Sri Lankan Journal of Banking and Finance

An endeavor to share knowledge

Volume: 3 Issue: 02 December: 2020

POTENTIAL FOR COMMERCIALIZATION OF APICULTURE AS A BIOFIN LIVELIHOOD OPTION IN ANURADHAPURA DISTRICT, SRI LANKA

De Silva H T O P[1], Premarathne N M K C[1], and Mapatuna Y[2]

Department of Agricultural Systems, Faculty of Agriculture, Rajarata University of Sri Lanka, Anuradhapura, Sri Lanka[1], Smallholder Agribusiness Partnerships Programme, Sri Jayawardenepura Road, Rajagiriya, Sri Lanka[2].

oshanidesilva016@gmail.com[1]

ABSTRACT

Apiculture is the scientific management of honeybees, which provides an environmentally friendly livelihood option. The honeybees play a key role in the ecosystems by supporting to pollination and food production. However, modern agricultural practices have threatened the survival of honeybees. Therefore, conservation, rearing, and management have been taken due attention. The study was carried out to assess the suitability of apiculture as a (Biodiversity Finance –BIOFIN) livelihood option and to design a value chain for the community in the *Anuradhapura* district. The study used a randomly selected sample of 130 respondents representing 50 beekeepers from *Bandarawela* to study the existing bee honey value chain, 50 fruit or vegetable farmers in *Palugaswewa*, and 30 value chain actors for the analysis. The data collection was done using a pretested structured questionnaire. Binary logistic regression was used to identify the factors affecting farmers' willingness for apiculture. Further, SWOT analysis and value chain analysis were conducted. The regression results revealed that land size (p=0.015), and credit access (p=0.041) have positive impacts, while gender (p=0.012), has a negative impact on farmers' willingness at 5% significance level. According to the SWOT analysis, land availability and the obtainability of bee colonies are the

strengths. Among the weaknesses, the need for specific skills and low access to inputs like beehives have been identified. Moreover, the demand for dry zone bee honey was identified as an opportunity while deforestation and over-application of pesticides were identified as threats. The study finds that beekeeper – processor – local consumers are the stakeholders of the market chain for bee honey. The processors obtain the highest gross margin and market margin. Results conclude that apiculture can be used as a BIOFIN livelihood option by providing sufficient knowledge and training, developing an input supply system, introducing value addition, and marketing linkages.

Keywords: Apiculture, Bee honey, BIOFIN, Farmers' willingness, Value chain

1. INTRODUCTION

Apiculture is defined as, rearing of honeybees in a broader sense (Punchihewa, 1994). It is the way of managing and caring of honey bees in a scientific way (Sharma and Das, 2018). Bee honey, pollen, propolis, bee wax, royal jelly, bee venom, the queen, and the beehives are the major products of apiculture (Sforcin *et al*., 2017; Sharma and Das, 2018; Vapa- *et al*., 2020).

Sri Lankan context, there is a demand for natural bee honey in Ayurveda medicine, the beauty culture industry, and the food industry. Therefore, annually around 60 to 80 metric tons of bee honey is imported to Sri Lanka from Australia, India, China, and Thailand where annual local production is around 20 metric tons at present (Thambavita, 2019). Natural raw honey, value-added products like garlic with honey, cinnamon with honey, and bee balm are commonly available products in Sri Lankan supermarkets. But, only bottled natural raw honey is available in Sri Lankan retail and wholesale shops.

Apiculture is an important component in agriculture, rural employment, human nutrition, and economic development (Aiyeloja *et al*., 2015; Fels *et al*., 2019; Gratzer *et al.*, 2019). For instance, apiculture can be used as a solution for youth and women unemployment in the rural sector since apiculture can be practiced by anyone irrespective of sex and age. Furthermore, apiculture can be used as an employment opportunity for disabled people, because it does not require heavy works (An, 2015). Moreover, apiculture helps to generate employment opportunities such as the manufacturing of equipment and materials, especially the bee boxes needed for the creation of the apiary, smokers, honey extractors, selling bee colonies, and value addition (Tej *et al.*,

2017). Since Sri Lanka is one of the great tourist hotspots; apiculture can be linked with the tourism industry (Wos, 2014; Belma, 2020).

As pollinators, honey bees play a significant role in biodiversity and food production. They provide sustainable benefits to humans through pollination, helping plants grow, and producing foods. Therefore, it concludes as Honey bees are the world's most important single species of pollinators in natural ecosystems. It is estimated that one-third of food that we consume each day relies on pollination mainly by bees (FAO, 2018).

However, deforestation, crop monoculture, bee-killing pesticides, Genetically Modified Crops (GMC), climate change, and parasites are the major reasons for the decline of honeybees. On the other hand, pests i.e. wax moth, diseases i.e. American foulbrood disease, European foulbrood disease, and Chalkbrood disease are the major threats for commercialization of apiculture (Bradbear, 1988; Aronstein and Murray, 2010). The honey bee decline is directly linked with biodiversity degradation. Thus, conservation of natural honey bee population and propagation of honey bees become a timely important matter. In this regard, the promotion of apiculture and commercialization are important to conserve the natural honey bee population (Goulson *et al.*, 2015).

As a conservation strategy, the Biodiversity Finance Initiative (BIOFIN) would be a viable option to build a link between beekeeping which has an impact on biodiversity conservation and livelihood development. BIOFIN is a UNDP-managed global partnership that supports countries to enhance their financial management for biodiversity and ecosystem conservation. In the year 2012 UNDP and the European Commission launched the BIOFIN (UNDP, 2018).

Premarathne *et al.*, (2018) have proposed a model that considers economic, environmental, and social sustainability with apiculture under BIOFIN. The study highlighted the potential for promoting apiculture as a BIOFIN livelihood option by considering the country specific factors that collect through the literature. According to the suggested model, credit facilities will be offered to functioning farmer organizations (FOs). Then FOs will dissolve funds further to invest on apiculture with their members as small groups. At the end, small groups will repay the loans to the corresponding FO and ultimately FO will pay the initial loan to the respective bank. After the successful adaptation of the suggested model, it expects to protect the ecosystems while expanding biodiversity. Income gains for farmers through bee honey production and high crop yields due to enhanced crop pollination are expected through the proposed model. But the suggested model has not yet been tested for the suitability at the farmer level. The research team have recommended assessing the suitability of the model at desired areas before

implementing in their publication. Therefore, this study aimed to examine the potential for apiculture as a BIOFIN livelihood option model as suggested and the potential to establish it as a sustainable value chain.

Value chain approach is highly used in the promotion of agricultural commodities in the world (Miller and Jones, 2010; Trienekens, 2011) In this regard, National Agribusiness Development Program (NADeP) and International Fund for Agriculture Development (IFAD) have proposed a value chain by introducing Producer-Public-Private Partnership (P4) project together with one of the private sector business organization in Sri Lanka in the Uva Province for the promotion of bee honey production. There are around 600 beneficiaries, and this is the biggest honey production development project launched in Sri Lanka at present (Kumara and Prasad, 2019). Therefore, the study was carried out to find out the ways of promoting apiculture in the *Anuradhapura* district by considering the value of such initiation.

Moreover, there are a limited number of studies that have been done on both bee honey value chain and apiculture in Sri Lanka.in this background, the study focused to fill the information gap to develop a bee honey value chain and the apiculture as a BIOFIN livelihood option.

2. REVIEW OF LITERATURE

2.1. Honey bee species in Sri Lanka

Honey bees are social insects that live in colonies. Sri Lanka is home to nearly 150 species of bees and four of these species produce their own honey. They are *Apis cerana* (Asian hive honeybee), *Apis dorsata* (Giant honey bee), *Apis florea* (Dwarf honey bee), *Trigona iridipennis* (Stingless honeybee). They are called 'True Honey bees' in Sri Lanka (Karunaratne, 2004).

A. cerana is generally distributed in tropical, subtropical and temperate areas of Asia. *A. dorsata* can be found in Pakistan, through the Indian subcontinent and Sri Lanka. *A. florea* is distributed in warm areas like Pakistan, Iran, Oman, India, and Sri Lanka (Yadav *et al.*, 2017).

2.2. Apis cerana

A. cerana is Sri Lanka's indigenous species and they are commonly used in honey production because of their relatively non-aggressive nature (Jayathilaka and Mudaliyar, 1881: Punchihewa, 1994). In some parts of China and India, *A.cerana* honey is considered to be superior quality than that of *A. mellifera* (Abrol, 2013). Generally, they are called as 'Indian honeybee'

or 'Asian hive honey bee'. *A. cerana* belongs to order Hymenoptera and family Apidae. It is similar to the European honeybee: *A. mellifera*. *A. cerana* usually build their multiple combed nests in tree hollows and man-made structures.

A bee colony consists of one queen, thousands of workers, and few drones (Punchihewa, 1994; Devillers, 2002). *A. cerana* colonies consist of approximately 34,000 bees (Egelie *et al.,* 2015). Queen is the reproductive female of the colony and she has a large body with wings that covers only about two-thirds of the abdomen. She does not have structures to collect pollen or functional wax glands. The main function of the queen is to lay eggs and keep the workers uninterested in reproduction through pheromonal control. The drones are the largest bees in the colony. They do not have a sting, pollen baskets or wax glands. They are produced to mate with the queen. The workers are the smallest and the most numerous individuals in the colony. They are sexually underdeveloped females. Worker bees have specialized structures such as; brood food glands, scent glands, wax glands, and pollen baskets. They perform all hive maintenance like cleaning, foraging, tending to the brood (eggs, larvae, and pupae), and producing honey (Devillers, 2002; Egelie *et al*., 2015). Within the colony worker bees rear new queens for some reason as; the former queen left with a swarm, the queen is laying increasingly fewer eggs and the colony is overcrowded and has no space to expand. *A. cerana* has a longer daily foraging period than *A. mellifera.* Also, *A. cerana* can forage at lower temperatures (Egelie *et al.,* 2015).

2.3 Importance of honeybees

As stated by Albert Einstein, “If bees disappeared off the face of the earth, man would only have four years left to live”. It means the honey bee plays an important role in the ecosystem. In many crops, insect pollination is essential for seed production. Among the insect pollinators, bees are the most important pollinator because of their foraging behavior and constancy (Corbet and Osborne, 1991).

The majority of horticultural crops including fruits, vegetables, spices, and plantation crops depend on different kinds of insect pollinators. Absent of insect pollinators lead a 70-90 percent fruit set ranging reduction in different mango varieties. Similarly, for onion and watermelon, native honey bee species called, *A. cerana, A. dorsata,* and *A. florea* are the major pollinators (Reddy *et al.,* 2019).

2.5 Reasons for honey bee drop

Invasive species, habitat loss, climate changes, and insecticides are the major drivers of honeybee decline (Meeus *et al.,* 2018).

Pesticide-contaminated flowers affect the health of the honeybee colonies and decline their productivity (Krupke and Long, 2015). Exposure of honeybees to a sub-lethal dose of neurotoxic insecticides can cause stress, paralysis, or abnormal behavior but not kill the honeybees (Zaluski *et al.,* 2015). Neonicotinoids reduce the mating frequency of the queen and it negatively affects the genetic diversity in the colony (Nadege *et al.,* 2017). According to Williams *et al.,* (2015), contamination of neonicotinoid pesticides during colony development stage can severely affect queens.

Unfavorable weather conditions and habitat degradation which resulted due to deforestation are adversely effect on honeybees (Mustafa *et al.,* 2015). Habitat loss reduces the abundance and diversity of floral resources and nesting opportunities (Goulson *et al.,* 2015). Monoculture also leads to habitat degradation and ruin floral resources for honeybees (Nicholls and Altieri, 2013). Annual fires in some areas are considered a serious threat to honeybees and bee honey production because fire reduces the availability of floral resources. Also, during the dry season, Bush burning considerably reduces the wild bee population (Mustafa, 2015).

Pests and diseases are another major threat to honey bee drop. The wax moth is the major problem to beekeeping in Asia. Wax moth occurs because of poor management practices by the beekeeper. *Galleria mellonella* (Greater wax moth) and *Achroia grisella* (Lesser wax moth) are the major damaging wax moth species found in India. Maintaining good hygienic beekeeping practices can prevent a wax moth attack. Hive Beetle (*Aethina tumida*), ants and wasps, birds, and Indian Bear (*Melursus ursinus*) are the other minor pests of honeybees in India (Nirupama, 2018).

American foulbrood (AFB) disease, European foulbrood (EFB) disease are the dangerous bacterial diseases infecting honey bee colonies (Bradbear, 1988; Kishan *et al*., 2017). Chalkbrood is a fungal disease of honey bee brood caused by *Ascosphaera apis.* Supplemental feeding to improve the nutritional and health status of honey bees, keeping hives clean and well ventilated, using clean equipment, and avoiding transfer of combs between colonies are the possible management and sanitation strategies to control the Chalkbrood disease (Aronstein and Murray, 2010).

European foulbrood (EFB) disease is caused by the Gram-positive bacterium *Melissocccus plutonius* (Forsgren, 2009). EFB affects honey bee larvae. Adult

worker bees act as carriers of the bacterium within the colony, between colonies and apiaries (Belloy *et al.*, 2007; Mckee *et al.*, 2003). In many countries, Oxytetracycline hydrochloride (OTC) is used as a bacteriostatic antibiotic to inhibit the multiplication of the causal organism (Thompson and Brown, 2001).

2.5 Apiculture

Apiculture contains the management and scientific background for the management of honey bees. Rearing of bees is done for honey production or wax production or crop pollination (Punchihewa, 1994). According to FAO, (2009), there are the ten excellent reasons for engaging in apiculture such as pollination process, production of bee honey, bee wax like products, required few resources only, no need of land ownership, no competition with other livestock or crops for pollen and nectar, having benefits to different sectors and trades from a strong beekeeping industry, apiculture encourages ecological awareness, everybody can be a beekeeper and apiculture is being environmentally friendly.

According to Chanthayod *et al.*, 2017 have resulted that all beekeepers being male (98%) and beekeeping families had a marginally higher net income from honey production than non-beekeepers. Family size, number of labors, education level, and beekeeping experience affects honey income generation. Beekeepers have more conservation-minded attitudes and they tend to be more environmentally friendly. Lack of technology for apiculture, lack of bee honey market information is the main constraints in apiculture.

Rock bee (*Apis dorsata*), little bee (*Apis florea*), Indian bee (*Apis cerana*), European bee (*Apis mellifera ligutica*), and stingless bee are the honey bee species in India. During the honey flow season, honeybees have to be managed by providing more space for honey storage, dividing strong colonies into two or three new ones, and building a sufficient population prior to honey flow by providing sugar syrup. Management methods such as providing sufficient shade conditions, sprinkling water on gunny bags or rice straw put on the hive to increase RH and reduce the heat, providing sugar syrup, pollen supplements or substitutes, and water should be needed during the severe summer season (Kishan *et al.*, 2017).

2.6 Bee honey value chain

The concept of the value chain was introduced by Porter in 1985 (Zamora, 2016). The value chain represents a series of activities that an organization performs to deliver a valuable product for the market (Simatupang *et al.*,

2017). When a product or a service moves from one actor in the chain to another, it is assumed to gain value (Hellin and Meijer, 2006; Zamora, 2016).

The value chain is defined by Kaplinsky as "the full range of activities which are required to bring a product or service from conception, through the intermediary phases of production, delivery to the final consumer, and final disposal after use" (Kaplinsky and Morris, 2001). In Porter's value chain; there are two categories of business activities, "primary" and "support". Primary activities consist of five components, and all are essential for adding value to the product or service. Inbound logistics, operations, outbound logistics, marketing and sales, and services are the "primary activities". Support activities help to make the primary activities more efficient. Procurement, technological development, human resources management, and infrastructure are the "support activities" in the value chain (Porter, 2001).

In 2011, Shackleton *et al.,* revealed that honey and honey products are sold at different stages of the value chain through both formal and informal channels in Zambia. In isolated, traditional honey production areas, honey is directly sold to buyers. In less isolated areas producers or intermediaries travel to the market. Women actively participate in honey marketing and sales. Formal companies and traders buy honey from individuals or groups.

The value chain actors who manage a particular product through the value chain include, input supplier, producer, processor, wholesaler, retailer and final consumer (Hellin and Meijer, 2006). “The wholesaler is one who buys goods on a large scale with the objective of selling them at a profit in smaller quantities.” (Carrad and Oliphant, 1970). Retailers typically buy goods from a manufacturer, wholesaler, or other distributor and then resell them to the consumer (Hudson, 2020). Retailing consists of all the activities of selling goods or services directly to the final consumer (Kotler and Armstrong, 2012).

3. METHODOLOGY

3.1. Study Area

Anuradhapura district was purposely selected for the study since there is a high demand for bee honey, produced in dry zone areas due to its unique flavour. *Palugaswewa* Agrarian Service Division (ASD) (8°19′0″N, 80°35′0″E) was purposely selected to test the suitability of the proposed model because there are numerous fruit and vegetable growing farmers. *Bandarawela* DS division (6°50′13″N, 80°59′8″E) was purposively selected as the bee honey producing area under Smallholder Agribusiness Partnership Program (SAPP) to study the existing bee honey value chain to identify the

facts related to the successful establishment of a new bee value chain in *Anuradhapura.*

3.2. Sample Size

A total of 130 samples were selected by using a simple random sampling method. 50 beekeepers from the *Banadarawela* DS division and 50 fruit or vegetable growing farmers in the *Palugaswewa* ASD area were selected. 10 respondents from each actor in the value chain were used (i.e. processor, retailers, and consumers).

3.3. Data Collection

Primary data were collected using a pretested structured questionnaire.

3.4. Data Analysis

The binary Logistic Regression model was proposed (Schulz *et al.*, 2014) to identify the factors affecting farmers' willingness on apiculture.

$$\textbf{Log [Y]} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \varepsilon$$

Where the dependent variable is the willingness to do apiculture with considering the phobia to bee stings (binary). There are nine independent variables as; age, gender, level of education, awareness about beekeeping and technology, land size, information access on apiculture, credit access for apiculture, starting capital for apiculture and farmers' income (Mujuni *et al.*, 2012; Ahikiriza, 2016).

Almost all the responders in *Palugaswewa* were willing to do apiculture. But people with apiphobia would be unsuccessful in apiculture. A phobia is a "type of anxiety disorder defined by a persistent and excessive fear of an object or situation" (American Psychiatric Association, 2013). Melissophobia or apiphobia is the fear of bees. Thus, apiculture cannot be practiced by people with the phobia for bee stings. Therefore, true willingness is considered as the dependent variable where people who do not have the phobia for bee stings.

A SWOT Analysis was conducted to see the applicability of the suggested model by Premarathne *et al.*, 2018.

The Gross Margin and Market Margin analysis techniques were used to determine the profit gained by different actors in the bee honey value using 10 respondents from each actor in the value chain.

Gross Margin (GM)

Gross margin (GM) is defined as the difference between total revenue and total variable costs (Lazaro, 2008).

$$GM = \sum TR - \sum TVC = \sum PyY - \sum PxX \quad \ldots\ldots\ldots\ldots (1)$$

Where GM = Gross margin per 30ml of bee honey bottle
$\sum TR$ = Total revenue from sales of one 30ml bee honey bottle
$\sum TVC$ = Total variable cost spent on producing / selling of one 30ml bee honey bottle
Py = Price of honey per one 30ml bee honey bottle
Px = Price of input used in producing one 30ml bee honey bottle
Y and X are the quantities of honey produced and inputs used respectively.

Market Margin (MM)

The marketing margin (MM) is the percentage of the final weighted average selling price taken by each stage of the marketing chain (Tomek and Robinson, 1991).

$$MM = WSp - WBp / WSp * 100 \quad \ldots\ldots\ldots\ldots (2)$$

Where MM = Market Margin
WSp = Selling price
WBp = buying price

4. RESULTS AND DISCUSSION

4.1. Socio-economic profiles of beekeepers in *Bandarawela*

The results were based on the responses of 50 beekeepers in *Bandarawela.* The majority of the beekeepers were male (78%) and 60% of the beekeepers were above 50 years of age. Regarding the educational background 66% had attended up to G.C.E. O/L. When considering the monthly income, 38% of the beekeepers received monthly income between 10,000 and 30,000. Beekeepers who received more than LKR 50,000 monthly income were either government employees or private-sector employees. The majority of the beekeepers (73%) cultivated upcountry vegetables other than beekeeping. The average land size owned by a beekeeper was 0.91ac.

Every beekeeper had more than 5 years of experience in beekeeping and 66% had experience of over 10 years. Previous experience was considered as a pre-requisite for joining the project.

More than 90% of the beekeepers mentioned that the environmental conditions such as rainfall and deforestation, current market price, market opportunities, and agro-chemicals were highly affecting for beekeeping.

Beekeeping contributes 22% to the annual income of a beekeeper. The beekeeper can receive an average of Rs. 16,000 annual income by maintaining only 2 bee honey colonies. Engage in beekeeping as a supplementary income ensures a considerable amount of monthly income. Even though bee honey harvesting is not practicing regularly, the beekeeper can store the products until it gets a fair price. Therefore, beekeepers can receive a year-round income by identifying the demand and supply of the product.

4.2. Socio-economic profiles of fruit and vegetable farmers in *Palugaswewa* ASD

The results were based on 50 fruit and vegetable growing farmers in *Palugaswewa* ASD. The majority of the beekeepers were male (70%) and 40% of the beekeepers were with the age range of 40-50. Regarding the educational background 72% had attended up to G.C.E. O/L. When considering the monthly income, 40% had monthly income between 10,000 and 30,000. The average land extent per farmer was 8.88ac.

From the studied sample 27 farmers liked apiculture as a supplementary income source (54%) and 23 farmers did not like it. Difficult in finding inputs like bee boxes, not having sufficient knowledge on hive management, phobia to bee stings, and unable to afford starting capital for beekeeping themselves were the mentioned reasons for not like apiculture as a supplementary income source.

Based on the survey, 43farmers (86%) said that they have information access on apiculture through agricultural instructors. Remaining 7 farmers (14%) said they do not have access to information and their most preferable information source was via organizations. Regarding their knowledge about beekeeping, 30 farmers (60%) said, they have sufficient knowledge about beekeeping. When considering the capital access, 23 farmers (46%) said that they can afford the capital for beekeeping by themselves and 27 (54%) farmers said that they like to apply for a loan to access the credit. Among those 27, 21 farmers preferred to get a loan through government banks and 6 preferred through farmer organizations.

4.3. SWOT Analysis

Premarathne *et al,* (2018) have conducted the SWOT analysis by using the available literature and suggested the BIOFIN model for farmer level. However, a SWOT Analysis was conducted for *Palugaswewa* Agrarian Service Division (ASD) using the data gathered through the structured questionnaire to examine the validity of the previous study. The results revealed that,

Strengths

1. There are enough land resources around the study area (Average land size per person – 8.88ac)
2. There are enough pollen and flower nectar for honey bees – 52%
3. Availability of bee attractive plants – 64%
4. Most farmers have basic knowledge and experience about beekeeping – 60%
5. Easy to find bee colonies – 90%

Weaknesses

1. Lack of specific skills for the establishment and maintenance of honeybee colonies – 40%
2. Lack of technical guidance – 80%
3. Low access to specific equipment such as bee boxes, smoker, honey extractor and Hazmat suit – 84%
4. Low interesting among women – 10%
5. Most farmers unable to afford the capital – 46%

Opportunities

1. Good growing demand for dry zone bee honey in both local and export market
2. Can link beekeeping with the tourism industry (Wos, 2014; Pelaez,2019; Belma, 2020)

Threats

1. Deforestation - 76%
2. Pest and disease incidence – 58%
3. Impact of climate change – 40%
4. Over-application of pesticides – 68%

4.4. Factors affecting farmers' willingness for apiculture in the *Anuradhapura* district

Table 1: Model Estimate

Variables	**Parameter Estimates (β)**	**p> |z|**
Land size	3.085233	**0.015*****
Gender		
0 Female	-2.963439	**0.012*****
1 Male	Reference group	-
Income		
1 (<10,000)	Refence group	-
2 (10,000-30,000)	2.71539	0.130
3 (30,000-50,000)	Omitted	-
4 (>50,000)	No observations	-
Level of education		
1 (No schooling)	Reference group	-
2 (Up to primary education)	No observations	-
3 (Up to GCE O/L)	-1.216946	0.522
4 (Up to GCE A/L)	-6.604474	**0.074****
Age		
1 (<30)	Reference group	-
2 (30-40)	-1.899204	0.458
3 (40-50)	-2.660987	0.418
4 (>50)	-7.091163	**0.089****
Awareness about beekeeping and technology	-1.392328	0.178
Information access on apiculture	2.632179	**0.067****
Starting capital for apiculture	-3.438321	0.159
Credit access for apiculture	2.688263	**0.041*****
Constant	-20.54968	0.017

(***Significant at 5%, ** Significant at 10%)

Source: Feld survey, 2020

According to binary logistic regression analysis, Land size, gender, and credit access for apiculture were statistically significant at 5%. Level of education, age, and information access on apiculture were significant at 10% with the dependent variable. Income, awareness about beekeeping and technology, and starting capital for apiculture were not statistically significant (Table 2). But Ahikiriza, 2016, and Mujuni *et al.*, 2012, revealed that age of the farmer, level of education, level of awareness about beekeeping and technology, information access on apiculture, and starting capital for apiculture were significantly affected for the farmers' willingness on apiculture.

As revealed by the results, gender (p=0.012) has a negative relationship with the willingness for apiculture. Compared to males, females are less likely to engage in apiculture. Being female decreases the willingness for apiculture. One possible reason for that could be the bee sting phobia. Research carried out by Kumwenda, 2016, also got the same results and the mentioned reason for that is female is not able to do apiculture without the help of men. Mburu *et al*., 2015 pointed out that most of the women do not carry out activities like hanging of beehives, beehives construction, and repair and bee honey harvesting. Lack of skills, bee sting phobia, and cultural constraints would be some of the reasons for not being interesting in beekeeping. In most African countries, beekeeping is predominantly a male activity (Shackleton, 2011). But in Pakistan, women are involved in beekeeping by feeding bee's supplements, extracting bee honey from combs, and packaging (Qaiser *et al.*, 2013).

Land size (p=0.015) has a positive relationship with the willingness for apiculture. It implies that, when the farmer has more land, his willingness for doing apiculture is increased. Research carried out by Kumwenda, 2016, also got the same results. When the farmer has more land to cultivate, this attracts more honey bee pollinators to his land. So, farmers can easily find honeybees required for doing apiculture. On the other hand, more honeybees around his cultivation mean his production will be higher. Those are the possible reasons for the increment of farmers' willingness on apiculture when the increase of land size. Credit access for apiculture (p=0.041) has a positive relationship with the willingness for apiculture. It means, when the farmers have access to the credit their willingness to do apiculture will be increased. In 2012, Mujuni *et al.,* got similar results.

The level of education (p=0.074) has a negative relationship with the willingness for apiculture. According to the results, when a person educates more the willingness to do apiculture is getting reduced. A possible reason would be educated people tend more to find non-farm activities rather than engage in agriculture-based activities as their occupation. The age of the farmer (p=0.089) has a negative relationship with the willingness for apiculture. Results imply that older farmers (>50 years of age) are less interested in apiculture. The result is also supported by earlier studies (Adgaba *et al*., 2014: Kalanzi *et al.,* 2015). Information access on apiculture (p=0.067) was found to be positively related to the willingness for apiculture. Mujuni *et al.,* 2012 also had got the same results and they mentioned, good extension services play a major role in the dissemination of information.

According to the results, the likelihood ratio chi-square of 23.06 with a p-value of 0.027 at a 5% significance level revealed that the whole model fits significantly than the empty model. Pseudo R2 values from 0.2-0.4 indicate

excellent model fit (McFadden, 1974). Therefore, the Pseudo R2: 0.3420 indicates the binary logistic model with gender, age, level of education, land size, information access on apiculture, and credit access as the independent variables are a very good model fit.

Table 2: Model Summary

LR chi2 (12)	23.06
Prob > chi2	0.0273
Pseudo R2	0.3420
Log-likelihood	-22.180985

Source: Author Constructed

4.5. Value Existing bee honey chain in *Anuradhapura* district

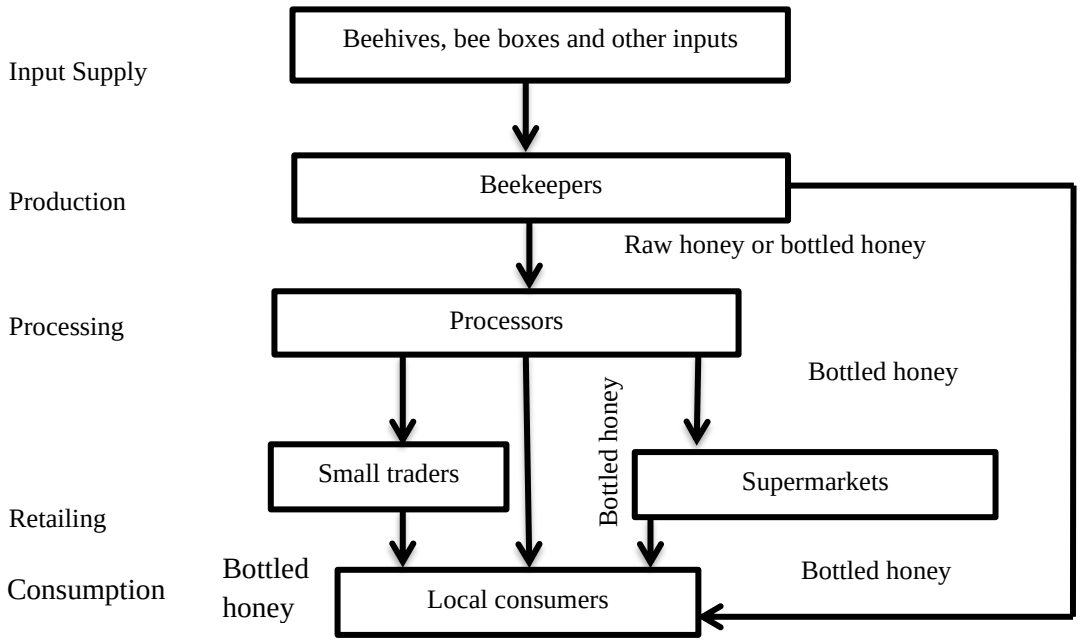

Figure 1: Existing bee honey value chain in *Anuradhapura* district

4.6. Bee honey marketing channels in *Anuradhapura* district

Beekeeper – local consumer
Beekeeper – processor – local consumer
Beekeeper – processor - small trader - local consumer
Beekeeper – processor - supermarket - local consumer

In *Anuradhapura*, the most common bee honey marketing channel is beekeeper – processor – local consumer. Most of the regional processors buy one raw honey bottle (750ml) at Rs.800 to RS.1000 directly from the beekeepers or honey collectors in the *Anuradhapura* district. The price is varying with the time of the year due to supply. Processors buy 500 to 2000kg of raw honey at once per one honey flow season. Quality of the bee honey, fineness of the bee honey, and purchasing price are the most considering factors by the processor. Processors produce 30ml, 180ml, 750ml, and 1000ml bottles and among them, 30ml and 180ml have more demand (86%).

In supermarkets, there was a low demand for bee honey. Processors are the supply side to supermarkets. Only 6 to 8 bottled bee honey is being sold per month in *Anuradhapura* supermarkets. Imported bee honey collection is more common in observed supermarkets. Garlic in honey (immersed) and cinnamon in honey(immersed) like value-added products are found in supermarkets other than raw honey. Consumers buy bee honey in supermarkets by considering its nutritional value and for beauty cultural purposes. Some consumers in urban areas believe that the quality of bee honey in supermarkets is superior to other local small retail shops.

According to the general definition for wholesaler, it was difficult to identify wholesalers in the *Anuradhapura* district. Beekeeper or processor directly sells their product to either consumer or to the retailer. In retail shops (small trades), 30ml, 90ml, and 180ml bottled bee honey can be commonly found. The processor is the supplier of retail shops.

From the interviewed consumers, 60% said that they buy honey from processors and 30% said that they buy honey from supermarkets. Remaining 10% buy honey from retailers (small traders). Consumers who receive more than Rs.100, 000 monthly income usually buy bee honey from supermarkets for health benefits. They buy bottled bee honey for every three months. Consumers who receive Rs. 50,000 – 100,000 monthly income ranges buy honey from processors. Consumers pay more attention to price, quality, taste, and packaging when they buy bee honey. They highly consider the date of manufacture, expiry date, price, and the quantity displayed within the label.

Table 3: Distribution of gross margin and market margin in value chain actors

Actor	Market Margin (MM) % Rs./30ml bottle	Gross Margin (GM) Rs./30ml bottle
Processor	45	45
Retailer	14	15

Source: Field survey, 2020

The findings of the analysis for the gross margins received by actors in the value chain revealed that processors obtained the highest gross margin and market margin. According to the identified value chain channels, there was a strong forward relationship of the beekeeper. Those could be clearly identified. But it was difficult to identify the backward relationship of a beekeeper with the input supplier.

4.7 Bee honey Production in *Bandarawela*

According to the studied sample in *Bandarawela*, beekeeping was directly linked to a private organization. The linkage ensured a fixed price to the beekeeper and a market to the product. Beekeepers sold a greater portion of their raw honey to the bee honey collection centers. Some amount of raw honey is sold directly to the consumers. In the studied sample 64% of beekeepers have used glass bottles as their packaging type. They did not use any kind of labeling method for their product. They did not practice storing of the bee honey. They did not have stocks of honey at the time of the interview. Due to the heavy rain in 2019, the colony number had reduced significantly. Heavy rains slow honey bees' flying ability and lead breakages in bees' wings (Urquhart, 2018). According to the beekeepers, black mustard tree (*Brassica juncea*), Kudu-Dawula *(Neolitsea fuscata*), and avocado tree (*Persea Americana)* can attract honey bees. Therefore, they think, those types of trees should be protected to protect honey bees.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusion

From the study, it can be concluded that gender, age, level of education, land size, information access on apiculture, and credit access for apiculture have a significant influence on the farmers' willingness for apiculture in *Palugaswewa* ASD. According to the results, 54% of the total sample were said they were willing to do apiculture as a supplementary income source. Being women decreases the willingness in apiculture as a supplementary income source mainly due to bee sting phobia and lack of skills. Credit access, land size, and information access on apiculture are positively affected

for the willingness of beekeeping. Of the sample, 46% did not like to apiculture as a supplementary income source. Lack of knowledge in hive management, poor access to inputs, lack of knowledge in market opportunities are the major reasons for not like in apiculture as a supplementary income source. But according to the SWOT analysis conducted, there is a potential and more opportunity in the *Anuradhapura* district for the commercialization of apiculture. The study revealed that there is no commercialized bee honey production in the *Anuradhapura* district. Identified marketing channels revealed that there is a weak backward relationship of a beekeeper with the input supplier. The most common value chain channel for bee honey is beekeeper – processor – local consumer. Processors obtain the highest gross margin along the value chain. According to the conducted SWOT analysis and consumer interviews, it can be identified that there is a growing demand for good quality bee honey for consumption by considering the health and nutritional benefits of bee honey and for beauty cultural uses. Based on the results, apiculture could be introduced as a BIOFIN livelihood option to the fruit and vegetable growing farmers in the *Anuradhapura* district.

5.2. Recommendations

Based on the findings of the study, the following recommendations were made.

1. The extension services are needed to be strengthened for better dissemination of knowledge regarding hive management, harvesting techniques, and value addition. Providing sufficient knowledge about the importance of honeybees and beekeeping in crop production via extension service can help to move chemical-free agriculture.
2. Providing sufficient knowledge and training can improve women participation in beekeeping. Women with bee sting phobia can engage in bee honey harvesting, processing, and selling like activities. Apiculture can be used as a solution for rural women empowerment.
3. The study found that inadequate knowledge in hive management, lack of input supply, and poor harvesting techniques are constraints facing beekeepers. Therefore, there is a need for training beekeepers on appropriate beekeeping and honey harvesting technologies.
4. Providing financial support for the beekeepers. For that mini-bank loans through government state banks would be more supportive for the farmer who is willing to do apiculture in commercialization level.
5. Improvement of market opportunities such as, linking to the export market, value addition, proper packaging, link with the tourism industry to expand the production.
6. Beekeeping should be up scaling up to the commercialization level to improve the living standards of rural people. For that, there should be a proper linkage between beekeepers and input suppliers.

Development of an efficient input supply system improves production and value addition and introducing marketing linkages are important.

7. The study pointed out that there is no proper channel to reach beekeepers. The government should be involved in promoting bee honey-based entrepreneurs. Therefore, beekeepers in *Anuradhapura* can be linked with any private organization by introducing a P4 partnership to protect the beekeeper by ensuring a fixed price and market opportunity. Because in *Bandarawela* there is one of the biggest honey production development projects.
8. The government should assist to improve the quality of bee honey. A certification system can be introduced to maintain the quality of bee honey.

REFERENCES

Abrol, D.P. (2013). Asiatic honey bee Apis cerana: Biodiversity conservation and agricultural production. Heidelberg: Springer-Verlag.

Adgaba, N., Al-Ghamdi, A., Shenkute, A. G., Ismaiel, S., Al-Kahtani, S., Tadess, Y., ... & Abdulaziz, M. Q. A. (2014). Socio-economic analysis of beekeeping and determinants of box hive technology adoption in the Kingdom of Saudi Arabia. J Anim Plant Sci, 24(6), 1876-1884.

Ahikiriza, E. (2016). Beekeeping as an alternative source of livelihood in Uganda (Doctoral dissertation, Master's thesis, Ghent University)

Aiyeloja , A.A., Adedeji, G.A., & Emerhi, E.A. (2015). Impacts of beehive stand's heights and hives' types on the ergonomics of honey harvesting in Port Harcourt, Nigeria. NY Sci J, 8(4), 23-27.

American Psychiatric Association (2013). Diagnostic and Statistical Manual of Mental Disorder (5th ed).

An, T. (2015). Revitalization plan for urban agriculture park through the introduction of urban beekeeping: focuced on Yeowol Urban Agriculture Park in Bucheon-si Guinggido. Master's Thesis, Korea University. Korea.

Aronstein, K.A., & Murray, K.D. (2010). Chalkbrood disease in honey bees. Journal of invertebrate pathology, 103, S20-S29.

Belloy, L., Imdorf, A., Fries, I., Forsgren, E., Beerthoud, H., Kuhn, R., & Charriere, J.D. (2007). Spatial distribution of Melissococcus plutonius

in adult honey bees collected from apiaries and colonies with and without symptoms of European foulbrood. Apidologie, 38(2),136-140pp.

Belma, S. (2020). An exploratory journey to the use of beekeeping in tourism. Anatolia: Turizm Arastirmalari Dergisi, 31(1), 19-30.

Bradbear, N. (1988). World distribution of major honeybee diseases and pests. Bee world, 69(1), 15-39.

Carrad, H.L., and Oliphant, L. (1970). The elements of commerce.

Chanthayod, S., Zhang, W. and Chen, J. (2017) 'People's perceptions of the benefits of natural beekeeping and its positive outcomes for forest conservation: A case study in Northern Lao PDR', Tropical Conservation Science, 10. doi: 10.1177/1940082917697260.

Corbet, S.A., Williams, I.H., & Osborne, J.L. (1991). Bees and the pollination of crops and wild flowers in the European Community. Bee world, 72(2), 47-59.

Devillers, J. (2002). The ecological importance of honey bees and their relevance to ecotoxicology.

Egelie, A.A., Mortensen, A.N., Kaufman, J.L.G and Ellis, J.D. (2015). Entomology and Nematology Department, University of Florida.

FAO, I., & UNICEF. (2018). WFP and WHO: The State of Food Security and Nutrition in the World 2018. Building climate resilience for food security and nutrition, 200.

FAO. (2009). Bees and their role in forest livelihoods.

Fels, D.I., Blackler, A., Cook, D., & Foth, M. (2019). Ergonomics in apiculture: A case study based on inspecting movable frame hives for healthy bee activities. Heliyon, 5(7), e01973.

Forsgren Eva (2009) European foulbrood in honey bees, *Journal of Invertebrate Pathology* 103(2010) S5-S9.

Goulson Dave, Nicholls Elizabeth, Botias Cristina, Rotheray Ellen L. (2015), bee declines driven by combined stress from parasites, pesticides, and lack of flowers, Science 347 (6229), 1255957.

Gratzer, K., Susilo, F., Purnomo. D., Fiedler, S., & Brodschneider, R. (2019). Challenges for beekeeping in Indonesia with autochthonous and introduced bees. Bee World, 96(2), 40-44.

Hellin, J. and Meijer, M. (2006). Guidelines for value chain analysis, Food and Agriculture Organization (FAO), UN Agricultural Development Economics Division, November.

Hudson, M. (2020). Definition & Examples of Retailers.

Jayatilaka, S. and Mudaliyar (1881). 'Ceylon bee culture'

Kalanzi, F., Nansereko, S., Buyinza, J., Kiwuso, P., Turinayo, Y., Mwanja, C., ... & Mujuni, D. (2015). Socio-economic analysis of beekeeping enterprise in communities adjacent to Kalinzu forest, Western Uganda.

Kaplinsky, R. and Morris, M. (2001). A Handbook for Value Market Chain

Karunaratne, W.A.I.P. (2004). Taxonomy and natural history of bees in selected areas of Sri Lanka. Ph.D. Thesis, Faculty of Science, University of Peradeniya, Peradeniya.

Kishan, T.M.A., Aruna, R., Mishra, G., & Srinivasan, M.R. (2017). Beekeeping in India. Industrial Entomology (pp.35-66). Springer, Singapore.

Kotler, P. and Armstrong, G., (2012) Principles of Marketing, Pearson Prentice Hall, 14th edition.

Krupke, C.H., Long, E.Y. (2015). Interactions between neonicotinoid seed treatments and honey bees, Current opinion in insect science 10, 8-13.

Kumara & Prasad. (2019). A case study on converting basic CSR initiative to a sustainable value chain driven producer-public-private partnership (P4). Retrieved from https://sapp.lk/

Kumwenda, S. (2016). The impact of beekeeping on the household income of small holder farmers: A case of Mikunku in Kapiri-Mposhi district of Zambia.

Lazaro, A. (2008). Value chain Analysis for Oranges in Muheza district. Dissertation for Award of MSc Degree at Sokoine University of Agriculture, Morogoro, Tanzania. 62pp

Mburu, P., Affognon, H., Irungu, P., Mburu, J., & Raina, S. (2015). Beekeeping for women empowerment: Case of commercial insect program in Kitui country, Kenya.

McFadden, D. (1974). The measurement of urban travel demand. *Journal of Public Economics*, 3: 303-328pp.

McKee, B.A., Djordjevic, S.P., Goodman, R.D., & Hornitzky, M. A. (2003). The detection of Milissococcus pluton in honey bees (Apis mellifera) and their products using a hemi-nested PCR. Apidologie 34(1), 19-27.

Meeus Ivan, Pisman Matti, Smagghe Guy, Piot Niels, (2018) Interaction effects of different drivers of wild bee decline and their influence on host-pathogen dynamics, Current opinion in insect science 26, 136-141.

Miller, C., & Jones, L. (2010). Agricultural value chain finance: Tools and lessons. Warwickshire: Practical Action.

Mujuni, A., Natukunda, K. and Kugonza, D. R. (2012) 'Factors affecting the adoption of beekeeping and associated technologies in Bushenyi District, Western Uganda', Livestock Research for Rural Development, 24(8).

Mustafa, M.O., Adeoye, O.T., Abdulalzeez, F.I., & Akinyyemi, O.D. (2015). Mitigating effects of climate change & deforestation on bees with respect to their ecology & biology. Journal of Environment and Ecology, 6(2), 1-12.

Nadege Forfert, Aline Troxler, Gina Retschnig, Laurent Gauthier, Lars Straub, Robin, FA Moritz, Peter Neumann, Geoffrey R Williams (2017) PloS one 12(10).

Nicholls I Clara, Altieri Miguel A (2013), plant biodiversity enhances bees and other insect pollinators in agroecosystems. A review, Agronomy for Sustainable development 33(2), 257-274.

Nirupama, S., Gupta, J. K., & Harish, S. (2018). Diseases, pests and other natural enemies of Indian honey bee (Apis cerana F.) in Katrain area of Kullu Valley, Himachal Pradesh. *Journal of Experimental Biology and Agricultural Sciences*, 6(5), 895-897.

Pelaez, D. P., Lindholm, L. V., Green, N. T., & Quinlivan, R. (2019). Determining the Feasibility of a Bee Honey Value Chain.

Porter, M.E. (2001). The value chain and competitive advantage. Understanding Business Processes, 50-66.

Premarathne, N.M.K.C., Kodithuwakku, A.N., Lankapura, A.I.Y., & Dissanayake,S.P (2018). A model to ensure the sustainability of rural livelihood through Biodiversity Financing Initiative (BIOFIN) on apiculture.

Punchihewa, R.W.K. (1994) Beekeeping for Honey Production in Sri Lanka..Sri Lanka Department of Agriculture.

Qaiser, T., Ali, M., Taj, S., & Akmal, N. (2013). Impact assessment of beekeeping in sustainable rural livelihood. *Journal of Social Sciences* (COES&RJ-JSS).

Reddy, P.V.Rami , Sankaran, M., Vasugi, C. (2019), pollinators of mango-diversity, dynamics and ecosystem services. NAAS.

Schulz, N., Breustedt, G., & Latacz-Lohmann, U. (2014). Assessing farmers' willingness to accept "greening": Insights from a discrete choice experiment in Germany. *Journal of agricultural economics*, 65(1), 26-48pp.

Sforcin, J. M., Bankova, V., & Kuropatnicki, A.K. (2017). Medical benefits of honeybee products.

Shackleton, S., Paumgarten, F., Kassa, H., Husselman, M., & Zida, M. (2011). Opportunities for enhancing poor women's socioeconomic empowerment in the value chains of three African non-timber forest products (NTFPs). *International Forestry Review*, 13(2),136-151.

Sharma, S., & Das, D. (2018). Factors affecting adoption of beekeeping and associated technologies in Kamrup (rural) district, Assam state, India. Biodiversity Int J, 2(3), 279-284.

Simatupang, T.M., Piboonrungroj, P., & Williams, S.J. (2017). The emergence of value chain thinking, *international Journal of value chain management*, 8 (1), 40-57.

Tej, M.K., Aruna, R., Mishra, G., & Srinivasan, M.R. (2017). Beekeeping in India. In Industrial Entomology (pp35-66). Springer, Singapore.

Thambavita, T.B. (2019). A program to uplift bee honey production. Daily News. Retrieved from https://www.dailynews.lk/2019/07/25/local/192145/program-uplift-bee-honey-production

Thompson, H.M., Brown, M.A., (2001). Is contact colony treatment with antibiotics an effective control for European foulbrood? Bee World 82, 130-138.

Tomek, W. G. and Robinson, K. L. (1991). Agricultural Product Prices. Ithaca. 87pp.

Trienekens, J.H. (2011). Agricultural value chains in developing countries a framewaork for analysis. International food and agribusiness management review, 14(1030-2016-82778), 51-82.

UNDP (2018). The BIOFIN workbook. Finance for nature. The Biodiversity Finance Initiative. United Nations Development Program: New York.

Urquhart, K.M., (2018). Rainy Day Beekeeping: Wet winter hive inspections are a bad idea.

Vapa-Tankosic, J., Miler-Jerkovic, V., Jeremic, D., Stanojevic, S., & Rasovic, G. (2020). Investment in Research and Development and New Technological Adoption for the Sustainable Beekeeping Sector. Sustainability, 12(14), 5825.

William Geoffrey R, Troxler Aline, Retsschnig Gina, Roth Kaspar, Yanez Orlando, Shutler Dave, Neumann Peter, Gauthier Laurent (2015). Neonocotinoid pesticides severely affect honey bee queens, scientific report5, 14621.

Wos, B. (2014). Api-tourism in Europe. *Journal of Environmental and Tourism Analyses*, 2(1), 66.

Yadav Sunita, Kumar Yogesh, Jat Babul Lal (2017) Honeybee: diversity, castes and life cycle, Industrial Entomology, 5-34.

Zaluski, R., Kadri, S.M., Alonso, D.P., Martins Ribolla, P.E, De Oliveira Orsi,R (2015) Fipronil promotes motor and behavioral changes in honey bees (Apis melifera) and affects the development of colonies exposed to sub lethal doses, Environ Toxicol Chem 34(5), 1062-9.

Zamora, E.A. (2016). Value chain analysis: A brief review. *Asian Journal of Innovation and Policy*, 5(2), 116-128.