THE IMPACT OF BEEKEEPING ON THE HOUSEHOLD INCOME OF SMALL HOLDER FARMERS: A CASE OF MIKUNKU IN KAPIRI-MPOSHI DISTRICT OF ZAMBIA

BY

SAMSON KUMWENDA

(BSc. Degree in Agricultural Sciences – UNZA)

A THESIS SUBMITTED TO THE FACULTY OF DEVELOPMENT STUDIES IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN AGRICULTURAL AND APPLIED ECONOMICS

DEPARTMENT OF AGRICULTURAL AND APPLIED ECONOMICS

UNIVERSITY OF MALAWI

BUNDA CAMPUS

JULY, 2016

DECLARATION BY CANDIDATE

I, Samson Kumwenda, hereby declare that this thesis has been completed due to personal effort and is surely original. Where assistance was sought, it has been fully and clearly acknowledged. The findings in this thesis have not been presented to the University of Malawi or indeed any other institution of learning for the purpose of an academic qualification.

Name: Samson Kumwenda

Signature: ______________________

Date: __________________________

CERTIFICATE OF APPROVAL

We hereby declare that this thesis is from the student's own work and effort and all other sources of information used have been acknowledged. This thesis has been submitted with our approval.

Major Supervisor: Prof. M.A.R. Phiri

Signature : ______________________

Date: __________________________

Supervisor: Dr. T. Kalinda

Signature : ______________________

Date: __________________________

DEDICATION

I dedicate this thesis to my wife Evelyn and our children (Mwali, Mwajiluvya, Simon, Samson, Tebulayi, Rajiv and Sekelani) for the moral support rendered during my studies. I also include my parents (Tivesi and Timothy Kumwenda the late) to this list. Above all else, credit goes to Jehovah; the great purposer (Rev.4:11) to whom all is possible.

ACKNOWLEDGEMENTS

This thesis has been successfully completed due to the assistance rendered throughout the program. The author is particularly grateful to the following supervisors; Prof. M.A.R Phiri of the University of Malawi and Dr. T. Kalinda of the University of Zambia for their tireless advice to come up with this thesis.

ABSTRACT

The main objective of this research was to assess the impact of beekeeping on household incomes of the Mikunku Smallholder farmers as an intervention strategy to alleviate their poverty levels. The program was sponsored by Mpongwe Beekeepers Enterprise (MBE) in 1996. The specific objectives of the research were to establish factors that influence participation of smallholder farmers in beekeeping business and to determine the differences in income between participants and nonparticipants. To achieve these objectives, the study had set out an estimate of income contribution from the program based on primary data which was collected through formal interviews by a structured questionnaire and focussed group discussions in 10 villages of Mikunku area comprising a total of 2,900 households. A sample of 340 households was interviewed (112 beneficiaries and 228 non-beneficiaries). The study used probit regression as the participation equation and estimated the propensity score with a logit model. Nearest Neighbour Matching, Radius Matching and Kernel Matching were used as estimators of the Average Treatment effects on the Treated (ATT). The study results indicate statistically insignificant (t-value-0.947, t-value 0.649 and t-value-0.356) impact of beekeeping on household income in the three estimators i.e. Nearest Neighbour Matching, Radius Matching and Kernel Matching respectively. The study's results indicate no impact from beekeeping intervention. The overall results obtained by Nearest Neighbour Matching (attnd), Radius Matching (attr) and Kernel Matching (attk), are similar to each other in the sense that they all give negative values which range from ZMK1.48 to ZMK5.45 ($0.15 to $0.55). On the other hand interesting findings were observed in the manner the characterized variables influenced participation in beekeeping intervention.

The results indicate four variables (family size, training in beekeeping, receiving of inputs from FRA and sales of maize to FRA) to be influencing smallholder farmers to participate in the intervention. These variables are all significant (p-value<0.05). However, the increase in the first three was reducing the chances of participation. The results of two variables (number of years a household spends in beekeeping and the question of women in general other than household head could keep bees without help from men) are significant (p-value<0.01). The research revealed a number of areas for further research i.e. studies on value addition in apiculture, identification of bee species of bees found in the area and their most favoured forage.

ABBREVIATIONS AND ACRONYMS

ATT	Average Treatment on the Treated
CI	Confidence Interval
FAO	Food and Agricultural Organization
FRA	Food Reserve Agency
GDP	Gross Domestic Product
GRPs	Groups
HHs	Households
HIPC	Highly Indebted Poor Countries
IFAD	Integrated Fund for Agricultural Development
IRDP	Integrated/Intensive Rural Development Program
Kg	Kilogram
LR	Likelihood Ratio
MACO	Ministry of Agriculture and Cooperatives
MDG	Millennium Development Goals
NGO	Non-Governmental Organization
NWBKA	North Western Beekeeping Association
Obs	Observations
OLS	Ordinary Linear Scale
PAID-ESA	Pan African Institute for Development East and Central Africa
pH	Concentration of hydrogen $[H]^+$ and hydroxyl ions$[OH]^-$

PRSP	Poverty Reduction Strategy Paper
PSM	Propensity Score Matching
Rev.	Bible Book of Revelation
SFM	Sustainable Forest Management
SNV	Netherlands Development Organization
TT	Treatment on the Treated
UNZA	University of Zambia
ZFAP	Zambia Forestry Action Plan

Contents **Page**

CONTENT PAGE

LIST OF FIGURES PAGE

CHAPTER 1: Introduction and Background

1.1 Overview of beekeeping in Zambia

The first Zambian written records of beehives date back to 1854, when David Livingstone described the log and bark hives used by the Southern Lunda on the upper Zambezi in North-Western Province (Mulemba, 2008; in Mickels-Kokwe, 2006). This means that beekeeping has been a good source of food and income in Zambia for a long time. Kaarsholm (1991) confirms this as well by saying that "The Lunda and Luvale had been connected to the outside world longer in beeswax via Angola Middlemen. Mulemba (2008) said beeswax production was bartered for materials, salt and other commodities by the Angolan Portuguese traders with the North- western people along the border.

In the colonial days, when Zambia was under the British rule, honey was produced for home consumption. Honey production came to be recognised as an important industry since 1931. The department of Agriculture engaged in extension work from 1931. However, the concentration was on the promotion of bark hive making and beeswax production (Mickels-Kokwe, 2006). This approach led to destruction of valuable tree species like Miombo.

Between 1970 and 1990s, the beekeeping industry received substantial support from the Zambian government and donor agencies in terms of investments (SNV, 2010). However, after the 1990s, the Zambian beekeeping sector underwent deep restructuring. After a series of economic reforms, the government withdrew its direct support from the industry. This led to the increase in private participation (SNV, 2010). Since then, the sector has been characterized by poor organization and lack of inter-professional communication. Government and the private sector have to find a suitable platform for dialogue.

Beekeeping as a sector has traditionally been a predominantly male occupation in Zambia, due to a mix of cultural and social factors, as well as practical constraints, that limit women's participation (Claire van der Kleij and Malani Simukoko, 2005).

A value chain study conducted by SNV in collaboration with other partners in 2005 revealed that despite its potential for enhancing rural livelihoods, limited value addition was being realized in prevailing beekeeping practices. Building on the study findings and comparative experiences in Ethiopia, SNV saw an opportunity to explore ways of stimulating technological and market innovations that would also contribute to the goals of encouraging women's participation and poverty reduction.

In collaboration with the North-Western Beekeepers Association (NWBKA) and Mpongwe Beekeepers Enterprise (MBE), the SNV intervention introduced modern top-bar beehives that can be installed close to the household and are easily managed by women. Linked to this, SNV facilitated awareness raising on the importance of enhancing women's involvement in the sector and supported the two associations to mobilize women beekeepers to form groups to facilitate access to credit as well as technical and management support. With funding from Cordaid, NWBKA and MBE established revolving funds to make the modern beehives affordable to the women groups (Claire van der Kleij and Malani Simukoko, 2005).

One of the immediate outcomes of the intervention was an increase in the number of women beekeepers, from virtually none to around 450 women beekeepers at present in North-Western province alone. Based on its experience in implementing honey supply contracts with both men and women producers MBE decided to focus on supporting women beekeeping with its input service provision facility as it is more likely to recoup its investments. Currently, MBE has achieved 33% women participation in its supply chain, of which slightly more than 60% are organized in producer groups. The use of top-bar beehives has contributed to higher household incomes not only due to the higher yields achieved but the higher quality of the honey produced, which is leading to growing demand in the market and opening up opportunities for up-scaling this intervention model into areas beyond North-Western and the Copperbelt Provinces in Zambia.

In general Zambia is endowed with abundant natural vegetation which is ideal for beekeeping. The vegetation is broadly divided into Miombo and a mixture of Chipya and dry ever green forest. The miombo woodlands are valuable as great source of nectar. The vegetation as a whole provides abundant food for the bees and in a good flowering season the queen may lay up to 2,000 eggs per day (Walt et al., 2008). The Miombo is two stored woodland with an open or lightly closed canopy of deciduous trees 15 – 21 m high and is characterized by species of *Brachystegi*a, *Julbernardia* and *Isoberlinia* (Muliokela S. W., 1995).

This ever green forest provides good flowering seasons which are essential for production of propolis which is sticky glue mixed with gums and resins from various plants. This substance is collected by the bees on the hind legs like pollen. It is used to make entrances smaller for the protection of the colony. It seals cracks and gaps and its antibiotic properties help to control diseases within the bees' nest. The availability of food is among the factors that prevent bees from absconding as a "hunger swarm" and migrate over many kilometres in search of better nectar and pollen sources (Bernhard and Renate Clauss, 1991).

Beekeeping is an important component of agriculture and rural development program in many countries. Bees are natural resources that are freely available in the wild. Where bees have not been poisoned, damaged or harmed, they will collect wherever they are able, provided the natural conditions include available flowering plants. Wild or cultivated areas, wasteland and even areas where there may be land mines all have value for beekeeping. Beekeeping is possible in arid areas and places where crops or other enterprises have failed; the roots of nectar-bearing trees may still be able to reach the water table far below the surface. This makes beekeeping feasible in marginal conditions, which is important for people who need to restore their livelihoods or create new ones (Bradbear, 2003). The role of beekeeping in providing nutritional, economic and ecological security to rural communities at the household level and is an additional income generating activity. This, being a non-land-based activity, does not compete with other resource demanding components of farming systems (FAO, 1990).

Mikunku is one of the best sites in Zambia for beekeeping as it lies between two districts (Kapiri Mposhi and Mkushi) in region III of the Zambian Agro-ecological Zone which receives a mean annual rainfall that exceeds 1000 mm. The climate is favorable for apiculture farming. The general elevation is 1100 to1700 meters above sea level.

The area had a total of 2900 households in the year 2010. Before the inception of beekeeping by MBE in 1996, the majority of the beekeepers depended on honey hunting from the bush. By then, those who tried to keep bees used a range of equipments to construct beehives such as tree barks, clay pots, reeds and tree logs. These were highly prone to termite attack and theft.

This area consists of highly weathered and reached soils that are characterised by low pH of less than 4.5 and very low reserves of primary minerals and are usually deficient of phosphorus, nitrogen and many other major plant nutrients and some micronutrients (Stephen W. Muliokela, 1995). The low soil pH and the associated high levels of aluminium and manganese are often toxic to plant growth. This gives a restriction to a number of crops that are grown in the area and underscores the importance of beekeeping which does not directly depend on good rich soils. Although the soils have serious chemical limitations to plant growth, the physical properties are favourable as its deep, well drained soils and high soil biological activity do support the vegetation which is essential for beekeeping.

1.2 Problem Statement of the study

The importance of beekeeping in providing extra income is one option that is available for developing countries as a means to meet the local needs of their people, yet this area has not been exploited. In spite of the importance of honey and it's byproducts from beekeeping, their contributions to rural livelihood in many developing countries are yet to be acknowledged (Shackleton, C. and Shena, S., 2004). Honey is perceived as one of the most convenient coping strategies available for the rural people in times of famine due to its ability to provide immediate energy and easy storage and yet no keen interest is shown by policy makers and economic planners to harness the technology. In Zambia particularly, there is no clear-cut policy directed at the Central Government, Local Government or even communal levels to assess the contribution of income from the beekeeping interventions. Thus, this study attempts to assess income contribution of the small holder farmers due to participation in beekeeping and factors that influence their participation.

Bee keeping for wealth creation has practically remained untapped in the country. A number of beekeeping interventions by Mpongwe Beekeeping Enterprise (MBE), Netherlands Development Organization (SNV), Keeper Zambia Foundation (KZF) and Africare among others have not been evaluated. Those already involved in beekeeping in the rural communities are not utilizing all the bee products but are mostly interested only in honey and bee wax extraction.

Another set of problem for bee keeping is the incidence of pest attack, bush burning, indiscriminate pesticide use, and abscondment of bees, non colonization and inadequate information on the enterprise reduces the productivity of beekeeping (Gutierrez, E.G. 1999 Caruthers, I.; Rodriquez, M., 1992). Besides lack of imperial evidence on the income contribution of beekeeping interventions, local beekeepers do not keep records of their activities making it even more difficult to determine the level of progress they make.

So much literature has been written on beekeeping that the intervention reduces poverty levels and improves the income of the rural people (Kaarsholm 1991, Mugongo, 1991, NWBKA, 2007, Wambua., 2015). However, the benefits associated with beekeeping as an intervention to alleviate poverty among small households still remains anonymous for the majority whom have not ventured into this business in part due to scant imperial evidence and composite assessment.

The composite assessment has resulted into blanket recommendations where it is assumed that benefits accrued from beekeeping will be the same across regions. This is consistent with Maguire 1981 who observed that most of the project interventions are too top-down rather than bottom-top in their implementation. In view of this, the study isolates Mikunku to assess household income contribution as a result of participation in beekeeping intervention. There is so much room for other researchers to explore in beekeeping as an intervention to alleviate poverty among the rural people such as market research for the honey and honey by-products, types of bees present, bee population decline and or bee abscondment.

1.3 Justification of the study

According to Baker (2000), impact evaluation serves both objectives of evaluation: lesson-learning and accountability; by identifying if development assistance is working or not, impact evaluation is also serving the accountability function. Hence impact evaluation is aligned with results based management and monitoring the contribution of development assistance toward meeting the Millennium Development Goals.

A properly designed impact evaluation can answer the question of whether the program is working or not and hence assist in decisions about scaling up. A well-designed impact evaluation can also answer questions about program design: which bits work and which bits don't, and so provide policy relevant information for redesign and the design of future programs. We want to know why and how a program works, not just if it does (Development Bank, 2006).

According to Bradbear 2003, beekeeping can add to the livelihoods of many different sectors within a society including village and urban traders, carpenters who make hives and stands, tailors who make veils, clothing and gloves and those who make and sell tools and containers.

Beekeeping promotes rural diversification and hence is an alternate source of income and employment, particularly in areas where arable land is restricted and demographic growth is resulting in insufficiently profitable landholdings. Beekeeping allows for a degree of risk avoidance by providing a reliable, high-value product that enables rural farmers to survive in times of economic crisis (Pete *et al.*, 1998; Bradbear, 2006). Bees are critical to the stability and persistence of many ecosystems, and therefore, must be understood and protected (Kearns, Inouye & Waser, 1998; Kremen, Williams & Thorp, 2002).

Policy makers, non-governmental organizations and donor agencies in Zambia have been trying to design and implement beekeeping intervention programs and projects in order to improve the small household incomes since 1854. In line with this, the results of the study will be significant for policy makers and implementers in providing appropriate technology in beekeeping to enhance the small household income base.

This research is quite unique among the apiculture studies done in Zambia as it specifically estimates the impact of beekeeping on household income and the characteristics of dependent households empirically. Thus it provides not only a quantitative impact evaluation in estimating the unobserved counterfactual outcome but also gives a qualitative description so as to come up with decisive recommendations.

Therefore, it will contribute to the existing knowledge on beekeeping instead of generalizing the benefits associated with beekeeping. To obtain a good understanding of the benefits from beekeeping, it is important to categorise the benefits associated with the intervention. This study may also be used as a base for further investigation by other researchers about the beekeeping development program in areas of marketing and value addition.

1.4 Objective

The main objective of this study was to assess the impact of beekeeping intervention on the small household farmer's income in Mikunku area.

1.5 Specific objectives

1) To determine factors that influence small holder farmers to participate in beekeeping.
2) To assess the differences in household incomes between participants and non participants.

1.6 Hypothesis

1) Socio-economic factors (age of household head, family size, training received in beekeeping, number of years spent in beekeeping, selling of maize to FRA, inputs received from FRA and land size) do not influence households' participation in beekeeping business.
2) Household incomes of beneficiaries are not significantly different from those of non beneficiaries.

1.7 Study scope and limitations

This study is limited to an impact assessment based on income contribution to the total household income as a result of participation in beekeeping. The study did not take into account the costs the households incurred in the beekeeping business. The study was further limited to determining factors that influenced the smallholder farmers to participate in beekeeping program. The research was based on primary data collected by the author himself.

1.8 Thesis Organisation

The thesis is organized into five chapters. It starts with the introduction and background, which includes problem statement and justification of study, objectives, hypothesis, scope and limitations. The second chapter reviews literature that deals with concepts and past studies and information pertinent to the study. The third chapter explains research methodology including description of the study area, sampling techniques, methods of data collection and tools for data analysis. In the fourth chapter the main findings of the study are discussed. Finally, conclusions and recommendations are provided in chapter five.

CHAPTER 2

2. Literature Review

2.1 Definition of Beekeeping and its associated benefits

Tabinda *et al*, (2013) defines *Beekeeping* or Apiculture as “the preservation of honey bee colonies to get pure honey and helps in pollination”. Tabinda (2013) defined Apiculture as the maintenance of honey bee colonies, commonly in hives, by humans.

The study found the definition by Tabinda (2013) to be appropriate for the current study since the eligible participants for the program were provided with Top Bar hives in which to preserve their honey. According to Tarunika (2014), beekeeping provides an excellent source of income for the landless farmers: since it is migratory in nature, even the landless farmers can take up this profession. It is prudent that the intervention does not compete with crop production or animal husbandry for any input. The beekeeper needs only to spare a few hours in a week to look after his bee colonies; making it ideal as a part time activity.

Both honey and brood are important sources of food (Mickels-Kokwe, 2006; Ntenga and Mugongo, 1991 Merker, 1910; Weiss, 1910; Thompson, 1881; Fuelleborn, 1906). According to Clauss (1991), beekeeping acts as a local currency for the smallholder farmers where it is used for the payment of services like field cultivation, this was a common trend among households during labour constrained periods. Specifically the local brew from honey brood was used as a payment for hiring labour to weed in the maize fields. The honey brood can be boiled and dried to be eaten in times of critical food shortages (Late November to February) awaiting the new harvest from the field.

Honey provides an important part of the energy needed by the body for blood formation. In addition, it helps in cleansing the blood. It has some positive effects in regulating and facilitating blood circulation. It also functions as a protection against capillary problems and arteriosclerosis (Medical Journal, 1986).

It contains enzymes which produce hydrogen peroxide that kills bacteria. Honey is good for healing wounds and for skin treatment: its hygroscopic property is good for drying out wounds, and its permeability allows oxygen to pass through it (Nicolas, 2003). This is made possible because the sugar molecules in honey can convert into other sugars (e.g. fructose to glucose), honey is easily digested by the most sensitive stomachs, despite its high acid content. It helps kidneys and intestines to function better.

North Western Beekeeping Association (NWBKA) (2007) found out that households with tertiary education had higher production using modern techniques of honey production compared to those with lower education still depending on traditional beekeeping methods.

Studies by Bernhard *et al.* (1991) and (SNV, 2010) show that Southern Africa has vast potential for honey production which is currently under exploited.

Most industrialized countries import honey to meet demand. This requirement can provide developing countries with a useful source of foreign exchange from honey exports. All developing countries can export honey if production is in excess of local requirements. Because beekeeping does not use land, production of honey for export need not conflict with growing crops for local consumption (Bradbear, 2003).

Enormous agricultural & agro-based opportunities exist in the rural areas to generate income and employment. In Nigeria, beekeeping is a useful means of strengthening livelihoods and has been identified as a viable agriculture practice that could alleviate poverty and sustain rural employment (Messely, 2007).

Pete *et al.* (1998) observed that even though beekeeping can only rarely become the sole source of income and livelihood for people in the Third World, its role as a source of supplementary earnings, food, and employment should not be underestimated. Key points in the argument that beekeeping is a key element in promoting rural self-reliance are that:

- Beekeeping promotes rural diversification and hence is an alternate source of income and employment, particularly in areas where arable land is restricted and demographic growth is resulting in insufficiently profitable landholdings.
- Beekeeping is an activity that has successfully been adopted by women in many parts of the continent.
- Beekeeping allows for a degree of risk avoidance by providing a reliable, high-value product that enables rural farmers to survive in times of economic crisis. This is particularly true of beeswax, which can be stored indefinitely.
- Beekeeping clearly is a low-cost, sustainable undertaking with a low environmental impact. The spin-off of enhanced plant pollination is an invaluable one.
- Although honey is not a primary source of food, it can be used as a dietary supplement. In addition, its cultural significance should not be ignored.

According to Bradbear (2006) African honey is rarely produced by farmers who are organized and empowered. Nevertheless Bees for Development Journal (2006), believes that African honey is a highly ethical product with very important pro-poor benefits. These are:

- Honey is harvested by some of the poorest and most vulnerable households, and sales bring income into their homes, and is spent on necessities such as school fees and medicine
- Beekeeping is accessible to the poor as there are no high start-up costs. This means that beekeeping can be without the risk of debt
- Beekeeping is undertaken by the young and old, men and women; it is a gender inclusive activity
- Beekeepers produce products (honey and beeswax) that require little further processing.

The environmental benefits of African beekeeping according to Bee for Development Journal (2006) include:

- Bees are indigenous and a natural component of the local ecosystem, and they contribute to biodiversity through pollination.
- Bees in most of Africa are disease free, which means that no medicines are used to maintain bee health - quite apart from the fact that poor people could not anyway afford them.
- Beekeeping causes no disturbance to the natural environment. Compare this to a tea estate, which even if certified organic, has involved replacement of natural vegetation with an imported monoculture.
- Beekeeping creates an economic incentive for rural African people to conserve natural vegetation. This is good news. Imploring people to conserve forests for non-tangible benefits is usually a non-starter. Compare this with earning an income, through beekeeping, from natural forest ecosystems.

Meaza (2010) found that the aroma, taste and colour of honey are determined by the plants from which the bees have gathered nectar. Sunflowers, for example, give a golden yellow honey; clover gives a sweet, white honey; agaves species give honey a bitter taste that is popular in some societies. Dark honey usually has a strong flavour and often has a high mineral content; pale honey has a more delicate flavour.

The popularity of dark and light honey varies from country to country. Colour can also indicate quality, because honey becomes darker during storage or if it is heated. However, some perfectly fresh and unheated kinds of honey can be dark in colour. Glucose is a major constituent of honey. When the glucose crystallizes, the honey becomes solid and is known as granulated honey.

Successful beekeeping enterprises require production equipment and infrastructure such as transport, water, energy, roads, communication systems and buildings. There are many ways to manage bees and obtain crops of honey, beeswax or other products. In sustainable beekeeping projects, all equipment must be made and mended locally which, in turn, contributes to the livelihoods of other local people (Bradbear, 2003). Balya (2006) came up with the following points that qualify a place to be used as an apiary;

- The area should have a history of good honey production and crops which produce nectar/pollen must be within short flying distance for the bees (preferably 2 Km)
- The yard must be accessible to vehicles at all times for easy delivery of inputs and the produce and not water logged but well levelled with water available nearby.
- The site must not be close to human dwellings.

A study by Claire *et al*, (2005) found that beekeeping as a sector has traditionally been a predominantly male occupation in Zambia, due to a mix of cultural and social factors, as well as practical constraints, that limit women's participation. However, a study from Tanzania shows beekeeping activities involved both genders at different stages of honey and beeswax processing and marketing (Lalika, 2008). In his study, he says that traditionally, men are responsible for honey harvesting which is normally carried out at night because they are scared of honey bees during the day. In Milola and Kinyope villages in Tanzania, division of labour was evident (Lalika, 2008*)*. While men specialize in the construction of hives and honey harvesting, women are involved in carrying unprocessed honey home from the forest. The dominance of men in beekeeping activities in the Milola and Kinyope villages seemed to have downplayed the role and contribution women have made with respect to managing bee reserves and habitats, harvesting of crude honey, and the processing of bee products (Lalika, 2008).

2.2 Major constraints associated with beekeeping

Despite the numerous direct and indirect benefits of beekeeping as outlined by different studies in this chapter, the sector experiences several setbacks of which can vary from one country to another and within the country. These constraints require immediate attention if the sector is to prove beneficial to the rural poor.

Biemba (2015) in his case study on prospects of beekeeping in Kaoma district of Zambia came up with the following challenges that the beekeepers face:

- Thefts by people being very much prevalent in the district.
- Interference by red ants which are the second worst enemy of bees to man as they feed on bees, brood and honey.

- Attack on hives by termites which feed on wooden materials some types of beehives are made from, for instance, bark and log hives.
- The Honey Badger, a powerful mammal that breaks into hives to get and feed on honey and brood.
- The lack of or limited skill on the part of the entrepreneurs to ensure that apiaries are well managed and hence increased production of honey and beeswax.
- Bees also abscond from hives or apiaries due to natural enemies like man, ants, diseases and fire.
- Inadequate transport is yet another challenge encountered by the entrepreneurs.
- Some entrepreneurs do not have the money to buy the necessary equipment for production as well as processing honey and beeswax.
- Loans are not easy to get as they demand collaterals which many of them do not have.
- Further, the interest rates are too high for the entrepreneurs to get and pay back the loans.

Desalegn (2001) commented on the existence of pests and predators as a nuisance to the honeybees and beekeepers as they can cause devastating damage on honeybee colonies within a short period of time and even over night.

The use of chemicals and pesticides for crop pests, weeds, *Tsetse* fly, mosquitoes and household pests control brings in to focus the real possibility of damaging the delicate equilibrium in the colony, as well as the contamination of hive products. There are two other circumstances in which bees are killed on plants by chemicals. These are by insecticides applied to non-crop pests such as mosquitoes and *Tsetse* flies and by herbicides applied to plants on which the bees are foraging. Insecticides have a much more dramatic effect on population of bees, thus, the important contribution made by bees to the production of food and human nourishment is being jeopardized. On the other hand, herbicides, which are commonly not toxic to bees, destroy many plants that are valuable to bees as source of pollen and nectar. The types of chemicals used include Malathion, Sevin, DDT, 2-4 D and Acetone. As it was seen from the beekeeper point of view, poisoning of honeybees by agrochemical has been increased from time to time. Some beekeepers lost totally their colonies due to agrochemical (Meaza, 2010 in Kerealem et al., 2009).

Building on the studies conducted by (Meaza, 2010 in Kerealem et al., 2009 and Biemba, 2015), a similar range of constraints were revealed by the people of Mikunku area in Kapiri Mposhi District of Zambia through focussed group discussions. These constraints are explained in chapter 3 under the conceptual framework.

Termite infestation- 20 beneficiaries and 6 non-beneficiaries had their beehives destroyed by termite attack. Once the hive develops holes and that the bees are unable to mend it, they will abandon the colony.

CHAPTER 3

3. Methodology

This section presents the methods and procedures employed in this study. It explains the conceptual framework, sampling design and collection of the data, empirical models and a discussion of the tools and methods used for data analysis. The use of the conceptual framework in this study is providing a schematic description and an explanation of the concepts upon which the study is based. The design of the thesis discusses the sampling and data collection methods and the procedures. The empirical models in this study are the actual models used to achieve the objectives of the study. The final part of the chapter presents a description of the tools and methods used to in data analysis.

3.1 Conceptual Framework

Miles and Huberman (1994) defined a conceptual framework as a visual or written product; one that "explains, either graphically or in narrative form, the main things to be studied the key factors, concepts, or variables—and the presumed relationships among them." Building on this definition, this study depicts a path through which beekeeping contributes income to the smallholder farmers who participated in the program. Figure 3:1 helps us to understand and conceptualise the participation of the small households in beekeeping intervention with the view of improving their household incomes. The participants had access to training and credit facility provided by the Mpongwe Beekeepers Enterprise (MBE). Figure 3.1 presents the various components in the conceptual framework i.e. dependent variable (household income) and the independent variables upon which selection was based and the relationships that exist among the two groups.

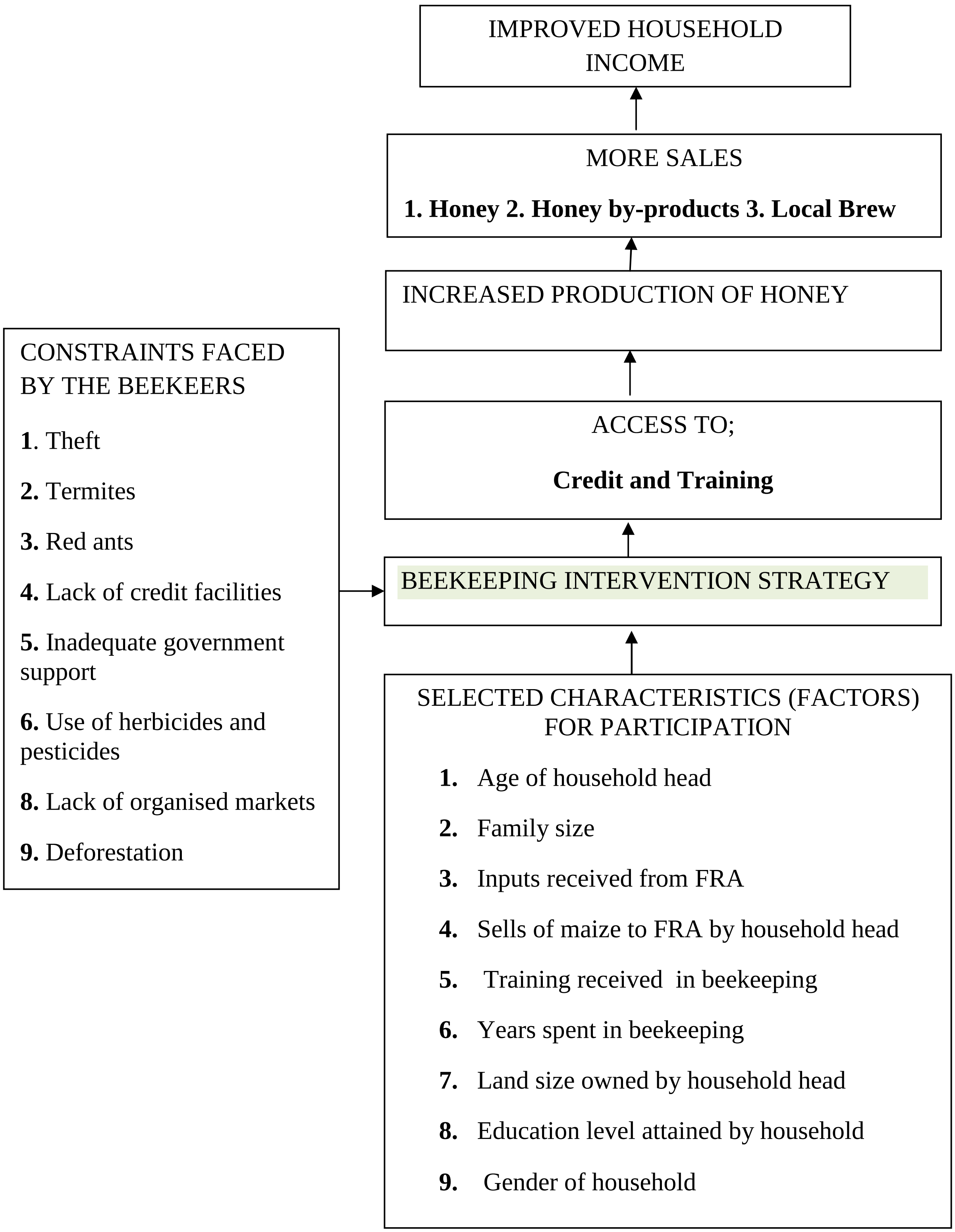

Figure3.1: Conception framework

Source: Authors' own computation

3.1 Main components of the conceptual framework

3.1.1 Factors influencing participation

These were the participation characteristics on which participation was based. As can be seen in figure 3.1 include; Age of household head, Family size, Inputs received from FRA, Sells of maize to FRA by household head, Training received in beekeeping, Years spent in beekeeping , Land size owned by household head, Education level attained by household, Value of assets possessed and Gender of household head. These variables were independent to the project. They provided a guide to construct the counterfactuals since there was no baseline survey.

3.1.2 Access to credit

This was vital in the execution of the program. Credit facilities were required so that the households could acquire physical capital such as top bar hives**,** long-bladed knives, veils and overalls**,** gumboots**,** water buckets and hand gloves**.** Anyonge (2000) referred to basic infrastructure (transport, shelter, water, energy and communications) and the production equipment as physical capital. If these are lacking, beekeeping would not be successful.

3.1.3 Access to training

It is the perception of the author that no piece of any technology can surpass the ingenuity of people as human capital. The households were trained in the following topics: handling and use of equipment, making bee hives, feeding bees, catching the queen, bee plant identification, apiary sitting and establishment and cropping honey from top bar hives. The households needed the skills, knowledge, and ability to apply the knowledge acquired and good health in order to achieve improved household income.

3.1.4 Improved household income

Attainment of high income at household level was the ultimate goal of the intervention. High incomes of the locals would translate into diversity of income generating activities. It was assumed that exposing the small households to credit and training would boost the production of honey and its by-products. One of the honey by-products is the brood. Brood are immature bees which are still in the hives. These are crushed and liquid extracted. This liquid is used to make local brew. The brew is either sold for cash or exchanged with labour in cultivation of field crops; mainly for weeding in labour constrained periods. The income realised is also used to buy agricultural inputs, educating children and purchase of household items.

3.2 Constraints affecting beekeeping in the area

The external factors in the conceptual framework of this study constitute the constraints the beekeepers face in the area. These include; Theft, Termite attack, Red ants, Lack of credit facilities, Inadequate government support, Use of herbicides and pesticides by farmers in crop production, Lack of organised markets, Deforestation, Poor government policy and inadequate funding for the beekeeping sector.

3.2.1 Interference by people (Theft)

Stealing is common in Mikunku and this trend discourages some beekeepers to continue with the business. Thieves have no time to follow the honey harvesting procedures as a result, a number of the beekeepers lose their colonies. The colony bees tend to abscond following a poor honey harvest. Examples of the poor harvest is where the queen bee is removed or where all the honey combs and brood are removed and worse still where the top bars are not replaced.

3.2.2 Deforestation

The bees are denied suitable foraging reserves throughout the season since local people solely depend on the miombo woodlands for fuel wood and construction of buildings. Fuel wood is the single most important energy source for cooking, heating and brick burning throughout Southern Africa (Geist, 1999). It accounts for 76% in Zambia (Chidumayo, 1997) and 14% in South Africa (Gander, 1994). Bees depend on the vegetation. They get their pollen and nectar from the flowers. Depletion of the trees in this area is jeopardising the beekeeping sector.

3.2.3 Use of pesticides and herbicides

The use of pesticides and herbicides to control pests and weeds respectively is widely practiced in the area. Bees are very sensitive to pesticides and herbicides the population of bees is declining as per evidence of absconding. As bees forage from the contaminated pastures, they may die or never find their way back. The study by Thomas E. and Ferrari(2014) show that adult honey bees possess a magneto-reception sense similar to other animals such as birds, fish, whales, dolphins, insects, and microbes for migrations and travelling long distances. The sudden loss and disappearance of honey bees from a hive or apiary has been linked to this disorder and predates virtually all herbicides and pesticides, many diseases or pests and honey bee management protocols (Thomas E. Ferrari, 2014)

3.2.4 Marketing

Market was only readily available in the first two years of program implementation. At the time of the survey, the beekeepers were selling their honey within the villages and by the road sides at $5 per two and half litres. These market places were not reliable as customers were not readily available. The beneficiaries could not pay back the loans.

3.2.5 Government policy/inadequate funding

In comparison to other enterprises like maize where farmers are given some fertiliser and seed packs, beekeeping intervention is lacking support from the government. There is a very high possibility that these factors were not given much attention as to how they could affect the intervention at the inception of the program

3.3 Sampling and data collection

The sampling design and data collection procedures used in the study are explained in this section. The study used primary data which was collected from the households using semi structured questionnaires administered personally and an enumerator. Additionally, the study used focussed group discussions with stakeholders in the program like the Mphongwe Beekeepers Enterprise (MBE), trainers of the program and the trainees.

The sampling frame standard enumeration areas were constructed using the primary data collected from 10 villages in Mikunku under Mubalashi farm block. A sample of 340 households was drawn from a total number of 2900 households. The sample comprised 112 beneficiaries and 228 non-beneficiaries.

The non-beneficiaries in this study were referred to as the counterfactual households (Control group). The beneficiary households were the individual households that were selected to participate in the beekeeping program in Mikunku after meeting the criteria selection to participate. Those in the program were given assistance in form of beekeeping equipment and training from Mpongwe Beekeepers Enterprise. The counterfactuals were the households with similar characteristics as those in the program but they were not given the chance of participation in the program sponsored by Mpongwe Beekeepers Enterprise.

The selected members were subjected to a ten day intensive training in beekeeping. Three trainers were assigned for an initial number of 51 households. After the training and installation of apiaries, the trained households were advised to train others with similar attributes under the supervision of the qualified instructors. The targeted number of households to be trained was 160 as beneficiaries. The main topics for this intensive training were as follows: a). Beekeeping equipment and their uses e.g. smokers, long-bladed knife, swarm boxes, veil, protective clothing and bee brush, b); Handling bees in top bar hives, c); Bee behaviour and communication, d); Setting an apiary, e); How to catch a queen and bee baiting, f); Cropping from a top bar hive. g); how to deal with pests and h); Bee plant identification. After the training, the households were given the equipment on loan.

3.3.1 Sample Size determination

According to Miaoulis and Michener (1976), there are several approaches to determining the sample size which include using a census for small populations, imitating a sample size of similar studies, using published tables, and applying formulas to calculate a sample size

This study used the formula by Israel (1992) in Cochran (1963) for a population that is large; which is given as

$$n_0 = \frac{Z^2(1-p)q}{e^2} \qquad (1)$$

This is valid where;

n_0 = is the sample size,

Z^2 = is the abscissa of the normal curve that cuts off an area α at the tails (1 - α equals the desired confidence level, e.g. for this study 95%),

e = is the desired level of precision,

p = is the estimated proportion of an attribute that is present in the population, and

q is 1-p. The value for Z is found in statistical tables which contain the area under the normal curve.

The study evaluated a beekeeping program in which small household farmers participated. The study assumed p=.5 (maximum participation).

The study desired a 95% confidence level and ±5% precision. The resulting sample size was calculated as follows;

$$n_0 = \frac{1.96^2 * 0.5 * 0.5}{0.05^2} = 385 \; households \tag{2}$$

Where; z =1.96, e =, =0.05, q = 1- p =0.5 and p=0.5

3.3.2 Correction factor for finite populations

Sampling from 385 households is too large for studies with small sample sizes. Therefore Israel (1992) in Cochran (1963:75) recommended reducing the size slightly; "because a given sample size provides proportionately more information for a small population than for a large population".

The sample size (n_0) was adjusted using the equation as shown below;

$$n = \frac{n_0}{1 + \left(\frac{n_0 - 1}{N} \right)} \tag{3}$$

valid where;

n = is the sample size and

N = is the population size.

The assessment of the study affected 2,900 households (beneficiaries plus non beneficiaries) in Mubalashi block. The sample size that was found suitable was obtained as follows;

$$n = \frac{n_0}{1 + \left(\frac{n_0 - 1}{N} \right)} = \frac{385}{1 + \left(\frac{385 - 1}{2900} \right)} = 340 \quad households \tag{4}$$

3.4 Empirical Model

Ashley (2000) explains that the goal of an *impact evaluation* is to attribute impacts to a project and to that project alone. To do this, a comparison group is needed to measure what would have happened to the project beneficiaries had the project not taken place. The process of identifying this group, collecting the needed data, and conducting the relevant analysis requires a lot of careful, thorough thought and planning. There is no standard approach to conducting an impact evaluation. Each evaluation has to be tailored to the specific project, country and institutional context and the actors involved (Ashley 2000).

Holland, (1986) defines Propensity-score matching (PSM) as “a quasi-experimental option used to estimate the difference in outcomes between beneficiaries and non-beneficiaries that is attributable to a particular program”. Essama (2006), states that PSM is an evaluation method which pairs observations on the basis of the conditional probability of participation.

However, by only controlling for the *observable* covariates that are partly responsible for the farmer self selection into the adoption state, the PSM only removes the part of the selection bias called “overt bias” (Lee, 2005; Rosenbaum, 2002). PSM cannot remove what is called “*hidden bias*” which is caused by the *unobservable* covariates that may also affect the farmer self-selection into the adoption state and the outcomes indicators (Heckman and Vytlacil, 2005; Rosenbaum, 2002).

Some researchers have used other methods for assessing impact of a program so that they resolve the problem of the unobserved variables. These include the Difference in Difference (DD) method which is a two-step procedure that relies on differencing to control for unobservable heterogeneity stemming from fixed effects, and on averaging to control for observed heterogeneity. This method is good if base line survey is available. The Instrumental Variables (IV) method relies on regression analysis to control for observables and uses an instrumental variable to recover conditional independence. The Heckman approach is analogous to the IV method except that it interprets unobservable heterogeneity as an omitted variable problem. Thus instead of using an instrumental variable for the endogenous dummy variable in the outcome equation, it adds an estimate of the omitted variable in the equation.

In contrast PSM can act as an effective adjuvant to all these methods if the selection procedure is well adhered to i.e. participants and non-participants should have sufficient similar characteristics; and the only difference is the program.

3.4.1 Modelling factors that influence participation (Specific objective 1) .

One of the specific objectives of this research was to determine the factors that influence the small household farmers to participate in beekeeping in Mikunku. This objective was achieved by running a probit regression model which is cardinal to obtain propensity scores with direction and magnitude. The propensity score is defined by Rosenbaum and Rubin (1983) as the conditional probability of receiving a treatment given pre-treatment characteristics:

$$p(X) \equiv \Pr\{B = 1|X\} = E\{B|X\}. \qquad (1)$$

where $B = \{0, 1\}$ is the indicator of exposure to treatment and X is the multidimensional vector of pre-treatment characteristics and p(X) propensity score (conditional probability that household *i* participated in beekeeping). The pre-treatment characteristics used in (1) to determine the propensity scores are presented in Table 3.1.

These are all the conditional variables that jointly influenced the outcome with no treatment, as well as the selection into the program.

Variable Definition	Expected Participation Result
Income (ZK)	±
Female (F=1, 0 otherwise)	+
Age of household (years)	-
Education (formal=1,0otherwise)	±
Married (m=1,0 otherwise)	-
Land possessed (ha)	+
Years in beekeeping business	+
Training received (yes=1, 0 otherwise)	-
Possibility of females to keep bees alone (yes=1, 0 otherwise)	±
Family size (Number of persons in a household)	+
Input park from FRA (Fertiliser)	±
Maize sold to FRA (50kg)	-

+ high probability of participating in the programme

- low probability of participating in the programme

± participation could either be high or low

Table 3.1: The variables used in the model p(X) ≡ Pr{B = 1|X} = E{B|X}.

3.4.2 Average Treatment Effects on the Treated (ATT) (Objective 2)

Rosenbaum and Rubin (1983) show that if the exposure to treatment is random within cells defined by X in (1), it is also random within cells defined by the values of the mono-dimensional variable p(X). As a result, given a population of units denoted by i, if the propensity score p(Xi) is known the Average effect of Treatment on the Treated (ATT) can be estimated as follows:

$^{2} \equiv E\{Y1i - Y0i|Bi = 1\}$ (2)

$= E\{E\{Y1i - Y0i|Bi = 1, p(Xi)\}\}$

$= E\{E\{Y1i|Bi = 1, p(Xi)\} - E\{Y0i|Bi = 0, p(Xi)\}|Bi = 1\}$

where the outer expectation is over the distribution of (p(Xi)|Bi = 1) and Y1i and Y0i are the potential outcomes in the two counterfactual situations of (respectively) participants and non participants. To obtain unbiased results, the following two conditions are needed to derive equation (2) given the equation (1)[1].

Condition1. Balancing of pre-treatment variables given the propensity score. If p(X) is the propensity score, then;

$B \quad X \mid p(X).$ (3)

Condition 2. Assumption of Conditional Independence (CIA). The CIA argues that treatment is random and conditional on observed variables (*X*). In other words treatment is unconfounded. This assumption implies that the counterfactual outcome for the participants was the same as the observed outcomes for the non-participants given the control variables (*X)*.

---

[1]Refer to Rosenbaum and Rubin (1983) for more details and proof.

This means that the counterfactual income is the same as the income level that would have existed if the household had not participated in beekeeping intervention. Below is the specification of the assumption that the nonparticipants approximate the participants;

$$Y1, Y0 \quad B \mid X. \qquad (4)$$

Then assignment to treatment is unconfounded given the propensity score, i.e.

$$Y1, Y0 \quad B \mid p(X). \qquad (5)$$

If the Balancing Hypothesis of condition 1 is satisfied, observations with the same propensity score must have the same distribution of observable (and unobservable) characteristics independently of treatment status. In other words, for a given propensity score, exposure to treatment is random and therefore treated and control units should be on average observationally identical. Any standard probability model can be used to estimate the propensity score. For example, Pr{Bi = 1|Xi} = F(h(Xi)), where F(.) is the normal or the logistic cumulative distribution and h(Xi) is a function of covariates with linear and higher order terms. In this study a logistic model was used. The choice of which higher order terms to include is determined solely by the need to obtain an estimate of the propensity score that satisfies the Balancing Hypothesis. In as much as the specification of h(Xi) which satisfies the Balancing Hypothesis is more parsimonious than the full set of interactions needed to match cases and controls on the basis of observables, the propensity score reduces the dimensionality problem of matching treated and control units on the basis of the multidimensional vector X[2].

---

[2]It is important to note that the outcome plays no role in the algorithm for the estimation of the propensity score. This is equivalent, in this context, to what happens in controlled experiments in which the design of the experiment has to be specified independently of the outcome (Becker, Sascha, O., 2002).

3.4.3 Propensity score estimation (Main Objective)

For the propensity score to be valid, the balancing properties need to be satisfied. It is intuited that two households with the same probability of access to beekeeping intervention will be placed in the treated (with access to beekeeping intervention) and untreated (without access to beekeeping intervention) samples in equal proportions. The propensity score was estimated by a binary logit model. The program *pscore.ado* estimates the propensity score and tests the Balancing Hypothesis (condition 1) according to the following algorithm[3];

$$\Pr\{Bi = 1|Xi\} = \Phi(h(Xi)) \qquad (6)$$

where Φ denotes the normal (logistic) cumulative distribution function (c.d.f) and h(Xi) is a starting specification which includes all the covariates as linear terms without interactions or higher order terms. This was a necessary condition for the Balancing Hypothesis [4] .

Once the propensity score (pscore) is estimated, the data is split into equally spaced p-score intervals, implying that, within each of these intervals, the mean p-score of each conditioning variable is equal for the treated and control households, known as the balancing property. Since the p-score is a continuous variable, exact matching may not be possible, in which case a certain distance between households with and without access to beekeeping intervention must be accepted.

---

[3]Note that the unconfoundedness Hypothesis of condition 2 cannot be tested.

[4] Note that it is not sufficient in the sense that the balancing may not hold for higher order moments of the distribution of characteristics. So, to be precise, the program does not test the Balancing Hypothesis, but only one of its implications (Becker, Sascha, O., 2002)

In this study, households with and without access to beekeeping intervention were, therefore, matched based on their p-score using the nearest neighbour, kernel, and radius matching methods. These methods identify the closest match for each participant beekeeper household (i.e., with the closest propensity score) among households that have no access to the program and then compute the effect of beekeeping intervention as a mean difference of household income between the two households based on principles (Becker and Ichino, 2004).

3.5 Estimation of average treatment effects based on propensity scores

3.5.1 Matching estimators of the ATT based on the Propensity Score (main Objective)

An estimate of the propensity score is not sufficient to estimate the average household income due to participation in beekeeping using equation (2). This is due to the fact that the probability of observing two subjects with exactly the same value of the propensity score is in principle zero because p(X) is a continuous variable. A number of methods have been proposed in the literature to overcome this problem. The most widely used are, Radius Matching, Nearest Neighbour Matching, Stratification Matching and Kernel Matching. However, this study has used Radius Matching, Nearest Neighbour Matching and Kernel Matching.

Basically these methods involve dividing the range of variation of the propensity score in intervals such that within each interval treated and control units have on average the same propensity score. For practical purposes the same blocks identified by the algorithm that estimates the propensity score can be used. Then, within each interval in which both treated and control units are present, the difference between the average outcomes of the treated and the controls is computed. The ATT of interest is finally obtained as an average of the ATT of each block with weights given by the distribution of treated units across blocks.

The three methods considered will reach different points on the frontier of the trade off between quality and quantity of the matches and none of them is a priori superior to the others. Although one may consider any of them alone for impact estimation, their utilization in combination has the advantage of testing the robustness of impact estimates (Becker and Ichino, 2004). Thus, the study opted to use them jointly consideration in order to assess the robustness of the estimates.

A common support restriction was imposed as a way of improving the quality of the matches. However, this could have led losing high quality matches at the boundaries of the common support and reduction of the sample. So imposing the common support restriction is not necessarily better (Lechner, 2001). With this background, a more detailed and formal description for each estimator has been written, starting with the analysis of Nearest Neighbour Matching, Radius Matching and moving to Kernel Matching.

3.5.1.1 Nearest Neighbour matching method

This method takes each treated unit and searches for the control unit with the closest propensity score, i.e. the Nearest Neighbour. Although it is not necessary, the method is usually applied with replacement, in the sense that a control unit can be a best match for more than one treated unit. Once each treated unit is matched with a control unit, the difference between the outcome of the treated units and the outcome of the matched control units is computed. The ATT of interest is then obtained by averaging these differences. While in the case of the Stratification method there may be treated units which are discarded because no control is available in their block, in the case of the Nearest Neighbour method all treated units find a match. However, it is obvious that some of these matches are fairly poor because for some treated units the nearest neighbour may have a very different propensity score and nevertheless he would contribute to the estimation of the treatment effect independently of this difference.

Let T be the set of treated units and C the set of control units, and $Y^T{}_i$ and $Y^C{}_j$ be the observed outcomes of the treated and control units, respectively. Denote by C(*i*) the set of control units matched to the treated unit *i* with an estimated value of the propensity score of *pi*. Nearest neighbour matching sets;

$$C(i) = \frac{\min}{j} \; \| \; pi - pj \; \| \qquad (7)$$

This is a singleton set unless there are multiple nearest neighbours. In practice, the case of multiple nearest neighbours should be very rare, in particular if the set of characteristics X contains continuous variables; the likelihood of multiple nearest neighbours is further reduced if the propensity score is estimated and saved in double precision.

3.5.1.2 Radius matching

The Radius Matching offers a solution to matching with fairly poor matches. With Radius Matching each treated unit is matched only with the control units whose propensity score falls in a predefined neighbourhood of the propensity score of the treated unit. If the dimension of the neighbourhood (i.e. the radius) is set to be very small it is possible that some treated units are not matched because the neighbourhood does not contain control units. On the other hand, the smaller the size of the neighbourhood the better is the quality of the matches.

The basic idea of radius matching is that it uses not only the nearest neighbor within each caliper, but all of the comparison group members within the caliper (Caliendo & Kopeinig, 2005). In other words, it uses as many comparison cases as are available within the caliper, but not those that are poor matches (based on the specified distance).

In Radius Matching, all the control units with estimated propensity scores falling within a radius r from *pi* are matched to the treated unit *i*. i.e.

$$C(i) = \{pj \mid \| pi - pj < \| r\} \tag{8}$$

In both nearest neighbour and radius matching, denote the number of controls matched with observation i T by $N_i^{\,C}$ and define the weights $wij = \frac{1}{N_i^{\,C}}$ if j C(i) and $wij = 0$ otherwise. Then, the formula for both types of matching estimators can be written as follows (where M stands for either nearest neighbour matching or radius matching and the number of units in the treated group is denoted by N^{T}):

$$\begin{aligned} T^{M} &= \frac{1}{N^{T}} \sum_{i \in T} \left[Y_i^{T} - \sum_{j \in C(i)} wij\, Y_j^{C} \right] \\ &= \frac{1}{N^{T}} \left[\sum_{i \in T} Y_i^{T} - \sum_{i \in T} \sum_{j \in (i)} wij\, Y_j^{\,C} \right] \\ &= \frac{1}{N^{T}} \sum_{i \in T} Y_i^{T} - \frac{1}{N^{T}} \sum_{j \in C} wj\, Y_j^{\,C} \end{aligned} \tag{9}$$

where the weights *wj* are defined by $wj = \Sigma i\ wij$. .

To derive the variances of these estimators the weights are assumed to be fixed and the outcomes are assumed to be independent across units.

$$
\begin{aligned}
Var\left(2^{M}\right)N &= \frac{1}{\left(N^{T}\right)^{2}}\left[\sum_{i \in T} \operatorname{var}\left(Y_i^{T}\right) + \sum_{j \in C}\left(wj\right)^{2} \operatorname{var}\left(Y_j^{C}\right)\right] \qquad (10\ ) \\
&= \frac{1}{\left(N^{T}\right)^{2}}\left[N^{T} \operatorname{var}\left(Y_i^{T}\right) + \sum_{j \in C}\left(wj\right)^{2} \operatorname{var}\left(Y_j^{C}\right)\right] \\
&= \frac{1}{N^{T}} \operatorname{var}\left(Y_i^{T}\right) + \frac{1}{\left(N^{T}\right)^{2}} \sum_{j \in C}\left(wj\right)^{2} \operatorname{var}\left(Y_j^{C}\right)
\end{aligned}
$$

3.5.1.3 Kernel matching method

With Kernel Matching all treated units are matched with a weighted average of all controls with weights that are inversely proportional to the distance between the propensity scores of treated and controls. In this way, the method overcomes the problem of matching with fairly poor matches. Andy *et al*, (2013) state that Kernel-matching estimation if used in PSM, typically compensates for possible differences between the treatment and control groups by measuring other factors thought to influence the outcome indicators and using these as covariates in a regression model. In the same reference it is stated that Kernel matching generates a weight for each matched pair of observations, where a pair consists of a participant and a member of the comparison group.

Following Heckman, Ichimura and Todd (1997) and Smith and Todd (2005), the PSM impact estimator can be written as follows;

For Kernel matching the weights are given by

$$\mu(i,j) = K\left(\frac{P_j - P_i}{a_n}\right) \bigg/ \sum_{k\in C} K\left(\frac{P_k - P_i}{a_n}\right) \tag{11}$$

Where;

K(.) is a kernel function and a_n is the bandwidth. As an example, the Epanechnikov kernel function is

$$K(z) = \begin{cases} 0.75\left(1 - 0.2z^2\right)/\sqrt{5} & if\ |z| < \sqrt{5} \\ 0 & otherwise \end{cases} \tag{12}$$

$$\Delta^{ATT} = \frac{1}{n}\sum_{i\in T}\left\{ y_i^T - \sum_{j\in C}\mu(i,j)\, y_j^C \right\}$$

3.5.2 Sumary on the use of estimators

In the program Kernel Matching (attk.ado), standard errors are obtained by bootstrapping using the bootstrap option while Nearest Neighbour Matching (attnd.ado) and Radius Matching (attr.ado), the standard errors are obtained analytically using the formulas described under their respective headings, or by bootstrapping using the bootstrap option.

The nearest neighbours are not determined by comparing treated observations to every single control, but by first sorting all records by the estimated propensity score and then searching forward and backward for the closest control unit(s). If for a treated unit forward and backward matches happen to be equally good, there are two computationally feasible options to obtain analytical standard errors while at the same time exploiting the very fast forward and backward search strategy: attnw.ado gives equal weight (hence the letters “nw” for nearest neighbor and equal weight) to the groups of forward and backward matches; attnd.ado randomly draws either the forward or backward matches (hence the letters "nd" for nearest neighbour and random draw). In practice, the case of multiple nearest neighbours should be very rare, in particular if the set of X's contains continuous variables, in which case both attnw.ado and attnd.ado should give equal results. The likelihood of multiple nearest neighbours is further reduced if the propensity score is estimated and saved in double precision, which is what pscore.ado does by default.

Variants of nearest neighbor matching include "with replacement" and "without replacement," where, in the former case, an untreated individual can be used more than once as a match and, in the latter case, is considered only once (Smith and Todd ,2005).

When interpreting the results, it is important to evaluate the robustness of the estimations by changing the matching algorithms or by altering the parameters of a given algorithm. Nearest neighbor matching is one of the most straightforward matching procedures. An individual from the comparison group is chosen as a match for a treated individual in terms of the closest propensity score (or the case most similar in terms of observed characteristics).

3.6 Data analysis

Relevant covariates to the study and model specification were generated with the use of computer software (version 12). Graphs and descriptive statistics were generated only on the variables of interest for the study. The use of these variables was noticed in the description of the characteristics of the samples. Descriptive statistics was also used in explaining the propensity of each characteristic to for a household to participate in beekeeping. The study used algorithms (Nearest Neighbour Marching, Radius Marching and Kernel Marching) to find out if there was any statistical difference in household income due to participation in beekeeping as opposed to the non-participants. To achieve this, Propensity Score Matching (PSM) was used while the algorithms were used to isolate only sufficiently similar propensity scores from both participants and nonparticipants. This made it possible to come up with the average effect of treatment on the treated. It was also useful in compensating for possible differences between the two groups that could affect the outcome.

3.7. Limitations of the evaluation methods

Impact evaluation focuses on program benefits, ignoring costs. This means that it measures only one side of cost effectiveness. However, this limitation provides motivation for cost studies to be undertaken (,Caldés Coady and Maluccio, 2004).

The impact evaluation methods provide estimates of average impact in a 'black box' form. The results obtained are good for demonstrating the impact of an intervention, but limited for broader policy analysis (Ravallion, 2005). In view of this, the results obtained by this study could not be generalized to the rest of the beekeeping programs due to differences in the geographical position of the areas which, to a greater extent, dictate the people's livelihood.

CHAPTER 4

4. Empirical Results and Discussions

4.1 Descriptive Analysis

This chapter starts with a summary of the sample descriptive statistics. The focus was on the difference in mean incomes of the beneficiaries and non beneficiaries and a few selected participation covariates. Test for statistical differences in relevant covariates between participants and the control group was conducted in describing. The study used Nearest Neighbour Marching, Radius Marching and Kernel Marching as estimators to establish the differences in mean income differences between the treated and control groups.

4.2 Descriptive statistics of selected variables

Table 4.1 shows the descriptive statistics of the selected variables. From a total population of 2900 households, 340 were sampled of which 33 % (112) were beneficiaries of beekeeping intervention and 67 % (228) were not beneficiaries of the program. The sample comprised 68 females and 272 males which was 20 % and 80 % representation respectively. The total number of households trained in beekeeping was 51 while 289 were not trained. Atleast 136 (40%) households attained some form of formal education while 204 (60%) of the households in the sample did not go to school. The minimum years recorded in beekeeping was 1.5 years. The average age of household head in the sample was 45 years but the range was 20 to 80 years. The average household size was 6 members but the range was 1 to 22 members. The average land sise per household was 3.2 hactares with a maximum size 5 ha. The average income for the households was ZK3.36 ($0.33) per annum. The highest amont of money attained by some households was ZK 15.96 ($1.59) per annum. 95 (28%) beneficiaries were able to sell maize to

Food Reserve Agency (FRA) and 85 (25%) had the chance of receiving input parks from the Food Reserve Agency (FRA).

These socio-economic variables had profound effect on the household to participate in beekeeping. Statistically significant differences were observed at household level with regard to age, family size, gender, education, training and years spent in beekeeping (experience). Details are inTable 4:1.

Variable	Obs	Mean	Std. Dev.	Min	Max
Beneficiary (P=1, 0 otherwise)	340	0.3294118	0.4706923	0	1
Income (ZK)	340	3.357478	5.93273	0	15.96
Female (F=1, 0 otherwise)	340	0.2	0.4005895	0	1
Age of household (years)	340	44.54412	13.32467	20	81
Education of household (1=Ed, 0 otherwise)	340	0.4088235	0.4923411	0	1
Married (married=1, 0 otherwise)	340	0.3117647	0.463897	0	1
Land size possessed (ha)	340	3.236176	5.72984	0	51
Years spent in beekeeping (No. of years)	340	1.467647	3.726903	0	33
Training received in beekeeping	340	0.1529412	0.3604613	0	1
Women in general other than household head without help from men (yes=1, 0, otherwise)	340	0.1647059	0.3714616	0	1
Family y size (number of persons)	340	6.367647	2.975338	1	22
Input park received from (FRA) e.g. fertilizer	340	0.2558824	0.4369991	0	1
Able to Sell maize to FRA in 2010/11 season	340	0.2823529	0.4508076	0	1

Table 4:1 Summary statistics

4.3 Household characteristics affecting participation in beekeeping

There are so many socio-economic factors that would influence a household to participate in beekeeping. The age of a household would limit someone to venture in such a business. We would expect an old person to decline the chance of participation in beekeeping because of aging. A study by Emmanuel (2011) reviewed that age increased participation and the variable was significant in improving farm household's welfare as age increased.

The land size of a household is another factor of interest in this study. It is expected that the larger the land size, the more the chance of participation in beekeeping. Bees are able to forage as far as 2 kilometres (Bernhard *et al.* 1991). However, some studies claim beekeeping can be practiced by landless people (Bradbear, 2006; Biemba, 2015; Tarunika, 2014). The interventions initiated by governments and Non Governmental Organisations (NGOs) are usually inclined to the most vulnerable groups like women and children. Thus, we expect female households to have higher chances of participation in beekeeping than the males. According to NWBKA, 2007, beekeeping should not be a female dominated activity because they are not able to climb trees for installation of the beehives.

We expect that education could either reduce or increase chances of participation. Since beekeeping does not compete with other agricultural activities, does not require strict supervision and that it can be practiced even by landless people, it is expected that people with less formal education can engage themselves in the business relative to those with high education. Each bee colony has its own queen to rule and give orders by way of producing pheromones to the worker bees. In absence of diseases, pests, ants and human interference bees can stay for years as long as the hive is intact.

To find out how these factors influence beekeeping participation, a probit regression was run to determine the variables that affect small households to participate in beekeeping. The probit model calculated the predicted probabilities of participation in beekeeping based on these predictors. The probit did so by using the cumulative distribution function of the standard normal. Table 4.2 presents the coefficients and significant levels of the variables used in the participation probit model.

4.3.1 Beekeeping participation model

To evaluate the impact of beekeeping intervention on the income of Mikunku households, the study implement a PSM estimator using primary data. Table 4.2 presents the results for the participation model. Looking at the standard errors (shown in parentheses) we see that participation is clearly (nonlinearly) related to training, input pack and female headed household.

Beneficiary (P=1, 0 otherwise)	**Coef**	**Sig. Level**
Income (ZK)	-5.09E-08 (-1.83E-07)	
Female (F=1, 0 otherwise)	-0.0575783 (-0.4308145)	
Age of household(years)	0.0018351 (-0.0107324)	
Education (formal=1,0otherwise)	0.0589461 (-0.2876234)	
Married (m=1,0 otherwise)	-0.44312 (-0.3704895)	
Land possessed (ha)	0.0336657 (-0.0201037)	*
Years in beekeeping	1.397917 (-0.1674163)	***
Training received (yes=1, 0 otherwise)	-1.277209 (-0.60388)	**
Women in general other than household head keep bees without help from men (yes=1, 0 otherwise)	1.806543 (-0.5752544)	***
Family size (No of persons per household)	-0.1289802 (-0.0554789)	**
Input park from FRA (Fertilizer)	-1.005858 (-0.4638617)	**
Maize sold to FRA (50kg)	0.6437674 (-0.3285719)	**

Table 4.2 Beekeeping participation model (probit)

*(p-value<0.1) ** (p-value<0.05) *** (p<0.01). The standard errors are reported in parenthesis.

Table 4:3 presents predicted probabilities of participation verses the actual outcome after modelling the factors influencing participation in beekeeping. The results indicate significant differences (p-value<0.1), (p-value<0.05) and (p<0.01) in the manner they affect small households to participate in the intervention. This observation confirms the findings of Ashley (2000) that each evaluation is tailored to the specific project, country and institutional context and the actors involved. This is the prime cause of certain variables to affect participation differently from the priori predicted probability of participation.

Variable	**Coef.**	**P-value**	**Predicted Probability of participation**	**Actual Result**
Income (ZK)	0.002136	0.933	±	-
Female (F=1, 0 otherwise)	-0.0544675	0.899	+	-
Age of household (years)	0.0015558	0.884	-	+
Education (formal=1,0otherwise)	0.0478098	0.867	±	+
Married (m=1,0 otherwise)	-0.437754	0.238	-	-
Land possessed (ha)	0.0330358	0.101	-	+
Years in beekeeping business (No. of years)	1.395113	0.000	+	+
Number of individuals in a family	-0.1295841	0.021	+	-
Training received (yes=1, 0 otherwise)	-1.277614	0.036	-	-
Women other than female headed household keep bees no men (yes=1, 0 otherwise)	1.824845	0.002	±	+
Input park from FRA (Fertiliser and seeds)	-1.03333	0.029	±	-
Maize sold to FRA (50kg)	0.646139	0.05	-	+

Table 4.3: Predicted probability of participation verses actual outcome

4.3.2 Selected variables influencing participation explained.

The probit income coefficient of -5.09e-08 is negatively and not significantly related to participation (p-value 0.781). This means that the more income a household had, the less the chances of participating in the program. This result suggests that the observed characteristics for participation were pro-poor households biased.

Female headed household: The results for female headed households indicate negative correlation with participation in beekeeping. The variable is not significant. As the number of female headed households was increasing, the predicted probability of participation was decreasing relative to the male headed households. This result is consistent with other studies that female headed households are not able to be in beekeeping business without the help of men and that the business be male dominated (NWBKA, 2007; Bernhard, 2007).

In a similar study entitled "Rural Livelihood Diversification and Agricultural Household Welfare in Ghana", it was found that relative to female-headed households, the level of welfare and non-farm diversification was higher for male-headed households (Emmanuel**,** 2011).

The best explanation offered by this study is that rural women are overwhelmed with multiple roles e.g. nursing babies, cooking, fetching fire wood, cultivation, drawing water and any other unprecedented events. This contributes to the inefficiency of women's performance.

Education of household head: The results indicate men had higher chances of participation in the intervention but not statistically significant (p-value0.838). The more education a household head attains the higher the chances of participation in beekeeping. The result agrees with the findings of Emmanuel (2011), which state that the higher the level of education of a household, the greater the probability of engagement in non-farm work and ultimately have improved welfare. Similar results were obtained by SNV (2000); the study revealed that the households with high education utilize beekeeping innovation better than those with low education. However, the expected priori of prediction in this study was both (positive and negative correlation).

Number of years of a household spends in business of beekeeping: Results indicate that experience in beekeeping is significant (p-value 0.000) and has a high positive coefficient (1.39). This probably explains the fact that experience perfects performance. With the passage of time, a household tends to be more conversant with the operational techniques, marketing strategies and coping livelihood strategies for beekeeping in times of poor flowering seasons when bee nectar forages are scanty.

Input pack from Food Reserve Agency: This variable was found to be significant ($p<0.030$) in beekeeping participation. However, it indicates that more access to input packs from FRA reduced chances of such households to participate in the program. It is in line with the prior prediction of participation in the intervention. The result indicates that households with high income were least considered. Nonetheless, it is evident that the inputs from FRA assist the households to earn more income from field crops which is partly ploughed in the beekeeping intervention. This underscores the importance of income diversification at rural household level.

Age of household head: A clear observation in this study is that age of household head is not significant (p-value<0.864). However, it shows that age increases the probability of participation in beekeeping but the likelihood to perform better decreases as the head of household grows in age. *Land size owned by household:* The results indicate that land size possessed by a household is significant (p-value<0.094) at 10 % level. The more the land a household possessed, the higher the probability of participation. This variable was among the factors that were in line with a priori expectation for targeting beneficiaries. This result builds on other studies that beekeeping can be practiced by landless people (Bradbear, 2006; Biemba, 2015; Tarunika, 2014). This is true because any increase in the size of the land for the household increased the chances of participation in the program.

Selling maize to FRA in 2011/12 season: It is observed that the households who were able to sell their maize to FRA or Private Millers had more chances of participation in the beekeeping program. The variable is significant (p-value<0.05). These households are able to get extra income which can be used in the apiary management.

Training received for the business (beekeeping):

Training shows a high level of significance (p<0.03). Knowledge is essential in beekeeping because a household needs to be conversant with the new technology in beekeeping. The negative coefficient indicates that the more training a household gets in beekeeping the less are the chances of participation in the program relative to those not trained.

Family size: This variable refers to the number of individuals at a given household that eat from the same pot. It indicates high significant (p-value<0.02) result. A high number of persons per household in the rural set up mean good labour force. However, the results show that as the number of members increase, there is less chance of participation in the program.

Marital status: Results indicate that marital status is not statistically significant (p-value< 0.232) at 0.1. As the number of married households increased, the chances of participation in the program decreased.

4.6 Propensity Score Estimation

All the variables thought to be influencing participation were used in the estimation of the propensity score i.e. pscore beneficiary household income, female household head, age of household head, education of household head, marital status, size of land possessed (ha), experience in beekeeping, family size, training received in beekeeping, possibility of women in general to keep bees without help from men, beneficiary of input parks from FRA and those who were able to sell maize to FRA , comsup > pscore(mypscore) blockid(blockf1) logit level(0.001) numblo(10). The main purpose of running the propensity score was to test whether the balancing property holds, and then proceeded to estimating the ATT with Radius Matching, Kernel Matching, and Nearest Neigbour Matching programs.

The logit option specified that propensity scores were estimated using logit model, the blockid and pscore options defined two new variables created by stata representing each observation's propensity score and blockid, and comsup option restricted the analysis to observations in the common support. The region of common support is [0.23343514, 1] by specifying the detail option in the above pscore command. The final number of blocks was 10. This number of blocks ensures that the mean propensity score is not different for treated and controls in each block. The balancing hypothesis is rejected when (p-value<0.01) within the cell.

Thus 0.01 is the default and this significance level applies to the test of each single variable of the vector X of pre-treatment characteristics, i.e. the balancing property is not rejected only in case it holds for every single X.

The results of the propensity score estimation indicate that the balancing property is satisfied, since the final distribution of treated and controls across blocks is tabulated together with the inferior of each block. Table 4.4 presents the inferior bound, the number of treated and the number of controls for each block, indication that the balancing property holds.

4.6.1 Inferior bound of treated and controls

This table shows the inferior bound, the number of treated and the number of controls for each block

Inferior of block of pscore	whether a hh particpated in Bee keeping or not: non participant	participant	Total
.2	1	2	3
.2334351	0	15	15
.4	0	5	5
.5	0	2	2
.6	0	3	3
.7	0	8	8
.8	0	6	6
.9	3	71	74
Total	4	112	116

Table 4.4: Inferior bound of treated and controls

Note that the study imposed the common support condition in pscore estimation by using the comsup option. Consequently, block identifiers are missing for control observations outside the common support and the number of observations in the table is 116 instead of 228. After running the pscore estimation of average treatment effects using attr, attk and attnd programs followed.

4.6.2 Description of the estimated propensity score in region of common support

Estimated propensity score

Following the algorithm described in chapter 3, blocks for which the average propensity scores of participants (treated) and nonparticipants (controls) differ are split in half. However, the algorithm continues until, in all blocks, the average propensity score of treated and controls does not differ. In this case, this happens for a number of ten blocks. Thereafter pscore proceeds to the test of the balancing property for each covariate as presented in Table 4.5. Balancing property satisfied.

	Percentiles	Smallest		
1%	.2400538	.2334351		
5%	.4651608	.2400538		
10%	.6853112	.2779447	Obs	116
25%	.9249286	.4157867	Sum of Wgt.	116
50%	.9984509		Mean	.9093256
		Largest	Std. Dev.	.1784097
75%	.9999964	1		
90%	1	1	Variance	.03183
95%	1	1	Skewness	-2.22909
99%	1	1	Kurtosis	7.273381

Table 4.5: Estimated propensity score

4.6.3 Estimation of average treatment effects based on propensity scores

Estimation of impact was done after the propensity score estimation. It is important to note that the outcome plays no role in the algorithm for the estimation of the propensity score. This is equivalent, in this context, to what happens in controlled experiments in which the design of the experiment has to be specified independently of the outcome (Becker, Sascha, O., 2002).

The impact of the program was calculated by just averaging the differences in outcomes between each treated unit and its neighbor (or neighbors). To achieve robustness of matching three estimators were used i.e. Radius Matching, Nearest Neighbour Matching and Kernel Matching.

To avoid the risk of poor matches, radius matching was used to specify a "caliper" or maximum r(0.0001) propensity score distance by which a match was made.

4.6.3.1 Option for Radius matching (attnd)[5]

There was no option pscore(scorevar) specification for attnd random draw apart from matching within the common support region. Therefore, logit allowed a logit estimation of the propensity score instead of the default probit model. The results indicate a negative ATT of ZK 3.20 ($0.32), a t-value of -0.947 and standard error of 3.378. This estimator gives evidence of no impact from beekeeping intervention. The standard error is far more than the ATT.

---

[5] Refer to App. 1.4 Output from attnd for further details

ATT estimation with Nearest Neighbour Matching method (random draw version)

Analytical standard errors

n. treat.	n. contr.	ATT	Std. Err.	T
112	8	-3.200	3.378	-0.947

Note: the numbers of treated and controls refer to actual nearest neighbour matches

ATT estimation with Nearest Neighbour Matching method

(random draw version)

Bootstrapped standard errors

n. treat.	n. contr.	ATT	Std. Err.	T
112	8	-3.200	4.553	-0.703

Table 4.6: Nearest Neighbour Matching Analytical and Bootstrapped standard errors

4.6.3.2 Option for Radius matching (attr)

Estimation of average treatment effects based on propensity scores

The study specified a radius of r(0.0001) instead of the default r(0.1). Note that the specification is so high to ensure quality results but could have traded off some variables. The results show a negative ATT ZK5.45 ($0.54), a t-value of -0.65 and standard error of 8.39. This estimator shows no impact on the household incomes of the smallholder farmers due to participation in beekeeping. Similar results are obtained for analytical standard errors and bootstrapped standard errors.

ATT estimation with the Radius Matching method [6]

Analytical standard errors

n. treat.	n. contr.	ATT	Std. Err.	T
43	**2**	**-5.448**	**8.393**	**-0.649**

Note: the numbers of treated and controls refer to actual matches within radius

ATT estimation with the Radius Matching method

Bootstrapped standard errors

n. treat.	n. contr.	ATT	Std. Err.	T
43	**2**	**-5.448**	**6.976**	**-0.781**

Table 4.7: Radius Matching Analytical and Bootstrapped standard errors

Note: the numbers of treated and controls refer to actual matches within radius

[6] Refer to App. 1.5 Output from attnd for more details

4.6.3.3 Option for Kernel Matching (attk)

Estimation of average treatment effects based on propensity scores

The study used Kernel Matching (Epanechnikov) with a comsup bwidth(0.06) as the specification. The estimator failed to compute analytical standard error and t-value. Thus the study went for bootstrap option to get bootstrapped standard errors. The results show negative impact of ZK1.48 ($0.15). The t-value is -0.356.

ATT estimation with the Kernel Matching method [7]

Analytical standard errors

n. treat.	n. contr.	ATT	Std. Err.	T
112	10	-1.482	.	.

ATT estimation with the Kernel Matching method

Bootstrapped standard errors

n. treat.	n. contr.	ATT	Std. Err.	T
112	10	-1.482	4.167	-0.356

Table 4.8: Kernel Matching Analytical and Bootstrapped standard errors

[7] Refer to App. 1.6 Output from attk for further details

4.6.3.4 Summary results from attr, attnd and attk

Analytical standard errors					
Estimator	**n.treat**	**n.contr**	**ATT**	**Std.Err**	**T**
Nearest Neighbour	112	8	-3.200	3.378	-0.947
Radius	43	2	-5.448	8.393	0.649
Kernel	112	10	-1.48	.	.
Bootstrapped standard errors					
Estimator	n.treat	n.contr.	ATT	Std.Err	T
Nearest Neighbour	112	8	-3.200	4.553	0.703
Radius	43	2	-5.448	6.976	-.781
Kernel	112	10	1.482	4.167	-0.356

Table 4.9: Summary of analytical standard errors and bootstrapped standard errors

Household income contribution

Estimator	Zambian Kwacha (ZK)	US Dollar ($)
Nearest Neighbour	(3.20)	(0.32)
Radius	(5.45)	(0.55)
Kernel	(1.48)	(0.15)

Table 4.10: Household income contribution due to participation in beekeeping

Note that the values in brackets are negatives.

4.7 Findings of the research.

The study's results indicate no impact from beekeeping intervention. The overall results obtained by attnd, attk, and attr are similar to each other in the sense that they all give negative values which range from ZK1.48 to ZK5.45 ($0.15 to $0.55). The standard errors are all positive values i.e. 4.55, 6.97 and 4.16 for attnd, attr and attk respectively. The decision rule is that the standard errors should be less than half the value of the ATT. Additionary, the t-values i.e. -0.947, 0.649 and -0.356 for for attnd, attr and attk respectively are less than two. All these factors considered together provide solid evidence that the intervention of beekeeping has no impact on the household income of the small holder farmers of Mikunku.

4.8 Direct impact on beneficiaries

Even though the results of the study indicate no impact on household incomes of the participants, beekeeping seemed to have helped the households in Mikunku. Discussions with focussed groups revealed that income accrued from beekeeping was used to purchase farm inputs i.e. fertilizers and seeds in the months of September, October and November. This led to the expansion of land under cultivation. This money was also used to purchase small items like cell phones and groceries for home consumption. However, with a systematic follow up of the questionnaire it was noticed that big assets were purchased with the involvement of family members and through other enterprises like field crops. Besides the income realised, the beekeepers are able to incorporate honey into their diets and some of it for brewing local beer. The local beer is used as local currency for exchange with labour in crop fields.

Figure 4.4 presents income distribution among beneficiaries and non beneficiaries in the range of $15 to $55 per year.

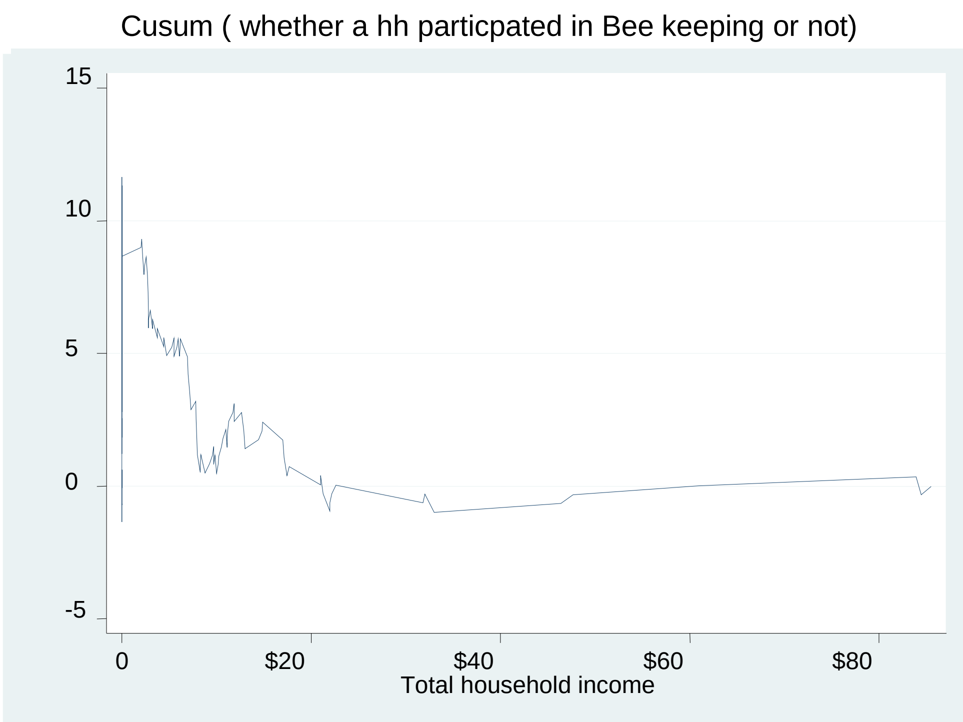

Figure 4.4: Total household income

4.9 Indirect impact on community

Through focussed group discussions with the households and the trainers the study revealed that beekeeping brought close ties among the group members. The beekeeping activities strengthened the support and collaboration between and among community members as they were experiencing common opportunities and obstacles. Team work was necessary during the time of selling the honey, transferring colonies from one beneficiary to another. In the process, these members came to share ideas on other farming activities. These community members who were trained in beekeeping are knowledgeable in apiculture and any future intervention related to this would easily be adopted.

4.10 Limitations of the Research Study

The evaluation results cannot be generalized to other beekeeping enterprises implicitly in Zambia because each project design is tailored to the local conditions (rainfall pattern, vegetation, people's activities and topography).

Primary data collection is very expensive. It requires adequate funds and reliable transport to cover the sample frame as soon as possible.

CHAPTER 5

5. Conclusions and Recommendations

5.1 Conclusions

The main objective of this research was to assess the impact of beekeeping on income contribution as a strategy to alleviate the poverty levels of Smallholder Farmers of Mikunku in Kapiri-Mposhi district of Zambia. The specific objectives were to establish the factors influencing the participation of smallholder farmers in beekeeping business, to determine the differences in income between participants of the intervention and nonparticipants. To do this, the study carried out an impact assessment of beekeeping on the household income contribution for those in the program (beneficiaries) and non-program (control group).

The results indicate four variables (family size, training received in beekeeping, receiving of inputs from FRA and sales of maize to FRA) to be influencing smallholder farmers to participate in the intervention. These variables are all significant ($p\text{-value}<0.05$). However, increasing the family size, training received in beekeeping and receiving of inputs from FRA reduced the chances of participation (negatively correlated). The study indicate significant ($p\text{-value}<0.01$) results for the number of years a household spends in beekeeping and the question of women in general to engage in beekeeping without help from men.

The results indicate that increasing the number of female headed households decreased the predicted probability of participation in the program. On the other hand, higher education for a household increased the chance of participation in the program. Similar results were obtained by Carolyn (2010) that higher the level of education, the greater the probability that households will engage in non-farm work and ultimately have improved income. As the value of assets for a household increases, the predicted probability of participation in beekeeping was decreasing. The age of a household head increased participation in beekeeping but the likelihood to perform better decreases as the head of household grows in age. Emmanuel (2011) found similar results where the coefficient of household head's age was positive and significant which meant that a farm household's welfare is improved as age increases.

The research results indicate no impact from beekeeping intervention. All the estimators (attnd, attr and attk) used for estimating the ATT computed negative values of income in the range of ZK1.48 to ZK5.45 ($0.15 to $0.55). The standard errors are all positive values i.e. 4.55, 6.97 and 4.16 for attnd, attr and attk respectively and greater than the ATT. Additionary, the t-values i.e. -0.947, 0.649 and -0.356 for for attnd, attr and attk respectively are less than two.

5.2 Recommendations

Conducive environment: The negative values of ATT obtained by the estimators reveal that smallholder farmers of Mikunku are operating under harsh conditions. In view of the foregoing, the writer recommends strongly that all the stakeholders (donors, locals and government) should work towards creating an enabling environment in which beekeeping households can utilize their potential to the maximum. There are several ways of creating an enabling environment for the beekeepers. These would include;

- Government putting in place favourable monetary policies, such as reduced interest rates so as to reduce the cost of borrowing capital, which would in turn encourage private business investments and development.

- The policy makers should design a rural tailed curriculum in beekeeping for small households. This will increase the technical knowhow of the households in apiary management. Zambia has so many qualified extension staff doted in the rural areas to do the job of giving lesson to farmers on beekeeping. The extension staff can be highly motivated if the government attaches an allowance to the curriculum.

- Government can assist the small households to start up beekeeping and grow their businesses by giving them tax rebate, as it does to large firms. The intervention of beekeeping should be recognized as a poverty alleviation strategy for the poor by action.

- Commercial banks should provide a wider range of loan conditions, collateral requirements, interest rates and repayment conditions for different segments of the economy.

- Modern industries that can process beekeeping produce into finished products should be located within the study area. This would ensure that secondary products like candles, cobra, honey, etc. are produced locally. It was observed that some of the households had nowhere to sell the wax after extracting the honey.

- There is need to establish programmes combining skills and management training for beekeeping entrepreneurs that would better equip them to start and expand the business.

- The creation of an information centre at Mikunku will allow the beekeeper to have access to important current information in beekeeping just as the Zambia Farmers Union (ZFU) has done.

Solution to termite problem: One of the biggest challenges the small household farmers face in Mikunku as per focussed group discussions was termite attack on the beehives. Therefore, the remedy to reduce termite attack on the beehives, it is advisable that farmers be educated and encouraged to place the beehives hanging from trees. This will keep off termite attack. The hives should be raised at heights where the beekeepers are able to work while standing. This would provide a twofold solution in that women's participation in beekeeping enterprise will increase since they have difficulties in climbing trees.

The problem of theft can be reduced by proper housing of beehives. In this case farmers should be encouraged to put up their apiaries in a safe proximity of their homesteads and preferably fenced with lockable gates. Additionally, the households in beekeeping are required to fully embark on modern hives such as the top bar hives which are least affected by adverse weather conditions, pests and even diseases.

The households need to be sensitized on the hazardous effects of using herbicides to control weeds in an area of bee farming. According to the study by Thomas and Ferrari (2014), bee absconding is highly linked to use of herbicides. It was observed that the sudden loss and disappearance of honey bees from a hive or apiary has been linked to the use of herbicides and pesticides.

References

Allsopp, M. H. 2004. Cause or consequence: *The pseudo- clone and the Capensis Problem*. S. Afr. BEE j. 76:25

American Sociological Association .2010. *A Hazard-Model Approach to propensity score Estimation for studying the treatment effect of an event,* Washington: United States of America; SAGE

Ashley, C. 2000. Working Paper 134: *Applying Livelihoods Approaches to Natural Resource Management Initiatives*

Baker, Judy, L. 2000. *Evaluating the Impact of the Development Projects on Poverty: A Handbook for Practitioners*, Washington, D.C.: The World Bank (Directions in Development)

Balya, H. 2006. The African Honey Trade Forum. Kenya

Baker .2000. *Evaluating the Impact of Development Projects on Poverty;* World Bank

Barany, M. and C. Holding-Anyonge .2000. *The importance of apiculture for rural Livelihoods:* case study 1 - Beekeeping and AIDS

Becker, Sascha, O. (2002) "Estimation of average treatment effects based on propensity scores", *Stata Journal 2022*. LABO Ratorio R. Revelli Centre for Employment Studies.

Berenbaum, M.R. 2007. *The Birds and the Bees—How Pollinators Help Maintain Healthy Ecosystems*. Testimonial before the Sub-committee on Fisheries, Wildlife and Oceans, Committee on Natural Resources, U.S.

Bee for Development. 2006. ApiTrade Africa Statement.

Bernhard and R, C. 1991. *Zambia Beekeeping Handbook,* Ndola: Printed by Mission Press, Zambia

B. Essama-Nssah. 2006. *Propensity Score Matching and Policy Impact Analysis:* A Demonstration in EViews; The World Bank, Washington, D.C

Biemba. 2015. Prospects of Beekeeping as an entrepreneurial option in Kaoma District of Western Province of Zambia

Bradbear, N. 2002. Strengthening livelihoods: exploring the role of beekeeping in development. Bees for development, Monmouth, United Kingdom.

Bradbear, N. 2003. Beekeeping and Sustainable livelihoods. Agricultural Support Systems

Bradbear, N. 2006. Benefits of African beekeeping. Bee for Development Issue No.81,

Buchmann, S. E. and Nabhan, G.P. 1996. *The forgotten pollinators*. Island Press, Washington, D.C U.S.A.

Caldés, N et al. 2004. *The Cost of Poverty Alleviation Transfer Programs: A Comparative analysis of Three Programs in Latin America.* Washington, DC: Dis. Paper No.17 4

Caliendo, M et al. 2005. *Some Practical Guidance for the Implementation Propensity Score Matching*, IZA: Discussion Paper No.1588

Caroll, T. 2006. A beginner's guide to beekeeping in Kenya. Legacy Books Press, Nairobi.

Carolyn Heinrich et al, (2010) A Primer for Applying Propensity-Score Matching Inter-American Development Bank

Caruthers, I. and Rodriquez, M. 1992. Tools for Agriculture. Intermediate Technology Publication, Nottingham, United Kingdom.

Charlotte Lietaer .2007. *Impact of beekeeping on forest conservation, preservation of forest ecosystems and poverty reduction:* Universita degli Studie Roma 3, Italy

Chernoff, H., Lehmann, E. L. 1954. *"The Use of Maximum Likelihood Estimates in χ^2 Tests for Goodness of Fit". The Annals of Mathematical Statistics **25** (3): 579–586. doi:10.1214/aoms/1177728726*

Chiyanyinga, B.M. 2008. *The effectiveness of the communication strategies of a rural Development project*; A case study of the North-western Bee products in Kabompo

COST. 2008. *COLOSS: Prevention of honeybee colony losses*. COST Action FA0803. European Cooperation in Science and Technology, Brussels.

Delaplane, K .S .1993.*Honey and Beekeeping: A year in the life of an apiary*, Georgia: The University of Georgia, Athens Georgia

Dehejia, R and Wahba, S. (2002) *"Propensity Score Matching Options for Non-experimental Causal Studies," Review of Economics and Statistics.* Volume 84, Number 1, pp. 151-161

Diaz, Juan-Jose and Handa, Sudhanshu. 2004. Estimating the Selection Bias of Matching Estimators using Experimental Data from PROGRESA. Department of Economics , University of Maryland, and Department of Public Policy, University of North Caroline at Chapel Hill.

Emmanuel, E. Asmah .2011. *Rural livelihood diversification and agricultural household welfare in Ghana*: Journal of Development and Agricultural Economics Vol. 3(7), pp. 325-334,

Essama, B. Nssah . 2006) *Propensity score matching and policy impact analysis A Demonstration in EViews* Poverty Reduction Group (PRMPR): Washington, D.C.

European Commission. 2011a. *Structural Change in Research Institutions: Enhancing Excellence, Gender Equality, and Efficiency in Research and Innovation.* Luxembourg: Office for Official Publications of the European Communities.

European Commission. 2011b. *Regulation of the European Parliament and of the Council: Establishing Horizon 2020, The Framework Programme for Research and Innovation, 2014-2020, Article 15*. Brussels: European Commission.

Falcone, J. 1991. *Household food security and forestry; an analysis of socio-economic issues*

FAO, 2003. *Food energy - methods of analysis and conversion factors*. *Report of a Social Social Work Research*, New Orleans: January, 2004 squo@email.unc.edu technical workshop. FAO Food and Nutrition Paper No. 77. Rome.

FAO .2005. *Livestock Sector Brief, Zambia. Food and Agriculture Organisation of the United Nations/Livestock Information*, Sector Analysis and Policy Branch.

FAO of the United Nations .2012. *AQUASTAT [online] Available at http://www.fao.org/nr /water/aquastat/dbase/index.stm>[Accessed 2012]*

FAO.2011.*The state of Food Insecurity in the World.* [pdf] Available at <http://www .fao.org/jocrep/014[Accessed 2012]

FAO. 2010. *The State of Food Insecurity in the World*. (www.fao.org/hunger/en/)

FAO. 2009. *Bees and their role in forest livelihoods. A guide to the services provided by Bees and the sustainable harvesting, processing and marketing of their products*. Rome

FAO, 2007a. *Crops, browse and pollinators in Africa: an initial stock taking*. Rome.

.Farré, R., Frasquet, I. and Sánchez, A. 2004. El própolis y la salud. *Ars Pharmaceutical*, 45(1)

Fetenu Bekele.1997. *Gender Dimension in Development Projects*; Concepts, Approaches and Framework for Gender Analysis

Fischer F. U .1993. *Beekeeping in the Subsistence Economy of the Miombo Savannah*

Woodlands of South-Central Africa. Rural Development Forestry Network Paper 15c.

Glenn D. Israel. 1992. '*Sampling the Evidence of Extension Program Impact"*, PEOD $_5$, one of a series of the Agricultural Education and Communication Department, UF/IFAS Extension. Available online; EDIS website at http://edis.ifas.ufl.edu

Greene, William, H .2000. Econometric Analysis. Upper Saddle River (New Jersey): Prentice Hall.

Greenwood, P.E.; Nikulin, M.S. 1996. *A guide to chi-squared testing. New York: Wiley. ISBN 0-471 5779-X*

Gutierrez, E.G. 1999. Guide to Natural Remedies for Health and Well Being. Orvil Publishing, Mexico pp 263-283.

Haddad, L and Kanbur, R. 1993."*The Value of Intra-household Survey data for Age-based Nutritional Targeting"* Reprinted from Annales d'Econmie et de Statistique, Vol.29. IFPRI Report No.272

Honey case study Zambia (www.opentradegate.se/) *Implementation of Propensity Score Matching* IZA Discussion Paper No.1588

John B. et al. 2008. *Social economics: an introduction and a view of the field.*

Juan, J. D and Handa. 2004. *An Assessment of Propensity Score Matching as a Non Experimental Impact Estimator*: Evidence from a Mexican Poverty Program

Kalaba, K.F .2010. *Contribution of agro forestry to biodiversity and livelihoods improvement in rural communities of Southern African regions*

Kerealem Ejigu, Tilahun Gebey and Preston, T. R. 2009. Constraints and prospects for apiculture research and development in Amhara region, Ethiopia.

Khaliso Kepaletswe .1991. *Beekeeping handbook (Third Edition) Gaborone-Botswana*

Kratch, U (1981)"*Food Security for people in the 1980s*". Paper prepared for discussion at North-South Food Round Table Meeting, Washington

Lalika M. C .S. and Machangu J. S, 2008. Beekeeping for income generation and coastal forest conservation in Tanzania. *Bee for development journal No. 88. Accessed from:* http://www.beesfordevelopment.org/, Lalonde and Robert, J. 1986. *Evaluating the Econometric Evaluations of Training Programs with Experimental Data*; The American Economic Review, Vol. 76, No. 4:604-620

Lee, Lung-Fei .1983. *Generalized Econometric Models with Selectivity. Econometric,* Vol. 51, No. 2:507-512

Lay-flurrie K. 2008. Honey in wound care: effects, clinical application and patient benefit. *Br. J. Nurs*., 17(11): S30, S32-6.

Lietaer, C. 2007. *Apitherapy: practical guide for remote areas in developing countries*. Not published. (Thesis)

Lubinda B. Imboela. 2005. *Poverty Reduction in Zambia*: A Conceptual Analysis of the Zambian Poverty Reduction Strategy Paper

Maddala, G. S .1983. *Limited-Dependent and Qualitative Variables in Econometrics*. Cambridge: Cambridge University Press.

Madeleen Husselman .2008. *Center for International Forestry Research*: Lusaka

Maguire, R. 1981. ***Bottom-Up*** *Development in Haiti.* Inter-American Foundation, Rosslyn, VA.

Marco, C and Sascha O. B. 2007. *Sensitivity analysis for average Treatment effects* The Stata Journal (2007)**7**, Number 1, pp. 71–83

Maja, I. 2014. "*A preliminary laboratory study on the longevity of A. m. carnica honey bees after feeding with candies containing HMF"* Journal of Apicultural Research, Vol. 53 (4) pp. 422-423

Meaza Gebreyohannes Berhane .2010. Socio-Economic Analysis of Market Oriented Beekeeping in Atsbi Wemberta District of Eastern Zone, Tigray Region

Melissa, H and Bryman A. 2004. *Hand book of data analysis: Great Britain*; Association with SAGE

Menard, S. 2000. "Coefficients of determination for multiple logistic regression analysis." *The American Statistician* 54: 17-24.

Messely Jos, 2007. Beekeeping for Sustainable Rural Livelihood in Ondo State, Nigeria.

Mickels-Kokwe .G (2006) *Small-scale woodland-based enterprises with outstanding potential.*

The case of honey in Zambia. Bogor, Indonesia: Centre for International Forestry Research

Miles, M. B., & Huberman, A. M. 1994. Qualitative data analysis: An expanded sourcebook: Sage

Moran, F. 2001. *Step Ahead; New Certificate Agriculture Book 1*: Longman Zimbabwe (Pvt) Ltd

Mwenechanya, K and Silne. 2007. *Legal empowerment of the poor,* Ndola: Zambia

Njovu, F.C .1993. *Consultant pilot country study-Zambia*.

Oldham, J. 2002. *An International Journal of Fundamental and Applied Research*, vol.74 (1), page 332

Omobowale, O et al. 2010. *Beneficiary Assessment/Impact Evaluation of the Gef / Cemp Development Project*; Draft report submitted to CEMP/GEF National Fadama

Orzáez Villaneuve, M.T., Díaz Marquina, R., Bravo Serrano, R. and Blazques Abellán, G. 2002. *The importance of bee-collected pollen in the diet: a study of its composition*. *Int. J. Food Sci. Nutr*. 53: 217-224.

Oyun, N. B. 2009. The Role of Non-Timber Forest Products on the Livelihood of Fringe Communities of Idanre Forest Reserve, Nigeria. Journal of Forest and Forest Products Vol.3,No. 5.

Paul B. et al. 2005.*Poverty Reducing Potential of Smallholder Agriculture in Zambia*: opportunities and constraints

Paul Shaffer .2004. Mixed Methods of Poverty Measurement and Monitoring: The World Bank

Pete M. Illgner., Etienne, L,. Nel, Mark ,P,. Robertson. 1998. Beekeeping and Local Self-

Reliance in Rural Southern Africa. Geographical Review, Vol. 88, 68

Plackett, R.L. .1983. *"Karl Pearson and the Chi-Squared Test". International Statistical Review (International Statistical Institute (ISI 51(1):59-72.doi:10.23o7/1402731*doi:*JSTOR 1402731*.

Ravallion, Martin .2005. *Evaluating Anti-Poverty Programs.* World Bank Policy Research Paper No. 3625. Washington D.C: The World Bank

Rosenbaum, Paul and Rubin, Donald .1983. *The Central Role of the Propensity Score in*

Observational Studies for Causal Effects. Biometrika, Vol.70, No.1:41-55.58

Russell, H and Bernard .2000. *Social research methods; Qualitative and quantitative approaches*: United States of America; SAGE.

Shackleton, C. and Shena, S. 2004. The Importance of Non-Timber Products in Rural community (Livelihood-Security and as Safety Nets. A Review of Evidence from South Africa. South Africa Journal.

Smith, J, A. et al .2001. Reconciling *Conflicting Evidence on the Performance of Propensity-Score Matching Methods*. The American Economic Review, Vol. 91, No.2: 112-118.

SNV.2010. *Capacity development services for apiculture in Zambia.* Available at:

Southern Africa Development Community. 2011. *Regional Agriculture policy-Country S Summery Agricultural Policy Review Reports* [pdf] Available

Tabinda et al. 2013. **“**Impact Assessment of Beekeeping in Sustainable Rural Livelihood” *Journal of Social Sciences*, Vol.2 No.2, p. 1

Tambo, G. 2007. Social Cash Transfers and Household Welfare in Zambia.

Tara Bedi et al. 2006. *Impact Evaluation and the Project Cycle*

Tarunika J. A. (2014) “*Beekeeping Industry in India: Future Potential “Impact: International Journal of Research in Applied, Natural and Social Sciences,* Vol. 2 (7) pp. 133-140

Tony Haddad, et al. 2013. *Kernel Matching versus Inverse Probability Weighting*: A Comparative Study; International *Journal of Mathematical, Computational, Physical, Electrical and Computer Engineering* Vol: 7, No: 8, 2013

The World Bank Group. 2012. *Data by Country: Zambia.* [online] Available at org/country . /Zambia> [accessed 2012]

Thomas, E et al. 2014. “*Magnets, magnetic field fluctuations and geomagnetic disturbances impair the homing ability of honey bees* (*Apis mellifera*)” *Journal of Apicultural Research*, Vol. 53 (4) pp. 452-465

Todaro, P. M and Smith C. S .2009. *Economic Development*. 10th ed. England: Pearson Education Limited

Website (www.beekeeping.com/articls) *Situation analysis of the Beekeeping Industry in B Botswana, Lesotho, Malawi, Mozambique, South Africa, Swaziland, Zambian and Zimbabwe*. Down Loaded 25th January 2011

Website (http://www.businessdictionary.com/definition date: 28/03/16; time: 07:27 am)

Walt Wright Elkton, Tennessee (2008) *Bee Culture,* South Africa. Available online: downloaded

World Bank. 2006. *Impact Evaluation*: methodological and operational issues: Asian

Zulu, J and Margret B. 2007. *Smallholder Household Maize Production and Marketing Behavior in Zambia*: Implications for Policy

1 APPENDICES

App. 1.1 Syntax: probit, pscore and att* are regression-like commands

```
. prob beneficiary ln_hhincome female_hh saq4 edu_hh m_status land_size sgq82 hh_size sgq85 sgq91 skq144  skq150

. pscore beneficiary ln_hhincome female_hh saq4 edu_hh m_status land_size sgq82 hh_size sgq85 sgq91 skq144  skq150 , comsup
> pscore(mypscore) blockid(blockf1)  logit level(0.001) numblo(10)

. attnd  ln_hhincome beneficiary female_hh saq4 edu_hh m_status land_size sgq82 hh_size sgq85 sgq91 skq144  skq150  , comsu
> p boot reps(100)

. attr ln_hhincome beneficiary female_hh saq4 edu_hh m_status land_size sgq82 hh_size sgq85 sgq91 skq144  skq150  , comsup
> boot reps(100)dots logit radius (0.0001)

. attk ln_hhincome beneficiary female_hh saq4 edu_hh m_status land_size sgq82 hh_size sgq85 sgq91 skq144  skq150, comsup bo
> ot reps(100) bwidth(0.06)
```

App.1.2 Output from probit regression

```
. prob beneficiary ln_hhincome female_hh saq4 edu_hh m_status land_size sgq82 hh_size sgq85 sgq91 skq144  skq150

Probit regression                              Number of obs   =        340
                                               LR chi2(12)     =     327.94
                                               Prob > chi2     =     0.0000
Log likelihood = -51.511204                    Pseudo R2       =     0.7609
```

beneficiary	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
ln_hhincome	.002136	.0252517	0.08	0.933	-.0473564	.0516284
female_hh	-.0544675	.4307824	-0.13	0.899	-.8987856	.7898505
saq4	.0015558	.010682	0.15	0.884	-.0193806	.0224922
edu_hh	.0478098	.2850239	0.17	0.867	-.5108268	.6064464
m_status	-.437754	.371041	-1.18	0.238	-1.164981	.2894729
land_size	.0330358	.0201294	1.64	0.101	-.0064171	.0724887
sgq82	1.395113	.1683097	8.29	0.000	1.065232	1.724994
hh_size	-.1295841	.056071	-2.31	0.021	-.2394812	-.019687
sgq85	-1.277614	.6077083	-2.10	0.036	-2.4687	-.0865278
sgq91	1.824845	.576145	3.17	0.002	.6956213	2.954068
skq144	-1.03333	.4744564	-2.18	0.029	-1.963248	-.1034129
skq150	.646139	.3290664	1.96	0.050	.0011806	1.291097
_cons	-1.156183	.55491	-2.08	0.037	-2.243787	-.0685796

Note: 0 failures and 19 successes completely determined.

Significant levels; *(p<0.1) 10%, **(p<0.05) 5%, ***(p<0.01) 1%

Variable	Definition of variable	Sig. Level
Skq 150	Farmers who were able to sell their maize to Food Reserve Agency	**
Skq 144	Beneficiaries of input parks from FRA	**
Sgq91	Ability of women to keep bees without the help of men	***
Sgq 85	Training received in beekeeping	**
Sgq82	Years in beekeeping (experience)	***
hh_size	Family size (number of individuals eating from the same dish)	**
Land_size	Size of land I hectares possessed by the farmer	*

App. 1.3 Output from pscore

Estimation of average treatment effects based on propensity scores

```
. pscore beneficiary ln_hhincome female_hh saq4 edu_hh m_status land_size sgq82 hh_size sgq85 sgq91 skq144  skq150 , comsup
> pscore(mypscore) blockid(blockf1)  logit level(0.001) numblo(10)

****************************************************
Algorithm to estimate the propensity score
****************************************************

The treatment is beneficiary
```

whether a hh particpated in Bee keeping or not	Freq.	Percent	Cum.
non participant	228	67.06	67.06
participant	112	32.94	100.00
Total	340	100.00	

```
Logistic regression                               Number of obs   =        340
                                                  LR chi2(12)     =     341.26
                                                  Prob > chi2     =     0.0000
Log likelihood = -44.849873                       Pseudo R2       =     0.7919
```

beneficiary	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
ln_hhincome	.0184142	.0537274	0.34	0.732	-.0868895	.1237179
female_hh	-.1549253	.9655639	-0.16	0.873	-2.047396	1.737545
saq4	.0051032	.0219804	0.23	0.816	-.0379775	.0481839
edu_hh	.2817072	.6182007	0.46	0.649	-.9299439	1.493358
m_status	-.9156539	.8559383	-1.07	0.285	-2.593262	.7619542
land_size	.0510909	.038153	1.34	0.181	-.0236876	.1258695
sgq82	3.225074	.4804645	6.71	0.000	2.283381	4.166768
hh_size	-.2567638	.1277091	-2.01	0.044	-.507069	-.0064586
sgq85	-2.730111	1.471454	-1.86	0.064	-5.614107	.1538854
sgq91	4.926283	1.800827	2.74	0.006	1.396727	8.455839
skq144	-2.322254	1.116317	-2.08	0.037	-4.510196	-.1343132
skq150	1.263565	.6987306	1.81	0.071	-.1059215	2.633052
_cons	-2.350736	1.145414	-2.05	0.040	-4.595707	-.1057654

Note: 0 failures and 15 successes completely determined.

Note: the common support option has been selected

The region of common support is [.23343514, 1]

The table below shows the inferior bound, the number of treated and the number of controls for each block. This is a clear indication that the balancing property holds, since the final distribution of treated and controls across blocks is tabulated together with the inferior of each block:

```
Description of the estimated propensity score
in region of common support

                 Estimated propensity score
-------------------------------------------------------------
      Percentiles      Smallest
 1%     .2400538       .2334351
 5%     .4651608       .2400538
10%     .6853112       .2779447       Obs                116
25%     .9249286       .4157867       Sum of Wgt.        116

50%     .9984509                      Mean          .9093256
                        Largest       Std. Dev.     .1784097
75%     .9999964              1
90%            1              1       Variance        .03183
95%            1              1       Skewness      -2.22909
99%            1              1       Kurtosis      7.273381


****************************************************
Step 1: Identification of the optimal number of blocks
Use option detail if you want more detailed output
****************************************************

The final number of blocks is 10

This number of blocks ensures that the mean propensity score
is not different for treated and controls in each block
```

Following the algorithm described in chapter 3, blocks for which the average propensity scores of participants (treated) and nonparticipants (controls) differ are split in half. However, the algorithm continues until, in all blocks, the average propensity score of treated and controls does not differ. In this case, this happens for a number of ten blocks. Thereafter pscore proceeds to the test of the balancing property for each covariate.

```
*******************************************************
Step 2: Test of balancing property of the propensity score
Use option detail if you want more detailed output
*******************************************************

The balancing property is satisfied

This table shows the inferior bound, the number of treated
and the number of controls for each block

           |      whether a hh
  Inferior |   particpated in Bee
  of block |     keeping or not
 of pscore | non parti  participa |     Total
-----------+----------------------+----------
        .2 |         1          2 |         3
  .2334351 |         0         15 |        15
        .4 |         0          5 |         5
        .5 |         0          2 |         2
        .6 |         0          3 |         3
        .7 |         0          8 |         8
        .8 |         0          6 |         6
        .9 |         3         71 |        74
-----------+----------------------+----------
     Total |         4        112 |       116

Note: the common support option has been selected
```

Note that the study imposed the common support condition in pscore estimation by using the comsup option. Consequently, block identifiers are missing for control observations outside the common support and the number of observations in the table is 116 instead of 228. After running the pscore estimation of average treatment effects using attr, attk and attnd programs followed.

App. 1.4 Output from attnd

Estimation of average treatment effects based on propensity scores

```
.  attnd  ln_hhincome beneficiary female_hh saq4 edu_hh m_status land_size sgq82 hh_size sgq85 sgq91 skq144  skq150  , comsu
> p boot reps(100)


 The program is searching the nearest neighbor of each treated unit.
 This operation may take a while.

ATT estimation with Nearest Neighbor Matching method
(random draw version)
Analytical standard errors

---------------------------------------------------------
n. treat.   n. contr.       ATT   Std. Err.           t
---------------------------------------------------------

      112           8    -3.200       3.378      -0.947

---------------------------------------------------------
Note: the numbers of treated and controls refer to actual
nearest neighbour matches

Bootstrapping of standard errors

command:     attnd ln_hhincome beneficiary female_hh saq4 edu_hh m_status land_size sgq82 hh_size sgq85 sgq91 skq144 skq150
>     , pscore()   comsup
statistic:   r(attnd)
(obs=340)

Bootstrap statistics

Variable |    Reps   Observed       Bias   Std. Err.   [95% Conf. Interval]
---------+-------------------------------------------------------------------
     bs1 |      95    -3.1997   1.894158   4.764123   -12.65898  6.259578  (N)
         |                                            -9.383644  5.318956  (P)
         |                                            -9.603503  5.318956 (BC)
---------------------------------------------------------------------------
                              N = normal, P = percentile, BC = bias-corrected
```

```
ATT estimation with Nearest Neighbor Matching method
(random draw version)
Bootstrapped standard errors
```

n. treat.	n. contr.	ATT	Std. Err.	t
112	8	-3.200	4.764	-0.672

```
Note: the numbers of treated and controls refer to actual
nearest neighbour matches
```

App. 1.5 Output from attr

```
.  attr ln_hhincome beneficiary female_hh saq4 edu_hh m_status land_size sgq82 hh_size sgq85 sgq91 skq144  skq150  , comsup
> boot reps(100)dots logit radius (0.0001)
```

```
 The program is searching for matches of treated units within radius.
 This operation may take a while.

ATT estimation with the Radius Matching method
Analytical standard errors
```

n. treat.	n. contr.	ATT	Std. Err.	t
43	2	-5.448	8.393	-0.649

```
Note: the numbers of treated and controls refer to actual
matches within radius
```

```
Bootstrapping of standard errors

command:     attr ln_hhincome beneficiary female_hh saq4 edu_hh m_status land_size sgq82 hh_size sgq85 sgq91 skq144 skq150
>    , pscore() logit  comsup radius(.0001)
statistic:   r(attr)
(obs=340)

Bootstrap statistics

Variable |    Reps   Observed       Bias   Std. Err.   [95% Conf. Interval]
---------+-------------------------------------------------------------------
     bs1 |      77  -5.448282   2.374101   7.863789   -21.11038  10.21381  (N)
         |                                            -13.93773  9.225171  (P)
         |                                            -13.93773  9.225171 (BC)
---------+-------------------------------------------------------------------
                              N = normal, P = percentile, BC = bias-corrected

ATT estimation with the Radius Matching method
Bootstrapped standard errors

---------------------------------------------------------
n. treat.   n. contr.         ATT   Std. Err.           t
---------------------------------------------------------

       43           2      -5.448       7.864      -0.693

---------------------------------------------------------
Note: the numbers of treated and controls refer to actual
matches within radius
```

The study specified a radius of r(0.0001) instead of the default r(0.1). This gives a huge difference with regard to the caliper matching results. Caliper matching differs from radius matching in that the nearest control is used as a match if a treated unit has no control units within radius r (Dehejia and Wahba, 2002). While caliper matching uses all treated units, thus this method only uses those treated that have control matches within radius r (here, 2 out of 43 treated). This explains the sensitivity of the results to extreme assumptions used in the matching procedure. If the radius is chosen is too small, quality is improved but more trade off.

App. 1.6 Output from attk

```
.  attk ln_hhincome beneficiary female_hh saq4 edu_hh m_status land_size sgq82 hh_size sgq85 sgq91 skq144  skq150, comsup bo
> ot reps(100) bwidth(0.06)
```

```
 The program is searching for matches of each treated unit.
 This operation may take a while.


ATT estimation with the Kernel Matching method

---------------------------------------------------------
n. treat.   n. contr.         ATT   Std. Err.           t
---------------------------------------------------------

      112          10      -1.482           .           .

---------------------------------------------------------
Note: Analytical standard errors cannot be computed. Use
the bootstrap option to get bootstrapped standard errors.


ATT estimation with the Kernel Matching method
Bootstrapped standard errors

---------------------------------------------------------
n. treat.   n. contr.         ATT   Std. Err.           t
---------------------------------------------------------

      112          10      -1.482       4.167      -0.356

---------------------------------------------------------

Bootstrapping of standard errors

command:     attk ln_hhincome beneficiary female_hh saq4 edu_hh m_status land_size sgq82 hh_size sgq85 sgq91 skq144 skq150
>    , pscore() comsup    bwidth(.06)
statistic:   r(attk)
(obs=340)

Bootstrap statistics

Variable |   Reps   Observed       Bias   Std. Err.   [95% Conf. Interval]
---------+-----------------------------------------------------------------
     bs1 |     97  -1.481975   .3852097   4.166556   -9.752525  6.788574  (N)
         |                                           -9.315388   4.96755  (P)
         |                                           -9.682148  4.632165 (BC)
---------------------------------------------------------------------------
                              N = normal, P = percentile, BC = bias-corrected
```

Summary of att* results

The overall results obtained by attnd, attk, and attr are close to each other in the sense that if considered together give evidence of a negative ATT in the range of [-(ZK148) to – (ZK545)] . This is equivalent to ---$15, -$32 and -$54 for attnd attk, and attr respectively. These results indicate no impact of beekeeping intervention on the household income of the small holder farmers of Mikunku.

App. 1.2 : Glossary of Terms used in Apiculture

Absconding: Tendency of bees to abandon their nest completely.

Apiary*:* A place with at least one or more colonies.

Bee milk (royal jelly): Special secretion produced by young bees (nurse bee) rich in protein, fed to young larvae, the queen larvae and the queen.

Beeswax*:* The building material for combs, produced in special glands of young bees.

Brood Comb*:* A comb containing cells mainly filled with brood.

Brood: Collective name for the eggs, larvae and pupae.

Cells: The little hexagonal sections on both sides of the comb containing brood, pollen or honey.

Bee Colony*:* This is a complete biological unit and normally consists of one queen; thousands of workers, a few drones and combs which may consist of honey, pollen, and/ or brood.

Comb: A hanging sheet of wax with cells on both sides.

Drones: The male bees which develop from unfertilized eggs.

Drone Brood: Eggs, larvae and pupae of drones.

Foraging: Collecting of pollen, nectar and water by bees.

Hive: An artificial shelter for the bees.

Honey: Sugary liquid made from nectar, which is split up into more palatable sugars within the honey stomach of the workers and is further processed in the cells.

Honey Comb: A comb containing only honey.

Larva: In the life cycle of insects generally an egg hatches into larva, then changes pupa from which the adult insect emerges.

App. 1.2 : Major initiatives to promote beekeeping industry in Zambia 1970s – 2007s

Organization – Project	**Initiative to support beekeeping industry**
OXFAM	Oxfam supported the construction of Kabompo Beekeeping Training Centre in Kabompo District. The training centre is under Forestry Department.
Area Development Project – Funded by IFAD	The area development project funded by IFAD supported beekeeping extension in three districts of the NWP namely, Solwezi, Kasempa and Mwinilunga.
Community Based Natural Resources Management Project – Kasempa District	The project supported beekeeping extension in Kasempa District.
Community Environmental Management Project – Mufumbwe District	The project supported beekeeping extension in Mufumbwe District
GRZ-Beekeeping Division, Forestry Department	Provision of Equipment, Beekeeping training, extension and buying
GTZ	Importation of beekeeping equipment and introduction of frame hives
Zambia environmental development	Marketing & Environment
Caritas	Purchasing of Honey
KZF	Training & capacity building
Africare	Training
ZDA	Export promotion
ZATAC Ltd	Finance
SNV	Capacity development
MATTEP	Export finance
USAID/PROFIT	Finance/Training
Agri-Business Forum	Linking finance and advocacy to honey processors, facilitate Bee Keeper group formation

Source: (SNV, 2010:7)

App.1.3: Government Agencies and Government Institutions that promote beekeeping industry in Zambia

STAKEHOLDER	ROLE
Export Bureau of standards [1]	Export promotion. facilitation in the branding process
Zambia Bureau of Standards [1]	Honey and beeswax standards
Forestry departments [1]	Extension, training, forest protection & management
MACO [2]	Export licenses, accreditation of organic & fair trade certifiers
Ministry of Commerce, Trade and industry [2]	Trade conventions, WTO regulations etc
Local Councils [2]	Health inspections, trading licenses & honey licenses
Forestry Research and Training Institutions [2]	R & D and training
Environmental council of Zambia [2]	Environmental standards
Zambia Honey Council [3]	Representation, lobby and advocacy
Keeper Zambia Foundation [3]	Group mobilization and strengthening
Evangelical Church of Zambia [3]	Group mobilization and strengthening
SNV Netherlands development Organization [3]	Capacity Development
Northern Bee-Keepers Association [3]	Lobbying and advocacy
Financial Institutions (Finance Bank, Stanbic etc) [3]	Financial services
OPPAZ / EPOPA (z) [3]	Organic promotion / certification
Caritas [3]	Group mobilization
FLO [3]	Fair trade registration
Environmental development of Zambia [3]	Group mobilization

Source: SNV (2010:10) Key: Government Agencies [1], Institutions [2] and Other Organisations [3]

The Zambia Honey Council was formed to organize the honey sector in terms of establishing and strengthening beekeeper groups. Some of the major initiatives to promote beekeeping industry particularly in North-Western province are summarized in table 1.

App.1.4: Beekeeping Survey household Questionnaire

Name of Enumerator ……………………………….

Date of Interview……………………………………

Y Y Y Y

☐Beneficiary Year of implementing Program by women for change ☐☐☐☐

☐ Non beneficiary.

Indicate **1** for beneficiary and **2** for non beneficiary in the box

Section A: Household Identification Details	**Coding**
1. What is your status in the household?	*1=head of household, 2= spouse, 3=child, 4= worker,5= mother,6= father, 7=other relative*
2. Name of Household Head/Respondent	
3. Sex of household head	*1= Female 2=Male*
4. Age of the head of household (years)	Indicate actual age(years) and tick appropriate box_______yrs ☐*1 = Adult male-headed (18 - 59);* ☐*2 = Adult female-headed (18 - 59);* ☐*3 = Elderly male over 60+;* ☐*4 = Elderly Female over 60+;* ☐*5 = Boy child-headed (< 17 years old)* ☐*6 = Girl child-headed (< 17 years old)*
5. Agricultural Block	
6. Camp	
7.Village	

Section B: Basic Household Information	**Coding**
11. Literacy level of household head.	*1= Never been to School* *2= Grade 1-7* *3= Secondary 8-9* *4=Secondary 10-12* *5= Tertiary/University* *6= Adult Literacy* *7= Unable to read and write*
12. Marital Status of Household head.	1. Married *2. Widow* *3. Widower* *4. Bachelor* *5. Spinster*
13. Literacy level of spouse if married.	*1= Never been to School* *2= Grade 1-7* *3= Secondary 8-9* *4=Secondary 10-12* *5= Tertiary/University* *6= Adult Literacy* *7= Unable to read and write*
14. How many people live in this household?	*1. Male (>15years)……………* *2. Male (<15years) ……………..* *3. Female (> 15years) ……….* *.4. Female (< 15 years) …………* *5. Total No.…………*
Section C: Land Possession	

15. *Do you own any land including your homestead?* ☐ *1= yes, 2= No*

Plot description		Which member owns the plot?	Mode of acquisition	when acquired	Quality of land if not homestead	Agric. Season 2010/2011	
Plot type **Code A**	Size (ha)	Name of the member **Code B**	**Code C**	e.g. 1980	**code D**	Was it Leased? **Code E**	If leased give value ZK
☐		☐	☐		☐	☐	
☐		☐	☐		☐	☐	
☐		☐	☐		☐	☐	
☐		☐	☐		☐	☐	
☐		☐	☐		☐	☐	
☐		☐	☐		☐	☐	
☐		☐	☐		☐	☐	
☐		☐	☐		☐	☐	
☐		☐	☐		☐	☐	
☐		☐	☐		☐	☐	

Code A
1= Homestead with court yard
2= pasture for grazing
3= arable land
4= unarable land
5= pond
6= orchard
7= marsh land

Code A continue
8= dimba land
9= low land i.e. can be irrigated
10= up land that can be irrigated

Code B
1= jointly owned (husband and wife)
2= family property (with children)
3= temporary gift (user right)

Code C
1= gift
2= heritage
3= bought with own savings
4= land given by chief
5= through marriage
6= shared with family members
7= purchased with credit
8= obtained as loan collaterally from a defaulter

Code D
1=Very good
2=Good
3=Very Poor
4=Poor

Code E
1= was leased against fixed payment
2= was given away
3=was not given
4= other specify.......

ASSET POSSESSION					
	Section D: Physical Assets Does house hold posses any of the following?				
	Description	Quantity	Means of acquisition *1= Bought* *2 = Gift* *3 = Inherited* *4= other specify........*	Age of asset in years.	Estimated Value. (ZK)
16	burnt brick house & corrugated iron sheets				
17	unburnt brick house with thatched grass				
18	House made of poles thatched grass				
19	house made of poles plastered with mud				
20	Shop				
21	Cow shed				
22	Mattress				
23	Bed				
24	Lamb				
25	Cattle				
26	Goats				
27	Pigs				
28	Donkeys				
29	Ox carts				
30	Ox drawn ploughs				
31	Ox drawn ploughs				
32	Cultivators				
33	Ridging plough				
34	Magoye ripper				
35	Knapsack sprayers				
36	Bicycles				
37	Radios				
38	TV set				
39	Hacksaw				
40	Refrigerator				
41	Hammer				
42	fish pond				
43	Mobile phone				
44	Gun				
45	Hand pump				
46	Water pump				
47	Valuable shoes				
48	Valuable brackets				
49	Wheelbarrow				

Section E: Social Assets		
Description	*1= Yes* *2= No*	*Name of Organization*
50. Does household belong to any Farmer group?		
51. Does hh belong to any externally organized social group?		
52. Has hh benefited from the Fertilizer Support Program (Farmer Input Support Programme) before?		
53. If yes to above how many times in the last five years has hh benefited from the Fertilizer Support Program?		

Section F:Financial Assets		
Does household receive income from the following Livelihood strategies?	*1= Yes* *2=No*	*Estimated Annual Income (ZMK)*
54.Petty trading (Specify)		
55.Gardening activities/Off season farming		
56.Local chicken rearing		
57.Goat rearing		
58.Cattle rearing		
59.Remittances		
60.Sale of rain fed food crops (specify)		
61.Sale of rain fed cash crops (specify)		
62.Piece work		
63.Sale of charcoal		
64.Beekeeping. if ***yes*** proceed to section G		
65.Other (Specify)		
66.Other (Specify)		
67.Other (Specify)		
Total annual Income		

Section G: Beekeeping Equipment/ Materials owned.			
Does the hh possess any of the following in the business of beekeeping? *If does not keep bees please proceed to section H*	**Number**	**Source** *1= Wfc* *2=MACO Research* *3= NGO 5=GART* *6= Input Market 7= Other*	**Mode of acquisition** *1=Bought 2=Gift* *3=Inherited 4= Self made* *5=Other(Specify)*
68.Beehives			
69. Water troughs			
70. Honey processing equipment			
71. Fencing wire			
72. Buckets			
73. Gumboots			
74. Overall			

Marketing of bee products						
Which of the following bee products does the hh produce at the farm?	*Domestic use*		*Marketing (sales)*			
	kg	*Value ZK*	What is your main market? *1= neighbors in the village* *2= by the road side* *3= forestry department* *4= traders from Kapiri Mposhi* *5= traders from Lusaka* *6= NGOs* *7= others specify…………*	*kg*	*Value ZK*	Who decides on sales? *1= wife* *2= husband* *3= children* *4= others specify…….*
74. Honey						
75. Bee queens						
76.Wax						
77.Drones						
78.Broody						
79.Bee worker						
80.Other specify						

81. List five (5) problems in order of their importance you face in beekeeping business?	
1= *low producer price* *2= lack of market* *3= poor market* *4= long distance to market* *5= transport to take products* *6= low production* *7= over production* *8= water* *9= bee hives* *10= lack of processing equipment* *11= labour constraint* *12= others specify………………..*	*Given a chance how would you solve this problem?*
1st ☐	
2nd ☐	
3rd ☐	
4th ☐	
5th ☐	

82. How many years has the hh been in this business (years of practice)? ☐

83. Does the hh receive any extension services? 1=yes 2= No ☐

84. If yes in question 83, specify____

85. Did hh receive any training in this business? 1=yes 2= No ☐

86. If yes in question 85, specify____

87. Does hh have any access to credit or microfinance? 1=yes 2= No ☐

88. If yes in question 87, specify_______________________________________

89. Does this business conflict with normal agricultural season (crop and livestock activities)? *1= Yes 2= No* ☐

90. If the answer is *yes* in question 89, what do you do to solve the problem? *The hh is free to give more than one problems.*	
1=hire labour *3= make use of family labour* *5= do nothing about it* *7= lease part of the land* *8= others specify………………..*	*2=start ploughing early* *4= reduce land cultivated* *6= reduce beekeeping activities*
☐	
☐	
☐	

91. Can women do this business without the help of men? *1= Yes 2= No* ☐

92. If No in question 91, what are the reasons? Tick in the following boxes:

☐ They are too weak to lift hives onto the trees
☐ They are too busy with house chores
☐ Husbands discourage them
☐ They are afraid of bee stinging when harvesting honey
☐ Others specify……………

93. In your opinion, has this business achieved its objectives and goals? *1= Yes 2= No* ☐

94. Please, give reasons if the answer is *yes* in question 93.

i. ____
ii. ____
iii. ____
iv. ____

Section G. Crop Production				
Which of the following crop did hh grow?	*Total Planted area (ha/ lima)*	*Total production (Ox-carts or 50 kg bags/20L tin/Meda)*	*Production for consumption/use (Oxcarts or 50 kg bags/20L.tin?Mead)*	*Production for sale (Ox-carts or 50 kg bags/20litre tin/ Meda*
95.Maize				
96. Soya beans				
97. Cotton				
98. Ground nuts				
99. Sorghum				
100. Sunflower				

101. Irish potatoes				
102.Sweet potatoes				
103.Bambara nuts				
104.Millet				
105.Vegetables				
106.Cassava				
107.Millet				

Section H: Orchard Production		
Which of the following ***Trees*** does the hh grow ?	***1=Yes, 2=No***	***Number of trees***
108. Mango		
109.Orange		
110.Lemon		
111.Guava		
112.Jathropha		
113.Moringa (kapulanga)		
114.Tephrosia		
115.Faidherbia albida (musangu tree)		
116.Avocado		
117. Pawpaw		
118.Banana		
119.Mulberry		

Section I: Livestock Possession									
Does household have any of the following livestock?									
				consumption			Sales of animals		
	1=Yes 2=No	*No/#*	*Who owns? 1=husband 2=spouse 3=children 4=other Specify….*	*No./#*	*Value consumed (ZK)*	*Who decided? Use code as for who owns.*	*No./#*	*Who decided? Use code as for who owns*	*Value Sold (ZK)*
120.Oxen									
121.Bulls									
122.Cows									
123.Total # of cattle									
124.Goats									
125.Sheep									
126.Donkeys									
127.Chickens (local)									
128.Broilers									
129.Layers									
130.Ducks									
131.Geese									
132.Dogs									
133.cats									

Section J: Food Consumption	
134. How much (Ox-carts or 50 kg bags/20litre tin/ Meda) of the listed food crops do you consume per month?	1. Maize……………………………….. 2. Sorghum……………………………… 3. Rice…………………………………..

	4. Pearl millet………………………….. 5. Finger millet………………………… 5. Cassava……………………………… 6. Other (Specify)………………………
135. Which months last year were you short of food?	
136. Did you buy any grain last year?	*1. Yes 2. No*
137.If ***yes*** in 136 how much was it (maize) (Kg or Value)	
138. Did you receive relief food last year?	*1. Yes 2. No*
139. If ***yes***, how much maize grain did you receive as relief food last year? (Kgs)	
140. Do you expect to buy grain this year?	*1=Yes 2=No*
141.if ***yes*** how much grain do you expect to buy this year? (In Kgs or monetary value)	
142.Which season was better in terms of rainfall quantity and distribution?	*1= 2010/2011or 2= 2011/2012*

Section K: Food Security, other Programme Support and Marketing

143. How long will your total cereal production last this season?
Starting month: ___________________ Ending Month_____________________

144. Did you receive an Input Pack under the government FISP programme in the 2011/12 season? Yes☐1 No☐2

145. If yes, indicate the weights of the Input Pack items you received (in Bags and Kilograms):
Enter zero if none

	Bags	Kg
Maize seed		
Bean seed		
Groundnuts seed		
Cowpeas seed		
Sorghum seed		

	Bags	Kg
Millet seed		
Fertilizer (D-Compound)		
Fertilizer (Urea)		
Lime		
Other (specify)________________		

146. Did you receive a Food Security Pack in the 2011/12 season? Yes☐1 No☐2
147. If yes, which organization provided the Food Security Pack?
☐1 CARE
☐2 PAM
☐3 Ministry of Community Development
☐4 World Vision
☐5 Women for change
☐6 Local Extension Worker
☐7 Other (Specify)_________________________
☐8 Not Applicable

148. If yes, indicate the weights of the Food Security Pack items you received (in Bags and Kilograms):
Enter zero if none

	Bags	Kg
Maize seed		

	Bags	Kg
Millet seed		

Bean seed			Fertilizer (D-Compound)		
Groundnuts seed			Fertilizer (Urea)		
Cowpeas seed			Lime		
Sorghum seed			Other (specify)_______________		

149. Did you sell your maize crop in the 2010/11 marketing season? Yes☐1 No☐2

150. Have you sold your maize crop in the 2011/12 marketing season? Yes☐1 No☐2

151. If you have not sold your maize in the 2011/12 marketing season, what is the reason? (*Tick all that apply)*
☐1Did not have surplus to sell ☐2 FRA did not accept to buy ☐3 Low prices offered ☐4 No traders come to the area ☐5 Long distance to major market ☐6 Other (specify) ___________________________

152. If yes, indicate the details in the table below: (**Enter zero if none)**

Crop	Quantity Sold *(eg. Ox-carts or 50 kg bags/20litre tin/ Meda)*	Price Offered *(Kwacha/50kg bag)*	Buyer FRA Local trader Millers Other (specify)	Was the FRA price offered better than the other buyers Yes☐1 No☐2
Maize crop in 2010/11				
Maize crop in 2011/12				

Thank you for your time and effort

THE END