STUDY ON HONEY PRODUCTION BY USING WOODEN AND POLY HIVE IN DIFFERENT SEASONS IN BANGLADESH

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CERTIFICATE

This is to certify that the thesis entitled ***STUDY ON HONEY PRODUCTION BY USING WOODEN AND POLY HIVE IN DIFFERENT SEASONS IN BANGLADESH*** *,submitted to Department of Entomology, 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* ***MD. MOHI UDDIN FAZLULLAH, Registration No. 10-04160****, under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma.*

I further certify that any help or sources of information has been availed of during the course of this investigation has duly been acknowledged.

Dated**:** June, 2017

Dhaka, Bangladesh

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DEDICATED TO

MY

BELOVED PARENTS

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STUDY ON HONEY PRODUCTION BY USING WOODEN AND POLY HIVE IN DIFFERENT SEASONS IN BANGLADESH

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ABSTRACT

A study was conducted in three districts viz. Sirajgonj, Gazipur and Satkhira during the mustard, litchi, and mangrove multifloral blooming period respectively of the year 2015-2016 and 2016-2017 to study honey production efficiency of wooden traditional boxes and poly hive super boxes. The experiment was carried out in paired plot design. 36 boxes were used in each setup, among them 18 were wooden hive and 18 were poly hive. In Sirajganj during 2015-16 poly hive with super boxes yielded the highest (17.03 kg/hive/season) honey from Ullapara and the lowest (16.33 kg/hive/season) honey yield was obtained in Tarash. In 2016-17 the highest honey was harvested with poly hive super from Tarash (18.63 kg/hive/season) and the lowest honey yield with poly hive super was in Shahjadpur. In Gazipur during 2015-2016 in poly hive super the highest (20.46 kg/hive/season) honey yield was obtained from Kapasia and the lowest (20 kg/hive/season) in Kaliganj. On the other hand in 2016-2017 it was observed that in poly hive super the highest (14.92 kg/hive/season) honey yield was obtained from Gazipur Sadar and the lowest (13.93 kg/hive/season) in Kaliganj. In Satkhira it was observed that in 2015-16 in poly hive super the highest (14.92 kg/hive/season) honey yield was obtained from Tala and the lowest (14.65 kg/hive/season) honey yield was obtained in Kaliganj. Again in 2016-17 in poly hive super the highest (12.5 kg/hive/season) honey yield was obtained from Tala and the lowest (11.45 kg/hive/season) in Munshiganj. There was a significant difference of honey production in traditional hives and the poly hive super boxes. It is very clear that the production of honey is very efficient and suitable in poly hive with super bee boxes in comparison to wooden traditional hives. Additionally, polyhive with super boxes provides bees a good environment to raise and to keep their population strong due to its high-tech internal facilities and sanitary system.

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ABBREVIATIONS AND ACRONYMS

FULL WORD	ABBREVIATION
And others	*et al.*
Cultivar	cv.
Degree Celcius	^{o}C
edest (means That is)	i.e.
Figure	Fig.
Bee Hive	BH
Modern Hive	MH
Gram	G
Kilogram	Kg
Milligram/litre	mgL^{-1}
Namely	Viz.
Percentage	%
Species (plural number)	spp.
Variety	var.

CHAPTER I

INTRODUCTION

Beekeeping industry worldwide is affected by the ecological factors. These factors have great effects not only on the behavior and activities of honey bee colonies, but also on plant growth and development. The microclimate of honeybee colonies is still in need to more and more studies to assess the effect of the ever changing environmental factors on their microclimate, and to investigate whatever the subsequent effects of these changes on biological, morphometrical, physiological, behavioral and productivity aspects of the worker bee individual and colony (Komisar and Southwick, 1991). Data on the changes over time in the main biological components of honey bee colonies, i.e. adult and brood populations and food stores, are used by researchers to monitor hive health and to study behavior and population dynamics. Weighing hives daily or weekly is done by beekeepers and bee researchers (Szabo and Lefkovitch 1991, Harbo 1993, Savary 2006) to help determine the best time to harvest honey or estimate food reserves for periods with no nectar flow. Weighing is fast, requires little training and is not disruptive to the colony so it can be done at any time of year. Weighing hives regularly, often, and with relatively high precision can provide useful information on colony dynamics. Buchmann and Thoenes (1990) first proposed using high-precision electronic balances, an idea also explored by Meikle *et al*. (2006). Hives are a convenient way of containing a colony of bees and protecting them from the elements and predators, thereby enabling the bees to thrive and maximize honey production without encouraging swarming or in any way being detrimental to the bees. One of the main purposes (aim) of the behavioral and microclimatic studies for honeybee colonies inside and outside the hive is to determine the most suitable habitat for honeybees to survive and reproduce to maintain its kind.

Bee keeping is an important sub sector of agriculture and honey bees are the most crucial pollinator of agricultural crops and more than 80% of agricultural crops are more or less dependent on bee pollination.Though there are many type of bee products present in the bee hive i.e. honey, beeswax, pollen, propolis, royal jelly, bee venom etc., beekeepers only harvest honey and very little amount of wax from the bee hives in Bangladesh. Beekeepers do not collect pollen, propolis and other bee products from bee hive due to lack of available technology and inputs.

In Bangladesh beekeeping is done in traditional single boxes where broods of honey bee and honey remain in same box, and during honey harvest broods of bee are damaged which is unhygienic and not scientific. On the other hand, bee management in wooden boxes encourages pest and diseases of honey bee, and therefore, using poly hive box is important to reduce pest and disease of bee. However, it is clear that there is an urgent need to improve beekeeping sector not only for honey and other bee products production but also to attain food security of Bangladesh. Clearly the expectancy of beekeeping and especially honey production in Bangladesh is efflulgent if handled with care and in a scientific way. On the other hand, most of the beekeepers are migratory for keeping their colony honey productive. But, migratory beekeeping is very challenging and sometimes very strugglesome due to trasport dependance and there is no security system for beekeepers while shifting their bee colonies to enriched floral sources. To solve these problems Sher-e-Bangla Agricultural University (SAU) apiary is improved with different type of bee boxes and bee stocks. Research and development program is in progress in SAU apiary. Honey, Pollen and Propolis yield were increased in comparison to our traditional method in three sites of Sirajgonj, Gazipur and Shatkhira (Sundarban area) districts. Appropriate carbohydrate based food sugar syrup ratio was fixed for maintaining bee hive in the dearth period. Natural pollen feeding effect was also observed in the dearth period. Different pests and diseases identification are ongoing in the field. Additionally, Beekeepers are reporting non-productive queens and drones which could be an effect of inbreeding depression. For improving stocks and lesser the chance of inbreeding depression a permanent bee breeding centre is inevitable to be added with SAU bee research system. However, Bees stocks are maintained at SAU apiary for queen breeding and drone breeding purposes.

Chemical Composition of Honey

Carbohydrates

Unsurprisingly, these comprise the major portion of honey - about 82%. The carbohydrates present are the-

Monosaccharides fructose (38.2%), glucose (31%),

Disaccharides (9%) sucrose, maltose, isomaltose, maltulose, turanose and kojibiose.

There are also some oligosaccharides present (4.2%), including erlose, theanderose and panose, formed from incomplete breakdown of the higher saccharides present in nectar and honeydew.

Proteins and Amino acids

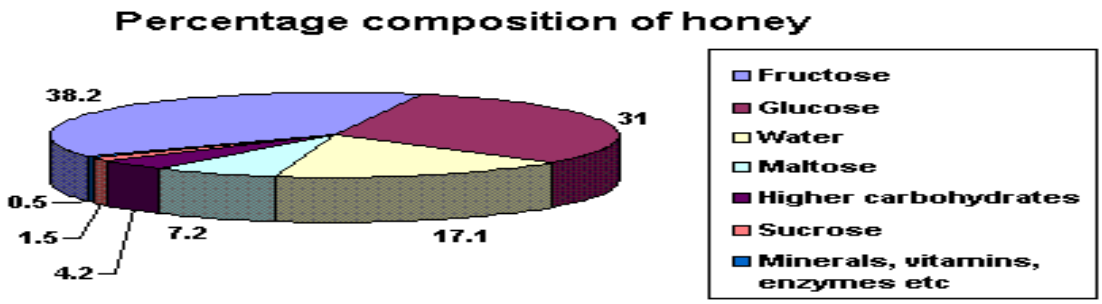
Honey contains a number of enzymes, including invertase, which converts sucrose to glucose and fructose; amylase, which breaks starch down into smaller units; glucose oxidase, which converts glucose to gluconolactone, which in turn yields gluconic acid and hydrogen peroxide; catalase, which breaks down the peroxide formed by glucose oxidase to water and oxygen; and acid phosphorylase, which removes inorganic phosphate from organic phosphates. Honey also contains eighteen free amino acids, of which the most abundant is proline.

Vitamins, Minerals and Antioxidants

Honey contains trace amounts of the B vitamins riboflavin, niacin, folic acid, pantothenic acid and vitamin B6. It also contains ascorbic acid (vitamin C), and the minerals calcium, iron, zinc, potassium, phosphorous, magnesium, selenium, chromium and manganese. The main group of antioxidants in honey are the flavonoids, of which one, pinocembrin, is unique to honey and bee propolis. Ascorbic acid, catalase and selenium are also antioxidants. Generally speaking, the darker the honey, the greater its antioxidising properties.

Other compounds

Honey also contains organic acids such as acetic, butanoic, formic, citric, succinic, lactic, malic, pyroglutamic and gluconic acids, and a number of aromatic acids. The main acid present is gluconic acid, formed in the breakdown of glucose by glucose oxidase. Honey also contains hydroxymethylfurfural, a natural product of the breakdown of simple sugars below pH 5.



Objectives of the Study

- To study efficiency of honey production in different hive setup viz. traditional wooden boxes and polyhive with super boxes (Langstroth).
- To study honey production and foraging behaviour differences in different districts viz. Gazipur, Sirajganj and Satkhira.

CHAPTER II

REVIEW AND LITERATURE

"Honey is the natural sweet substance produced by honey bees from the nectar of blossoms or from the secretion of living parts of plants or excretions of plant sucking insects on the living parts of plants, which the honey bees collect, transform and combine with specific substances of their own, store and leave in the comb to ripen and mature." Honey is made by several bees' species and even wasps. Honey is largely composed of sugars that contribute 95 percent or more of its dry weight. These are largely simple sugars, namely, fructose and glucose, which comprise 85% or more of the sugars present. These sugars contribute to the physical and nutritional aspects of the honey. Water is the other major component with its concentration being influenced by humidity, nectar and processing. Other contents include minerals like potassium, amino acids and vitamins. The colour of honey varies from clear and colourless to dark amber. There are other colour shades such as bright yellow, reddish, greyish and greenish. It tends to turn lighter as it crystallizes because the glucose crystals are white. The colour influences marketability. Lighter honeys are often more marketable for direct consumption. The darker honeys on the other hand, are more commonly used for industrial use, especially in western markets. The colour also influences the price with lighter honeys commanding higher prices.

- Honey is food that contains fructose, glucose, sucrose, mineral water and other undetermined substances
- Honey is a necessary ingredient in making medicines to be taken orally or as injections
- Honey is also used as an ingredient in making some clear soap.
- Can also be used in making drinks e.g. wine.
- Honey is on its own a very reliable cough syrup. Bakers would use honey in their different processes. Honey is made from nectar and pollen.

There are some kind of hives used by the beekeepers all over the world. In Bangladesh, beekeepers usually use modern wooden Langstroth hives. Langstroth hive is the most

modern type of hive. The Langstroth hive is the most productive of all the hives. Langstroth frames are made in such a way that when fitted to the frames, to the bees they appear as unfinished combs and hence would encourage the bees to finish them off-thereby encouraging productivity.

Advantages of the Langstroth hive

- It produces the highest amount of honey.
- There is no bee killing during harvesting
- It is environment friendly
- It does not allow intrusion of hive by bees enemies like mice and spiders.
- It works well with trap boxes
- It makes it easy for bees to fan and clean the hive
- It is fitted with wax foundations that reduce work for the bees in making combs
- It promotes cleanliness during harvesting
- Brood and honey are never mixed as in log hives
- All members of the family can work with the hives
- The shadow frames can be easily tired up three or more stories high
- The beekeeper can add supers at the rate at which they are required by the bees

Table 1: Major nectar producing plants and their hotspot in Bangladesh (Hossain, 2017)

Common Name	**English Name**	**Botanical name**	**Family**	**Hotspot**
Sharisha	Mustard/ Rape seed	*Brassica juncea*	Brassicaceae	Sirajgonj,Tangail, Manikgonj, Shavar, Sherpur, Jamalpur
Litchu	Litchi/ Lychee	*Litchi chinensis*	Sapindaceae	Ishwardi, Dinajpur, Magura,Gazipur,Rajsh-ahi, Pabna, Natore
Dhania	Coriander	*Coriandrum sativum*	Apiaceae	Faridpur, Gopalgonj, Shariotpur,Madaripur
Kalojira	Black seed	*Nigella sativa*	Ranunculaceae	Faridpur, Gopalgonj, Shariotpur,Madaripur
Guji Til	Niger	*Guizotia abyssinica*	Asteracea	Faridpur, Gopalgonj, Shariotpur,Madaripur, Rajbari
Shajina	Drumstick	*Moringa oleifera*	Moringaceae	Jessore, Mymensingh, Sherpur, Muktagasha
Jambura	Pomelo	*Citrus maxima*	Rutaceae	Moulavibazar,Gazipur, Sylhet
Aam	Mango	*Mangiferaindica*	Anacardiaceae	Rajshahi,Dinajpur, Ishwardi, Pabna
Shurjom-ukhi	Sunflower	*Helianthus annuus*	Asteraceae	Borguna, Bhola, Jessore
Til	Seasame	*Sesamum indicum*	Pedaliaceae	Khulna,Dumuria, Manikgonj, Tangail
Boroi	Jujube	*Ziziphus jujuba*	Rhamnaceae	Mymensingh, Gazipur, Jessore
Rubber	Rubber	*Hevea brasiliensis*	Euphorbiaceae	Tangail, Rangamati

Dhainca	Sesbania	*Sesbaniabispinosa*	Fabaceae	Narshingdi,Bikrampur ,Narayangonj, Munshigonj
Jolpai	Indian olive	*Elaeocarpus floribundus*	Elaeocarpaceae	Gazipur
Kulshi	Aegicerus	*Aegiceras majus*	Myrsinaceae	Sundarban, Shatkhira
Amur	Amoora	*Amoora cucullata*	Meliaceae	Sundarban, Shatkhira
Goran	Ceriops	*Ceriops decandra*	Rhizophoraceae	Sundarban, Shatkhira
Keora	Sonneratia	*Sonneratia apetala*	Lythraceae	Sundarban, Shatkhira
Passur/ Pitamari	Cedar Mangrove	*Xylocarpus mekingensis*	Meliaceae	Sundarban, Shatkhira
Sundri	Heritera	*Heritera fomes*	Malvaceae	Sundarban, Shatkhira
Gewa	Excoecara	*Excoecaria agallocha*	Euphorbiaceae	Sundarban, Shatkhira
Kakra	Oriental Mangrove	*Brugiera gymnorrhiza*	Rhizophoraceae	Sundarban, Shatkhira
Baen	Gray Mangrove	*Avicennia officinalis*	Avicenniaceae	Sundarban, Shatkhira

Beekeeping is recognized as being a very important hidden treasures for development, poverty alleviation and conservation and sustainable use of forest resources. Apiculture industry provides enormous potential for income generation and socio-economic development. There is an expanding international market niche for special flavored and organic honey which could be exported. The most important service the honeybees render to mankind is pollination of agricultural and forestry crops. Despite the substantial attention is given to the importance of beekeeping in Bangladesh, little research in apiculture has been carried out. Among the panoply of food products, honey has been used since prehistoric times as an effective healing, antiseptic, antioxidant and antibacterial therapy. The present research aimed to investigate erstwhile undocumented litchi honey samples from Bangladesh, for its antioxidant and physico-chemical parameters that may increase

knowledge of product quality in a given geographic area, as well as its commercial value. Three litchi honey samples were collected from different regions of Gazipur and Tangail district, Bangladesh. The major physicochemical properties such as- moisture, ash, protein, fat, carbohydrate, energy content, pH and TSS were measured. Although the physicochemical parameters of the honey samples varied, most of the honey samples were in the acceptable range of international standards. There is inadequate information about a national beekeeping calendar that relates flowering of honeybee forage plants to honey flow and harvesting seasons. Humans keep bees, but honey bees are not considered domesticated in the way that a dog, cat, or cow is. It makes no difference to the bees whether they live in a hollow tree or in a human-made hive in someone's backyard. They are, therefore, not dependent on humans. However, beekeepers can help the bees by managing their living space and stimulating their activity. This bee management helps the beekeeper as well as the bees. One of the beekeeper's first tasks is to get the bees into a living situation where he or she can inspect their progress from time to time. A hollow tree or other natural nest site is not very convenient for inspection; so honey bees are kept in human-made houses called beehives. Some of important and informative works have so far been done in home and abroad related to this experimentation have been presented in this chapter.

Abrol (2015) conducted an experiment on the diversity of pollinating insects visiting litchi flowers (*Litchi chinensis Sonn*) and path analysis of environmental factors influencing foraging behaviour of four honeybee species. Honeybee species *Apis dorsata* F; *A. mellifera* L; *A. cerana* F. and *A. florea* F. were the most important and efficient pollinators of litchi flowers (*Litchi chinensis* Sonn.). They constituted more than 65% of the total pollinating insects. The ecological threshold for commencement and cessation of flight activity of each honeybee species varied from one another. In general, 15.5 -18.5°C temperature, 600 -1700 lx light intensity, and 9 -20 mW/cm^2 solar radiation appeared to be the minimum ecological conditions for commencement of flight activity in *Apis* species. Cessation of activities in all the honeybee species was controlled mainly by decline in values of light intensity and solar radiation irrespective of other factors. Between commencement and cessation, the foraging activity of all honeybee species followed the same general pattern as temperature, light intensity, solar radiation, nectar sugar

concentration and inversely with relative humidity. Path analysis revealed that all honeybee species differed in their responses to temperature, light intensity and solar radiation, the three most important factors in foraging behavior.

Alemu *et al*. (2013) conducted to characterize honey produced in Sekota district in northern Ethiopia and to assess the effects of location (lowland, midland and highland) and hive type (modern zander-frame and traditional tube basket) on the quality of honey produced in the area. A total of 20 honey samples were collected from four locations in Sekota district. Reducing sugars, apparent sucrose, pH, moisture, ash, hydroxymethylfurfural, acidity and water-insoluble solids contents of the honey samples were analyzed. The pH of honey samples collected from the midland of the district was significantly higher than ($p < 0.05$) the pH of honey samples collected from lowland areas. Hive type significantly ($p < 0.05$) influenced the reducing sugars contents of the honey samples. The water-insoluble solids content of the honey samples analyzed in his study was above the maximum limit set by national and international standards for water-insoluble solids content of honey. Although honey produced in Sekota district was generally of good quality, efforts need to be made to reduce the water-insoluble solids content of the honey.

Al-Ghamdi *et al*. (2017) carried out a study on 182 beekeepers using cross sectional survey and employing a random sampling technique. The data were analyzed using descriptive statistics, analysis of variance (ANOVA), the Cobb-Douglas (CD) production function and partial budgeting. The CD production function revealed that supplementary bee feeds, labor and medication were statistically significant for both box and traditional hives. Generally, labor for bee management, supplementary feeding, and medication led to productivity differences of approximately 42.83%, 7.52%, and 5.34%, respectively, between box and traditional hives. The study indicated that productivity of box hives were 72% higher than traditional hives. The average net incomes of beekeepers using box and traditional hives were 33,699.7 SR/annum and 16,461.4 SR/annum respectively. The incremental net benefit of box hives over traditional hives was nearly double. Their study results clearly showed the importance of adoption of box hives for better productivity of the beekeeping subsector.

Ali (2011) carried out a research to evaluate two honeybee races namely; *Apis mellifera jementica* (indigenous race) and *Apis mellifera carnica* (carniolan race) based on brood production, population development, foraging activity, and queens status through the experimental period extended from March, 2009 up to March, 2010 under main physical environmental conditions of the central region of the Kingdom of Saudi Arabia. The obtained results showed that, indigenous bees transferred from traditional hives (Aoud) into Langstroth (modern) hives and supplied with frames contained 33 cells/l2 (regular worker-size cell for indigenous bees) (group I) had significantly higher brood production and population development than indigenous bees transferred from traditional hives into Langstroth hives and supplied with frames contained 25 cells/l2 (regular worker-size cell for European bees) (group II) and carniolan bees transferred from honey bee nuclei into Langstroth hives and supplied with frames contained 25 cells/l2 (regular worker-size cell for European bee) (group III). The general mean of brood area in cm^2, frames of brood and frames covered with adult bees were (2813.13, 1730.94 and 1867.05 cm2 /colony), (3.13, 2.21 and 2.07 brood comb/colony) and (6.39, 4.44 and 4.38 comb of bees/colony), in groups I, II and III, respectively. The indigenous race significantly surpassed the carniolan race in brood production during summer season during high temperature commonly exceeds 45 C. Data also showed that no significant difference in foraging activity between the two examined races (indigenous and carniolan race) for gathering pollen during the first inspection period extended from 6 to 7 am during the relatively cold, moderate and very high air temperature during inspection months. This situation differed between the two examined races during the second and third inspection period extended from 11 to 12 am and 4 to 5 pm, relatively high air temperature in June, August and October, during which the indigenous race significantly surpassed the carniolan race in foraging activity for gathering pollen. Moreover, the foraging activity was significantly higher in the first inspection period (6–7 am) than the other two periods (11–12 am and 4–5 pm). When the numbers and percentages of died or superseded queens in the three inspection groups (I, II and III) were studied, no died or superseded queens were found in honey bee colonies in group (I) during the experimental period which was extended from March, 2009 to March, 2010. However, the percentages of failed queens during the experimental period were 0.00%, 45.00% and 60.00% in groups (I, II and III), respectively. The results also showed

that increasing the size of the worker cells negatively affected brood production and population density in indigenous race and indigenous race is more tolerant and well adapted to the environmental conditions in the search area than carniolan race (imported). Therefore, this study recommends that improving the characteristics of indigenous and carniolan races should take place through breading programs, because the indigenous race shows high ability and good adaptation to the environmental conditions in the area but it is small in size, in addition their honey stomach and pollen basket are small, meanwhile the carniolan race is large in size and their honey stomach and pollen basket are great, but is not acclimatized to environmental conditions in the region, especially during the hot summer when the air temperature exceeds 45 C.

Ande *et al*. (2008) carried out an experiment to study comparative influence of hive types on bee colony establishment. They showed that bee colony establishment was generally poor, but Kenyan top bar (KTB) and Clay-pot (PTH) hives performed significantly well by establishing bee colony earlier than others and achieving 50% success of bee colony establishment.

Beyene *et al*. (2015) conducted an experiment in Adami Tulu and Arsi Negelle districts from September 2009 to June 2012 to evaluate the productivity performance of transitional and modern bee hives. Their study was purpose, three representative sites namely: Asebo, Adami Tulu research station and Ashoka Lepis site were used. Based on farmers' capacity, one modern hive and one transitional hive made from locally available materials were used for the trail at each of the experimental farmer back yard. Before actual commencement of that study, theoretical and practical training session was given for a total of 30 beekeeper farmers at the selected sites. Data were collected for three years and analyzed using the General Linear Model analysis variance procedure of the statistical Analysis System (SAS) programmme. The average honey yield per hive/year from transitional hive was 13.88 kg, 13.21 kg and 10. 45 kg at Asebo, Adami Tulu Research station and Ashoka Lepis site respectively. There was a ($p < 0.05$) variation between Adami Tulu Research station and Ashoka Lepis site in honey yield per hive per year from transitional hive. Whereas the mean of honey yield from transitional at Adami Tulu Research Center and Asebo site was not significantly different ($p > 0.05$).Significantly higher and lower honey yield from

transitional hive was recorded at Asebo and Ashoka Lepis site respectively. The average honey yield per hive/year from modern hive was 23.18 kg, 21.61 kg and 18.45 kg at Adami Tulu Research center, Asebo and Ashoka Lepis site respectively. There was ($p < 0.05$) difference between the three representative sites in honey yield per hive/year from modern hives. The mean yield obtained from modern hive at all study sites was statistically higher when compared to transitional and traditional hives. The mean honey yield per hive/year from traditional hive was 6.08 kg, 5.94 kg and 4.94 kg at Adami Tulu Research Center, Asebo and Ashoka Lepis site respectively. There was no ($P < 0.05$) variation between all study sites in terms of honey yield from traditional hives. Generally, there was highly significant difference ($p < 0.05$) between the three types of hives in terms of honey yield per hive/year. Location and hive types interaction had significant effect on honey yield per hive at study area. Whereas hive types and season of honey harvesting interaction had no significant effect on honey yield per hive at the study area. It was concluded that using improved bee hives with improved management practices can improve honey yield and ensure better quality. Modern hive demand high expensive beekeeping equipments and accessories as well as skilled personnel compare to transitional and traditional hives. It was therefore recommended that government and non-government organization should focus on scaling up and promoting the adoption of transitional bee hives to improve farmers' income with little skills and low costs.

Cebotari and Buzu (2012) carried out an experiment on comparative study of maintaining bee colonies in different types of hives: horizontal and vertical, both with Dadant frames. Two similar batches of bee colonies were created. The first batch of 20 colonies was put in horizontal hives and second batch with 25 colonies– in vertical hives. The main sources of honey in the area were: Acacia, Linden tree and spontaneous flora. In beekeeping season of 2011 have been studied main biological and morpho productive characters of bee colonies, such as: colony strengthens, resistance to overwinter and diseases, queens prolificacy, brood viability, total quantity of honey collected in nest after harvest. Appreciation of morpho productive characters was done according to our methodology developed by the new zootechnic regulation according to bee colonies valuation, growing and certification of genitor beekeeping materials, approved by decision of Government of Republic of Moldova no. 306 of 28.04.2011. It was found that the types of hives, where

were housed the experimental bees, all other equal conditions of maintenance and exploitation, have not had any impact on the biological process of bees overwinter. This is confirmed by the fact that the average strengthens of bee colonies in both experimental groups, being equal at the beginning of experiment (1,78 kg in the autumn of 2010, in entry of overwinter) remained same in spring of 2011 (1,49 kg out of the winter). Therefore, overwinter resistance of bee colonies in both groups was also identical, averaging 83.1%. At the same time, the hive types, tested in experiment, had a significant influence on reproduction process and development of bee colonies in high beekeeping season. Thus, the queens prolificacy from 2nd batch with bee colonies located in vertical hives during the season, was higher compared to the Ist batch, accommodated in vertical hives, with 60 eggs/24 hours, or with 3.5% ($B > 0.95$). A better prolificacy activity of queens in vertical hives can be explained, in our view, by the fact that they have a better comfort of laying, compared with those from horizontal hives. We found that in horizontal hives, queens prefer for laying the area near bee entrance and it is explained by the fact that this place is better aired and ensure the brood with sufficient oxygen. In vertical hives queens laying is more uniform and it is spread on more honeycombs. This is due to a better and uniform ventilation in entire hive, which gives enough oxygen to brood. All this, has led to an active laying of queens from vertical hives, also to a bigger amount of capped brood and as a result, essential increase of bee colony strengthens. At the beginning of first harvest (locust tree), bee colonies placed in vertical hives reclaimed at a bigger rate than those placed in horizontal hives. Regarding bee colonies strengthens, those from 2nd batch exceeded significant, at this stage, those from 1st batch, with 0.33 kg or 9,4% ($B > 0,99$). Bee colonies from vertical hives entered overwinter significantly more powerful than bees from horizontal hives, which creates premises for a stronger development and better productivity in the next beekeeping season. Due to a quicker development, bee colonies kept in vertical hives accumulated, during active season, a bigger quantity of honey in the nest. Thus, the total quantity of honey accumulated in nest, bee families maintained in vertical hives have significantly exceeded those from horizontal hives with 7.5 kg, or 19,1% ($B > 0.999$). Economic effect obtained at exploitation of vertical hives only from honey production is 375 MD lei, or 23.8 euro per bee colony. Based on obtained results were made following conclusions. 1. Vertical hives compared to horizontal hives, offer to bee colony more

comfortable biological conditions. 2. Maintenance of bee colonies in vertical hives ensures an increase of queens laying -3.5% and of average annual strengthens of the bee colony – with 6.0%. 3. Use of vertical hives contributes to increasing of honey production with 19.1%. 4. Bee colonies exploitation in vertical hives ensures economic efficiency at least 23.8 euro per bee colony.

Famuyide *et al*. (2014) examined with a view to describing the socio-demographic characteristics of honey producers; to determine the economic contribution and level of honey production in Iseyin-Ogbomoso Local Government Areas of Oyo State. Six (6) Local Government Areas were purposively selected for his study. Seventy three (73) questionnaires were administered to honey producers. Data were analyzed using descriptive statistical tools such as frequency distribution and percentage, while inferential statistics such as Gross Margin and Linear Regression were implored. The result revealed that 26% of honey farmers were females while 74% were male, this showed that honey production is male dominated and the people involved are in their active working age. R2 value (0.5948) explaining almost 60% of the dependent variable, the overall P – value (0.0000) indicates the level of significance of explanatory variables at 1%. Positive co-efficient of educational level revealed that the higher the educational status, the higher the productivity and better management. The economic efficiency was 2.31 which implied that for every N1 spent to produce honey, in the study area 15.5 kobo was realized as profit. Honey business is however found to be lucrative.

Gebremedhn and Estifanos (2013) designed a study to familiarize alternative new technology, Kenyan top bar hive (KTBH) and to evaluate its honey productivity under farmers' condition. A total of 15 honeybee colonies which had similar strength were selected for comparison of KTBH with Modern beehive (MH) under farmers' condition. Honey yield data from each hive per harvesting season was recorded immediately after harvest. The collected data were analyzed using GLM analysis of variance procedure. There was significant difference between modern and Kenyan top bar hive for honey yield. The potential productivity of the modern hive (22.8 kg/hive) was higher than the KTBH (17.8 kg/hive). In Begasheka honey yield from the modern hive (25.7 kg/harvest) was significantly higher than the Kenyan top bar hive (17.8 Kg/harvest). While, in Debrekidan

there was no significant difference between both hives. It is therefore recommended to use the KTBH as an alternative technology in areas like Debrekidan watershed for farmers with little skill in modern hive management and to minimize the shortage of beeswax.

Getachew *et al*. (2015) examined four beehive types: namely improved frame hive (Zander model), Kenya Top Bar Hive (KTB), Ethio-ribrab hive and traditional log hives based on honey yield performance, honeybee colony strength and profitability under environmental condition of Bonga, southwest Ethiopia. The overall average annual honey yield performance clearly revealed both improved frame hive (30.09 ± 2.69 kg/hive) and Ethio-ribrab hive (29.22 ± 2.69 kg/hive) were significantly higher ($p < 0.000$) than KTB hive (15.71 ± 2.22 kg/hive) and traditional log hive (15.36 ± 0.86 kg/hive). In addition, the strength of honeybee colonies in the present study found to be higher in improved frame hive and Ethio-ribrab hive but medium in KTB hive and Traditional log hive. The total cost of production and gross return of improved frame hive was higher than Ethioribrab, KTB hive and traditional log hives. However, Ethio-ribrab hive stands first in profitability followed by improved frame hive compared to KTB and traditional log hive types. His study result could be useful in humid and subhumid areas of the country, therefore, introduction of both improved frame hive and Ethio-ribrab hives is recommended along with all packages important to beekeepers.

Guyo and Legesse (2015) were undertaken a study in different parts of the Ethiopia to identify the opportunities and challenges of beekeeping systems in the country and in so doing to suggest possible intervention measures for the identified problems. Based on the review indication in most part of the country except nearby research center areas only two types of honeybee production systems were identified, namely traditional and transitional honeybee production systems. Based on these criteria, a honeybee production system in the country is predominantly traditional and transitional (90.3%) and very few (9.7%) were practiced with modern beekeeping systems. According to different citation most of beekeepers explain that they started beekeeping, most of them (92%) have started beekeeping by trapping swarms and some (7%) received from their parents as gifts. Honeybee flora compositions of the country are dominated by natural vegetation, undergrowth, and some perennial crops; cultivated crops, annual herbs, and some natural

trees have significant contribution for beekeeping. The major challenges were drought, pests and predators, pesticide poisoning, low hive occupation rate, absconding, lack of modern beekeeping equipment and materials, honeybee diseases, lack of honey storage facilities, poor extension service, non-existence or low involvement of women in beekeeping development and lack of knowledge of appropriate methods of beekeeping. On the other hand the opportunities for beekeeping in the country were the existence and abundance of honeybee, availability of potential flowering plants, ample sources of water for bees except in drought prone area, traditional knowledge of beekeepers' experience and practices and socio-economic value of honey. As concluding remarks, the traditional and homemade hives were financially feasible and appropriate for relatively good use of locally available resources. Thus, the major concern to sustain the beekeeping activities should be integration of beekeeping with natural resources conservation programs, introducing affordable and appropriate.

Islam *et al*. (2014) investigated erstwhile undocumented litchi honey samples from Bangladesh, for its antioxidant and physico-chemical parameters that may increase knowledge of product quality in a given geographic area, as well as its commercial value. Three litchi honey samples were collected from different regions of Gazipur and Tangail district, Bangladesh. The major physicochemical properties such as- moisture, ash, protein, fat, carbohydrate, energy content, pH and TSS were measured. Although the physicochemical parameters of the honey samples varied, most of the honey samples were in the acceptable range of international standards. Results indicated that total phenolic content ranged from 33.241 to 34.824 mg Gallic acid/ 100g, flavonoid content varied between 4.024 and 4.954 mg Catechin/100 g and vitamin C was found in the range 13.612 to14.636 mg/100g, indicating a high antioxidant potential. Their study revealed that Bangladeshi litchi honey samples maintain the international honey standards and contain a good source of antioxidants.

Ito (2014) examined the honey production taking place in mountain forest area of southwestern Ethiopia and discusses the roles and relevance that local people see in their way of honey production and the honey they harvest. The honey production in Ethiopia has recently been attracting attention of various agencies as a tool for revitalizing Ethiopian

economy, reducing poverty, and conserving the forests. As expectations for the honey production rise, many researchers have worked all over Ethiopia to improve the productivity and efficiency of current production process. However, most of previous research emphasize too much on improving productivity and efficiency and disregard the roles and relevance that the local people see in the local method of honey production. His article first illustrated local honey production process in detail and points out local honey production serves a place of exchanging knowledge and technique regarding honey production and strengthened social relationships and honey producers value honey they harvested by the local method.

Kinati *et al*. (2013) conducted an experiment in Gomma district of Jimma Zone, south western Ethiopia to assess honey production and marketing systems. For their study, six peasant associations (Pas) were selected using purposive sampling techniques. From each PA, 30 beekeepers (a total of 180) were randomly selected and interviewed using pre-tested, structured questionnaires. Data were collected and analyzed using descriptive statistics. Results of their study showed that the mean age of the respondents was 40.47 years, indicating an active and productive age. The beekeepers had an average experience of 5.66 years where male respondents (92.8 %) take the largest share to be engaged in beekeeping activities. The average honey yield per year/colony was 7.20 ±0.23, 14.70 ±0.62 and 23.38±0.73kg for traditional, transitional and moveable frame hives, respectively. Honey marketing participants were producers, collectors, retailers and consumers. There was no difference in price of crude honey between study locations ($P>0.05$), while significance difference ($P<0.05$) was observed for table honey. From results of their study honey yield per hive/year was found to be low from traditional and transitional hives as compared to moveable frame hive. Thus, strong extension and technical intervention was important for farmers to use the moveable frame hives to increase honey production and income of beekeepers in that study area.

Kiros and Tsegay (2017) conducted in two purposefully selected zones of Oromiya Regional State, namely Jimma and Illubabor in Ethiopia. The objective of their study was to analyse the honey-bee production and to assess hive technology preferences in that study area. A total of 156 beekeepers were randomly and proportionately selected from four

districts (Mana and Gomma from Jimma and Bacho and Yayo from Illubabor). Data were collected through formal survey and secondary sources. Accordingly, the average age of the beekeepers was 40.2 ± 8.13 years with an average of 13.5 ± 6.58 years of experience. The majority of the respondents (53.2%) in the study area got their colonies by catching swarms. Three hive types (traditional, transitional, and frame hive) were found in the study area. More than 70% of the respondents harvested once a year from traditional hives, while 25% of respondents harvested up to three times per year from frame hives. Moreover, an average of 22 ± 4.6 and 16 ± 4.1 kg of honey were harvested from frame and transitional hives per year, respectively. Compared to these two hives, a much lower (7 ± 1.6 kg) amount of honey was harvested from traditional hives. Various honey-bee floras were identified in the study area. Plants such as *Vernonia amygdalina, Croton macrostachyus*, and *Schefflera sp*. produce white honey. Half of the respondents' preferred transitional hive followed by frame hive (37.2%). Factors which affect the use of frame hives were lack of equipment (36.5%) followed by wax quality and availability problems (34%). That is why few beekeepers tried to modify the frame hive to solve the problems of wax in vertical frame hive. In order to adopt and sustain modern hive technology, the focus should be on honey-bee equipment as well as wax quality and availability.

Kumsa and Takele (2014) conducted a study in Jimma Zone where modern beekeeping has been practiced since 40 years. For their study three districts (Kersa, Goma and Gera) were purposively selected depending upon the existence of large number of modern beekeeping. A total of 75 beekeepers engaged in modern beekeeping were contacted and interviewed. Visual assessment of apiaries and internal inspection of suspected colonies were carried out to harmonize the relevant information noted by respondents. Interview on beekeepers characteristics, seasonal bee management practices of modern beekeeping, bee forage flowering seasons, bee management constraints and honey production were collected and analyzed. The result revealed that 62.7% modern beekeeping in the study area is based on inappropriate colony management practices and characterised predominately by high absconding and low honey yield despite the abundant bee forage potential in the study areas. Inappropriate skill bee management practices, colony absconding, poor design of modern beehives, low honey yield and bee pests are the main problems that impede the full use of apiculture resources in that study area. Interventions in modern beekeeping should

be focused on empowering beekeepers with skills through ensuring availability of improved beekeeping technologies with standard seasonal bee management practices should be strengthened.

Mohammed *et al*. (2017) revealed vital information on the demography of the Apiculturists and the traditional honey beekeeping, honey production; male's youths (83%), married persons (57%), those with formal educational status (68%), business persons (31%), attended secondary level of education (35%), number of house hold size (16 persons and above), had experience in beekeeping (9 years and above), were mostly involved in Apicultural practicing. They also revealed that most of the Apiculturists in the study area use grass hives for the traditional method (27%), honey bee wax as attractant for new colonies formation (51%), wild honey harvesting (63%) and traditional methods of honey production (68%), rude method of honey processing (61%) and theft of the honey being produced was the most serious problems they encountered were (37%). The majority of the Beekeepers in Biu and its environs sale their honey at retails price (41%) and sales were done in the rural market (47%) inclusively. Youths were urging to engage and participate in this sector of farming, it adds more beauty to the agro – ecosystem - ecology and economic values systems.

Okonta (2014) examined honey production in Delta State using traditional hives. Structured questionnaires, survey and interviews were used to elicit information from respondents in fifteen Local Government Areas of Delta State where traditional beekeeping has been identified to thrive. Data collected were subjected to descriptive and inferential statistics using frequency count and percentages. Analysis of variance was used to test for significance and LSD used to separate significant means at 0.05 level of probability. His study results showed that more men were into traditional beekeeping and that the straw hive was more popular and the best in terms of yield when compared with clay pot and the Calabash. More awareness and education were recommended.

Patidar *et al*. (2017) conducted a research work during *rabi* 2013-14 and 2014-15 at ARS, Kota to enhance the yield of mustard through honey bee pollinator. Mustard variety "Bio-902" was grown following all recommended agronomic practices without spraying through the crop season. The colonies of honeybee (*Apis mellifera*) were placed in cage measuring

10X10 sq. meters before the initiation of flowering. Their study contained three pollination treatments viz., Plants caged Pollinator Exclusion (PE), Plants caged with bee hive (BP) and Plants kept open to all pollinators (OP). The comparative data pertaining to modes of pollination in mustard crop revealed that highest values of mean no. of siliqua/plant (186.44), no. of seeds/ siliqua (13.82) and seed yield (20.54 q/ha) were obtained from OP followed by BP and it was recorded lowest in PE. The introduction of honeybees in agricultural crops plays a vital role in pollination which in turn resulted in higher production of seed yield as well as honey production.

Pocol and Popa (2012) evaluated the comparison of different production practices: stationary beekeeping versus pastoral beekeeping; conventional beekeeping versus organic beekeeping. In the area of scientific research at a national level these issues have not been considered so far. Their research methods used for these comparisons were the survey and the focus group. Following the quantitative and qualitative data analysis, the advantages and disadvantages of the above mentioned beekeeping practices were identified: stationary beekeeping generates products designed primarily for use in the household or within the close network of friends, does not require significant resources, but the productivity of the hives is lower. By practicing pastoral beekeeping instead, a higher productivity was obtained, but the expenses for the travel are high and the risks associated to moving the hives were significant. In terms of the comparison between the economic efficiency of conventional versus organic beekeeping, although 82% of the respondents agree at the declaratory level with the principles of organic beekeeping, this type of beekeeping it is not yet sufficiently attractive for several reasons: bureaucracy, the difficulty of selling the products within the country, very expensive periodic inspections, higher costs and greater risks. The practical implications of the present research are meant to provide solutions to beekeepers from the North West Region and not only, in order for them to choose the most efficient production techniques, consistent with the three components of sustainable development: the economic, social and environmental component.

Rahman and Moniruzzaman (2009) conducted a research to examine the scope of beekeeping in Bangladesh. The data were collected from beekeepers of Tangail and Gopalgonj districts, because this enterprise is working more in these areas than others in

Bangladesh. Fifty-four beekeepers were selected randomly and they were interviewed for getting the necessary data to determine the costs and return of beekeeping and to assess the scope of beekeeping. Forty six percent of the total beekeepers had own land of 0.51 to 1.50 acres and 37 per cent of them were young beekeepers in the age group of 15-30 years. Most of the beekeepers took it as a main occupation. The benefit cost ratio of beekeeping was 1.59 which showed that this business was profitable. It will be a great source of employment creation for the rural poor people to reduce the poverty. There is a great prospect of beekeeping in Bangladesh on the basis of the socio-economic context of the country and some special features of the enterprise. There are some problems identified by the beekeepers and they have suggested some solutions also.

Shenkute *et al*. (2012) investigated an experiment in the Southwest parts of Ethiopia particularly Kaffa, Sheka and Bench-Maji zones which are endowed with very diverse and dense natural forests. This favoured for the existence of dense honeybee population and production of large volume of honey. However, detail information on honey production systems of the area was lacking. In their study five representative districts were selected and data on beekeeping practice and its major constraints were collected. Traditional beekeeping system is practiced by more than 99% of beekeepers. The average traditional hives owned/household in Masha and Gesha were significantly higher ($P < 0.05$) than Gimbo, Chena and Sheko districts. Honey yield per traditional hive/harvest in Masha and Gesha were significantly higher ($P < 0.05$) than Gimbo and Chena districts. In the study areas honey contributes 50% of the total household incomes. The major proportion of the honey comes from forest beekeeping. In Kaffa and Sheka Zones, honey harvesting is done by removing all the content of the hive by discarding the colony while, in Bench-Maji Zone, harvesting is done by leaving all brood and some honey to maintain the colony. Prevalence of ant attacks, less adoption of improved beekeeping technologies and management practices, lack of practical skill training, under utilization of apicultural resources are the major constraints which require attention to be intervene.

Tesfaye *et al*. (2017) planned to assess beekeeping practices, trends and constraints of beekeeping production in Bale, south-eastern Ethiopia in 2014/15. Three districts were considered based on variations in agro-ecology (high, mid and lowlands). From each

districts two Rural Kebele (RKs, from each RK 30 beekeepers and a total of 180 beekeepers were selected using purposive sampling method. The selected beekeepers were interviewed using pretested structure questioners and single- visit – multiple formal survey method to collect the data. The data revealed that the majorities (98.26%) of the respondents follow traditional production system. An average honeybee colony holding size of the study area was about 6.18 per head with 5.70 kg mean honey yield per traditional hive and no record for transitional and movable-frame beehives. From result of their study, the major challenges of beekeeping identified were: application of herbicides and pesticides, pests, lack of beekeeping equipment's, shortages of bee forages, lack of improved beehives, migration, absconding, lack of extension services, swarming, and death of bee colonies in order of their importance. Their study identified major beekeeping constraints and beekeeping practices in Bale zone. Hence, it required high attention and both techniques and technology intervention to make benefit of the large beekeepers in Bale zone and the country in general.

Verma and Attri (2008) conducted a survey in seven blocks of district Chamba revealed that there are about 2.45 hives per house and occupancy rate of hive is 53.94 % in the region testifying to the rich ness of this culture. The Indigenous wall hives are locally called as Ganari in Chamba district. The dimensions of wall hive was accordingly, made by leaving a cavity in the wall when the house is under construction. On the inside, it is covered usually with a slate or stone plastered with mud. The size depends upon the availability of hollow tree trunk of Toon, Robinia, Bann, Kail trees. Beekeepers of district Chamba prefer the wall hive, however quantity of total honey harvested and ease of harvest is best in log hives. People clean their hives by scrubbing them from inside with scrubbers made of pine needle, Juniperis sp. or old raw combs. This helps in attracting the bees to the hives. Economic efficiency of Apis cerana (Indigenous beekeeping) is shown to be more economic then Apis mellifera. Beekeeping with Apis cerana should be encouraged for rural households with low investment capacity.

Weldemariam (2015) demonstrated a survey to develop information on the quality and productivity of modern (framed) hives which have been introduced at different years and its determinant factors and drawing policy implications for future extension approaches.

His study included four districts of central zone of Tigray where beekeeping has significant role in the livelihoods of smallholder farmers. Two local administrations from each district were taken purposely and totally 200 beekeepers including cooperatives were used for interview. About 92.5% of the beekeepers were male and the rest women. Use of framed bee hive started in the central zone since 1998 with massive introduction during 2005 to 2008. His study indicated that only 63.4% of the respondents received technical support and 75.1% of beekeepers exercise replacing of old combs in addition to this 81.4% removed and applied suppering according to the feed availability and strength of the colony. Absconding of bee colonies from framed hive indicated increasing over years. The productivity of colonies in the framed hive was almost similar across year except the first two. The highest honey yield (31.5kg/hive) was record during the early years while the minimum (19.59kg/hive) was in 2009.Pests and predators, lack of management, poor skill, improper use of agrochemicals and feed shortage were identified by beekeepers as the most factors affecting beekeeping in all areas. About 60.3% of the beekeepers had full trust and confidence on the framed beehive while the rest 39.1% outlined that the technology has drawbacks. About 89.7% of the interviewed farmers reflected their interest to use the hive in an increasing way for the future. The results showed that performance of framed hive had slight difference across years with maximum at the early stages. This could be due to the difference in the quality of extension service delivered with time. Therefore effective use of the technology needs effective training and extension support and supply of accessories and rising of awareness on application of herbicides and pesticides with developing its application rules.

Wongsiri *et al*. (2012) carried out an experiment on the organic honey in the kingdom of Thailand was new and innovation since few records in the literatures. Mostly the normal traditional beekeeping in Thailand was possible to be changed to the organic beekeeping in many bee-yards. The point they have to educate the beekeepers and verify the standard of organic honey in the Kingdom. The average annual honey production of a traditional hive is 3-5 kg/ annum, while that of a box hive is 5-20 kg/annum. In areas with beekeeping potential, there are two or more harvests resulting from multiple flowering periods. In the country, about 10,000 metric tons of honey are produced annually. The types of honeys produced in Thailand are well known according to their seasons and their botanical origins.

These types included *Eupatorium odortum*, *Dimcarpus fumatus*, *Hilianthus annus*, *Sesamum orientale*, and *Croton roxburghii* honeys. The majority of beekeepers extract honey by the traditional straining method, while some beekeepers with modern hives extract their honeys using honey extractors. This method has to be modified to be the standard or organic beekeeping methods. Now China produces organic honey from the Asian honey bee *Apis cerana* more than one million colonies in the forest. Bee flora and the beekeeping practice of Asian honey bees need not use pesticides and anti-biotics.

CHAPTER III

MATERIALS AND METHODS

The experiment was conducted at the Research farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, 23°41′N latitude and 90°22′E longitude with an elevation of 8.6 meter above sea level. The experiments were carried out during 2015-17. The material used and methodology adopted for these experiments are described as follow:

Experimental site

The present study on honey collection efficiency of *Apis mellifera* L. was done in Sirajgonj, Gazipur and Satkhira districts. Three upazilla i.e. Ullapara (Site 1), Shahzadpur (Site 2) and Tarash (Site 3) were selected in Sirajgonj for the study. Similarly Gazipur Sadar (Site 1), Kapasia (Site 2) and Kaligonj (Site 3) upazilla were selected in Gazipur districts. Moreover, Munshigonj (Site 1), Kaligonj (Site 2) and Tala (Site 3) upazilla were selected in sundarban areas of Satkhira district. The experimental duration was 01 November 2015 to 30 May 2017. Peak mustard flower blooming period, litchi blooming period and mangrove plants blooming period were selected for data recording. Data collection regarding the predetermined parameters and the analysis of data was performed to measure the efficiency of honey bee.

Experimental Duration: The experiment was conducted during 1st November 2015 to 30 May 2017.

Design and layout: The experiment was carried out in paired plot design.

Materials required

i.	Wooden hive single	ii.	Poly bee hive
iii.	Frame	iv.	Healthy colon
v.	Healthy queen	vi.	Hive tool
vii.	Cover all	viii.	Smoker
ix.	Bee brush	x.	Gray box
xi.	Nuc box	xii.	Gunny bag
xiii.	Polythene	xiv.	Tool box
xv.	Veil	xvi.	Feeder pot
xvii.	Foundation wax sheet	xviii.	Frame wire
xix.	Queen catcher clip	xx.	Queen marker
xxi.	Handgloves	xxii.	Weight gauge
xxiii.	Tent and Data book.		

Plants

Honey was collected from the following plants :

- Gewa, Kewra, Bain, Poshur and many other trees of sundarbon in Satkhira district
- Mustard in Sirajgang district
- Litchi in Gazipur district

Replication

36 boxes were used in the experiment among them 18 were wooden hive and 18 were poly hive.

Treatment

1. Wooden hive

2. Poly hive

Collection of honey: By using honey extractor

Data Collection

- ❖ Amount of honey/box (Kg)
- ❖ Assessment of honey moisture

Plan of Work:

Table 2 : Time frame

Area selection and box preparation	2 month
Data collection	6 months
Data processing and analyzing	2 months
Report writing	2 month
Total	12 months

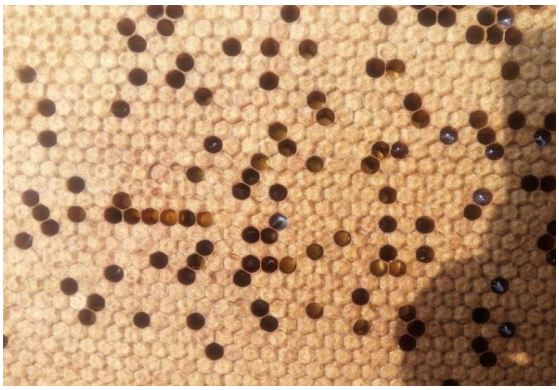
Data analysis

Data was analyzed using MSTAT-C computer program. Wherever necessary, data was transformed following appropriate methods before ANOVA. Standard error calculated by MSTAT-C and plotting bars and boxes in R i386 3.4.0 (R Gui-32 bit).

a. Honey comb of traditional box

b. Polyhive super bee boxes

c. Honey comb of polyhive super box



d. Good brood pattern

e. Traditional bee boxes

f. Honey bee foraging in the apiary

CHAPTER IV

RESULTS AND DISCUSSION

Foraging behaviour of *A. mellifera* on Mustard flower

Honey bee forages on mustard flower to collect nectar and pollen. Data was observed from the morning 9.00 hour to 16.00 hour. It was found that number of bees/m²/min was highest (13) at 12.00 and 13.00 hours of day time whereas, the lowest (5) number of bees/m²/min was observed at 16.00 hours of day time (Table 3). Average number of bees/m²/min was low in the morning and it reaches in peak over the time and from 14.00 hours of day bee foraging declined.

Table 3: Foraging behaviour of *A. mellifera* on Mustard flower

Observ -ation	**Day hours**							
	9:00	**10:00**	**11:00**	**12:00**	**13:00**	**14:00**	**15:00**	**16:00**
No. of bees/m² /min(av erage)	8±0.03	9±0.03	11±0.02	13±0.14	13±0.02	8±0.00	6±0.03	5±0.07
No. of flowers visited/ min(av erage)	10±0.00	17±0.02	21±0.06	25±0.03	25±0.06	21±0.04	18±0.03	12±0.03

Similar pattern of honey bee foraging was observed in terms of number of flowers visited/min (Table 3). The highest number of flowers visited/min of honey bee was observed from the morning 9.00 hour to 16.00 hour. It was found that number of flowers visited/min was highest (25) at 12.00 and 13.00 hours of day time whereas, the lowest (10) number of flowers visited/min was observed at 16.00 hours of day time (Table 3). Average number of flowers visited/min was low in the morning and it reaches in peak over the time and from 14.00 hours of day bee foraging declined significantly. From this table it is concluded that foraging efficiency i.e. number of bees/m²/min and number of flowers visited/min was low in the morning and evening but at noon time it was high. It also expresses that sunlight increases efficiency of honeybee foraging up to a certain limit which is correlated with the temperature.

Honey yield/hive in three different locations of Sirajgonj

Three different sites of Sirajgonj district were abundant of bee nectar during the mustard flowering period. In traditional bee hive the harvested honey produce was lower than the super. It was observed that in the poly hive super the highest (17.03 kg/hive/season) honey yield was obtained from site 3 i.e. Ullapara and the lowest (16.33 kg/hive/season) honey yield was obtained in site 1 i.e. Tarash by poly hive super (Fig. 1).

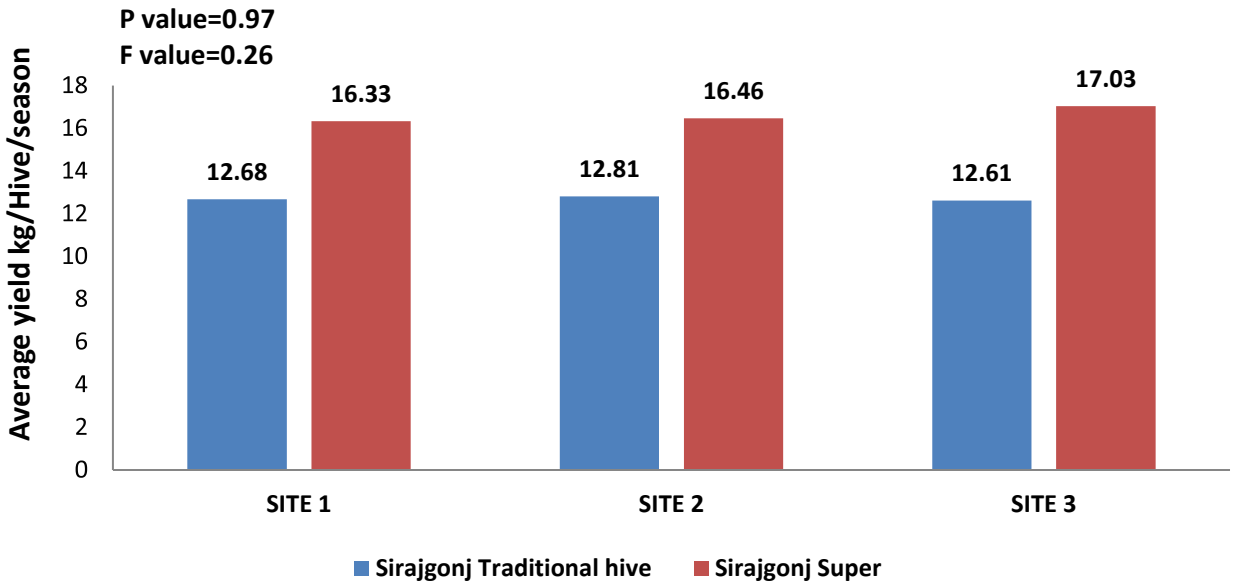


Fig 1. Honey yield/hive in three different locations of Sirajgonj during 2015-2016

There was considerable yield in traditional bee hives and it was significantly differed from the modern poly bee hives with super. The highest honey yield harvested with traditional bee hive from Shahjadpur, Sirajganj in site 2 and that was 12.81 kg/hive/season in 2015-2016. There is a significant comparison in traditional hives with the poly hive super (fig 1).

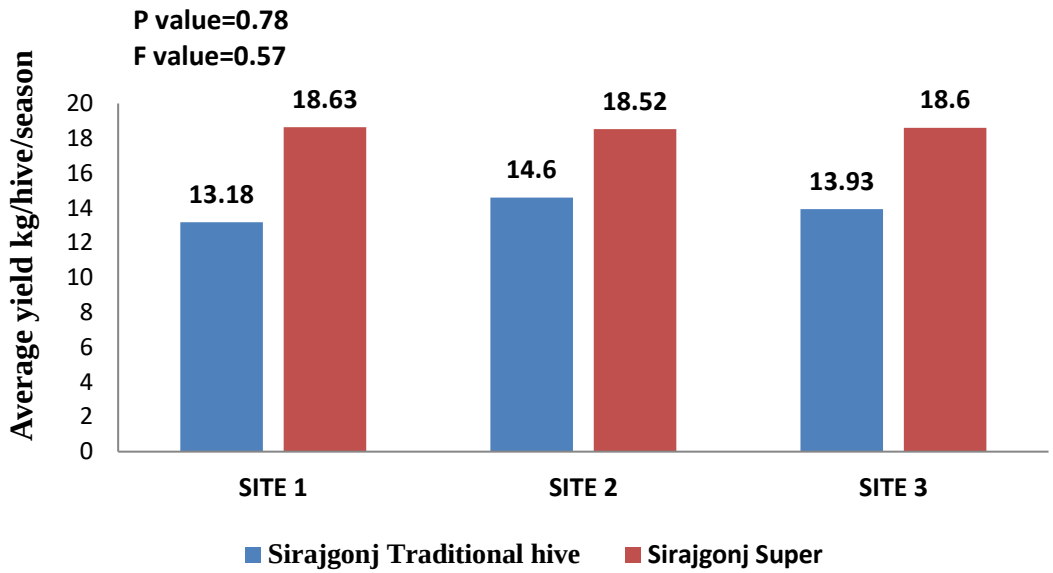


Fig 2. Honey yield/hive in three different locations of Sirajgonj during 2016-2017

On the other hand, the highest honey yield harvested with poly hive super from Tarash, site 1, Sirajganj and that was 18.63 kg/hive/season in 2016-2017 and the lowest honey yield with poly hive super was in site 2 i.e. Shahjadpur. There is a significant comparison in traditional hives with the poly hive super (fig 2)

Year comparison

There is a significant comparison that expressing honey yield between two successive years and in between traditional hive and poly hive with super in figure 3 below. Figure 4 shows that In Sirajganj traditional box both of the boxes data ranges within 12-14 kg/hive/season honey yield

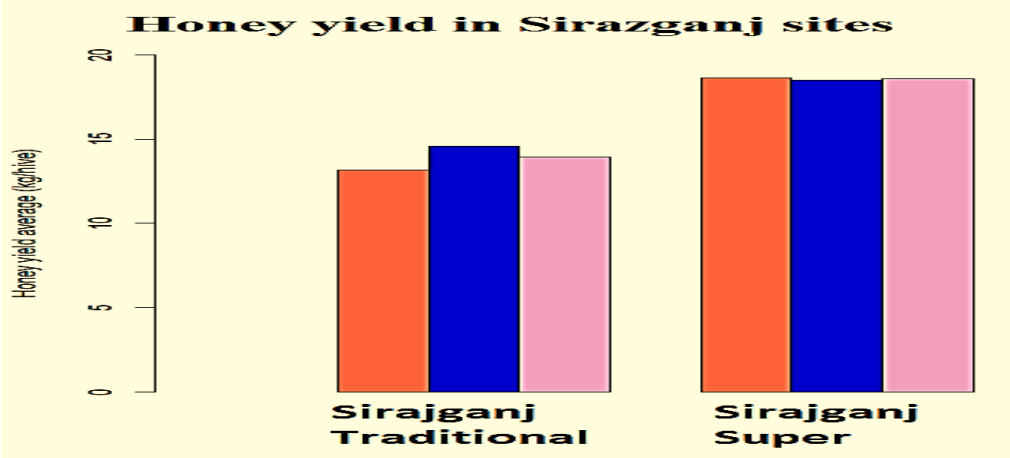


Fig 3. Procedural difference changes honey production efficiency

whereas in Sirajganj Super box showing honey yield ranges within 15 to over 18 kg/hive/season. It is significantly expressing the lower capability of traditional honey boxes than the poly hive super. On the other hand, in both cases year difference produced dissimilar data rather than equal contribution of honey yield. (fig: 4)

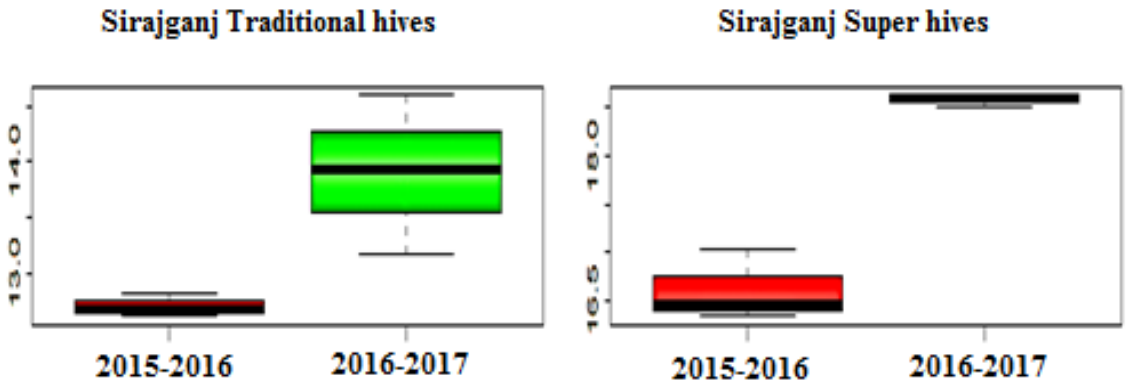


Fig 4.Yearly comparison of honey yield in Sirajganj district.

Explanation could be assumed as below:

a. There could be weather and environmental factor (temperature, wind, RH etc) differences between these two successive years.
b. There could be a difference in honey bee population in these years.

Foraging behaviour of *A. mellifera* on Litchi flower

Honey bee forages on litchi flower to collect nectar and pollen. Data were collected from the morning 7.00 hour to 17.00 hour. It was found that number of bees/m²/min was highest (13) at 9.00 to 10.00 hours of day time whereas, the lowest (5) number of bees/m²/min was observed at 14.00 to 15.00 hours of day time (Table 2). Average number of bees/m²/min was low in the morning and it reaches in peak over the time and from 14.00 hours of day bee foraging declined.

Table 4: Foraging behaviour of *A. mellifera* on litchi flower for understanding honey production efficiency

Observation	**Day hours**				
	7.00-8.00	**8.00-9.00**	**9.00-10.00**	**10.00-11.00**	**11.00-12.00**
No. of bees/m²/min (average)	6±0.031	7±0.02	13±0.145	11±0.02	8±0.036
No. of flowers visited/min (average)	15±0.03	17±0.04	25±0.039	22±0.039	21±0.06
Day hours	**12.00-13.00**	**13.00-14.00**	**14.00-15.00**	**15.00-16.00**	**16.00-17.00**
No. of bees/m²/min (average)	8±0.002	7±0.02	5±0.02	6±0.031	5±0.073
No. of flowers visited/min (average)	19±0.06	9±0.001	8±0.002	12±0.036	10±0.001

Similar pattern of honey bee foraging was observed in terms of number of flowers visited/min (average) (Table 2). The number of flowers visited/min of honey bee was observed from the morning 7.00 hour to 17.00 hour. It was found that number of flowers visited/min was highest (25) at 9.00 to 10.00 hours of day time whereas, the lowest (8) number of flowers visited/min was observed at 14.00 to 15.00 hours of day time (Table 2). Average number of flowers visited/min was low in the morning and it reaches in peak over the time and from 14.00 hours of day noof flowersvisited/min gradually declined

From this table it is concluded that foraging efficiency i.e. number of bees/m²/min and number of flowers visited/min was low in the early morning and afternoon but with the increase of daytimeper square meter appearance/visitation increased.

Honey yield/hive in three different locations of Gazipur

Three different sites of Gazipur district were abundant of bee nectar during the litchi flowering period. In traditional bee hive the harvested honey produce was lower than the poly hive with super. It was observed that in the poly hive super the highest (20.46 kg/hive/season) honey yield was obtained from site 2 i.e. Kapasia and the lowest (20 kg/hive/season) honey yield was obtained in site 3 i.e. Kaliganj by poly hive super (Fig. 5).

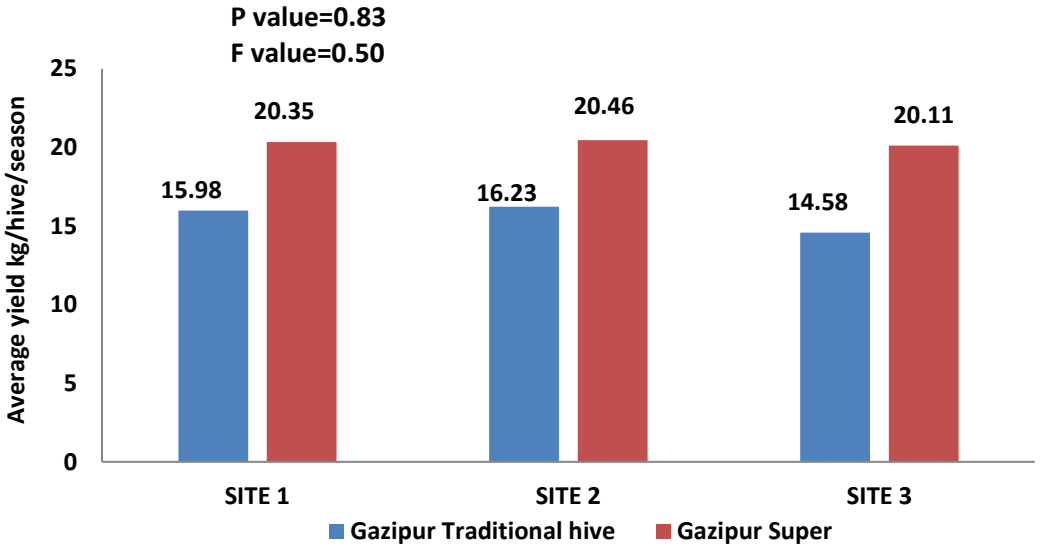


Fig 5: Gazipur litchi sites honey yield comparison during 2015-16 flowering period

There was considerable yield in traditional bee hives and it significantly differed from the modern poly bee hives with super. The highest honey yield harvested with traditional bee hive from Kapasia, Gazipur in site 2 and that was 16.23 kg/hive/season.

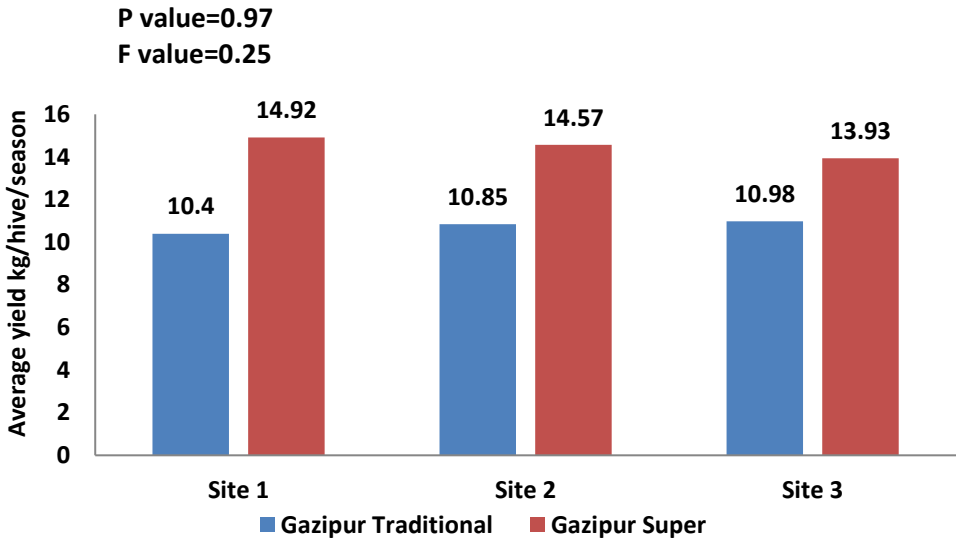


Fig 6: Gazipur litchi sites honey yield comparison during 2016-17 flowering period

On the other hand, during 2016-17 litchi flowering period three different sites of Gazipur district were also abundant. In traditional bee hive the harvested honey produce was lower than the poly hive with super. It was observed that in the poly hive super the highest (14.92 kg/hive/season) honey yield was obtained from site 1 i.e. Gazipur Sadar and the lowest (13.93 kg/hive/season) honey yield was obtained in site 3 i.e. Kaliganj by poly hive super (Fig. 6). There was considerable yield in traditional bee hives and it significantly differed from the modern poly bee hives with super. The highest honey yield harvested with traditional bee hive from Kaliganj, Gazipur in site 3 and that was 10.98 kg/hive/season.

Year comparison

There is a significant comparison expressing in honey yield within two successive years and in between traditional hive and poly hive with super in figure 4 below. Figure 4 shows that In Gazipur Traditional box both of the boxes data ranges within 11-16 g/hive honey yield whereas in Gazipur Super box showing honey yield ranges within 14 to over 20 g/hive. It is significantly showing the lower capability of honey production in traditional honey boxes than the poly hive super. On the other hand, in both cases yeardifference produced dissimilar data rather than equal contribution of honey yield.

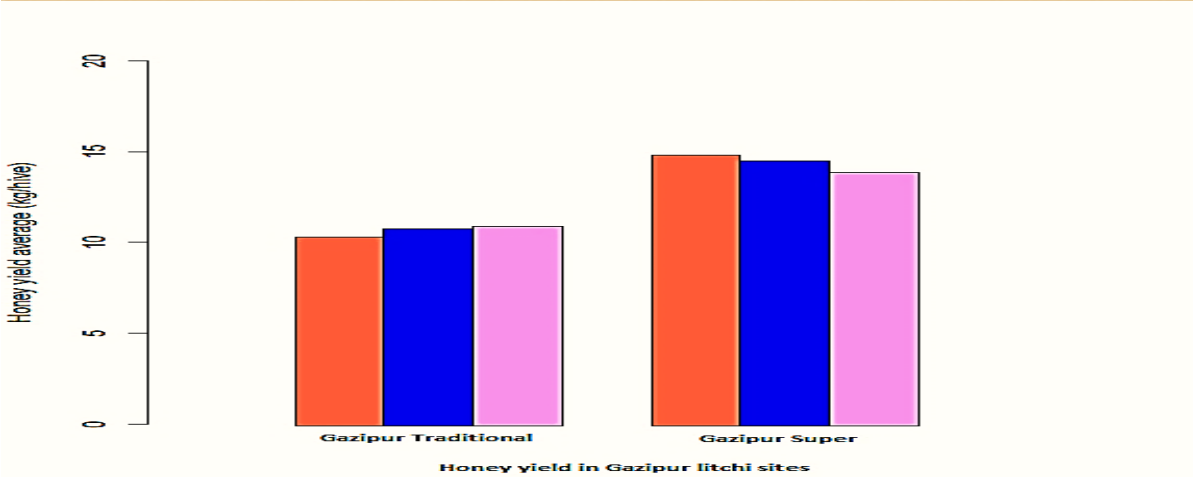


Fig 7: Gazipur litchi sites honey yield comparison

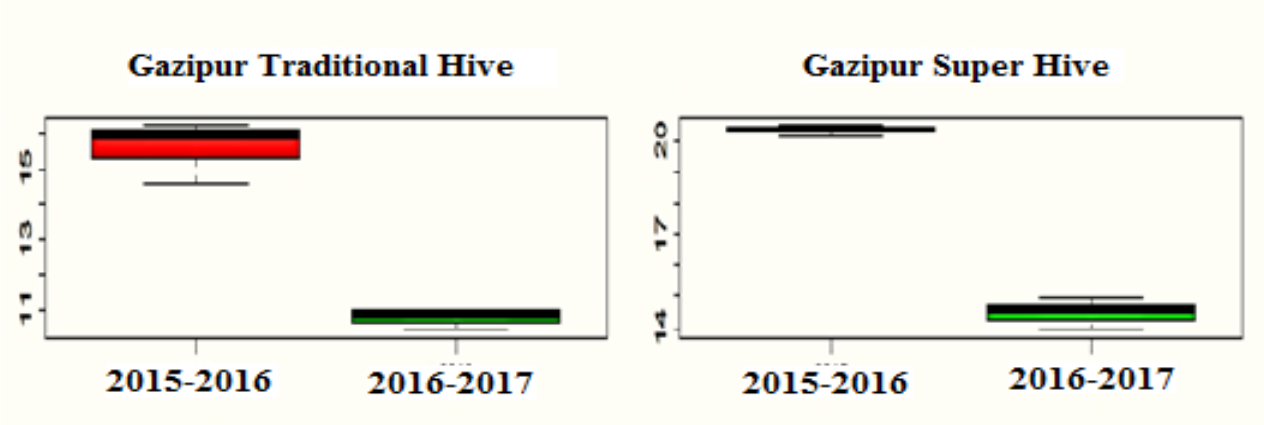


Fig 8: Gazipur litchi sites honey yield comparison year basis

Explanation could be assumed as below:

a. There could be weather and environmental factor (temperature, Rainfall etc) differences between these two successive years.
b. There could be a difference in honey bee population in these years.

Honey yield/hive in three different locations of Sundarban

Three different sites of Sundarban district were abundant of bee nectar during the pick period of various flowers in Sundarban. In traditional bee hive the harvested honey produce was lower than the super. It was observed that in 2015-16 in poly hive super the highest (14.92 kg/hive/season) honey yield was obtained from site 3 i.e. Tala and the lowest (14.65 kg/hive/season) honey yield was obtained in site 2 i.e. Kaliganj by poly hive super (Fig. 9).

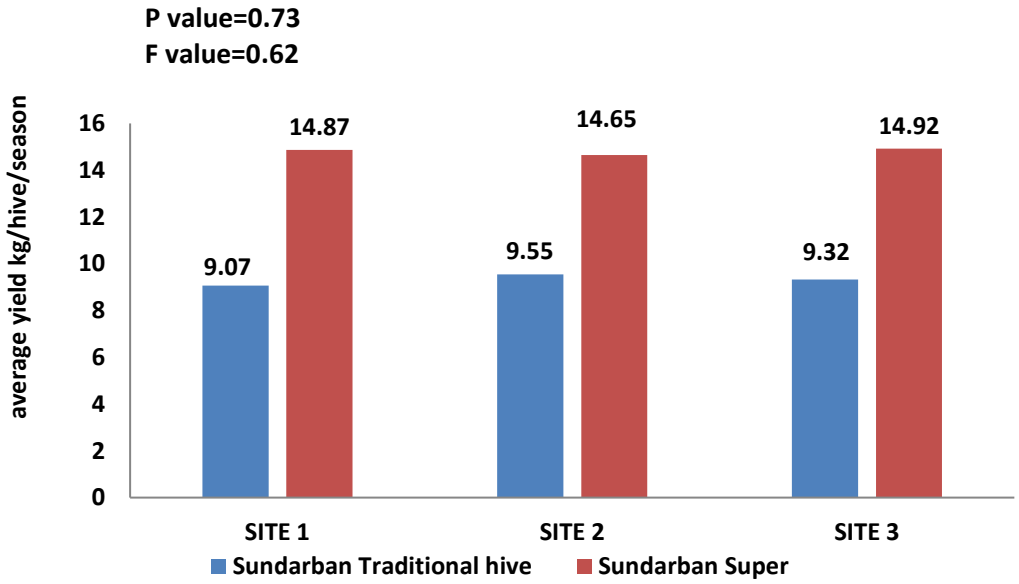


Fig 9: Honey yield in 2015-16 in Sundarban

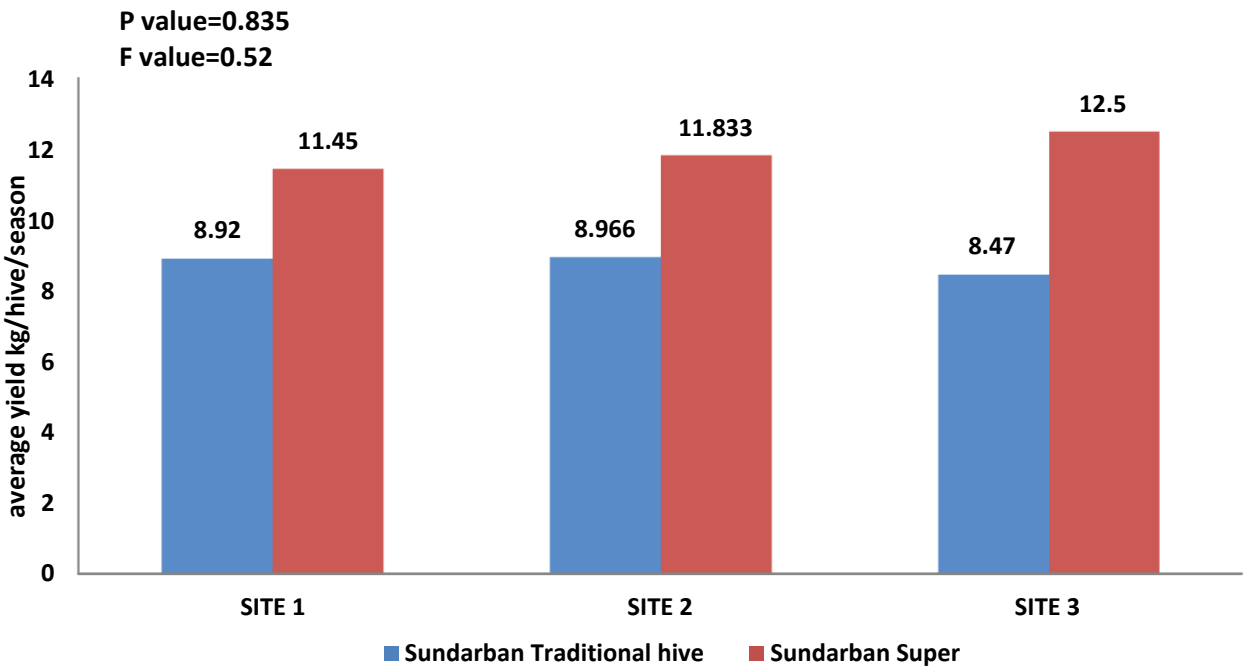


Fig 10: Honey yield in 2016-17 in Sundarban

On the other hand, in 2016-17 in poly hive super the highest (12.5 kg/hive/season) honey yield was obtained from site 3 i.e. Tala and the lowest (11.45 kg/hive/season) honey yield was obtained in site 1 i.e. Munshiganj by poly hive super (Fig. 10).

There was considerable yield in traditional bee hives and it significantly differed from the modern poly bee hives with super. The highest honey yield harvested with poly hive super and the amont was 14.92 kg/hive/season from multi floral source in 2015-16 year.

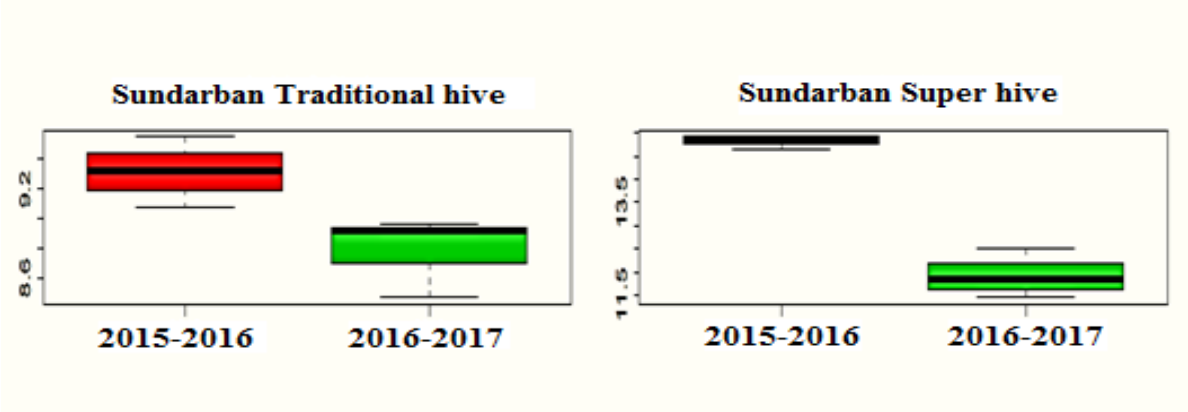


Figure 11.Yearly comparison of honey yield in Sundarban multifloral source.

In figure 11 and figure 12 there are a comparative box plot and a barplot showing the yeardifference at a glance with two different way of bee colonization. There is also a significant change in honey production between these two successive years.

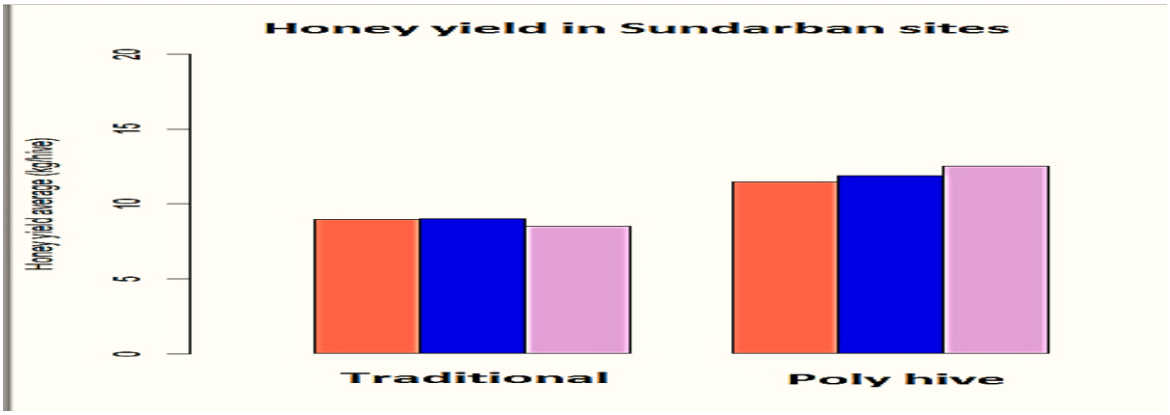


Fig. 12. Traditional hive and super hive honey yield comparison plot

CHAPTER V

SUMMARY AND CONCLUSION

Honey bee foraging efficiency in mustard flower was studied to find out the foraging efficiency of honey bee in mustard flower at blooming period and to discover the yield of pollen in traditional and modern poly bee hive with super. It was found that during day time between the hours 11.00 and 13.00 the bee foraging was higher in comparison to other hour time of the day. Nectar harvest best time is also in 11.00 hour of day time. Again in both of the study year the modern poly hive super is signicantly efficient in terms of honey production. In the study year 2015-16 the poly hive super the highest (17.03 kg/hive/season) honey yield was obtained from site 3 i.e. Ullapara and the lowest (16.33 kg/hive/season) honey yield was obtained in site 1 i.e. Tarash by poly hive super. The highest honey yield harvested with poly hive super from Tarash, site 1, Sirajganj and that was 18.63 kg/hive/season in 2016-2017 and the lowest honey yield with poly hive super was in site 2 i.e. Shahjadpur

Honey bee foraging efficiency in litchi flower was studied to find out the foraging efficiency of honey bee in litchi flower at blooming period and to discover the yield of pollen in traditional and modern poly bee hive with super. It was found that during day time between the hours 10.00 and 12.00 the bee foraging was higher in comparison to other hour time of the day. Again in both of the study year the modern poly hive super is signicantly efficient in terms of honey production. In the study year 2015-16 poly hive super the highest (20.46 kg/hive/season) honey yield was obtained from site 2 i.e. Kapasia and the lowest (20 kg/hive/season) honey yield was obtained in site 3 i.e. Kaliganj by poly hive super. During 2016-17 in traditional bee hive the harvested honey produce was lower than the poly hive with super. It was observed that in the poly hive super the highest (14.92 kg/hive/season) honey yield was obtained from site 1 i.e. Gazipur Sadar and the lowest (13.93 kg/hive/season) honey yield was obtained in site 3 i.e. Kaliganj by poly hive super

Honey bee foraging efficiency in multifloral source in Sundarban was studied to find out the foraging efficiency of honey bee at blooming period and to discover the yield of honey in traditional and modern poly bee hive with super. In both of the study year modern poly

hive super is signicantly efficient in terms of honey production. It was observed that in 2015-16 in poly hive super the highest (14.92 kg/hive/season) honey yield was obtained from site 3 i.e. Tala and the lowest (14.65 kg/hive/season) honey yield was obtained in site 2 i.e. Kaliganj by poly hive super. In 2016-17 in poly hive super the highest (12.5 kg/hive/season) honey yield was obtained from site 3 i.e. Tala and the lowest (11.45 kg/hive/season) honey yield was obtained in site 1 i.e. Munshiganj by poly hive super.

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