and artificial nectar supplement:

Another challenge of beekeeping is the dearth period of nectar. Due to a shortage of bee flora, particularly during summer & monsoon seasons (April to September), the

task of beekeeping becomes difficult and troublesome (Kumar *et al.*,2013). In this study, colonies of honey bees were examined for their performance during periods of summer dearth. The values for all the selected colony parameters were observed: egg-laying, unsealed and sealed brood, honey and pollen stores, were maximum during April when there were sufficient food stores in the beehive. Such values began to drop significantly in the months that followed i.e., May and June when Nectar and Pollen were limited. Sealed brood, pollen shops, and honey shops were observed in the month of June when dearth Duration had hit its height. An increase was observed in various colony parameters from July Then it was found that the bee colony was in mid-September. In June month, when the dearth period was at its peak, no sealed brood, pollen stores, and honey stores were observed. An increase was observed in various colony parameters from July onwards, and it was noted that bee colonies started to recover from losses during pollen dearth periods by mid-September.

The colonies become prone to face drastic effects of sunstroke, heat waves, shortage of water, and attacks of enemies like black ants, wasps, and wild bees, etc. Heavy bee mortality may occur in some of the colonies resulting in absconding, quick dwindling, and even perishing of bee colonies (Kumar *et al.*,2013).

A study was conducted by Bodla *et al*. in 2009 in south-western Haryana. Honey bees of the area face unusually hot summer followed by floral dearth, causing significant hindrance in productive beekeeping. The temperature was recorded to a maximum of 48 ° C, thus making it difficult for honeybees to collect food. At the beginning of the dearth period, colonies with 10 frame bee strength were left with 8.1, 5.9, 4.2, and 3.0 frame bee strength after the dearth period if they were fed at intervals of 1, 2, 3, and 4

weeks respectively. During the time of dearth (June to August) at 1, 2, 3- and 4-weeks intervals Apis mellifera colonies with 500 g of sugar syrup (1:1 sugar water) proved beneficial.

In an attempt by Peng *et al*. (1984) to determine the feeding effect on the *Apis mellifera L*. Populations and economic value of feeding colonies for package-bee spring production, feeding experiments were conducted to assess the effect of feeding time and feeding treatments on *A.mellifera* Population and cost comparison with feeding benefit. Colonies produced significantly more bees from fall feeding than from spring feeding, or from fall to spring continuous feeding ($P < 0.01$; analysis of variance). Colonies fed with a protein supplement containing 21 percent Torula yeast and/or syrup protein also produced significantly more bees than unfed control colonies ($P < 0.05$; a multiple-range test of Duncan). During the fall, colonies fed with 1⁄3 of the protein supplement could yield high adult populations and a net gain in package bee production. Spring feeding of sugar syrup was less profitable than in the fall feeding of protein supplements.

Beekeeping success depends upon what is appropriate Floral source available. Honey bees require a few nutrients; Including carbohydrates, proteins, lipids, minerals, and vitamins for their growth and development proper to them. An experiment was conducted by Pande *et al*. in 2015 on the nectar supplement. The study revealed that fruit-containing syrup was evaluated as a dietary supplement to establish an effective and cheap alternative to the nectar. The 4 syrup viz., T1 Banana, T2 Papaya, T3 Grapes, and T4 Guava supported bees and compared to T5 Sugar to determine their effect on desirable colonial attributes. Results indicated that, in both years, banana and papaya's palatability was 100 percent. A steady increase was observed in the area of brood

(sqm), honey stores (sqm), pollen stores (sqm) and foraging activities (forager / minute), which were maximum in bananas (brood area 768.00, 774.00; honey stores 836.33, 856.00; pollen stores 329.00, 335.33 with 18.33, 20.33 respectively) followed by papaya (brood area 733.00, 741.67; honey store 822.33, 845.00; pollen store 313.00, 318.67 with 16.66, 18.67 respectively), sugar (brood area 680.00, 683.00; honey store 799.00, 804.67; pollen store 298.67, 304.33 with 16.66, 17.33 respectively), and grapes (brood area 612.00, 615.67; honey store 734.67, 746.67; pollen store 282.67, 290.00 with 11.66, 11.67 no. of forager/minute respectively). For guava, all necessary parameters were found to be the least. So, among the evaluated banana fruits was the best nectar supplement followed by papaya which reduces feeding costs by more than 35 percent and 50% respectively.

An experiment was conducted in Chitwan, Nepal, by Thapa and Pokhrel in 2005 to assess the response of supplement diets to crossbreed honeybee (Apis mellifera Lin.) flight activities. The experiment consisted of five replications and four feeding treatments: feeding low-dose sugar (166 g sugar syrup); feeding high-dose sugar (333 g sugar syrup); feeding modified diet (166 g sugar syrup + 30 g pollen replacement), and control (no dietary supplement except 250 g sugar honey candy to prevent starvation). Each hive (replication) was composed of 5-framed Apis mellifera colony, which earned four days breaks in each feeding for six days and a total of eleven feedingstuffs. Sugar syrup feeding stimulated bee foragers flights by outgoing 908-987 percent, and incoming 578-704 percent, respectively. Modified diet (low dose of sugar syrup combined with pollen substitute) was suitable for managing honeybee colonies off-season, which supported high flight activity rates, i.e. 3.3 times out-of-date and 2.8 times in-coming compared to control colonies. Other types of treatments were intermediate. The combined diet also showed higher flights than feeding low-dose

sugar syrup alone highlighting the need to feed adequate diet during off-season conditions under Chitwan for good flight and honeybee foraging activities.

Honey bees use pollen and various flowers' nectar. Honey bees need protein, carbohydrates, minerals, lipids, vitamins, and water to complete their production and growth by collecting pollen, nectar, and water, according to Funari *et al.* (2003). The workers consume large amounts of pollen for protein and amino acids during the first five or six days of adulthood that will ensure their full growth and development.

(De GrandiHoffman *et al*., 2008) suggested that differences in the nutritional quality of the diets (i.e. Amounts of protein and carbohydrate) and perhaps the digestibility and accessibility of their nutrients to worker bees influence the amount of brood that can be reared even when consumption rates are similar.

Honey bees use floral nectar as a source of protein for individual body functions and colony needs, for their energy needs and pollen. Rathee *et al*. ,2019 stated that domesticated European honey bees, *Apis mellifera L*. face long floral dearth from May-October in Haryana threatening their survival, and Colonies need to be provisioned with artificial carbohydrate nourishment and protein supplements to entail this dearth period. The study revealed that Beekeepers only routinely feed colonies with commercial cane sugar solution (50:50) at weekly intervals, resulting in enormous expenditure in addition to ill effects on colony health resulting in weakening or even deaths from the colony. In an experiment conducted for two years, 2017 and 2018 at the apiary of CCS Haryana Agricultural University located at the College of Agriculture, Kaul (district of Kaithal), carbohydrate source consumption patterns were assessed for growth and survival of honey bee colony. In food-grade plastic half frame

feeders, four carbohydrates, namely cane sugar (S), jaggery (J), liquid glucose (LG), and high fructose rice syrup (HFRS), were given at 500 ml/week. A similar collection of colonies was also provided at weekly intervals with the feeding of pollen supplements to determine their synergistic/antagonistic effects. The feeding experiments showed a hundred percent intake of feed (500 ml/week) by honey bees fed with sugar alone or sugar combined with pollen, followed closely by LG + pollen (499.26 ml/week) and LG alone (489.63 ml/week).

Jaggery was least eaten by the bees when fed alone (431,96 ml/week), or with pollen (456,85 ml/week). Additional pollen feeding has had an additive effect on the use of specific sources of carbohydrates. It increased the intake of the less favored source jaggery of carbohydrates from 431.96 ml to 456.85 ml/week. LG consumption reported a rise of 10 ml/week. Conversely, pollen feeding substantially decreased the intake of HFRS from 483.15 ml to 460.37 ml/week. Least bee mortality (0.05 dead bees/feeder / week) was recorded with sugar feeding supplemented by pollen feeding, closely followed by sugar alone (0.17 dead bees). In colonies fed with jaggery alone (27,02 dead bees), or supplemented with pollen feeding (27,67 dead bees), the maximum bee mortality was recorded. To require this dearth time, colonies must be supplied with artificial carbohydrate diets and protein supplements.

CHAPTER III

MATERIALS AND METHODS

The methodology used in leading any research is of paramount importance and deserves vigilant attention. It ensures that the researcher has to collect valid and dependable evidence in terms of proposition or research instrument and to investigate the information appropriately to come to valid outcomes. Methodology clarifies the validity of the research.

3.1 Experimental site:

The study was conducted in 3 upazilas of Cumilla district namely Adarsha Sadar, Sadar Dakshin and Burichong under lalmai moynamoti hill region. The data was collected from 200 households of beekeepers of this area.

The study focused on the potential yield of the homestead plants in term of income per box of honeybee colony after introduction of bee rearing in 3 upazilla of Lalmai-Moynamoti Hill area of Cumilla and the astonishing biology of the founded honey bee species *Apis mellifera* and *Apis florea and Apis cerana.* The study is done in 3 upazillas of Lalmai Hill areas under Cumilla district namely Adarsha sadar, Sadar dakkhin and Burichong upazilla. The study is done in 8 unions of the Upazills.

Table 3.2. The Number of Bee Keepers According to Upazilas

Name of Upazilas	Number of bee keepers
Adarsha Sadar	31
Burichong	78
Sadar Dhakkhin	91
Total	200

3.2 Experimental Duration: The experiment was conducted from November 2018 to May 2020.

Table 3. 3. Plan of Work

Site selection	1 months
Data collection	12 months
Data processing and analyzing	3 months
Report writing	3 months
total	19 months

3.3 Materials used for data collection:

Honey bees, bee boxes, nectar supplying plants around the homestead area of the beekeepers and the data collecting tools were Questionnaire survey, Key Informant Interview (KII), Focused Group Discussion (FGD), Case Study, Lab Experiments.

3.4 Data Collection:

Honey production and increased amount of yield of crop and homestead plants due to beekeeping in term of income per box was the main concern. Various sampling techniques was applied to identify the sample and determine the sample size.

Detailed sampling plan and technique for household survey, Focused Group Discussion FGDs, Key Informant Interview (KII), In-Depth Interview (II) along with the sample size is presented below.

Table 4. 3. Detailed Sampling Plan and Technique for Household Survey

Data Collection Tools and Technique	**Sampli-ng Method**	**Sampling Size**	**Sample source**
Questionnaire interview	Simple Random Sampling	200	Beekeepers
Focused Group Discussions (FGDS)	Purposively	10	Beekeepers, Farmers, Representative from Local Government, School Teachers, Honey Consumers Etc.
Key Informant Interview (KII)	Purposively	5	Sub Assistant Agriculture Officer (SAAO), Upazila Agriculture Officer (UAO), Agriculture Extension Officer (AEO), Agriculture Scientists etc.
In-Depth Interview (II)With Honey Bee Market Actors	Purposively	25	Whole seller and retailers of Honey in local markets, Honey consumers, Honey Processor etc.
Case Study	Purposively	2	Successful Beekeepers
Total		245	

Data from 200 beekeepers are for quantitative analysis and others for qualitative analysis. After completion of data collection, further study of bee biology was

accomplished in Sher-e-Bangla Agricultural University (SAU) Apiary and Central Laboratory.

The study used Both qualitative and quantitative approaches for collecting and analyzing the data. Required data was gathered through systematic way to meet the objectives of the study. Mostly primary data was collected for analyzing purpose. Different Method and tools i.e. Questionnaire Interview, Focused Group Discussion (FGD), Key Informant Interview (KII), In-Depth Interview (II), Case Study, Observation etc. was used to collect cross sectional primary data.For collecting primary data, structured and semi-structured interview schedule was used and data was collected through face to face interview. A structured questionnaire will be developed for the study which included questions on household demography and socioeconomic household interest in bee keeping, supporting plants available in the bee loving sites, finding the blooming period of bee loving plants, availability of resources like feed for bee-keeping, honey production(bee keeping) inputs and outputs, their prices, bee keeper's perception on the production and marketing and potentialities of bee keeping in Lalmai hill areas and problems of bee keeping. Questionnaire was discussed thoroughly any extensive field-testing was done for necessary modifications. For calculating the cost of bee keeping, all variables cost of wooden box, cost of colony (queen bee with other bees), cost of honey extractor, cost of Feed(sugar), cost of family labor, cost of hired labor, cost of transportation, cost of Bee veil, hand gloves, knife, cost of marketing etc. Total return from bee keeping was calculated by estimated value of main product as well as the byproducts.

On the basis of Approximate price of honey, other byproducts and increased yield of homestead fruit and vegetable plants and other crops the cost was analyzed according to the following tables.

Table 3.4. Yearly cost per unit from starting to harvesting of honey per bee box

SL no.	Items of Cost	Amount in TK.
1.	Bee box	3000/-
2.	Whole Colony of honeybee for a Box	1000/-
3.	Sugar	200/-
4.	Accessories needed for Beekeeping	800/-

Table 3.5. Yearly Income Per Unit

SL no.	Sources of income from beekeeping	Price /unit (TK.)
1.	Harvested honey	500/- / kg
2.	Produced bee wax in the box	500/- /kg
3.	Collected Pollen by the honey bee	2000/- /kg
4.	Produced Propolis	5000/- /kg
5.	Produced Royal Jelly	100000/- /kg
6.	Increased average yield of homestead plants and other Crops in term of income	3000/-

Only honey was extracted but the potential items like Royal jelly, Bee wax, Propolis, Pollen could not be extracted due to lack of knowledge and proper technology. But

another important point is the increasing yield of homestead plants and crops around the bee box added significant value to the environment and by helping pollination.

Cost estimation is an important issue for Beekeeping. So, the study calculated the net income from each bee box of the study area.

The Net Income (NI) and Benefit Cost Ratio (BCR) was calculated by using the following formula;

NI = TR – TC…… (i)

Where,

TR (Total Return) = Volume Produced x Market Price

TC (Total Cost) = Variable cost + Fixed Cost …… (ii)

BCR was calculated by using by the following formula;

BCR = Total return/Total cost……. (iv)

The case study was accomplished on the basis of collected information of two successful Bee keepers including the reason behind the success.

Secondary data was gathered from various available sources on relevant topics according to requirement as following list.

- Books
- Journal Articles
- Different Publications
- News papers
- Sher-e-Bangla Agricultural University library

3.5 Data Processing and analyzing:

The standard data processing procedure was used. After screening is over, editing was undertaken to ensure the interview schedules have been correctly filled-in, interviews conducted to right respondents, items of information recorded or responses to questions obtained are consistent with one another. Editing involved for categorization of the response to open-ended questions. The data from interview schedules was incorporated into Microsoft Excel. After processing the data, it was analyzed using Microsoft Excel, SPSS-23 program and Statistix 10 software.

Plate 3.1. Roof top placement of beebox.

Plate 3.2. Observing hive in farmer's house.

Plate 3.3 . Queen bee on farmer's hand.

Plate 3.4. Propolis and bees on cover.

Plate 3.4. Observing Beehive.

Plate 3.5. Queen gate used in a bee box.

. **Plate 3.7.** Harvested Honey.

Plate 3.8. Litchi's increased yield during beekeeping.

Plate 3.9. Different cells of the hives.

Plate 3.10. Colony of *Apis Cerana* Bee.

Plate 3.11. Different larval stages of honey bee.

CHAPTER IV
RESULTS AND DISCUSSION

Because of its suitable geographical location, diverse plant species, agricultural crops and the country's socioeconomic context, there is a great prospect of beekeeping in Bangladesh. This shows that in rural areas, beekeeping enterprises can be successfully promoted to create self-employment among rural youth and farmers as well.

4.1 Bee loving plants around the study area

During the study period a survey was conducted to identify the flowers of plant species which act as the natural pollen and nectar source for honey bee (*A. mellifera*). Among all of the plant present in study area some species were identified which provide nectar and pollen to honey bee. The list of honey and pollen supplying flowering plants recorded in the area are presented in Table 4.1.

Table 4.1. The list of nectar and pollen supplying flowering plants and their blooming period in a year

Local Name of Flowering plants	**Scientific Name**	**Flowering Time**	**Blossom in a Year**
Mustard	*Brassica nigra*	December 1st week to mid-January	1
Coriander	*Coriandrum* sativum	1st February to mid-February.	1
Black cumin	*Nigella sativa*	Mid-February to the end of February	1
Litchi	*Litchi chinensis*	March	1
Mango	*Mangifera indica*	February to March	2-3
Carambola	*Averrohoa carambola L.*	April-May, September-October, January-February	3
Jackfruit	*Artocurpus heterophyllus*	November to December	1
Jamrul		March to April	1
Lemon	*Citrus limon*	March to June	2
Rose Apple	*Syzygium jambo*	March to April	1

Table 4.1. Cont'd

Local Name of Flowering plants	**Scientific Name**	**Flowering Time**	**Blossom in a Year**
Papaya	*Carica papaya*	September to December	2
Lantana(Kutuskata)	*Lantana Camara*	March-September	Several times
Cosmos	*Cosmos atrosanguineus*	January	1
Earleaf acacia (Akashmoni)	*Acacia auriculiformis*	December-January	1
Rose	*Rosa species*	Year Round	Year Round
Marigold	*Tagetes erecta*	November to December	1
Bokul	*Mimusops elengi*	July to August	1
Lantana(Kutuskata)	*Lantana Camara*	March-September	Several times
Indian helitorpe (Hatisur)	*Heliotropium europeaum*	March-September	Several times
Spider wort	*Tradescantia virginiana*	April-May	1
Red silk Cotton	*Bombax ceiba*	February to March	1
Kadam	*Anthocephalus chinensis*	February-June	1
Bitter guard	*Momordica charantia*	June-July	1
Guava	*Psidium guajava*	June to September	2
Sunflower	*Helianthus annuus*	February to March	1
Sesame	*Sesamum indicum*	June	1
Bean	*Phaseolus vulgaris*	June to July	1
Sweet guard	*Cucurbita pepo*	November to December	1
Drumstick tree	*Moringa oleifera*	October to February	1
Safeda	*Manilkara zapota*	Year round	Year round
Elephant fruit(Chalta)	*Dillenia indica*	May-June	1
Jujube	*Ziziphus jujuba*	September to November	1
Malabar Ebony (Gab)	*Diospyros malabarica*	December-January	1

The foraging range of honeybees was recorded to reach up to 13·5 km (Frisch,1976). These flowering plants include homestead fruiting and forest like plants Litchi (*Litchi chinensis*), Mango (*Mangifera indica*) etc. to common weeds like hatishur(*Heliotropium europeaum*), spider wort(*Tradescantia virginiana*) etc. where

honey bees go for foraging.

4.2. Beekeepers and their Demographic Information

The study focused on the Beekeepers demographic information such as the number of the household members, age group, gender, educational group, working group and their yearly income from various sources to find out the social status of the targeted beekeepers. 200 beekeepers were selected for a well-organized pretested questionnaire. Bee boxes were set in 3 upazillas of cumilla.

Table:4.2. The number of Beekeepers of the study area according to Upazillas of Lalmai Hill araeas of Cumilla

Number of Beekeepers of the Study Area		
Name of Upazillas	Number of bee keepers	Percent
Adarsha Sadar	31	15.5
Burichong	78	39.0
Sadar Dhakkhin	91	45.5
Total	200	100.0

The study was done in 8 union of these three upazillas. They are 6 no. moynamoti, 3no. south durgapur, kalir bazar, Bijoypur ,Bakshimul,Rajapur,Baro para and Baghmara.

The study revealed the demographic status by the questionniare survey of the targeted people. So the group of beekeepers according to gender of themselves without and with family members are given in the following Bar charts.

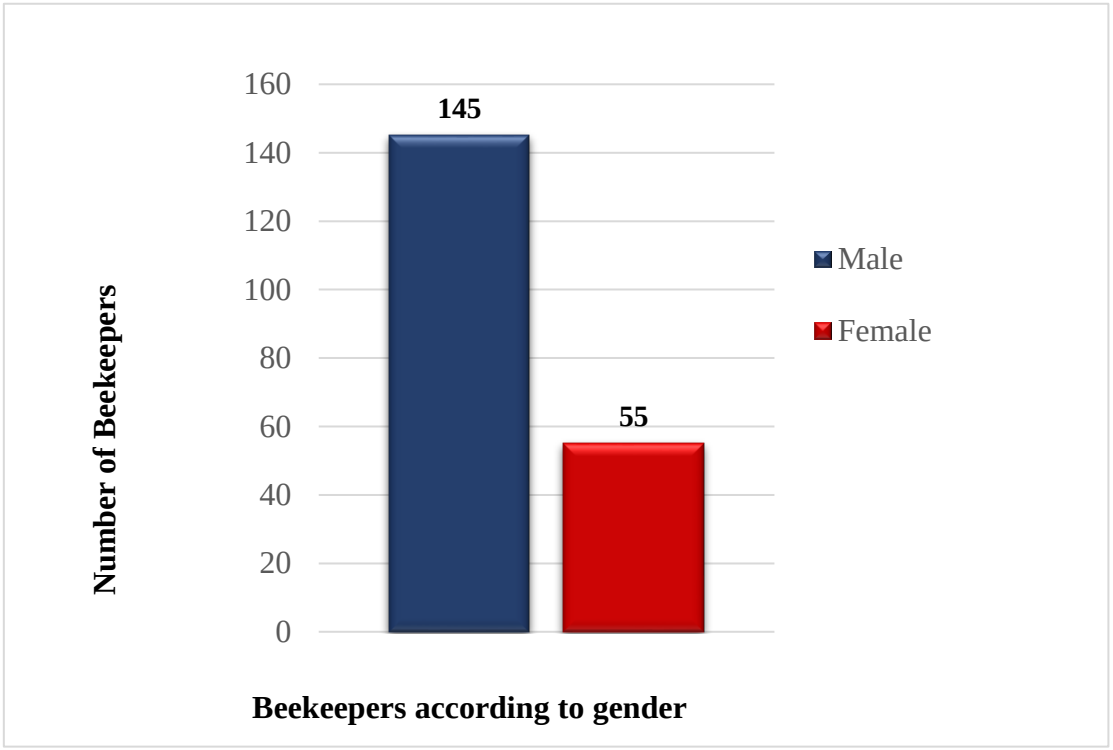


Figure1: Total number beekeepers according to gender.

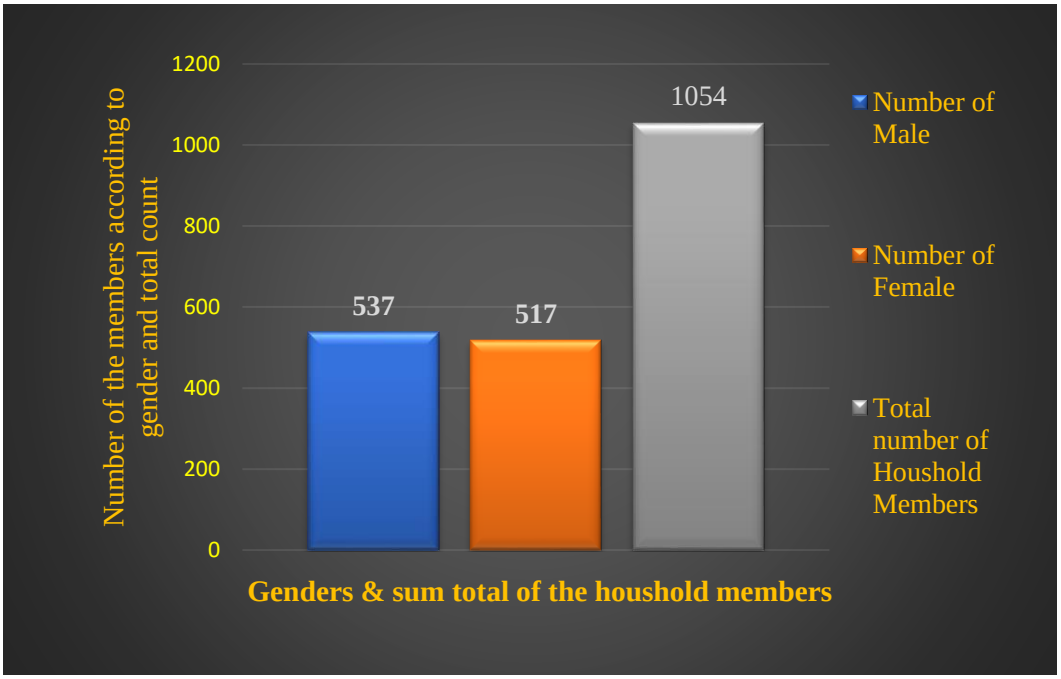


Figure 2. Number of the household members of the beekeeepers according to gender.

From the bar charts of Figure 1 and 2 it can be seen that of 20 beekeepers 145 are male and 55 of them are female but including the total household members they are 1054 where the number of male and female members are 537 and 517 respectively.

Age group information is another important part of demographic status. So a Bar chart is presented below about the age group of the targeted people.

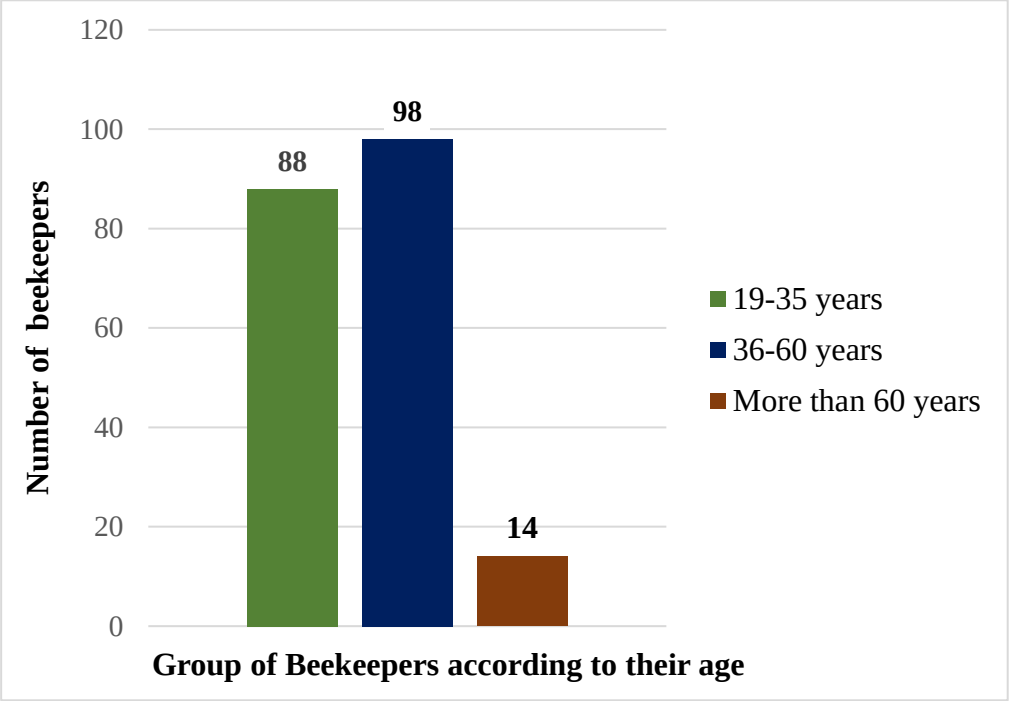


Figure 3. Beekeepers according to age.

From the above bar chart, we can see that most of the beekeepers are in the group of 36 to 60 years old. 88 of them are in 19-35 years age group where the lowest are in over 60 years.

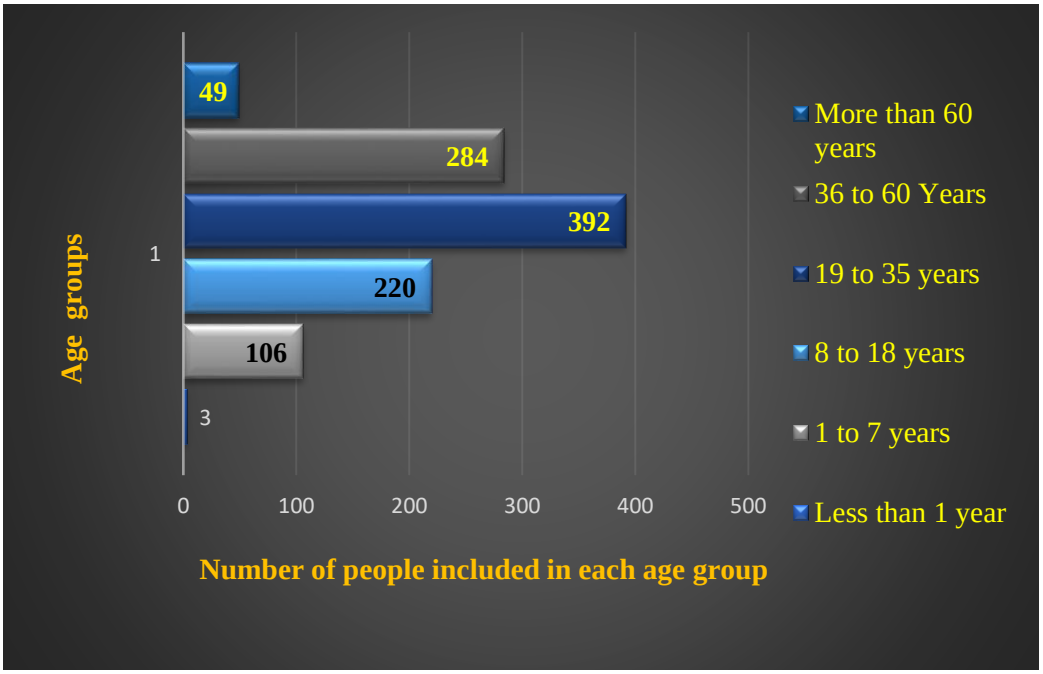


Figure 4. Age groups of the beekeepers including their family members.

Figure 4 is exhibiting the age group of the beekeepers including their family members. This chart of Age group shows us 6 groups of age ranges from 0 to 60 plus age people.the lowest number of people are in the group less than 1 year old but the maximum number of people is 392 and it is in the 19-35 years old age group. 2nd large group is 36-60 years old age group. 106 of them are between 1-7 years old and the number of people included in 8-18 years old age group is 220. The group of elderly people occupied the 60 pluse age group and they are 49 in number.

Educational group is given below in following Figure.

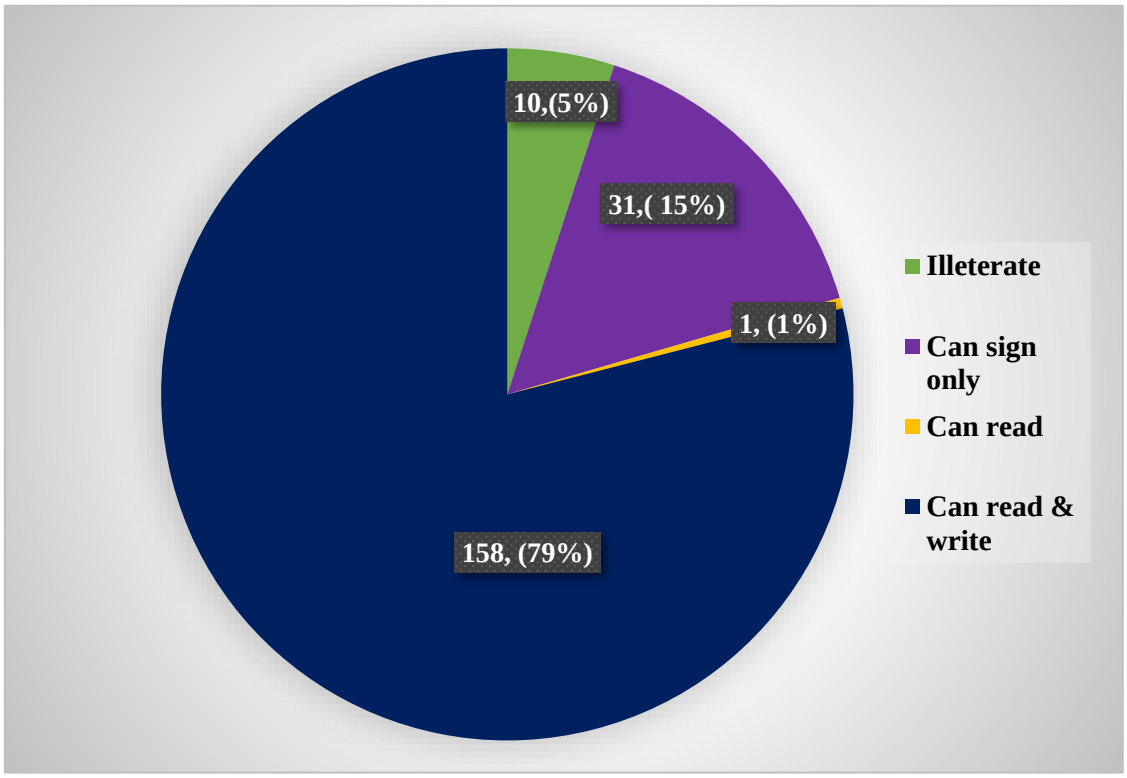


Figure 5. The educational group of the 200 beekeepers.

The pie chart is showing 4 educational groups.The largest group can read and write and they occupied 79% of the total people and 158 in number. Second large group occupied 15% who can sign only, 1% can read But 5 % of them are illeterate who are 31,1 and 10 in number among 200 beekeepers as well.

The working group is another important part of the targeted people. They play essential role in the families. Their main occupations are presented below in the following bar chart.

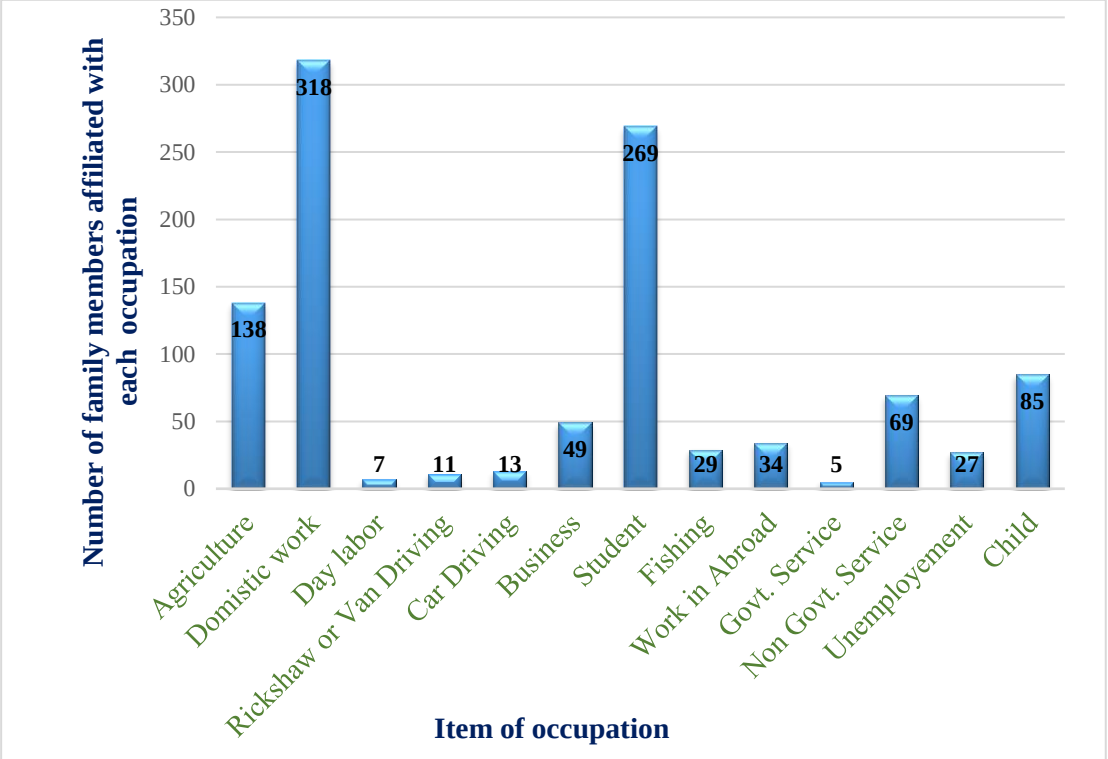


Figure 6. Occupational group of the targeted people.

The chart shows 13 working groups where 138 people are affiliated with Agricultural practice, 138 are in household works, 7are day labor, 11 of them are in rickshaw or van driving. 49 of them earns their livelyhood from business, 13 from car driving, 29 from fishing. 34 people work in abroad and add valueable remittance in our economy where as 5 of them are engaged in government service and 69 are in non government services as well. But the rest of the people are student, unemployed and children.

Yearly income from various sources is also presented in the following Bar chart.

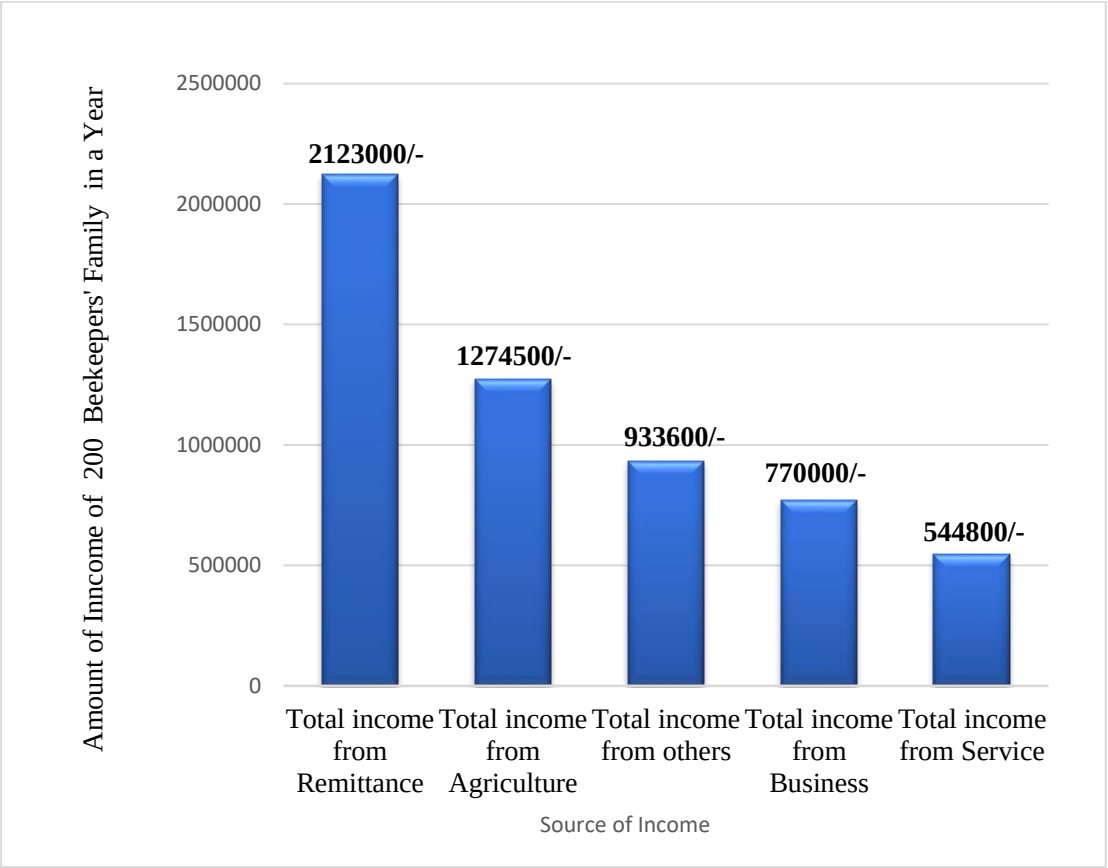


Figure 7. Amount of yearly income from various sources.

The chart of income shows us the yearly income from Agriculture, Remittance, Business, Services and others sources. The greatest source of income is remittance and it added approximately 2123000 /- while agriculture, business, service added 1274500/- , 77000/-, 544800/-, and 933600/- respectively who occupied 22%,14%, 10% and 16% of the whole income. The greatest source of yearly income occupied 38% of the whole income of the 200 beekeeper's family. 22% of yearly income comes from agriculture which is the 2nd important source of income.

After analyzing the Source of income and the amount of income of the families of all beekeepers we got the total income from Remittance, Agriculture,Business,Services, and Other sources is (2123000+ 1274500+544800+77000+933600)/- = 5645900/-.

4.3. Potentials of Beekeeping

The study revealed the Potentials of Beekeeping in terms of the price due to honey production and increased yield and in price value. Though in beehive other bee products like royal jelly, propolis, pollen, bee wax is produced but in study area technology of extracting these bee products is not transferred yet. But extraction of these bee product will open a new dimension for the economy of the area. A price list is given bellow in table 4.

Table 5.3. Yearly income per unit from starting to harvesting of honey per bee box

SL no.	Sources of income from beekeeping	Price /unit (TK.)
1	Harvested honey	500/- / kg
2	Produced bee wax in the box	500/- /kg
3	Collected Pollen by the honey bee	2000/- /kg
4	Produced Propolis	5000/- /kg
5	Produced Royal Jelly	100000/- /kg
6	Increased average yield of homestead plants and other Crops in term of income	This income is relative and depends on the variability of price of increased yield.

The study revealed that the income from bee box is not constant due to various reason like the amount of crop field and homestead area occupied by a specific beekeeper, the nectar supplying plants and the management practices of the beekeeper as well.

The budget for starting beekeeping was fixed. the expenditure per unit is given bellow:

Table 4.4. Yearly cost per unit from starting to harvesting of honey per bee box

SL no.	Items of Cost	Amount in TK.
1.	Bee box	3000/-
2.	Whole Colony of honeybee for a Box	1000/-
3.	Sugar syrup during dearth period	200/-
4.	Accessories needed for Beekeeping	800/-

So, from Table 4.4 the estimated expenditure per bee box was 5000/- and for 200 bee box it is 5000×200 = 1000000.0/-.

So, Total Cost (TC) = 10,00000.0/-.

Table 4.5. The yearly income of the bee keepers from each bee box

Income per Box in (Tk)	Number of beekeepers	Percent of Beekeepers	Total income of corresponding number of Beekeepers in (TK)
0/-	43	21.5	0/-
1300/-	1	.5	1300/-
3000/-	2	1.0	6000/-
6000/-	1	.5	6000/-
6900/-	1	.5	6900/-
8000/-	3	1.5	24000/-
8100/-	1	.5	8100/-
8123/-	1	.5	8123/-
8300/-	1	.5	8300/-
8320/-	1	.5	8320/-
8321/-	1	.5	8321/-
8500/-	115	57.5	977500/-
9000/-	2	1.0	18000/-
9030/-	1	.5	9030/-
9040/-	1	.5	9040/-
9810/-	2	1.0	19620/-
10000/-	22	11.0	220000/-
10100/-	1	.5	10100/-
Total	200	100.0	1348654/-

As in study area beekeepers not only extract honey from the box but also became benefited from the pollination of honey bee in the aspect of increased yield of various plants. So, these two aspects are included in our study. The yearly income of the bee keepers from each bee box are presented in table 4.3.

The table shows the number and percentage of beekeepers and their earnings. The calculation is done in such a way that each of the income amount was multiplied by the number of beekeepers. So, we got the sum total of the income is 1348654/-. Each of 115(57.5%) beekeepers earned approximately 8500/- and the total of their income is 977500/- where 43(21.5%) beekeepers could not earn anything due to poor management practice which was noticed from the field visits.

On the basis of the information from table 4.5 a linear chart is drawn to compare the number of beekeepers and incomes of the beekeepers from their bee boxes.

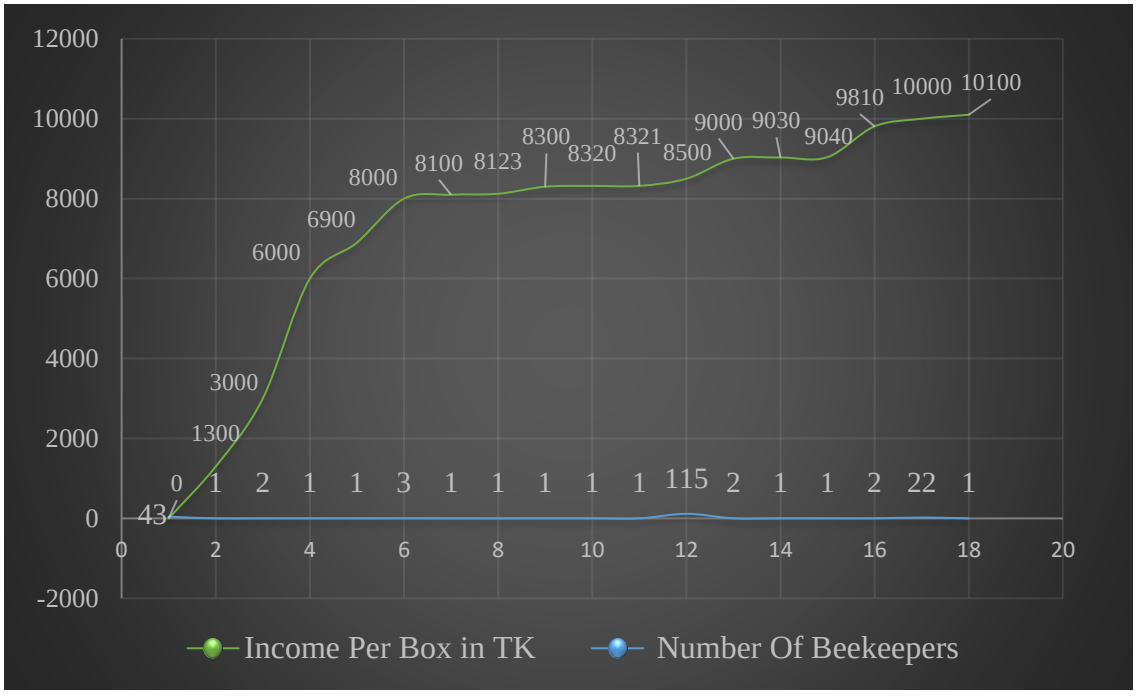


Figure 8. total Income from corresponding boxes and the number of beekeepers who earned.

The linear graph shows the highest earner (155) earned 8500/- but the maximum

income is 10100/- which was earned by only 1 beekeeper. The second large income is 10000 which was achieved by 22 beekeepers whereas 4 of them earned 9000/- to 9800/. So, the lowest income is 0 was earned by 43 beekeepers due to their poor management which is seen during inspecting their bee boxes.TR (Total Return) = 1348654.00/-, TC (Total Cost) =1000000.00/- and Net Income (NI) = 348654.00/-

Benefit Cost Ratio (BCR) = 1.348654 which is equivalent to 1.35.

The Net Income (NI) and Benefit Cost Ratio (BCR) is calculated by using the following formulae; NI = TR – TC and

BCR = Total return/Total cost

4.4. The effect of Beekeeping in Socio-economic Development of the study Area

From the summation of the amount of income from different sources shown in Figure 7. We saw that the yearly income of beekeepers from various sources rather than beekeeping was approximately 5645900/-. But the net income of Beekeeping added more value to their socio-economic status. A bar chart is given below to show the added value of beekeeping.

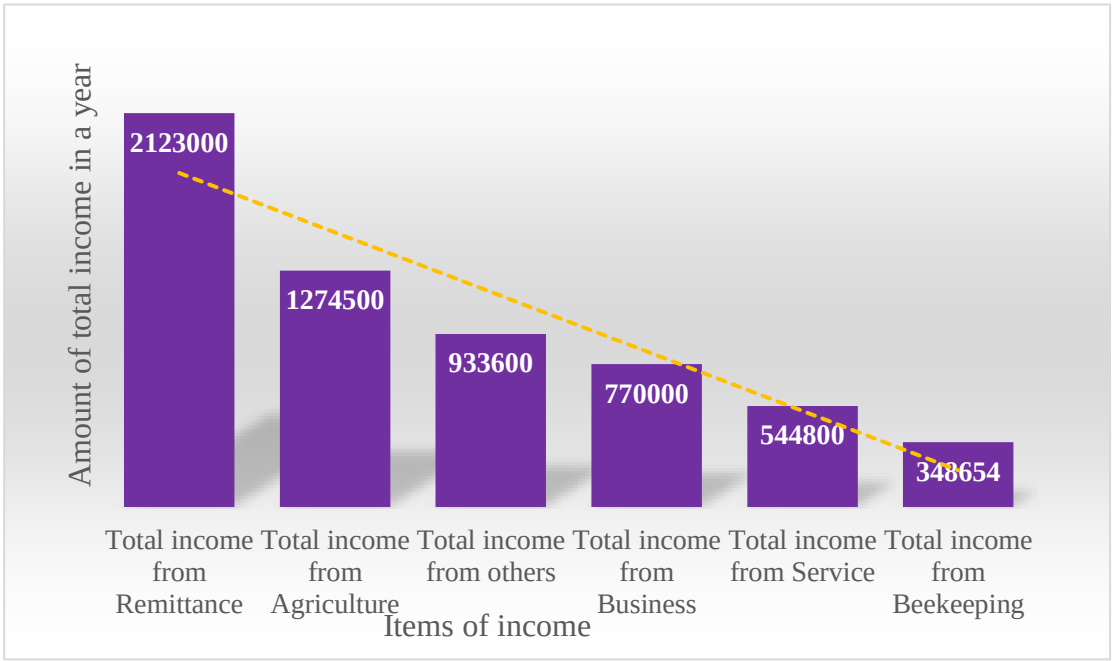


Figure 9. Yearly total income from various sources after beekeeping.

Beekeeping added 348654/- in total yearly income of the beekeepers so the sum total of income with beekeeping is (348654+ 5645900)/- = 5994554/-.

Though remittance is the greatest sources of income beekeeping is a valuable source of income which not only add economic value but also plays important role to the environment.

A pie chart showing percentage of contribution from various sources including beekeeping is given below.

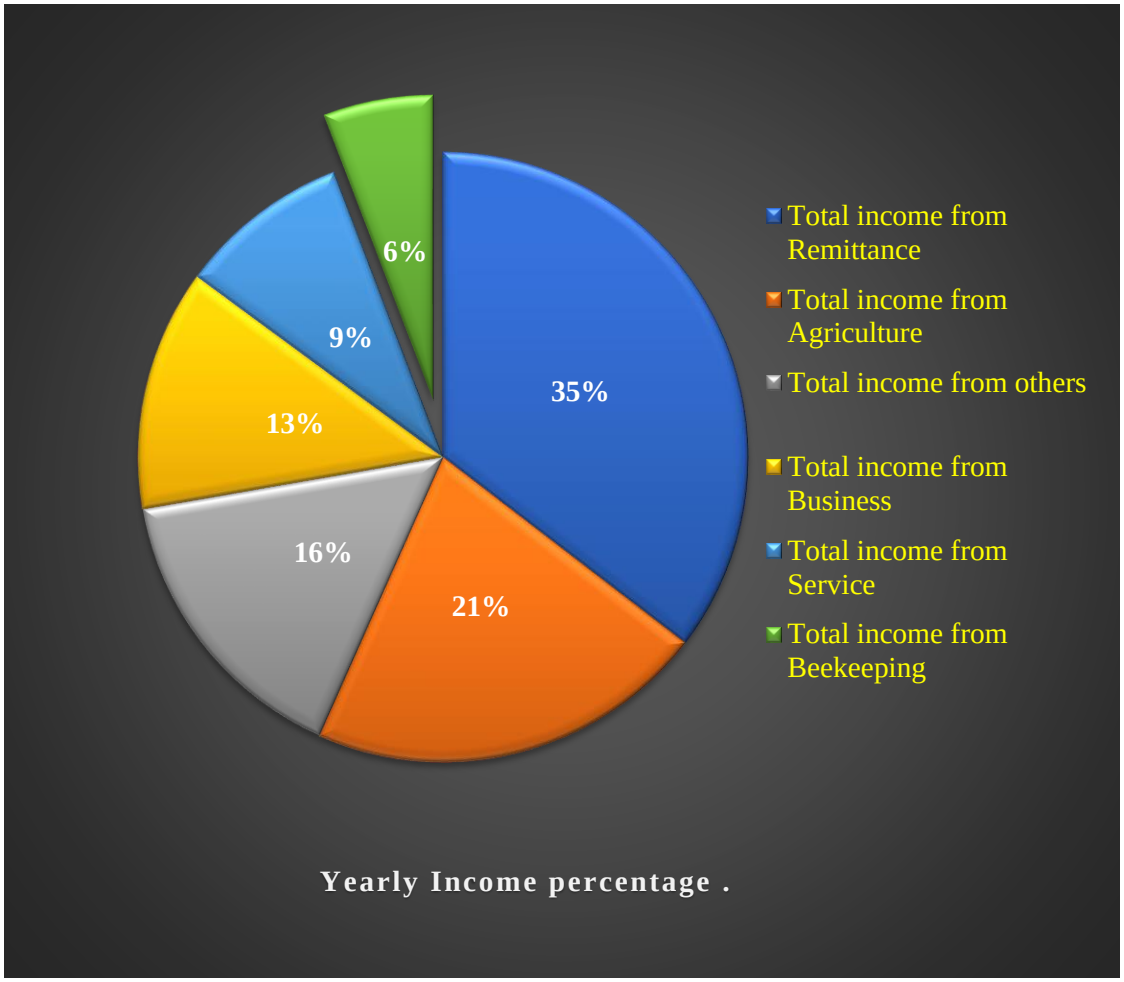


Figure 10. Comparison of income sources after beekeeping.

The pie chart shows that beekeeping is 6% of the total income of the beekeepers whereas the biggest income (35%) comes from remittance. Agriculture, Business,

Services and other sources are 21%,13%,9% and 16% respectively. This additional 6% will help the socio-economic development of the beekeepers. though it is in initial stage the profit is great with its environmental value.

4.5. The effect of Artificial nectar Support during Dearth period

Extracting honey and increased yield depends on the attitude of the beekeepers towards beekeeping. In study area beekeeping is in introductory stage and the management practices of beekeepers is crucial during dearth period. It is vital to provide artificial food support to the bee box. The graphical view of the management practice performed by the beekeepers during dearth period of nectar of the study area is presented below:

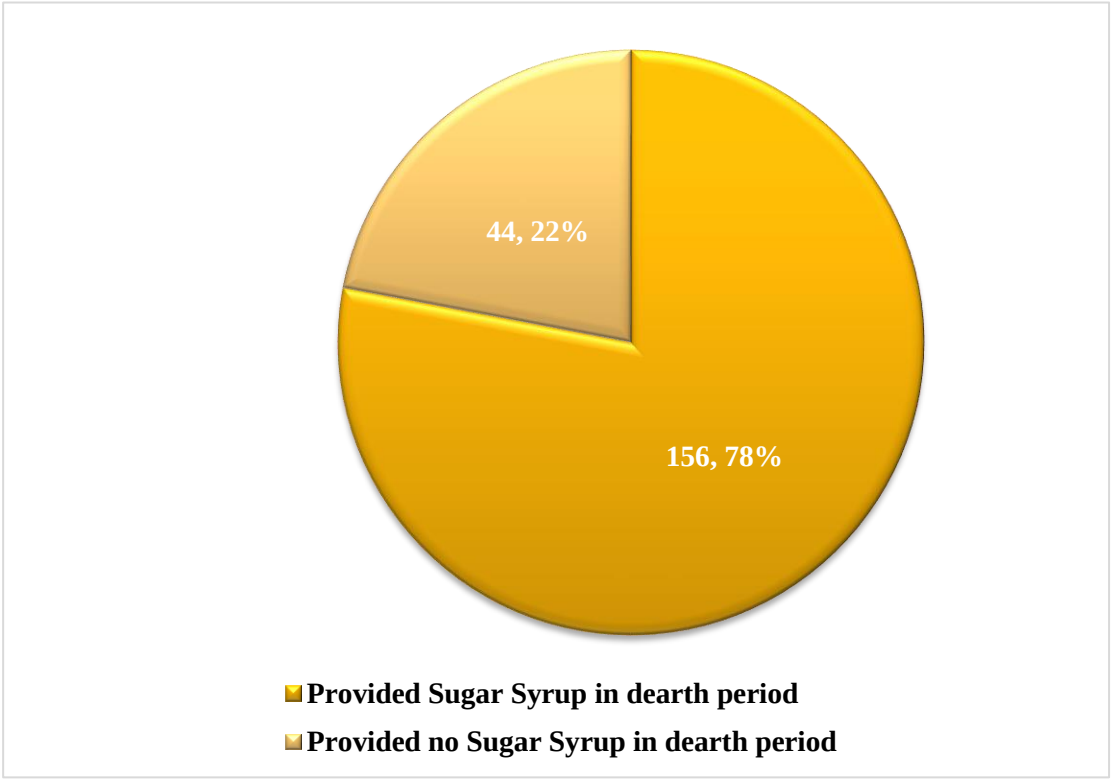


Figure 11. Number of beekeepers according to their Management practices during offseason.

Among 200 beekeepers 156 provided artificial food support and only 44 provided no food support during dearth period. So, most of the beekeepers provided sugar syrup

to support their bee colony in adverse condition and nurture their bee boxes by proper monitoring. But there are also other beekeepers who were influenced by other beekeepers and started beekeeping but did not provide artificial food support or properly monitor the bee boxes.

In study area sugar syrup was used to provide food support to honeybees during the period when there is shortage of nectar as flowering season of plants contribute to the bees. But honeybees provide important service by pollination of various homestead plants and crop around 3 km (Frisch, 1976). of beehive. After introduction of beekeeping most of the farmers got increased yield of fruiting trees and other crops like mustard, coriander, black cumin etc. They calculated the profit and the recorded result shows that maximum income came from beekeeping is10,100/- from honey and increased yield. And this beneficiary acknowledged that his homestead litchi plant bore 3 time more fruits than the previous years.57.5% beekeepers made an income of more than 8000/-, 11% of them achieved around 10000/- but 21.5% could not achieve anything from beekeeping according to their opinion. But the truth behind it is they did not provide artificial food support or proper monitoring during off season which is revealed during checking their bee boxes. Some boxes were empty as bees flew away due to scarcity of food or death. The most interesting information is honey bees don't discriminate to pollinate the flowers of the nurturer and careless beekeepers in the foraging area covered by their flying ranges. So, it can be said from the field visits that the beekeepers who did not follow the management practices they did not harvest honey but they were also benefitted by other beekeepers' bees of the same area. From table 4.5. the highest income 10100/- is achieved by only .5% of the beekeepers and 1 beekeeper who did not provide any support during dearth period he earned 1300/-. But after field visit it was cleared that the box was nurtured by other successful beekeeper.

So, there is an effect of artificial food support during adverse condition.

A bar chart showing the relation between the management practice and income from the bee box is given below.

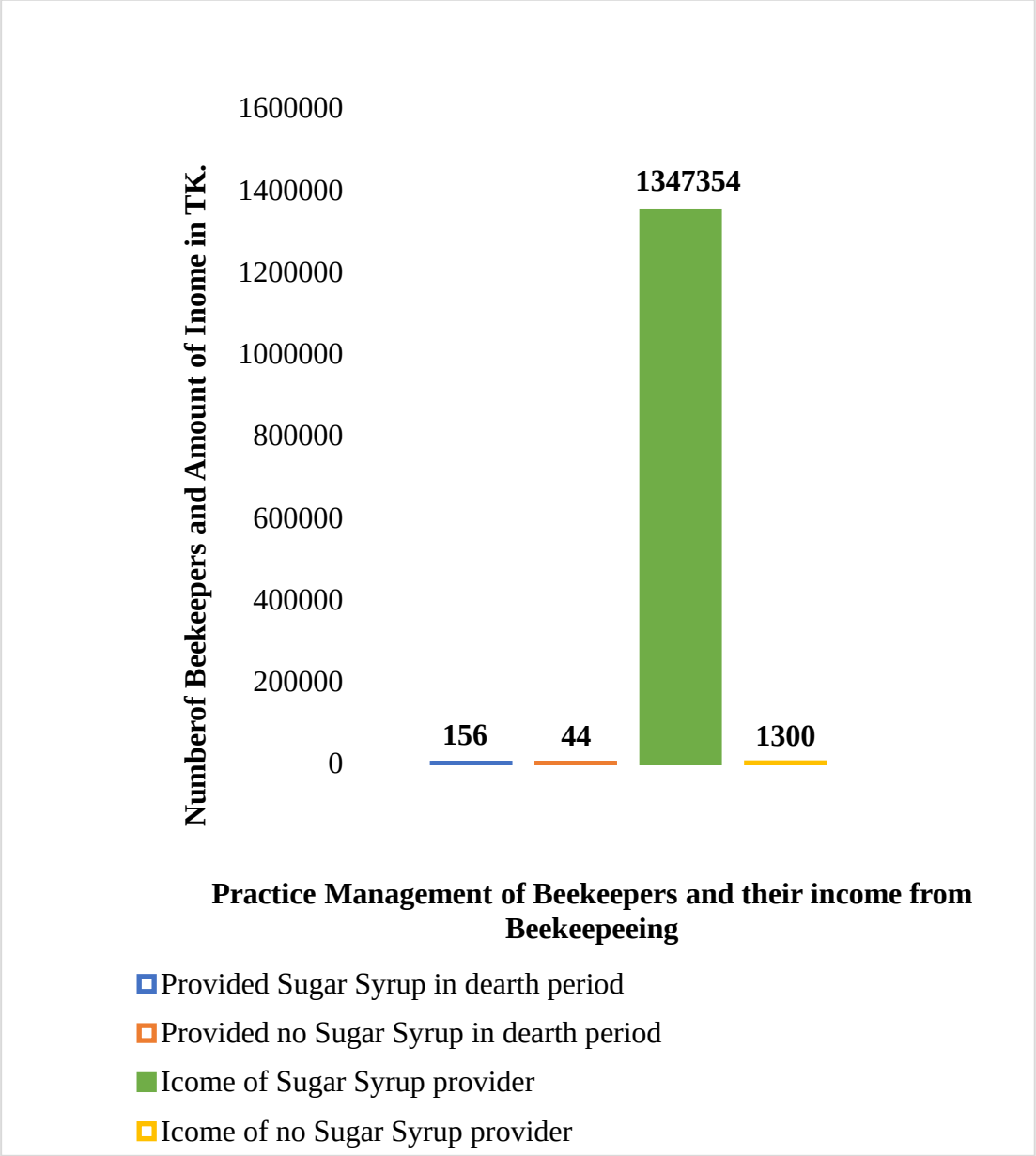


Figure 12. Relation between the management practice and the income.

The corresponding bar chart shows the contribution of the artificial nectar support during the dearth period. Beekeepers who provided sugar syrup; their income is far more than those who didn't provide any artificial food support. Only one of them was

able to produce honey without suppling any artificial nectar and his income is only 1300 is an exception was thought previously but in field visit the truth revealed that the box was nurtured by the nearest sincere beekeeper other than the owner of the corresponding bee box.

On the basis of this described condition a working table is made where our sample size is 200 as the number of beekeepers are 200. The treatment T_1= Providing sugar Syrup and T_2 = Providing no sugar Syrup during offseason of flower. 156 Beekeepers practiced the T_1 treatment and the rest 44 practiced Treatment T_2. As the targeted population used the same size of bee boxes and colony so the Completely Randomized design (CRD) of experiment chosen.

Table 4.6. Working table

Treatments	Replication	Total income due to treatment	Mean income
Provided Sugar Syrup (T_1)	156	1347354.00	8636.88
Don't Provided (T_2)	44	1300	29.55
Total	200	1348654.00	GM = 6743.27

4.5.1 Hypothesis Testing

So, the **Null Hypothesis (H_0)** = There is no significant difference between the effect of providing sugar syrup(T_1) and not providing Sugar syrup(T_2) during adverse condition of nectar collection.

Alternate Hypothesis (H_A) = There is significant difference between the effect of providing sugar syrup (T_1) and not providing Sugar syrup (T_2) during adverse condition of nectar collection.

Table 4.7. Analysis of Variance

ANOVA					
Source of variation	**Sum of Squares**	**df**	**Mean Square**	**F**	**P**
Treatment	2542641384.588	1	2542641384.588	4003.210	.000
Error	125759826.832	198	635150.641		
Total	2668401211.420	199			

From the ANOVA table we can see that the **F** value is 4003.210. The **P** value is .000 which is < 0.05 at the 5% level of significance at 198 error **df** So, $T_1 \neq T_2$. So, **Null Hypothesis (H_0)** is rejected and **Alternate Hypothesis (H_A)** is accepted.

4.5.2 Calculation of Coefficient of Variance (CV):

CV will be calculated by following formula

CV = (√ Mean Square due to Error ÷ Grand Mean) ×100

From table 5 we got Mean Square due Table to Error = 635150.641

So, CV = (√635150.641÷ 6743.27) ×100

=11.82%

4.5.3. Comments on CV: CV indicates the reliability of the experiment. Higher the CV value lower the Reliability. Here, 11.82% CV value means, the experiment is 88.18% reliable. Therefore, the present experiment is mostly reliable and further trial is not needed.

4.5.4. Mean Comparison:

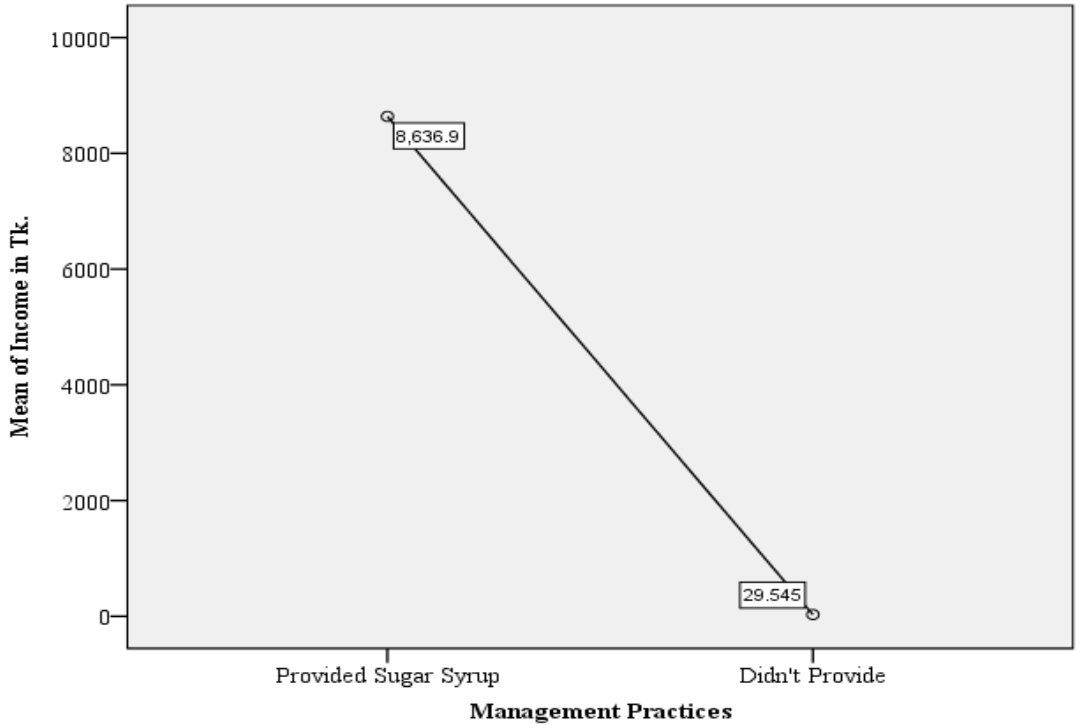


Figure 13. Mena income from beekeeping due to two different management practice.

4.2.4 Interpretation of the Result:

Significant difference was observed between the treatment T_1 = Providing sugar Syrup and then T_2 = Providing no sugar Syrup on the honey production and increased yield of homestead fruiting plants and other cultivated crops in term price in Tk. as well. From Figure 13 it is evident that the mean income due to T_1 is 8636.9/- is far greater than the mean income 29.545/- from treatment T_2. So, they are statistically different from each other. So, T_1 is better Than T_2.

4.6. Problems of Bee keeping

In study area the main problem is scarcity of nectar Source during dearth period from April to September. There are also some other difficulties came out from FGDs, KII,

II and case studies. Analyzing their opinion, a Bar chart is developed about the problems of Beekeeping.

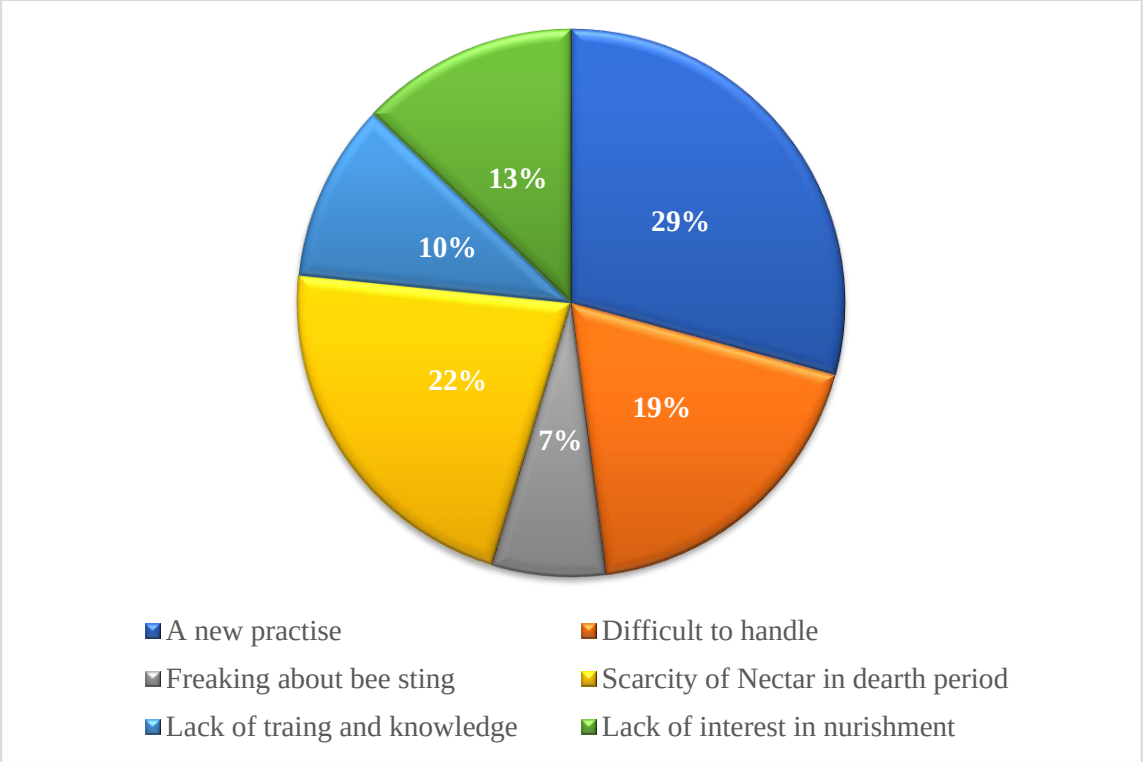


Figure 14. Problems of beekeeping claimed by the targeted group of people.

The bar chart shows 6 problems of beekeeping 100(29%) of them claimed it as a new practice, 50 (14%) of them claimed that some people are not interested to nourish and monitor the be boxes regularly. 30 of them (9%) said there is lack of knowledge and training about beekeeping that is a barrier of beekeeping whereas 19% of them claimed it difficult to handle as they scare bee sting. But 77 (22%) of them reported that there is scarcity of nectar as flower sources is not up to the mark all year round.

4.7 Respondent's Interest and opinion about Beekeeping

Though Beekeeping is a new practice in the study area the respondents have a great interest in beekeeping. Most of the beekeepers want to continue beekeeping as it helped the increment of the yield of the homestead fruit, vegetable and various crops around

the bee box.

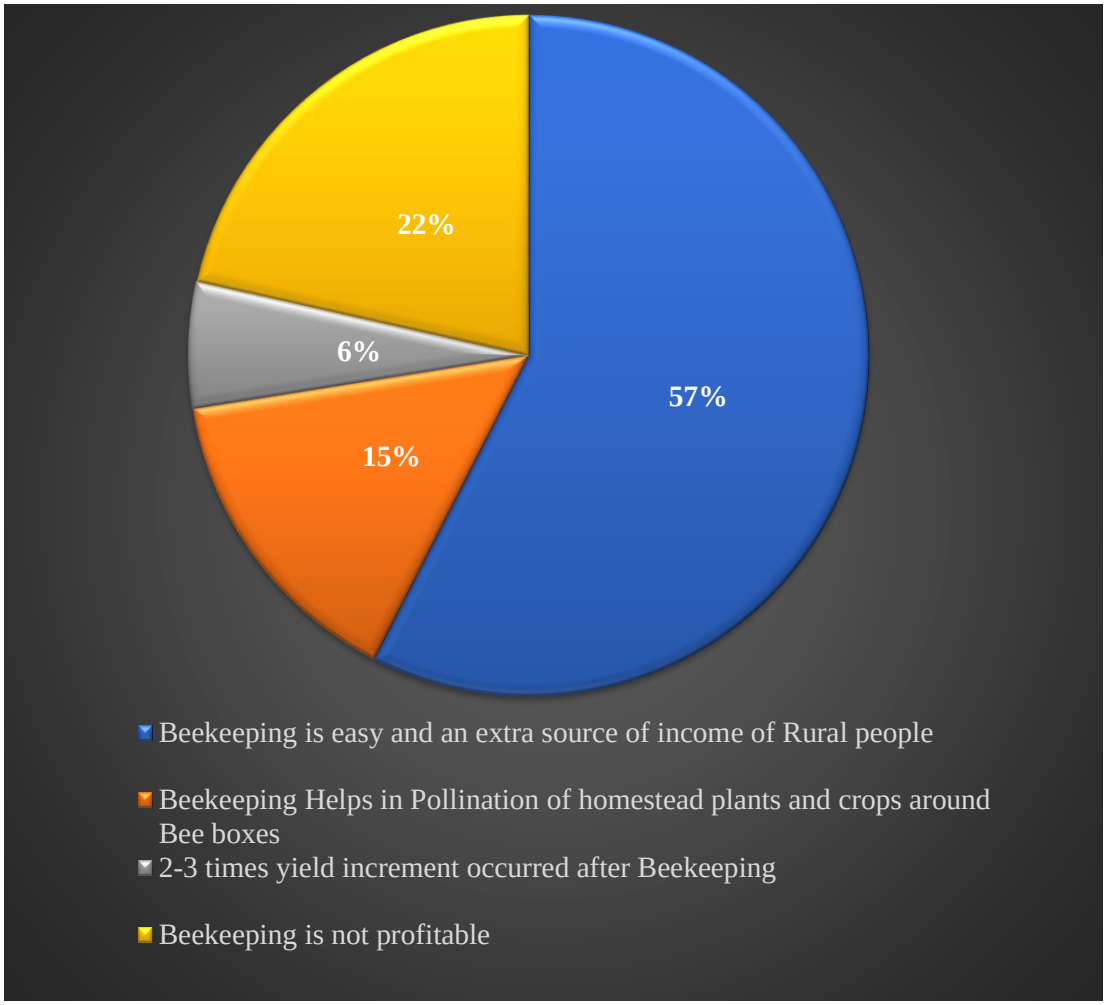


Figure 15. Beekeepers opinion and interest about Beekeeping.

From figure 15. it is clear that the beekeeper's feedback about beekeeping is positive as 115(57%) of 200 beekeepers said that beekeeping is easy and an extra source of income for the rural people. 43 of them claimed that beekeeping is not profitable. Rest of the beekeepers said it is helpful for the pollination of homestead plants and crops and some of them (12 respondents) also experienced with 2-3 times increment of yield of fruits and crops than previous year after beekeeping.

Two case study were also made in Kalir bazar union and in South Durgapur.

4.8 Case study

1st Case Study: A successful farmer Prodip Kumar was selected for the first case study. He is a farmer of 37 years old. He belongs to extended family with his parents, wife and two children. The case studywas held on April 20,2019. He is enthusiastic about apiculture and successfully reared the domestic species of honey bee *Apis mellifera.* He also collected naturally grown bee hive from hilly area of lalmai region near his homestead area. This wild species is actually *Apis cerana* which he managed without any problem. He used queen gate in this the box of this species to prevent escaping of queen. according to him the yield of his homestead vegetable, fruit plants and the crops like mustard, black cumin and coriander increased 2 times than the previous years when he did not practice beekeeping before 2018. He collected a significant amount of honey (approximately 5 kg from a flowering season). His family consumed this honey. Prodip kumar is so interested to practice beekeeping in a commercial basis though there is scarcity of nectar during dearth period but he is confident as he nurtured his colonies with artificial nectar like sugar syrup. Other beekeepers come to him for gathering knowledge about bees and other helps needed for beekeeping. But from further contact an interesting information was revealed that his bees flew away and most of them died after applying insecticide to prevent the attack of ants in his bee box. He said that if he could get appropriate training and knowledge about this unpleasant incidence would not occur. Beekeeping is not so difficult to him and it is not too laborious or expensive but it brings huge benefits so he is interested for further practices.

2nd case study: This case study was conducted on Mfia khatun from South Durgapur union of Adarsha Sadar upazilla. She is housewife of 40 years old and his husband is farmer. She has two children. The case study was made on 21st April 2019. She used to nurture her own bee box and also other's near her house as well. She became successful to collect honey from her bee box and she gave an interesting information that she got 3 times more yield of litchi fruit, pumpkin, mustard and some other crops after beekeeping. Another interesting information she has provided that the bees of neighborhood flew away but her box was full of bees and honey. She suspected that bees escaped from others came to her box. According to Mafia she provided sugar syrup in a regular basis during dearth period and check the box in every week. She said that bees go to Spider Wort flowers for nectar when there is scarcity of other flowers like litchi, mango, mustard etc. She collected 1 kg honey per month from the starting of beekeeping. She is interested for further practices. She is now an icon beekeeper of her area who helps other beekeepers with information and encourages the women of the neighborhood for beekeeping. Though children and some people are afraid of bee sting she tries to convince them that bee never harms without any reason caused by any object. Mafia said that she believes beekeeping will be great source of income and will empower women like her if they get proper training and incentives.

4.9 Biology of found Bees of the Study area

The two types of honey *Apis mellifera and Apis cerana* bees have a different Queen within a hive, there is only one queen. It is a female bee with a well-developed reproductive system. The queen mates only once with 6 drones at a time. Queen can live for 3 to 5 years and can lay up to 2,000 eggs per day. Female (workers) born from Fertilized eggs and unfertilized eggs become male (drones). After the death or sterilization of queen, the other bees will induct the development of a new queen. For queen bees, it takes 16 days from egg to emergence. Due to a specific diet during its development stage and the activity of queen pheromone a worker is a female bee with undeveloped reproductive organs. Majority of honey bees are worker bees. Worker bees may live for 16 weeks - 36 weeks. Worker bees emerges within 21 days from egg. The worker bees have series of sequential specific responsibilities in their lifetime. The activities of new bees start in the center of the brood nest with the cleaning of cells of the hive and nursing the brood. Workers turn around the outer edges of the nest in so that they can pack pollen and accumulate nectar. About three weeks later, workers become foragers for another 10- 20 days. they take care of the things which are brought from the environment that the colony needs in the hive: pollen, nectar, water and propolis. Some of the activities can be accomplished lifelong (e.g. patrolling, resting, and ventilating the nest). Drone dies after mating with the queen. Drones take 24 days from egg to emergence. Because of no use in the winter, drones are evicted from the hive in the autumn. Honey bees show a complete development or metamorphosis during their life: the undeveloped young and the adults look very different. Honey bees have the life stages of egg, larva, pupa and adult. It is noted that the cells are portrayed vertically, but they are oriented horizontally. The first three stages are also known as brood.

4.9.1 Eggs:

It takes two to three weeks to develop from egg to adult in general. Appearance of the eggs is as similar as sausage- shaped poppy seeds. Each egg has micropyle on the broad side which helps the entrance of sperm. It takes three days for hatching after egg laying. The larval stage lasts for six days. Queen can lay about 2000 eggs per day which is accelerate the population size within a very short time.

4.9.2 larva:

larva is almost microscopic in appearance after hatching resembling a white, small, C shaped segmented worm. Royal jelly and later bee bread, Propolis made by the workers from nutritional granule of pollen and nectar are consumed by the larvae. Each larva takes an estimated 10,000 feedings throughout this period. The larva moults five times during its larval stage. Durations of larval stages vary from queen to others. After workers have sealed their cells larvae started spinning their cocoons and turn into pupae.

4.9.3 Pupa:

The pupal stage is a stage of massive reorganization of tissues: the adult tissues develop from the imaginal discs carried by the larva. Organs also undergo a complete physical transformation; while the body changes from the larval body shape to the adult shape with three different body regions.

Table 4.8. Duration of different stages among the casts of honey bee

Cust	Queen	Worker	Drone
Egg period	3 days	3 days	3 days
Larval period	7 days	7 days	7 days
Pupal period	6 days	11 days	16 days
Total	16 days	21 days	26 days

Adult honey bees are either queens, workers or drones. Most of the of honey bees that one sees outside of a hive are workers. A representative colony in middle of the summer consists of up to 500 to 1,000 drones 20,0030,000 workers and one queen.

Some Pictures of The Study Area

Plate 4.1. Prodip kumar with beebox.

Plate 4.2. Mafia akter with hive.

Plate 4.3. Questionnaire survey.

Plate 4.3. Participants of FGD**.**

Plate 4.3. Inspecting bee box.

Plate 4.3. Visiting farmer's House.

Plate 4.3. Checking bee box.

Plate 4.3. Questionnaire Survey.

CHAPTER V
SUMMARY AND CONCLUSION

SUMMARY

The present study on the "Beekeeping in Lalmai hill areas of Cumilla potentials and problems" November 18 to May 2020 to determine the Blooming period of various homestead forest plants and cultivated crops, Potentials and problems of beekeeping in study area, Biology of the found honeybee species of the study area, effect of artificial nectar supplement in the dearth period. Among 200 beekeepers only 44 beekeepers did not provide artificial food support during the dearth period. Beekeeping is in introductory phase in the study area but it added an astonishing value in the socio-economic development of the study area by producing honey and increased yield of homestead plants and cultivated crops around the bee boxes. Expenditure per bee box is less than the profit achieved from it. Due to lack of knowledge, the beekeepers' attitude towards beekeeping is not up to the mark but most of them are interested in beekeeping.

Significant difference was observed between the treatment T_1 = Providing sugar Syrup and then T_2 = Providing no sugar Syrup on the honey production and increased yield of homestead fruiting plants and other cultivated crops in term price in Tk. as well. From Figure 9 it is evident that the mean income due to T_1 is 8636.9/- is far greater than the mean income 29.545/- from treatment T_2. So, they are statistically different from each other.

So, T_1 is better Than T_2.

100(29%) of bee keepers claimed it as a new practice, 50 (14%) of them claimed that some people are not interested to nourish and monitor the be boxes regularly. 30 of

them (9%) said there is lack of knowledge and training about beekeeping that is a barrier of beekeeping whereas 19% of them claimed it difficult to handle as they scare bee sting. But 77 (22%) of them reported that there is scarcity of nectar as flower sources is not up to the mark all year round.

But the socio-economic condition of the area has given us a clear picture of the yearly income per family. Bee keeping is adding extra income with less labor and capital. Beekeeping is 6% of the total income of the beekeepers whereas the biggest income (35%) comes from remittance. Agriculture, Business, Services and other sources are 21%,13%,9% and 16% respectively. This additional 6% will help the socio-economic development of the beekeepers. As it is in initial stage the economical profit is not so big as its environmental value. Beekeeping added 348654/- in total yearly income of the beekeepers so the sum total of income with beekeeping is 5994554/-.

Though remittance is the greatest sources of income beekeeping is a valuable source of income which not only add economic value but also plays important role to the environment.

Beekeepers cannot collect other bee products like propolis, royal jelly, bee wax and venom. But these all are potentials which they don't know how to extract from the hive. Extraction of these potential bee products will open new dimension in the economy of the area as well as the whole country. These products have enormous value in world market that many industries like cosmetics and medicine depend on them.

The greatest value of beekeeping is it helps in pollination which is a must for yield. We use various chemical fertilizer for the increment of our crops' yield. But by practicing bee keeping we not only harvest honey but also get more and more yield which decreases our cost of chemical fertilizer. So, it is environmentally sound and safe and economically beneficial.

Bees gives us nature’s best gifts with least cost and management practices. Beekeeping is drawing our attention day by day because of its effects on environment and the socio-economic development of rural area of our country.

CONCLUSION

The overall results of the present study indicated that for the management of *Apis mellifera* during dearth period from August to December artificial nectar influence the eggs, larvae, pupae, number of workers and drone, fecundity of the bee colony. That helps in good pollination and increased yield. Though some beekeeper did not practice enough nourishment they got increased yield due to the bees of other successful beekeepers but could not achieve honey as their bees migrated from their bee box to other or could not survive due to scarcity of nectar. So, beekeepers need to be more careful about the nourishment of bee boxes. In order to provide alternative occupations for rural migration, entrepreneurship is essential for the rural population. Despite the simplicity and tremendous advantages of beekeeping entrepreneurship, as well as its ability to provide honey production, pollination and, most importantly, jobs are enhanced; because beekeeping is migratory in nature, even landless farmers can take up this profession; Beekeeping has been conducted sideways in the study area as with other operations in agriculture. Though the main constrain is the scarcity of nectar in dearth period proper; nourishment and artificial nectar supplement can make great result. There were, based on the analysis, no respondents based their livelihoods on this sector alone. It is an age-old tradition; the production of honey is a lucrative business, an economically viable company that generates and Opportunities for jobs from generation to generation. There is ample scope to take up beekeeping on a commercial scale.

RECOMMENDATIONS

Based on the above results following recommendations may be made:

- More nectar supplying plants should be planted around the homestead area of the beekeepers.
- The nectar substitute significantly increases bee population of honeybee during dearth period which ensured maximum honey production following this period due to higher foraging tending of these honey bees.
- Therefore, the beekeepers of Bangladesh may be suggested to follow this practice during the dearth period to get good harvest of honey in the rest following season.
- Proper training and transformation of technology in the study area will accelerate the socio-economic development of the area and will be great source of income.
- Beekeepers should be aware about pesticidal application for saving their bee colonies.

References

Abrol, D. P. (2006). Life Cycle of the Honey bee, *Apis melifera*. *J. Apic. Res.* 10(45): 5-9

Amssallu, (2002). Bees for Development. *Beekeeping J*.1-11.

Arefin, R. (2019). An Overview of Apiculture in Bangladesh.

Arizaga, S., Ezcurra, E. (2002) Propagation mechanisms in Agave macroacantha (Agavaceae), a tropical arid-land succulent rosette. *Amarican J. Bo.t* **89**: 632–641.

Baltazar, N., Kianga, M. and Mwabless, M. (2013). Potentials and Challenges of Beekeeping Industry in Balang'dalalu Ward, Hanang' District in Manyara, Tanzania.*kivukon J.***1**,75-93.

Baranitharan, Kaliyamoorthy, Krishnappa,Pandiyan, Jeganathan. (2020). An Overview of Beekeeping.

Battino, M., Alvarez-Suarez, J.M. and Giampieri, F. (2013). Honey as a source of dietary antioxidants: structures, bioavailability and evidence of protective effects against human chronic diseases. *Curriculum Medical Chemistry*. **20**(5): 621-638.

Bawa, K.S., (1990) Plant-pollinator interactions in tropical rain forests. *Annual Review Ecol. Syst.* **21**: 399–422.

Bogdanov, S., Jurendic, T.,Sieber,R. and Gallmann, P. (2008). Honey for Nutrition and Health: *A Rev. J. American Colle Nutri*, **27**(6): 677-689.

Boniface, S. (2007). Beekeeping and conservation.Newsletter issue No. 1 December Tanzania Wildlife Research Institute Arusha Tanzania.

Bradbear, N. (2009). Bees and their role in forest livelihoods.

Bradbear, N. (2009). **In**:Bees and their role in forest livelihoods. Rome: FAO.

Buchmann, S.L. and Nabhan, G.P. (1996) The forgotten pollinators. Island Press, Washington, DC/ Chicago. p126

Chanie, D., Melese, G. and Ayalew, H. (2019). Honey Bee Products Marketing Practices: Challenges and Opportunities in and around Maksegnit Town, Amhara Region, Ethiopia. *Asian J. Adv. Agric. Res.* 1-8.

Crane, E. (1990). **In:** Bees and beekeeping: science, practice and world resources. Heinemann Newnes, Oxford,UK. p.1990.

Daily, G.C., Matson P.A., Vitousek P.M. (1997). Ecosystem services supplied by soil. **In:** Nature's services: social dependence on natural ecosystems. Island Press, Washington, DC, pp 113–132.

DeGrandi-Hoffman, G., Wardell, F. Ahumada-Segura, T. Renderer, R. Danka, and Pettis, J. (2008). Comparisons of pollen substitute diets for honey bees: consumption rates by colonies effects of brood and adult populations. *J. Agric. Res. and Bee World.* **47**(4): 265-270.

Devillers, J., & Pham-Delègue, M. (2002). **In:** Honey bees: Estimating the Environmental Impact of Chemicals. 1st ed. CRC press, New York, U.S.A. 347pp.

Dobson, A.P., Lodge, D.M., Alder. J., Cumming, G., Keymer, J.E., Mooney, H.A., Rusak. J.A., Sala, O.E., Wall.D.H., Winfree. R., Wolters. V. and Xenopoulos. M.A. (2006). Habitat loss, trophic collapse and the decline of ecosystem services. *Ecology*. **87**:1915–1924.

Frisch, V.K. (1967) The Dance Language and Orientation of Bees. Harvard University Press, Cambridge, MA.

Fuad, M. and Nurhasan, M. (2019). Potentials and Prospects of Beekeeping Entrepreneurship in Dinajpur Region: A Participatory Analysis. *Agric. Res. and Tech.*, **21**(5): 209-213.

Funari, S. R. C., Rocha, H. C., Sforcin, J. M., Curi, P.R., Funari, A. R. M. and Orsi, R. O. (2003). In: Archivos-Latinoamericanos-de-Produccion-Animal: Effects of pollen collection on colony development and in the bromatological composition *Apis mellifera L.* pupae. Government printer, Dar-es-

Salaam.Brunei.**11**(2): pp. 80-86

Günbey. V. S, (2007). Colony Management of Honey Bee (*Apis mellifera L.)* Breeders in Igdir Province. *Uluslararası Tarım ve Yaban Hayatı Bilimleri Dergisi*.**5**(2): 372-382.

Hellner, M., Winter, D., von Georgi, R., & Münstedt, K. (2008). Apitherapy: Usage and Experience in German Beekeepers. *Evid. Based. Complement. Alternat. Med*.**5**(4): 475-479.

Ingram, M., Nabhan, G. and Buchmann, S. (1996). Our forgotten pollinators: Protecting the birds and bees.

Kumar, R., Rajput, G. S., Mishra, R. C. and Agrawal, O. P. (2013). A study on assessment of duration of dearth period for Honey bees in Haryana, India. *Munis Entomol. and Zool.* **8** (1): 434-437.

Levin, M.D. (1983) Value of bee pollination to U.S. agriculture. *Bull Entomol. Soc. America.* **29**: 59–51.

Losey. J.E., Vaughan, M. (2006). The economic value of ecological services provided by insects. *Bioscience.* **56**: 311–323.

McGregor, S.E. (1976). **In:** USDA agriculture handbook No. 496: Insect pollination of cultivated crops. US Government Printing Office: Washington, DC. p.193.

Milner, A. (1996). An introduction to understanding honeybees, their origins, evolution and diversity.

Morse, R.A. and Calderone, N.W. (2000). The value of honey bees as pollinators of U.S. crops in 2000. *Bee. Cult.* **128**(3): 1–15

Mumbi, C. and Silas, I.O. (2008). Sting less bee species distribution. Beekeeping and Environmental Conservation News Letter issue number 02, July 2008

Münstedt K, Thienel J, (2012). Beekeepers in central Europe are at high risk for contracting Lyme borreliosis. *J. Apic. Res.* **51**(4): 291-297.

Narottam, M., Singh, Balraj, S., Kant, Krishna, K., Meena, R.D., M., & Solanki, Ramesh, S. (2015). Role of insect pollinators in pollination of seed spices: A review. *Int. J. Seed Spices*. **5**: 1-17

Pande, R., Karnatak, A. and Pande, N. (2015). Development of Nectar Supplement for Dearth Period Management of Honeybees (Management of Honeybees (Apis Mellifera Linnaeus) Linnaeus) Colonies In Foothills Of Shivalik Range Of Himalayas. *The Bioscan*, **10**(4): 1599-1603.

Peng, Y., Marston, J. and Kaftanoglu, O. (1984). Effect of Supplemental Feeding of Honeybee (Hymenoptera: Apidae) Populations and the Economic Value of Supplemental Feeding for Production of Package-Bees. *J.Econ. Entomol*. **77**(3): 632-636.

Peterson, M. (2017). The Basics of Beekeeping.
Pham-Delègue, M.H. (1998). Abeilles. La Martinière, Koning, R.E. (1994). Honeybee biology.

Pimentel, D., Wilson, C., McCullum, C., Huang, R., Dwen, P., Flack, J., Tran, Q., Saltman, T., & Cliff, B. (2007). Economic and Environmental Benefits of Biodiversity The annual economic and environmental benefits of biodiversity in the United States total approximately $ 300 billion.

Polatli, M., Sönmez, H. M., Cildag. O, (2002). Respiratory symptoms and pulmonary function tests in beekeepers exposed to biomass smoke inhalation. *J. apicul. Res.* **41**(1-2): 51-57.

Popa, A., Mărghitaș, L. A., Pocol, C. B., (2011). Factors that influence entrepreneurship in the beekeeping sector in the North-West Region of Romania.Analele Universității din Oradea, Fascicula: Ecotoxicologie, Zootehnieși Tehnologii de Industrie Alimentară, **10**(A), 287-295.

Prance, G.T. (1987). The first resource: Wild species in the North American economy. By C. and R. Prescott-Allen. *Brittonia.* **39:** p**.**427

Rajesh, B., Yogesh, K., and (2009). *Indian J.*

Rathee, Mandeep & Chaudhary, O.P. & Yadav, Sunita. (2019). Evaluation of consumption pattern and suitability of artificial carbohydrate diets to Apis mellifera (L.) colonies during dearth period.

Robinson, W.S., Nowogrodzki, R., Morse, R.A. (1989). The value of honey bees as pollinators of U.S. crops. *American Bee J*. **129**: 477–487.

Roubik, D.W. (1995). Pollination of cultivated plants in the tropic. Food and Agriculture Organization, Rome. FAO Agricultural Services Bulletin **118**: 1–196.

Saha, J. (2005). Beekeeping for Rural Development, Its Potentiality and Beekeeping Against Poverty - Bangladesh Perspective. Bsic.

Shaushi, R. (2007). The importance of establishing beekeeping groups/ Associations in beekeeping areas. Njiro wildlife research centre Beekeeping and conservation newsletter Issue No: 1 December 2007.

Silas, I.O. (2005). Contribution of beekeeping with sting less bees in daily life. Njirowildlife research centre Beekeeping and conservation newsletter Issue No: 4 May 2005.

Southwick, E.E., Southwick, L. Jr. (1992). Estimating the economic value of honey bees (Hymenoptera: Apidae) as agricultural pollinators in the United States. *J. Econ. Entomol*. **85**: 621–633.

Soysal, M. A., Gürcan, E. K. (2005). Tekirdağ İli Arı yetiştiriciliği Üzerine Bir araştırma. *Tekirdağ Ziraat Fakültesi Dergisi*. **2**(2): 161-165.

Strant, M., Varadi, A. (2016). Royal jelly, studies, clinical cases. Api-therapy Symposium and work-shop, ClujNapoca, Romania,18-19 February.

Strant, Mirela & Yücel, Banu & Topal, Erkan & PUSCASU, Ana & Mărgăoan, Rodica & Alina, Varadi. (2019). Use of Royal Jelly as Functional Food in Human and Animal Health. **60**: 131-144.

Strant. M, Topal. E., (2017). Possible Risk and Hazard Factors for Beekeeper Health. 45th APIMONDIA International Apicultural Congress. 29 September-4 Octaber 2017 İstanbul, Turkey.

Syngkon, W. (2017). Problems and Prospects of Bee Keeping at Khatarshnong In Meghalaya. *Int. J. Adv. Res.* **5**(8), 611-617.

Thapa, R., & Pokhrel, S. (2005). Impact of Supplement Diets on Flights of Cross Breed Honeybee (*Apis melliferaL*.). *J. Inst. Agric. and Animal Sci.* **26**: 71-76.

Topal, E., Strant, M., Cristina. B., Pocol. K. and Mustafa. (2019). **In**: A Critical Point in Beekeeping: Beekeepers' Health. Troy, Monmouth, UK. **76**: 10-18.

URT, (1998). Beekeeping Programme. Ministry of Natural Resources and Tourism.

URT, (1998). National beekeeping policy. Ministry of Natural Resources and Tourism.

URT, (2001). Bees and their role in forest livelihood. National Beekeeping Programme 2001-2010. Forest and Beekeeping Division, Dar-es- Salaam.

URT, (2006). Beekeeping Development Ministry of Natural Resources and Tourism.

Valiente-Banuet, A., Arizmendi, M.C., Rojas-Martínez, A., Domínguez-Canseco, L. (1996). Ecological relationships between columnar cacti and nectar feeding bats in Mexico. *J. Trop. Ecol.* **12**: 103–119.

Watson, L., Dallwitz, M.J. (1992). The families of flowering plants: descriptions, illustrations, identification, and information retrieval. *Nordic j. Botany*.**14**(5): 486

Westby, J. D., Lee. B. C. (2003). Antecedents of injury among youth in agricultural settings: A longitudinal examination of safety consciousness, dangerous risk taking, and safety knowledge. *J. safety res.***34**(3): 227-240.

Williams, G. (2007). Beekeeping in Different Areas of the world.

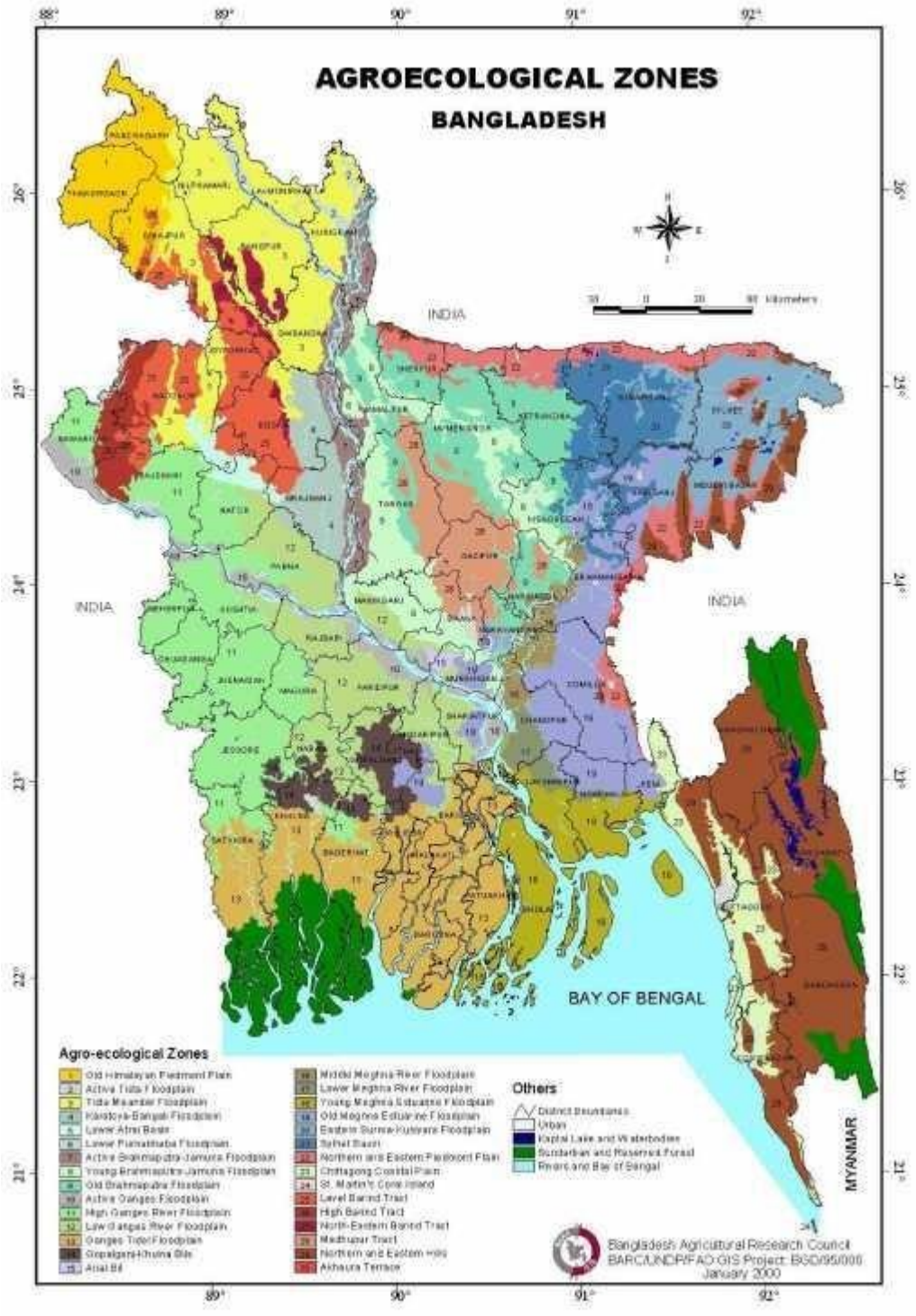
Yamane, T. (1967). Statistics, An Introductory Analysis, 2nd Ed. New York.

Appendix

Temperature of the study area

	Maximum	Minimum	(%)	(Total)
November	30.2	20.6	67	6.0
December	26.8	17.1	76	33.0
January	23.6	12.6	68	0.0
February	29.2	18.1	61	20.0
March	33.3	22.3	59	3.0

Source: Bangladesh Meteorological Department (Climate and Weather Division), Agargoan, Dhaka- 1217.



Source: Bangladesh Agricultural Research Council, Khamarbari