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Socio-Economic Analysis of Market Oriented Beekeeping in Atsbi Wemberta District of Eastern Zone, Tigray Region

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Declaration

This is to certify that this thesis entitled "**Socio-Economic Analysis of Market Oriented Beekeeping in Atsbi Wemberta District of Eastern Zone, Tigray Region**" submitted in partial fulfillment of the requirements for the award of the degree of MA., in Development Studies to the College of Business and Economics, Mekelle University, through the Department of Management, done by Ms. Meaza Gebreyohannes Berhane, ID.No. FBE/PR0013/00 is an authentic work carried out by her under our guidance. The matter embodied in this project work has not been submitted earlier for award of any degree or diploma to the best of our knowledge and belief.

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Abstract

This study was initiated to assess the ***process of beekeeping development and diffusion of improved beekeeping management*** *and evaluate the impact of improved beekeeping on household income, per capita income, changes in capacity development and social issues such as educational expenditure, health improvement, and human capita. The study was based on a representative sample of 200 farm households (99 modern beekeepers and 101 traditional beekeepers) selected using random sampling. To analyze the* ***process of beekeeping development and diffusion of improved beekeeping management*** *and to evaluate the impact of improved beekeeping on household descriptive statistics and matching estimation methods were used respectively. Estimated result of the Heckman regression model indicates there is no selection bias. The descriptive analysis explain due to a number of beekeeping development interventions (i.e. supply of beekeeping materials, training) most modern beekeepers had progressive improvement on the utilization methods and honey handling techniques (i.e. skill improvement) together with their accessories, have been distributed to farmers. The propensity score matching result also indicates that the mean income of modern beekeepers is significantly higher than that of traditional beekeepers. The estimated results for the matching methods showed that the average income gain due to improved beekeeping ranges from 2679 to 2888 Birr per household per annum. The overall average total educational expenditures gain due to improved beekeeping ranged between 79.75 and 90.74 Birr and was significant at 1% level based on the kernel, nearest neighbor, stratified and radius, matching methods. The overall average human capital gain due to improved beekeeping ranged between 82.35 and 98.45 Birr and was significant at 5% level based on the kernel, stratified, radius and nearest neighbor, matching methods. Average per capita income gain due to improved beekeeping ranged between 428.4 and 493.5 Birr and was significant at 1% level based on the stratified, radius, kernel and nearest neighbor matching methods. The results certainly imply that the modern beekeepers had better living status than the traditional beekeepers in the woreda. It is suggested to focus on modern beekeeping development technologies and provision of relevant training as well as technical assistances need to up grade for the improvements in beekeeping production.*

Keywords: Beekeeping development, Improved beekeeping, Matching Method

List of abbreviations and acronyms

BfD	Bee for Development
BoARD	Bureau of Agriculture and Rural Development
CSA	Central Statistics Agency
FAO	Food and Agriculture Organization of the United Nations
FS	farming systems
IPMS	Improving Productivity and Market Success of Ethiopian Farmers
MOFED	Ministry of Finance and Economic Development
OoARD	Office of Agriculture and Rural Development
PAs	Peasant Associations
PRA	Participatory rural appraisal

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Chapter I - Introduction

1.1 Background

Economic impacts include income, employment, and taxes; the affected parties; impacts on business and large property owners; increased short-term and long-term employment; the 'boom and bust' pattern of project construction; problems of local inflation and short-term changes in supply and demand patterns (Mary Edwards, 2005).

A social impact assessment must determine the quantity and variety of anticipated needs. The goods and services most commonly included in a social evaluation are open space and parks; cultural and recreation facilities; education; health care; special care for the elderly, the disabled, the indigent and preschool-age children; police and fire protection; and a variety of administrative support functions (Mary Edwards, 2005).

Socio-economic impact assessment is designed to assist communities in making decisions that promote long-term sustainability, including economic prosperity, health and social well-being. Assessing socio-economic impacts requires both quantitative and qualitative measurements of the impact of a proposed development market.

Beekeeping is an important component of agriculture and rural development program in many countries. 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).

Useful small-scale efforts to encourage beekeeping interventions can be found throughout the world, helping people to strengthen livelihoods and ensuring maintenance of habitat and biodiversity; strengthening livelihoods means helping people to become less vulnerable to poverty. Hence sustainable beekeeping seeks to address the importance of beekeeping in terms of its ecological, social and economic benefits. Within ecological dimensions, bees are a source of pollinators that help increase crop yields. The economic benefits lie within bee products such as honey, royal jelly, propilis bee pollen and beeswax that are highly valuable and have high market

prices. But most importantly honey is a source of food with high nutrition value. In communities where beekeeping is done for commercial purposes, it has led to self reliance through the innovation of local industries associated with the production of beekeeping equipment and bee products (Brad bear, 2003).

Ethiopia has a potential in beekeeping as the climate allows growing of different vegetation and crops, which are a good source of nectar and pollen for honeybees. Large and diverse botanical resources combined with suitable climatic conditions make it conducive for the beekeeping business (Nuru et al 2001).

Beekeeping is a good source of off-farm income to farmers in our country. It plays significant role in supplementing the annual income of the beekeepers through the sell of honey, wax, colonies and serving as a healthy food for the consumers. It almost requires no land, capital and does not take much part of the farmer's time, and generates a sizeable income (FAO 1984). The net return from a well-managed beekeeping is generally thought to be significantly large.

Due to suitable natural environment of Ethiopia, large honeybee colonies, which are estimated to be about 10 million, exist in the country (Workeneh, 2007). Ethiopia stands eighth by producing about 21% of the total world and about 21.7% of total African honey production. It is estimated that there are about 10 million bee colonies in the country. Out of these about 4.2 million are kept in hives. (TAMPA, 2007).

All the woredas of Tigray produce honey of various colors from white to red/dark. This potential offers wider market range to producers in Tigray (TAMPA, 2007). Atsbi Wemberta is also one of the potential Woredas of Tigray Region for beekeeping development. The woreda has 19,387 honeybee colonies out of them 6,127 bee colonies in modern hives and 13,260 bee colonies in traditional hives (BoARD, 2010). The honeybee colonies make the Woreda one of the potential areas for developing beekeeping sub sector in the region as well as in the country.

The sugar/sand type of honey is found in the Eastern Tigray region: namely Wemberta, Atsbi, and Adigrat. That area has a high altitude of at least 2,300 m as, which poses an obstacle for beekeeping. It hinders bees from foraging flowers and plants from sunlight to sunset. Nevertheless, there is a significant amount of bees in the region as a result of the regions rich

biodiversity, clean environment, and water availability. Therefore, while East Tigray honey is high in quality, its quantity is limited (Taddele & Nejdan, 2008). A butter-type white honey is also sold for 65 birr/kilo in 2008 represents the highest quality of butter-type white honey. Butter-type white honey comes from Atsbi and Wemberta. It was the most expensive honey in the Mekelle market (Taddele & Nejdan, 2008).

Both raw and extracted honeys have good local and international markets all the year round (TAMPA, 2007). In order to improve the honey yield in quantity and quality, Agricultural and Rural Development Office and different Non-Governmental Organizations have introduced improved box hives; Zander type (Workeneh, 2007).

1.2 Statement of the problem

Beekeeping has been a marginalized activity within most developing countries. The benefits associated with beekeeping still remain a huge mystery for many whom have not ventured into the field. The importance of beekeeping in grassroots socio-economic development 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.

Currently intensification of production and commercialization of smallholder is viewed by the government as a focal point to the agricultural development of Ethiopia (Neway, 2006). The rural development and food security strategy aims at market-oriented agricultural progress as a means for achieving and sustainable livelihoods for the rural population. This strategy is implemented and as BoARD (2006) reported 36,000 beehives disseminated in the region to improve beehives and beekeeping practice. Providing all the necessary components of beekeeping materials to the user is important to increase hive products. According to the information of Agricultural and Rural Development Office, the Woreda has 16,915 honeybee colonies. There are five beekeeping associations that were organized by Woreda Agricultural and Rural Development office with the assistance of ILRI-IPMS project and World Vision. The main objective of these associations is to serve as demonstration site for other beekeepers in the Woreda (Workeneh, 2007).

The small holders farmers are expected to increase market oriented beekeeping production and productivity, as well as their sustainable livelihood through the interventions. Even though those

organizations are contributing much in the dissemination of the technology, there was no adequate study on production and productivity of Beekeeping in the woreda. In addition to this, the livelihood change of those farmers was not adequately assessed so far. This research aimed at assessing the impacts of the interventions for socio-economic progress as well as the gender participation and decision in beekeeping activities by taking the following research questions into account.

1. What are the changes in the knowledge and skill level of people /the technology uptake?
2. What is the contribution of improved beekeeping to household income?
3. What is the level of investment and saving of modern beekeepers on other sectors?
4. What are the changes on the health, education, nutrition and gender participation?

1.3. Objective of the study

The overall objective of the study was to assess the processes and impacts of market oriented beekeeping development in Atsbi Wemberta, and draw implications to scale out and up the experiences. Whereas, the specific objectives were:

- To analyze and document the process of change of beekeeping technology development and diffusion in the project area
- To evaluate the economic impact of market oriented beekeeping development practices at household level.
- To evaluate the impacts of market oriented beekeeping development in social issues such as education, health, nutrition and gender participation.

1.4. Hypothesis

H1: *Modern beekeeping improves household income.* Ceteris paribus the predicted/estimated mean income of households with improved beekeeping should be significantly greater than the mean income of households with traditional beekeeping.

H2**:** *Improved beekeeping develops the household per capita income.* The average treatment effect of improved beekeeping is greater than that of traditional beekeeping.

H3: *Improved beekeeping develops household educational expenditures.* The estimated mean of educational expenditures for households with improved beekeeping should be significantly greater than the mean of educational expenditures for households with traditional beekeeping.

H4: *Modern beekeeping improves the household human capital.* The estimated mean of human capital for households with improved beekeeping should be significantly greater than the mean of human capital for households with traditional beekeeping.

1.5. Scope and limitations of the study

The study dealt with the analysis of market oriented beekeeping by taking the sample from one woreda and this may not represent the whole improved beekeeping activities of the country. This hindered generalization about improved beekeeping situation in the country. However, the research recommendations can be applied in other areas having similar socio-economic characteristics. Lack of detail information from the household is the main limitation of the study.

1.6. Significance of the study

Policy makers, non-governmental organizations and donor agencies in Ethiopia have been trying for decades with how to design and implement beekeeping intervention programs and projects in order to improve the household economic and social issues. This study is conducted on the assumption that there is an assessment on the contribution of the household economic and social issue so far achieved. Accordingly, the results of the study will be significant for policy makers and implementers in providing basic information about the beehive product utilization, actors in marketing technology intervention and management. This study may also be used as a base for further investigation by other researchers about the beekeeping development program.

This paper tries to show to what extent beekeeping intervention in Tigray contributes on household economic and social issues. The paper has paramount importance in showing the impact of beekeeping in socio-economic aspects so as to scale up the market oriented beekeeping activities.

1.7. Organization of the study

The thesis is organized into five chapters. It starts with the introduction, which includes background, statement of the problem, objectives, hypothesis, scope and limitation as well as the significance of the study. 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 II- Review of related literature

2.1. Concepts

2.1.1 Beekeeping and sustainable livelihood

Beekeeping is a useful means of strengthening livelihoods because it uses and creates a range of assets. Successful beekeeping draws upon all categories of capital assets. Types of capital assets needed for beekeeping:

Natural: bees, a place to keep them, water, sunshine, biodiversity and environmental resources.
Human: skills, knowledge, good health and strength, and marketing expertise;
Physical: tools, equipment, transport, roads, clean water, energy and buildings;
Social: help from families, friends and networks, membership of groups and access to a wider society, market information and research findings;
Financial: cash, savings and access to credit or grants.

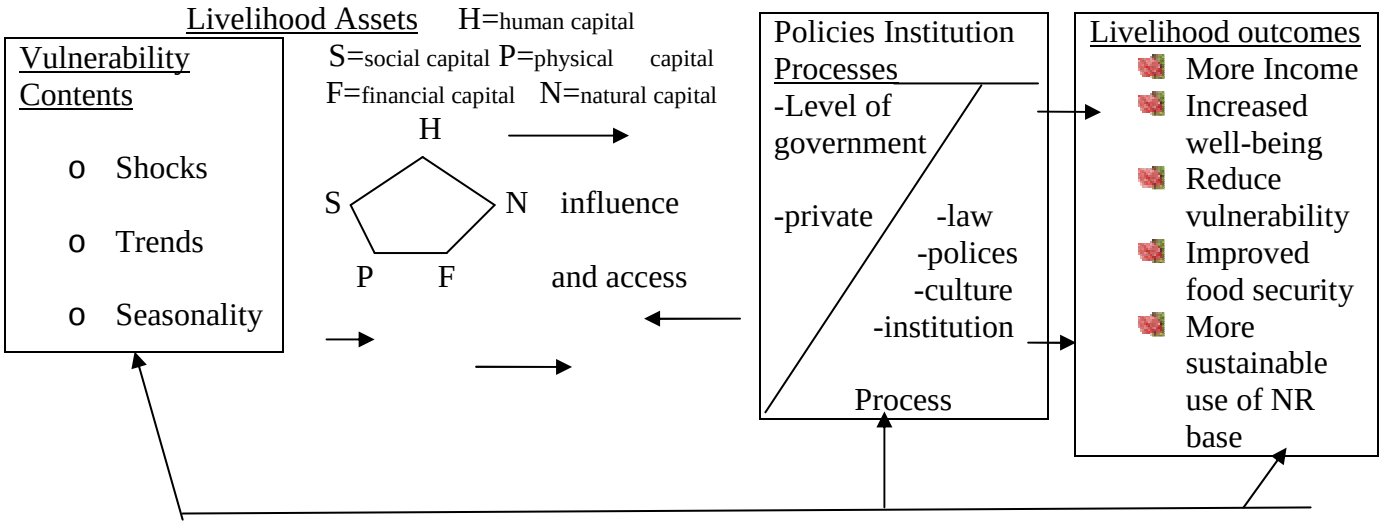
Natural capital assets: Beekeeping livelihoods are built upon natural resource stocks: bees, flowering plants and water. Bees collect gums and resins from plants and use plants and trees as habitat for nesting (Bradbear, 2003).

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).

Although 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 arguments that beekeeping is a key element in promoting rural self-reliance are that:

- Beekeeping promotes rural diversification and hence is an alternative source of income and employment, particularly in areas where arable land is restricted and demographic growth is resulting in insufficiently profitable land holdings.
- Beekeeping is an activity that can successfully be 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.
- Beekeeping is a low cost, sustainable undertaking with a low environmental impact.

2.1.2 Sustainable livelihood framework



Source: Anandajayasekeram p, et al. (2008).

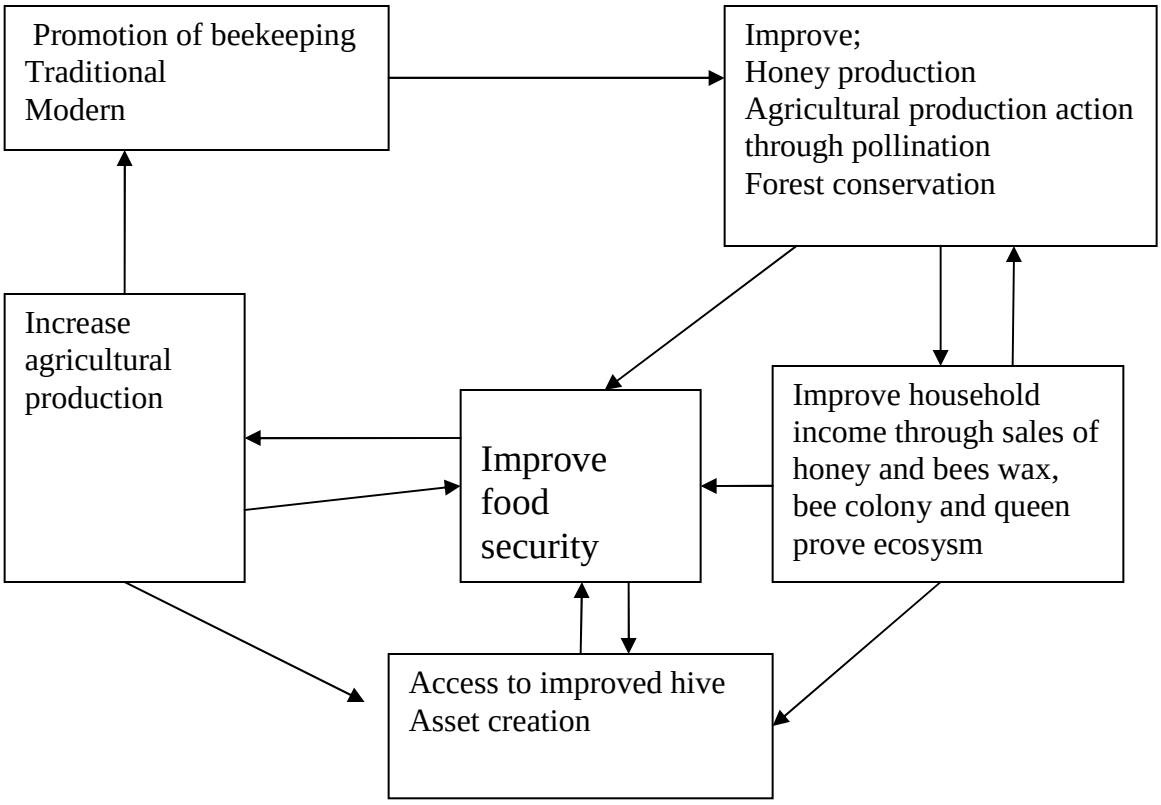


Fig.2. Conceptual model for positive Impact of beekeeping (Solomon, 2002)

2.2. African beekeeping practices

Beekeeping is an important component of agriculture and rural development programmed in many countries. 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.

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).

Although 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 (Pete et al., 1998):

- ✓ 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 in this way: Nevertheless Bees for Development 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. Therefore, they should capture relatively more of the end value of the final product.

- Honey has multiple market opportunities. If an export market collapses, people can still sell or use the product within towns and villages at home, or eat it. This is unlike other commodities such as coffee or vanilla.

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.

It is recognised that the beekeeping sector holds potential for creating sustainable incomes for Africa's rural beekeepers. But this potential is hardly tapped because these producers do not have access to infrastructure and organisational systems to allow them to reach the niche/speciality markets their products would otherwise reach, especially in the EU. To open new market opportunities for these beekeepers, a resolution is made for the Fair trade Labelling Organisation (FLO) to take cognisance of the situation in Africa, and put in place a system of recognising and registering small-scale private sector firms that are linking the producers to buyers in the fair trade market (Balya, 2006).

Apiculture Trade Africa believes that African honeys are special products. They are produced in the "last frontier", with indigenous bee stocks and no introduced bee diseases or predators, therefore enabling bee colonies to survive without the use of medicines to maintain bee health.

African honey is harvested by smallholder farmers, many of whom are the poorest in society. Selling bee products can provide a feasible way out of their poverty. Beekeeping is the ultimate environmentally sustainable activity. The indigenous species of honey bees contribute to biodiversity through pollination and provide economic incentive for rural African people to conserve natural forests, which provide an abundance of excellent bee forage (Bee for development, 2006).

A study from Tanzania shows beekeeping activities involved both genders at different stages of honey and beeswax processing and marketing (Lalika, 2008). 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 labor 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).

Smallholder beekeepers in Tanzania have rich indigenous knowledge of beekeeping. They also have good knowledge of different types of hives, bee smokers and honey containers. In terms of hive types, it was found that most smallholder beekeepers use local style gourd hives. The reason is that they are cheaper than other types of hive and are locally available (Lalika, 2008).

The gourd hive is one of the oldest items of indigenous equipment and has been adopted in areas of Tanzania where alternative materials for hive making are scarce. This indigenous knowledge enables smallholders to carry out beekeeping activities at minimal cost, as it does not need heavy investment in terms of financial and human capital, for equipment and extensions. Nevertheless, in terms of production, indigenous knowledge has an adverse impact on the quantity and quality of bee products (Lalika, 2008).

The aroma, taste and color 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.

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).

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 (Brad bear, 2003).

Where bee hives are located make the difference between a good crop and none at all.The characteristics of a good honey producing yard (Balya, 2006).

- The area has a history of good honey production.
- Crops which produce nectar/pollen must be within short flying distance for the bees.
- The yard must be accessible to truck and other vehicles at all times.
- The site must be level or nearly level and have water available nearby.
- It must not be in a low area subject to flooding
- The site must be within close driving distance to other bee yards.
- The site must not be close to human dwellings.

Honey bees are known to forage great distances from the hive but the fact is they gather nectar generally close to their hives. For the honey producer, the closer the better because a honey bee can make more trips to the field in a single day and use less energy in flying to the crop.

Dark honey usually has a strong flavor and often has a high mineral content; pale honey has a more delicate flavor. The popularity of dark and light honey varies from country to country. Color 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 color. Glucose is a major constituent of honey. When the glucose crystallizes, the honey becomes solid and is known as granulated honey.

Depending on the plants the bees are visiting, some kinds of honey are more prone to granulation than others; almost all honey granulates if its temperature falls below 15–24 °C. As with color, different people favor different qualities of honey. Some prefer granulated honey, while others choose liquid honey. Granulation is a natural process; there is no difference in nutritional value between solid and liquid honey. Some kinds of honey look cloudy because they contain a high level of pollen. Such honey is sometimes said to be of low quality, although the presence of pollen makes the honey even more nutritious (Bradbear, 2003).

East African nations export tremendous quantities of wax. Ethiopia and Tanzania produce about 2.5% and 1.15% of total world honey production, respectively. Keeping bees in beehives as practiced in Egypt, Kenya, Tanzania, is not well known in other part of Africa (Hussien, 2000).

2.3. Ethiopian beekeeping practices

The most important and available insect in the world to day is the honeybee. There are several species of honeybees existing, but *Apis mellifera* is country famous. It is a wonderful and popular bee type for its honey and bee wax production besides the major value obtained because of plant pollination (Ayalew, 2000).

Ethiopia is one of the homes of *Apis mellifera adenosine* (Ayalew, 2000). The methods used by the motives are usually primitive; the hives are generally cylindrical in shape and regarded the Abyssinian hives as the oldest in existence, since in its general shape it recalls the hives constructed by Egyptians. Padre Bellani , who lived in East Africa for more than 25 years, records that in the neighboring territories of Kenya and Uganda never saw hives constructed like those of Abyssinia which suggest that Abyssinian apiculture has its origins in Egypt (Hussein, 2000).

According to recent investigation, about five million bee colonies exist in Ethiopia (Ayalew, 2000); out of these 200,000 colonies are found in Tigray (BoARD, 2006). Due to natural vegetation that was present in the past and biodiversity of Ethiopia; the bees have made their own natural selection for nesting in lowland; mid-highland and in highland areas to rear and propagated. Except for some places in Afar and Somalia regions honeybees are fairly distributed in the country adapting varying degree of weather conditions. They all produce honey, the nutritious natural food good for both man and animals (FAO, 1990).

Ethiopia is generally believed to be one of those countries endowed with large apicultural resources. However outmoded and traditional production system, poor post harvest processing and handling techniques and practices combined with poor marketing efforts has kept it part of the subsistent sector.

Perhaps because of these fertile conditions beekeeping has been in practice for centuries in the country. The number of bee colonies in the country is believed to be large; but estimation with regard to the number of bee colonies in Ethiopia varies significantly. A recent CSA survey oı livestock of Ethiopia puts the number of bee colonies at 4.5 million, and the honey production at 30 million kg or 30,000 tons (CSA, 2005). Of this, 99% is of traditional beekeeping while the rest is modern hive. Because of this data, the yield per colony per year would be 6.7 kg. The CSA (2005) record suggests that the number of beehives in the country have growing at about 4.7% per annum.

Beekeeping in Ethiopia is an important activity for many rural people - both men and women - and is also carried out in home gardens and even houses in all parts of the country. There is no nationality in Ethiopia which doesn't have beekeepers and for some, beekeeping, and the collection and selling of honey and other bee products, is a major economic activity (Mehari, 2007).

Many societies have considerable traditional knowledge and skills concerning bees, honey and related products. The products of beekeeping are often used by women: the important tej (honey wine) industry in Ethiopia, for example, is run by women. Elsewhere in Africa, women brew and sell honey beer. These are the types of human assets or skills needed to create livelihoods within a society. Beekeeping projects have sometimes ignored existing knowledge or implied that it was wrong or out of date, which is worse. The best beekeeping projects recognize existing skills and build on them for greater income generation and to ensure sustainability. Many African women add to their livelihoods by brewing and selling honey beer. Ethiopian women make and sell tej (honey wine) and non-alcoholic drinks based on honey (Brad bear, 2003).

In Ethiopia three systems of beekeeping are said to exist, namely *honey hunting*, *forest beekeeping* and *backyard beekeeping* (FAO, 1990). *Honey hunting* is a system of looking for

honey with out taking care of the bee colonies. Honey hunters search for honey in caves, crevices of stones, hallow trunks of wood etc. Using fire flame, water and other materials to displaces the colony. This sort of hunting is not practiced in Tigray these days.

Forest beekeeping:- This is hanging of hives on tree branches for harvesting honey during the honey flow period with out taking care of the bees; this is not also widely practiced except that hives are hung on trees to catch swarms and taken home when occupied by bees. *Backyard beekeeping* this system of beekeeping in backyards in which the beekeepers take care of their bees providing with shelter, water, feed and protect them from bee enemies. This is the most advanced system of beekeeping in the region. In this system, bees are managed in hives either in door or out door apiaries and several million bees colonies are managed with the same traditional beekeeping methods in almost all parts of the country.

Farmer beekeepers of the Amhara region have well developed and long standing traditional beekeeping skills. In the region beekeeping is mostly practiced at a backyard level by keeping beehives either under separate shelters or around the house wall or even inside the house with domestic animals and family members without any problems. In the region beekeepers have relatively better know how to manage their honeybee colonies. Moreover, some beekeepers practice migrating their colonies for better forage. However, the level of beekeeping still remains in traditional system and about 94 to 97 percent of bees are still kept in traditional hives (Kerealem et al., 2009).

The difference between traditional and modern is not only the hive employed for beekeeping, but it also includes the management aspect of bees. In traditional way of beekeeping, beekeepers manage their bees in traditional made hives where as in modern beekeeping the management of bees is supported by scientific research, extension services and training packages, Moreover modern beekeeping employs improved hives that are more productive and easy to manage.

Frame hive beekeeping is the most intensive system, which needs comparatively expensive inputs and relatively skilled labor to manage the colonies successfully. The hives are more complex and difficult to build but they are easily transportable and generate greater quantities of better quality honey, which will command higher prices (Mehari, 2007).

Beekeeping has the potential to help many people to increase their incomes and their crop yields. As very little space is needed, beekeeping is ideal for people who have no land and little space and little money. They have chance for many landless peasants and small holders to improve their livelihoods. They go on to say any source of food or income that does not need land is potentially important.

Beekeeping is such an undertaking because beehives occupy minimal space and can be placed on west land. Beekeeping does not compete with other types of agriculture for resources, but produces food from natural resources that are not other wise exploited. It improves the ecology. It helps plant reproduction. Bees do not over-graze as other animals do.

Beekeeping has many attractions for rural farmers. It is cheap and it does not involve mass feeding of bees, because the insects can provide their own food all year round, and there is no over wintering bee management. Bees do not require daily attention and beekeeping does not take up valuable land or time, which would have been spent on other farming activities. Males and females of all age groups can practice it and it helps to create self- reliance. It does not depend on importation of foreign equipment or inputs. Individuals and private organizations such as churches, women's groups, youth associations and cooperative societies can initiate it with only limited funds.

Women in Ethiopia play multiple and overlapping roles, which have increasingly put pressure on their health, food security, productivity and potential contribution to improved human welfare and economic development (Ametemariam, 2009).

Despite the active involvement of women in a wide range of agricultural activities, they have limited access to extension services. The majority of women who participate in farmer extension groups are household heads. Wives may attend if their husbands are not available but are usually much more difficult to reach. Specific attention is being paid to encourage the participation of FHHs in the household extension packages; however field experience is demonstrating that many women are reluctant to take out loans and some lack labor to participate in the household extension packages (Bishop-Sambrook, 2004).

Bishop-Sambrook's study also indicates that few women participate in farmer research groups since it is culturally difficult for them to represent their husbands when their husband is present. The agricultural extension service in Ethiopia is male dominated and predominantly oriented towards advising and working with male farmers of the households (Ngatwa, 2006).

Women are typically, and wrongly, still characterized as economically inactive. Agricultural extension services still do not attach equal importance to reaching women farmers. Policy makers and administrators typically still assume that men are the farmers and women play only supportive role as farmers' wives. This attitude by both planners and implementers has significant adverse effects on women's access to agricultural extension services (Habtemariam, 1996).

Generally, through beekeeping communities are empowered to utilize the available local natural resource for local economic development on a sustainable basis. Beekeeping is probably the only form of agriculture with an overwhelmingly positive impact on the natural environment.

In the food-insecure district of Meket in Ethiopia, traditional bee-keeping has long been practiced by rural communities as a means of generating additional income and improving food security. As a result of improved honey production and contribution to household food security, extra benefits included the possibility to repay fertilizer debts and buy clothes for the children. Overall, the SOS sahel project offers valuable lessons to anyone about embarking on a new bee-keeping project (Tilahun, 2006)The increase of honey production in rural Ethiopia is important for the control of malnutrition in children (Hussien, 2000).

FARM-Africa and SOS Sahel Ethiopia have implemented participatory natural resource management projects in different forest areas in Oromia and South Nations, Nationalities and Peoples' Regional States. Training focused on bee biology, beekeeping systems, honeybee management, honeybee protection, and advantages and disadvantages of different types of beehives (traditional, transitional & modern).

Practical construction of transitional (Kenyan top bar) beehives was demonstrated and two hives were constructed by the trainees. Feedback from the trainees indicated that the advantages of the modern hives include, increased honey production potential, management simplicity, avoiding risks of climbing trees, less exposure to honey thieves and avoiding unsustainable cutting of trees

for hives construction. These efforts showed a green light towards sustainable livelihood improvement along with forest resource management.

Constraints in beekeeping

Shortage of bee forage

Shortage of bee forage due to population pressure, lack of land use policy and the high demand for farmlands put pressures on mountainous areas to be used for crop production and livestock grazing. These create deforestation, soil erosion and irreversible ecological degradation. Moreover, burning of undergrowth and destroying of forestland for expansion of farmland could trigger a reduction of honey producing floras and foraging areas. The elimination of good nectar and pollen producing tree species in many areas makes it difficult to maintain bee colonies without feeding (Kerealem, 2005). Based on the results of rural households' socio-economic baseline survey, shortage of bee forage was the major constraint of beekeeping in the Amhara Region (Kerealem et al., 2009).

Pesticides poisoning

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. Of the various kinds of chemicals only insecticides and herbicides are now major problems to the beekeepers. The chemicals used for crop protection are the main pesticides that kill the bees. Moreover, 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 (Kerealem et al., 2009).

Honeybee pest and diseases

Ethiopia, as one of the sub-tropical countries, the land is not only favorable to bees, but also for different kinds of honeybee pest and predators that are interacting with the life of honeybees (Desalegn, 2001). The existence of pests and predators are nuisances to the honeybees and beekeepers. Pests and predators cause devastating damage on honeybee colonies with in short period of time and even over night.

Marketing problems

It has been observed that in the Amhara region the marketing system of honey has many problems. Most of the local markets are far away from the beekeepers and are inaccessible. Beekeepers travel on foot for several hours to sell their honey. The lack of grading systems does not encourage farmers to produce high quality products, thus, the price of honey changes widely based on the good will of buyers (Kerealem et al., 2009).

The constraints to marketing of honey and beeswax in the country and these include low and discouraging price of honey and beeswax in local markets, lower quality of products, lack of market information, absence of organized market channel, transportation problem, lack of appropriate technologies for collecting, processing, packing and storage of honey to keep its natural quality, lack of government support in promoting market development, and low involvement of private sector. Because of beekeepers have limited knowledge of the preferences of their target market, they do not try to make any changes in the quality of their product. Presentation of quality honey is generally poor. Most honey come to market is un-extracted, unstrained and poorly managed (Gezahegne, 2001).

Other technical constraints in beekeeping activities include poor extension systems (absence of coordination between research, extension and farmers), lack of credit service, and shortage of records and up-to- date information, shortage of reading materials regarding to beekeeping, and lack of research stations to address the problems related to apiculture.

2.4. Tigray beekeeping practice

The economy of Tigray Regional State depends on agriculture mainly in rural areas .So the necessity of beekeeping, its expansion and development is unquestionable. Tigray has the low number of beehives and ranked low in honey production in Ethiopia (BoARD, 2006).

The number of bee hives in Tigray during the 2005/06 was 182340 in 2006/07 183800 and for the period of 2007/08 there were 242870 (CSA, 2008). The number of bee colonies in Tigray, roughly estimated to have 206040 bee colonies in 2009/10. Bee colonies of 76200 that are 36.98% of the total were in modern beehives and 63.02% were in traditional beehives (BoARD, 2009/10).

Tigray accounts for about 4.5 percent of the total bee colonies in the country and 5.5% of the total honey production. The annual production of both honey and beeswax are low compared to other region of the country (Mehari, 2007). In 2009/10 one season honey production was 25,454 quintal and 2008/09 annual production was 31,000 quintal.

The system of production commonly exercised in Tigray has the most advanced traditional practices of the regions of the country; of which the supering of hive, use of queen cage, seasonal hive management like additional foraging and watering, and splitting techniques, the farmers' knowledge of the bee biology and botany of the preventive measures against bee enemies and diseases. Even though this good practices of beekeeping commodity the contribution is low due to degradation of natural resource and weak market linkages and extension services (Mehari, 2007).

Traditional beekeeping activities have been practiced for possibly long history in Tigray. It makes use of hives made from cheap local materials such as gourds, pots, grass, logs, cow dung, mud and straw. All traditional hives are placed high in trees around dwellings in order to attract the bees, which are left alone for some time. After enough time has elapsed to build up honey stirred the container is lowered and the bees killed (usually by fire) and the hive product taken. However, this is not the tradition in Tigray but can be found in other regions of the country. Thus this is a very inefficient system, due to this productivity is low, they do not last long bees readily abscond from them and combs cannot be inspected without being broken on (CSA, 2005).

Frame hive beekeeping is the most intensive system, which needs comparatively expensive inputs and relatively skilled labor to manage the colonies successfully. The hives are more complex and difficult to build but they are easily transportable and generate greater quantities of better quality honey, which will command higher prices (CSA, 2005).

It is believed that Ethiopian honey is of good quality even though in the world market it is considered to be often dark in color and strong in flavor. These characteristics are however, taken by many to be not signs of poor quality but as signs that indicate the "need of a specialized market for this type of honey" (TAMPA, 2007).

The European Community is the world's largest importer of honey with Germany being the largest single consumer followed by Switzerland and France. The USA and England are among the top importers. Japan is the biggest importer in Asia while Nigeria, Algeria and Libya are among the highest in Africa. Major importers of Ethiopia's honey include the Middle Eastern countries of Saudi Arabia, Djibouti, Yemen, Israel and the United Emirates (TAMPA, 2007). Recent studies have indicated that around 97% of the 30, 000 tones of honey produced in the country is marketed with an estimated sale of about 290 million Birr (MoA, 2003; sited in TAMPA, 2007). Honey is almost produced in all regions of the country Tigray is one of the major honey producing regions in Ethiopia for both the domestic and foreign markets. China, Russia, USA, The EU, Argentina, Turkey, Ukraine, Mexico, India, Canada and Ethiopia are, in consecutive order, the highest world producers while Kenya, Tanzania, and Angola along side Ethiopia, are the major producers of honey in Africa (TAMPA, 2007).

All the woredas of Tigray produce honey of various colors - from white to red/dark. This potential offers wider market range to producers in Tigray. According to some studies, the total number of beehives in the region account for about 5% of the 3.39 million totals for the country with a contribution of about 7% or 909, 310 kg of the national production of honey. Using traditional hives and methods, productivity is estimated to be around 6.35 kg/hive/year (TAMPA, 2007) as compared to the national average of 5 kg. For comparison, world productivity estimates show that the USA has 150-200 kg/hive/year, while China and Israel have averages of 70-90 kg/hive/year, and 60-70 kg/hive/year, respectively (TAMPA,2007).

As Workneh (2007) stated in his thesis the adopters have more market for their product. This is mainly due to honey produced in improved box hive has quality and as a result has high demand. It is free of pollen, beeswax, brood and debris. In Atsbi Womberta the maximum honey yield obtained per improved box hive and traditional hive is 60 kg and 12kg, respectively, where as the minimum honey yield from both beehives is 10kg and 2 kg, respectively. In relation to its price, the highest and minimum price for honey from box hive is 45 Birr/kg and 30 Birr/kg, respectively. Similarly the highest price for honey from traditional hive is 28 Birr/kg and the minimum is 10 Birr/kg.The BoARD 2009/10 manual of beekeeping stated that the productivity of modern beehives was 4-120kg and from traditional hives 8-10kg. The difference is 28kg per hive.

2.5. Socio-economic importance of beekeeping

According to Brad bear, 2003 honey has value as a food, as a medicine, as a cash crop for both domestic and export markets and as an important part of some cultural traditions.

2.5.1. As a food

Honey is valued everywhere as a sweet and tasty food. At times of food shortage it is a useful carbohydrate source that contains trace elements and adds nutritional diversity to poor diets. Honey often has an important place in traditional food preparation. As cultural food honey is widely used as a source of sugars for making honey wines and beers.

Honey also has a high cultural value eating honey or using it for anointing is part of many traditional birth, marriage and funeral ceremonies; this cultural connection is evident in the term “honeymoon”. In the Masai society of East Africa, honey is used to pay the bride price; in Ethiopia, honey wine is brewed for weddings.

Honey is a useful source of high-carbohydrate food, and usually contains a rich diversity of minor constitutes (minerals, vitamins, and proteins), adding nutritional quality to human diets. In areas where caloric intake is low, the inclusion of honey in the diet will help supply needed carbohydrates. If basic calorie requirements are met, protein foods may be used by the body as protein.

Seasonally it can provide a useful addition to the diet, as it often can be gathered or harvested when other food is limited or monotonous. If harvested and processed properly, honey may be stored for long periods of time with no adverse effect; therefore, it can be use in times of food shortage. Compared with industrialized countries, honey consumption is generally low in developing countries. There is no exception in Ethiopia as well as in Amhara region. This is because honey is regarded more as a medicine or tonic, rather than a daily food. The tradition of using honey making mead (locally known as *'Tej'*, the national drink, is possibly Ethiopian's oldest alcoholic drink) must not be neglected in the dietary discussion (Kerealem et al., 2009).

2.5.2. As a medicine or tonic

In many parts of the world, honey is used as a medicine or tonic and as a special treat for children. Modern medicine is increasingly using honey for a variety of treatments.Honey is composed of sugars like glucose and fructose and minerals like magnesium, potassium, calcium, sodium chlorine, sulphur, iron and phosphate. It contains vitamins B1, B2, C, B6, B5 and B3 all of which change according to the qualities of the nectar and pollen; besides the above, copper, iodine, and zinc exist in it in small quantities. Several kinds of hormones are also present in it. Honey may also be good for your skin. It has the ability to attract water.

It is highly acid. 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).You can also use it as a moisturizing mask for your skin as well as your hair. To use it as a conditioner, mix the honey with olive oil.

Due to its natural anti-inflammatory effect, it will help to heal the wounds more quickly. It also has different phyto-chemicals--chemicals found in plants and different foods--that kill viruses, bacteria, and fungus making it a good substitute for wound dressings. The taste may also take your mind off the pain. There is evidence that honey diluted in water will help with your stomachaches and dehydration (Medical journal, 1986).

Honey is a natural antiseptic. Countries in Asia and Eastern Europe have a wealth of traditional knowledge of apitherapy – the healing properties of bee products. In recent years, there has been

a worldwide revival of interest. Honey, beeswax, propolis and bee venom, used in bee-sting therapy, are the main bee products used in apitherapy. Honey has antibiotic properties it is a sterile solution with a high sugar concentration that prevents the growth of micro-organisms (Medical journal, 1986).

Honey may also be effective in the treatment of your ulcers. In Europe, honey has been used internally to help cure ulcers, particularly stomach ulcers. Burns, too, heal better with honey, studies show. The advantage of honey is that it not only prevents infections from occurring, it actually accelerates skin healing. Since the sugar in honey absorbs water it helps to trap some of the moisture so that the bacteria and other microbes can't grow as easily as in other food. In treating diarrhea, honey promotes the re-hydration of the body and more quickly clears up the diarrhea and any vomiting and stomach upsets (Islamic Food and Nutrition Council, 1986).

Honey is added to porridge or tea as a substitute for sugar. In Kinyope village of Tanzania, honey is used mainly as the raw material for brewing. It was found that as medicine, honey is used in Milola and Mchakama villages of Tanzania to cure people suffering from stomach ulcers, burns, and wounds from fire and for children suffering blood shortages (Bee for Development, 2008).

Early British records indicate that Prince Hal was treated with rose honey for a facial injury sustained during the battle of Shrewsbury in 1403. Many curative claims have been made for honey including treatment for digestive disorders, respiratory problems, eye conditions, baldness, drunkenness and burns. This item looks at the use of honey in treating wounds (Bee Craft, 2008).

2.5.3. Other benefits

Pollination service

Honeybee is also believed to play a significant role in the economy of Ethiopia through pollination services. Pollination is one of the most important factors that affect seed production in agricultural crops. In Ethiopia, an experiment was conducted to evaluate the effect of honeybee pollination on Niger (*Guizotia abyssinica*) and the result revealed that honeybees increased the seed yield of Niger by about 43 percent (Admassu and Nuru, 2000). These indicated that honeybees have a vital role in increasing food production and overall agricultural productivity.

Social benefits

Beekeeping also has considerable socio-cultural significance. In the region farmer beekeepers are appreciated by the community for their sweet product. Moreover, production of honey mead (*'Tej'*) as a local festival drink and the use of beeswax for making of votive candles is an integral part of the cultural heritage within the many ethnic and religious groups.

Benefits of honey:

Easily digested: Because 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.

Good source of antioxidants: It plays a big role in the prevention of cancer as well as heart disease.

Has a low calorie level: Another quality of honey is that, when it is compared with the same amount of sugar, it gives 40% less calories to the body. Although it gives great energy to the body, it does not add weight.

Rapidly diffuses through the blood: When accompanied by mild water, honey diffuses into the bloodstream in 7 minutes. Its free sugar molecules make the brain function better since the brain is the largest consumer of sugar, thus, reduces fatigue.

S**upports blood formation:** 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).

Does not accommodate bacteria: This bactericide (bacteria-killing) property of honey is named "the inhibition effect". Experiments conducted on honey show that its bactericide properties increase twofold when diluted with water. It is very interesting to note that newly born bees in the colony are nourished with diluted honey by the bees responsible for their supervision - as if they know this feature of the honey (Medical Journal, 1986).

Royal jelly: Royal jelly is a substance produced by worker bees inside the beehive. Inside this nutritious substance are sugar, proteins, fats and many vitamins. It is used in problems caused by tissue deficiency or body frailty (Medical Journal, 1986).

2.5.4. As a cash crop

Many speakers reminded the African honey trade workshop that export is not always the best idea. The domestic and regional honey markets are currently under saturated in countries such as Kenya and Uganda; which is sound for Ethiopia, where urban supermarkets, hotels and other retail outlets provide opportunities for honey sales. The advantages of selling locally include: (Bee for Development Journal.81).

- lower marketing and transaction costs
- less stringent quality criteria
- less stringent certification requirements
- easier to sell without any special marketing approach
- fewer consequences if supplies are erratic
- small volumes are acceptable

The main issue is for the producer group to be governed by a business model based on calculating the profit margins of different marketing strategies. It is important for any honey business to know the market and make a rational decision about the markets for which to aim. Statistics for

honey trade in Africa - even the formal trade - are difficult to obtain, but anecdotal evidence suggests that domestic demand for local honey is increasing and sales are rising. For many producers there is no need to think of export (Bee for Development, 2006).

Fresh local honey is always more highly valued than imported honey. Many beekeepers sell their product directly to consumers. Honey is often used as a barter commodity in villages, especially in remote areas or areas isolated by war or sanctions. Honey is a stable commodity with a long shelf life. If harvested carefully, it will remain wholesome for many years. As standards of living rise, honey consumption increases (Bradbear, 2003).

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).

Fair-trade has opened up opportunities in a difficult market environment. Honey is not traded on the stock exchange. The price depends on various production costs, different climate and vegetation zones, and the yield per bee colony. There have been fierce price battles on the market for honey that resulted in beekeepers being hardly able to live from their income on the conventional market. In this economic environment, Fair-trade guarantees stability for honey producers through a Minimum Price. It allows producers to cover their costs and contributes to more security for the beekeepers and their families (Bee for development, 2006).

Beekeeping is one of the most important income-generating activities in the rural communities of Amhara region. The main emphasis given on honey production is as a cash crop. Honey has good domestic market all the year round with slight price change at different market points. In the region honey selling helps for the diversification of the incomes of farmers. Some farmer beekeepers of the region reported to earn up to 3000 *Birr* (about US$ 353) annually from honey selling only which contribute the largest portion of their annul incomes (Kerealem et al., 2009).

These facts indicate the high potential of apiculture as source and means of diversifications of incomes for the rural communities. Many resource poor farmers sell their honey to the local markets and use income to purchase livestock, agricultural inputs, food crops and other household items. Many beekeepers sell their honey mixed with beeswax without further processing. Honeybees can also be sold to meet cash requirements (Kerealem et al., 2009).

Chapter III- Materials and methods

3.1 Description of the study Area

Atsbi Wemberta Woreda is found in eastern zone of Tigray Region at about 65 km from Mekelle. The Woreda is located in the north east of the regional city, Mekelle at 13º 36``N and 39º 36``E. The Woreda is bounded in the north by SaeseTsaedaemba Woreda, in the south by Enderta Woreda, in the east by Afar regional state and in the west by KilteAwuelalo Woreda. The district has an altitude at Dega (highland), which ranges from 2400 m to 3000 m and at weinadega (midland) ranging from 1800 m to 2400 m above sea level. The Woreda has a total area of about 1223 sq. km. Generally the Woreda has 70% and 30% Dega and Weina dega, respectively.

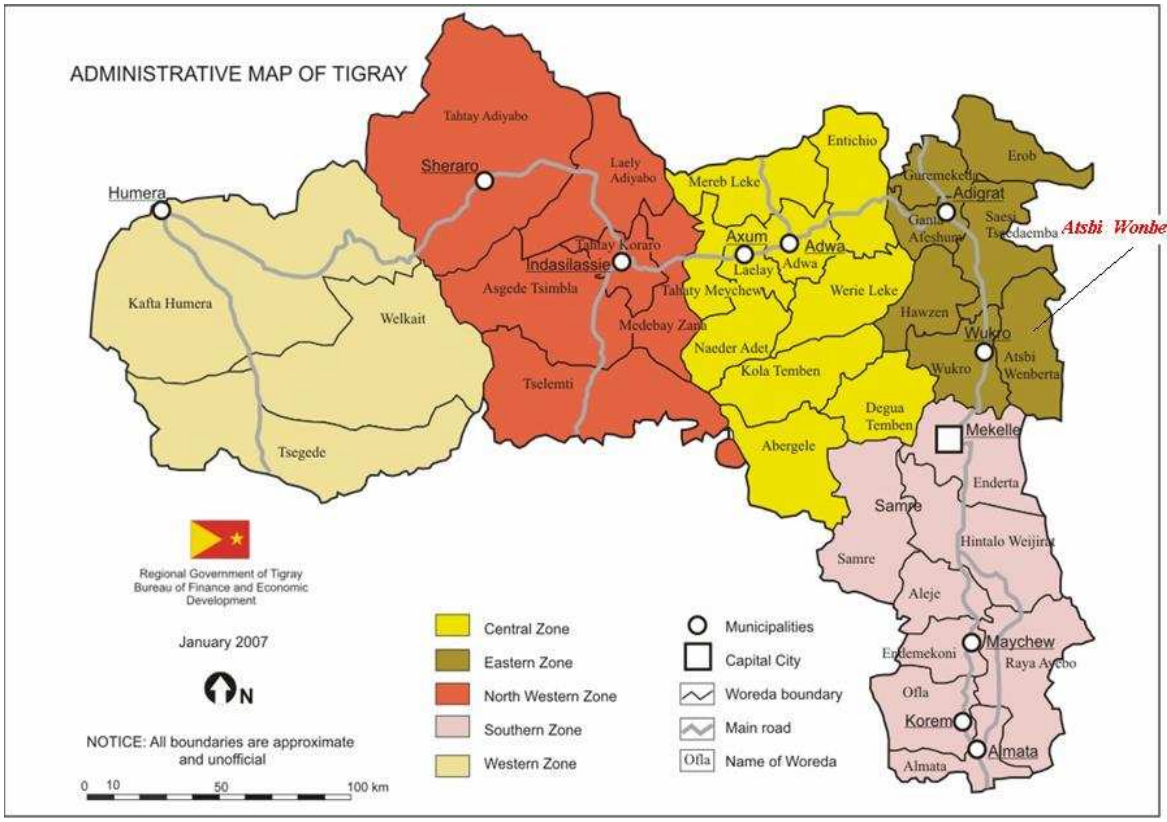


Fig1.The location of Atsbi Womberta in eastern Tigray.

3.1.1. Climate

The climate of Atsbi Wemberta ranges from cool to warm. The average temperature of the area is 18^{o}c. Generally the climate of the area is characterized as highland and middle land. Rainfall is usually intense and short in duration, with an annual average of about 667.8 mm.

3.1.2. Population

Atsbi Wemberta has a total population of 112,234 of which male and female are 53,615 and 58,619, respectively (CSA, 2008). Urban and rural population is 9609 and 103,030, respectively (OoARD, 2006).

3.1.3. Economic activities

According to Atsbi Wemberta Woreda OoARD planning office (2006) the dominant cereal crops of the area are barley, wheat, teff, maize and sorghum. Among the pulses, beans, field pea and lentil are the major dominant crops. There are also cattle, equines, sheep, goat, camel, and beekeeping. Honeybee colony multiplication through over crowding and splitting method is practiced in the highland areas where as honey production is a common practice in middle altitude.

Livestock population of the study area was; Oxen 21908, Cows 30588, Goats 15431, Sheep 82950, Donkeys 9416, Mules 1333, Horses 79, Camels 54, Poultry 47265, Honeybee Hives with honeybee Colony 16915 (OoARD, 2006).

Livestock population of the study area was; cattle 3119410, Goats 3005460, Sheep 1388100, Donkeys 462500, Mules 6670, Camels 34450, Poultry 4262340, Honeybee hives 242870 (CSA, 2008).

3.1.4 Infrastructure

The Woreda has 32 schools at different levels i.e. 7 (1-8 grade), 2 (1-7 grade), 4 (1-6 grade), 3 (1-5 grade), 15 (1-4 grade), and 1 (9-10 grade). The Woreda has 14 health posts, 3 clinics and one health station. In addition, it has all weather roads, which connect all Peasant Associations with neighboring Woredas. In the Woreda and its neighboring Woredas, the forest coverage is large.

The forest coverage is a good opportunity for beekeeping activities as it houses bee forage. In addition, the woreda has 3,473 hectare of area enclosure that also has bee forage. In the area enclosure, it is possible to integrate bee forage like in Tigrigna `gribiya` (*Hypostus ariculata*) and `tebeb` (*Basium clandiforbium*) etc, which are contributing much to honey production of the area. Land allocation of the study area was cultivated land 14535 hectare, ready to be cultivated 35305 hectare, grazing land 8742 hectare, area enclosure 3473 hectare and forest (include the project areas of neighboring Woredas 89185 hectare (OoARD, 2006).

3.2. Sampling Procedures

Out of the 16 rural tabias in the woreda, five tabias namely Hayelom, Dibab-Akorein, Barka-Adisabiha, Micheal-emba and Kal-Amin were selected for this research. The selection of the Tabias was based on their potential for the beekeeping activities.

Within the tabias 200 farm households were randomly selected (40 household per tabia). The proportion of households with and without improved beekeeping in the 200 sample households mirrors the proportion of households with and without improved beekeeping in the Tabia. This approach enabled to collect information about improved beekeepers households that are comparable in basic characteristics to the traditional beekeeping serving as counterfactual. From the total of 200 sample households, 99 had improved beekeeping and 101 were purely traditional beekeepers.

A structured questionnaire was designed and the sample households to collect information on process and out put of beekeeping by asking each household head to recall her/his activities in 2008.

3.3. Data collection

Due to the wide ranging implications of the agricultural technologies and the impacts to the society non single method can sufficiently capture these process and impacts. Therefore, data was collected by mixing methods such as, surveys, qualitative interviews focus group discussion (Dick et al., 2004). Accordingly, household interview was done using pre-tested structured questionnaires. For obtaining the relevant information on livelihood change, focus group discussion was conducted with beekeepers and non-beekeepers households. In the focused group

discussion, farmers' opinion towards beekeeping was assessed to evaluate the process and impacts of market oriented beekeeping on livelihood change of the rural communities. The researcher did explicit direct observation for more reliable judgment on the farm household improvements. Household survey was the main source of information.

3.4. Econometric/Estimating procedure/ model

Propensity score matching and Heckman regression methods is used to assess the impact of modern beekeeping on household income, expenditure on education, human capital and per capita income of the households. Although propensity score matching (PSM) is a widely used impact assessment method, there is significant skepticism regarding this approach due to its potential sensitivity to selection bias due to unobservable; hence, Heckman regression method was used after matching to test and correct for selection bias and to assess the robustness of the results.

The Impact evaluation problem

In studying the impact of improved beekeeping, a frequently-observed methodological problem is the tendency to assume that the whole income difference observed between households with and without improved beekeeping is attributed to the improved beekeeping factor (Gebrehaweria, 2008).

Quantitative methods for evaluating the impact of anti-poverty programs have been critically reviewed by (Ravallion, 2005). He argued that no single method dominates and hence policy-relevant, evaluations should be open-minded with regard to methodology, problem setting, and data constraints.

Experimental methods construct the counterfactual by randomly assigning a group of project participants (the treatment group) and a group of non-participants (the control group). Due to the random assignment of project participation, the treatment group is, on average, identical to the control group, except with respect to participation in the project (in this paper, improved beekeeping).

Randomization effectively eliminates all pre-existing differences between the treatment and control groups; therefore, the effect of the project is isolated. The literature has long recognized

that impact evaluation is essentially a problem of missing data. A group of non-participants may therefore be used as the control group and to represent the counterfactual.

Matching is a non-parametric method that is widely used in the impact evaluation literature (Ravallion, 2005; Cobb-Clark and Crossley, 2003; Heckman *et al*., 1998). Matching methods aid in creating a counterfactual from the control group. The basic assumption when using a counterfactual is that the untreated samples approximate the treated samples if they had not been treated, i.e., $E\ (Y_{0i}|B=1)$ (Heckman *et al*., 1998). For the matching method to be valid, the assumption of Conditional Independence (CIA) is critical and must hold true. The CIA argues that testament is random and conditional on observed variables (X) specified as:

$$(Y_{1i,}\ Y_{0i} \perp B|\ X_i) \qquad (1)$$

This assumption implies that the counterfactual outcome for the treated group is the same as the observed outcomes for the non-treated group given the control variables (X).

In the present case, this means that the counterfactual income is the same as the income level that would have existed if the household had no improved beekeeping, specified as:

$$E\ (Y_{0i}|X_i, B=1) = E\ (Y_{0i}|X_i, B=0) = E\ (Y_{0i}|X) \qquad (2)$$

Equation 2 implies that

E [ΔY|B=1] =E (Y1|B=1]-E [Y0|B=0], by subtracting and adding E [Y0|=1], we obtain

E [Y1|B=1]-E [Y0|B=0]-E [Y0|B=1] + E [Y0|B=1], by arranging this

$E[Yi\text{-}Y0|B=1] + E[Y0|B=1] - E[Y0|B=0] = E[\Delta Y|B=1] + \{E[Y0|B=1] - E[Y0|B=0]\}$ where, the first term denotes the impact of improved beekeeping, and the second term, i.e., {.} captures the bias. However, if Y_0 is the mean independent of improved beekeeping *(B)*, i.e., $E\ (Y0|B=1) = E\ (Y0|B=0)$, the bias disappears and $ATT = E\ (\Delta Y|B=1)$ is identified and is unbiased (Cobb-Clark and Crossley, 2003).

The first term of equation (2) represents the counterfactual income of the treated group and is equal to the observed income of the untreated (control) group.

This assumption rules out selection into the program and gains from improved beekeeping on the basis of unobservable characteristics. The CIA requires that the set of X's contain all variables that jointly influence the outcome with no treatment, as well as the selection into the program. Under conditional independence, therefore, the average treatment effect on the treated (*ATT*) can be computed as:

$$ATT=E\,(Y1-Y0|X,\,B=1)=E\,(Y1|X,\,B=1)-E\,(Y0|X,\,B=1) \qquad (3)$$

However, matching of households based on observables may not be feasible when the dimension of control variables is large. To overcome this problem of dimensionality, Rosenbaum and Rubin (1983) argued that one can match along a single index variable given by the propensity score, *p(X)*, which summarizes the multi-dimensional variables. This is the conditional probability that household *i* has improved beekeeping given the conditioning variables, written as:

$$P(X)=Pr\,(B=1|X) \qquad (4)$$

The *ATT* in equation (3) can then be written as:

$$ATT=E\,(Y1|P(X),\,B=1)-E\,(Y0|P(X),\,B=1) \qquad (5)$$

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 improved beekeeping will be placed in the treated (with access to improved beekeeping) and untreated (without access to improved beekeeping) samples in equal proportions. The propensity score is estimated by a binary choice model, which, in this thesis, is represented by a binary logit model. Once the propensity score (p-score) 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 improved beekeeping must be accepted.

In this thesis study, households with and without access to improved beekeeping were, therefore, matched based on their p-score using the nearest neighbor, kernel and stratification matching methods. These methods identify the closest match for each modern beekeeper household (i.e., with the closest propensity score) among households that have no access to improved beekeeping, and then compute the effect of improved beekeeping as a mean difference of household income between the two households. A brief description of the three matching methods used in this study is given below (Becker and Ichino, 2004).

1) *Nearest neighbor matching method:* Each treated observation is matched with an observation in the control group that exhibits the closest propensity score. In nearest neighbor matching, it is possible that the same household in the control group can neighbor more than one household in the treated group. Therefore, after matching, the difference between their incomes is calculated as the average effect of improved beekeeping on household income (ATT).
2) *Kernel matching method:* All treated observations are matched with households in the control group based on the weighted average that is inversely proportional to the distance between the propensity scores of the treated and control groups.
3) *Stratification matching method:* The dataset is divided into intervals having, on average, the same propensity score. The treated and control groups within that interval are placed under one block, and the mean difference of the outcome between the treated and control groups provides the average treatment effect of improved beekeeping on household income (ATT).
4) *Radius matching:* Each treated unit is matched only with the control units whose propensity score falls in a predefined neighborhood of the propensity score of the treated unit. If the dimension of the neighborhood (i.e. the radius) is set to be very small it is possible that some treated units are not matched because the neighborhood does not contain control units. On the other hand, the smaller the size of the neighborhood the better is the quality of the matches.

It is important to note that each matching method has its own strengths and limitations. 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).

The tools for quantitative data analysis were descriptive statistics such as percentage frequencies, mean and standard deviation. Any item that can not be captured through quantitative analysis was analyzed using qualitative based on interview and group discussion with extension workers and beekeepers.

Chapter IV-Results and discussion

This section deals with the process of beekeeping development and diffusion, economic impact and changes on social issues such as education, nutrition, health, and gender participation at household level in Atsbi Womberta.

4.1. The Process of beekeeping development and diffusion of improved beekeeping management

4.1.1. The process of beekeeping development

The communities in the key interview indicated that beekeeping practice is deeply rooted with the history of other agricultural activities in the farming community. Besides, the process of beekeeping in Atsbi-Womberta district can be roughly classified into three developmental stages based on the levels of beekeeping knowledge, investment and product orientation (Table 1). The first stage is a combination of forest honey hunting followed by honey bee colony hiving based on local knowledge with product orientation largely for home consumption as food, drink and medicine. The second stage is extension supported beekeeping mainly to increase honey productivity and production as a contribution to food security with less emphasis on the quality of marketable products, and the third stage is integrated and innovative knowledge based beekeeping management interventions with emphasis on improving market oriented products along the value chains.

Free honey hunting and honey bee colony hiving: before 1991. In the earlier years, honey hunting from the wild honey bee colonies had been practiced incidentally. At this stage, farmers went in search of honey to the forest. The ‘green figure’ or lucky farmers harvested honey from twigs, live tree trunks and caves without any investment in resources and skills in beekeeping. In Atsbi-Womberta district, seasonal honey harvests from rocks or caves still exist in churches and in rock outcrops sites where human disturbance is limited (Table 1). With increasing population pressure, the practice of honey hunting and availability of wild honeybee colonies reduced. Simultaneously the practice of honey bee colony hiving using locally made hives around home

yards and out yards hanging in tree branches has been gradually increased and became dominant. Farmers indicated that the honey bee colony management around home yards increased and that of out yards decreased largely owing to the reduction in diversity and cover abundance of bee forage plants. Home yard honey bee colonies were managed around homesteads hived in locally made hives (Table 1). The beekeeping products were low in quality and largely oriented for local consumption with limited market access. Hence, the honey yield per colony per year was not more than 5 kg until 1991 (IPMS, 2004). The skills and knowledge of beekeeping was essentially local without any extension support and thus honey was harvested with no or little investment in skills and input supplies.

Table 1. Processes of beekeeping development with various levels of knowledge and product orientation

Processes and period	Beekeeping product orientation	Skill and knowledge changes
Free honey harvests and honey bee hiving: before 1991	Honey collected and produced for restricted local consumption with limited access to market. Wax used for candle making in churches.	No or little local skills used. Intuitive knowledge mostly based on chances without any extension service support. Honey yield was not more than 5 kg colony^{-1}year^{-1}.
Production oriented beekeeping:1991-2004	Focused on improved honey productivity and production with less emphasis on product quality for market.	Extension services started to deliver skills and knowledge since 1991. Among them skills on modern hives and ancillary equipment introduced; and means on diversified and increased cover-abundance of bee forage plants popularized.
Market oriented beekeeping: 2005-2009	Focused on market oriented beekeeping products to improve and diversify income sources from honey and honey bee colony.	Improved skills and knowledge on beekeeping strengthened according to the assessed gaps in knowledge along the value chain of beekeeping systems. Capacity of actors to innovate, use and share knowledge strengthened.

Source: Authors' survey

Production oriented beekeeping development (1991-2004). The key informants also mentioned that the extension assisted beekeeping development was tested by the public extension services with the support of Irish Aid and World Vision Ethiopia. In 1994, the extension team and WV-E assessed the ecological suitability of the district for beekeeping development. Subsequently, the introduction and testing of the performance of honey bee colonies in modern hives were suggested. Two peasant associations (PAs) namely Hayelom from the midland while Felege Weini from the highland farming systems (FS) were selected as a test sites. In 1995, some modern hives were introduced in to the selected PAs and displayed to farmers. In 1997, the local honey bee colonies were transferred into the modern hives. In 1998, about 20 kg honey colony^{-1} yr^{-1} was harvested from honey bee colonies in modern hives from the village Kuret in Felege Weini PA (personal communication with district OoARD staff). However, the selected village Kuret was supposed to be cool for the honey bee colonies inside the modern hive and the honey bee colonies were re-allocated to a new village called Uset in the same PA. The performance of the local honey bee colonies in Hayelom PA was encouraging. In the same year, the district OoARD distributed about 18 modern hives for nine households. Thereafter, an expert was assigned to assist the beekeeping development in modern hives. The extension staff mentioned that this was the first modern hive introduced into Tigray region, about 33 years after the introduction of modern hive into Ethiopia (Workneh, 2007) and about 150 years after the invention of modern hives based on 'bee space' concept in the US.

Subsequently 27 modern hives distributed for 12 households in 1999, 82 modern hives for 53 households in 2000, 153 modern hives for 84 households in 2001. Initially the supplies of modern hive were for free and some households were reluctant to take the offer. Following the introduction of the modern hives into the farming community, there was intensive training on how to manage honey bee colonies in modern hives. In 2003, there was a massive introduction of modern hives along with the extension package program. However, the experts mentioned that there was no skill development training along the introduction of the modern hives in the packages. There was shortage of budget and manpower to deliver the necessary practical skills and knowledge on the management of honey bee colonies in modern hives. Alternatively, the extension experts organized the farmer to farmer sharing of knowledge. Thus, best model farmers were used to train their neighbors but the quality of the training was considered as low. The skills and knowledge of beekeeping was a mix of the local and scientific inputs. The beekeeping

management orientation was to increase productivity and production to ensure household food security with less emphasis on the quality of marketable products and market needs. This extension approach was inline with the documented production oriented strategic research plan and implementation in apiculture in Tigray (Ayalew, 2004). At the end of 2004, the total numbers of hone bee colonies were about 6729, of which about 30% was in modern hives and the rest in locally made traditional hives (IPMS, 2004). The estimated gross annual contribution from the beekeeping in the district was about 2.7 million birr benefitting about 3700 households in the district (IPMS, 2004). Since 2005, IPMS has facilitated the introduction of participatory market oriented income generating extension interventions planning and implementation along the value chain of beekeeping in Atsbi-Womberta district.

Market oriented beekeeping development. With the facilitation of IPMS, the emphasis of beekeeping orientation shifted from production to market led approach with the aim to improve the income of beekeepers using the available resources (IPMS staff personal communication). A shift in emphasis to market led beekeeping development in response to emerging market opportunities and challenges needs special skills and knowledge to produce marketable quality products. Besides, the introduced extension and research approaches were participatory, demand driven, market-led and follows the commodity chain approach. The emphasis has been on knowledge acquisition, sharing and use mechanisms, and capacity development of the actors based on the assessed gaps in knowledge as an input to increase income of rural farmers. The details of the approaches and processes in knowledge management, capacity development and participatory market oriented extension planning and implementation are described in the market led beekeeping interventions and approaches section below. With the facilitation of IPMS, the district was characterized and context specific market oriented and income generating agricultural commodities identified. Besides, the potentials, limitations and gaps in knowledge of the market led commodity diagnosed along the commodity value chain framework. Accordingly, interventions proposed and monitoring interventions impacts designed.

4.1.2 Diffusion of improved beekeeping management in Atsbi-Womberta district

IPMS facilitated the introduction and development of market led commodity development using participatory planning and implementation approaches within the value chain framework. Market led commodity development interventions started with the diagnosis of context specific development opportunities and challenges using participatory rural appraisal (PRA). In the PRA, the district was classified into relatively homogeneous recommendation domains known as farming systems (FS): Midland and highland FS (IPMS, 2004). The midland FS consists of seven peasant Associations (PAs) whereas the highland FS consists of nine PAs. The PAs in the midland FS include Kelisha Emini, Era, Hayelom, Michael Emba, Barka Adi Sebha and Dibab Akorein. The midland FS largely inclined to the south-eastern escarpment of the district. The PAs in the highland FS include Habes, Adi Mesanu, Golgol Naele, Felege Weini, Ruba Feleg, Haresaw, Zarema, Gebrekidan and Hadnet. The highland FS largely positioned to the north-west part of the district.

Both FS consists of about 23,400 households with an average family size of six. About 30% of the households are female headed households (IPMS, 2004). The two farming systems spatially vary in rainfall amount, temperature and altitude. The highland farming system ranges from 2600-3069 m above sea level and that of the midland from 918-2600 m above seas level. Air temperature and rainfall also varies spatially according to the altitude gradient (IPMS, 2004). In both FS, rainfall is extremely variable, the main rainfall occurs from June to August and that of the short rain occurs from March to May. In both FS, market led small scale beekeeping had been identified as one of the emerging market oriented commodities that could contribute to improve the livelihood of rural farmers (IPMS, 2004). In the midland FS, honey and honey bee colony were identified as market oriented products whereas in the highland honey bee colony split was selected. Based on the defined FS, the diffusion of improved beekeeping adoption was from the Woreda Office of Agriculture and Rural Development (OoARD, 2008). The data showed that about 87% of the improved beekeeping management adopted in the midland and the rest in the highland FS. That means most of the highland FS have still more of traditional beekeeping. The reasons for distinct difference in the diffusion of improved beekeeping along the midland FS is

not clear. Extension experts and farmers indicated that the reason in the difference in the diffusion of the improved beekeeping technologies might be related to the existing air temperature. The air temperature in the highland Fs is cool and perhaps may not be suitable to introduce modern equipment such as modern hives made of processed woods of timber. Farmers indicated that bee colonies have been unable to live comfortably in the processed timber made modern hive.

4.2. Economic impact at household level

The economic impact discusses the income at the household level with modern and traditional beekeepers. The difference in income was done by the mean comparison which was not matched the modern and traditional beekeepers. To get the impact of improved beekeeping matched result was discussed.

4.2.1. Difference in gross income of households: modern and traditional beekeepers

The driving force to have bee colonies comprises 93.5% for income and 6.5% for consumption purpose. The result implies beekeeping has both as a source of income and food diet. The average gross income of households with modern and traditional beekeeping is given in Table 2. The results showed that the average income of households with modern beekeeping (Birr 4570.4/household) was significantly (at 1% level) higher than those households with traditional beekeeping (Birr 1804.8/household). Despite relative investment in using modern beekeeping, households' gross income increased by 250% compared to the traditional beekeepers.

Table 2. Average gross income of households (mean $\pm$ SE) with modern and traditional beekeeping

Beekeeping type	*Number of households sampled (n)*	*Average gross income (Birr/household)*	*Pr*
Traditional	*101*	*1804.8 $\pm$ 135.4*	
Modern	*99*	*4570.4 $\pm$ 295.7*	
Difference		*-2765.6 $\pm$ 323.1*	*0.0000*

Source: Own data computation

Similarly, there was a highly significant difference (P<0.00) in average per capita income between households with modern (Birr 765/head) and traditional (Birr 347/head) beekeepers. This implies that modern beekeepers have higher per capita income than the traditional beekeepers.

Table 3. Average per capita income of households (mean ± SE) with modern and traditional beekeeping

Beekeeping type	*Number of households sampled (n)*	*Average per capita income (Birr/household)*	*Pr*
Traditional	*101*	*347.7 ± 27.5*	
Modern	*99*	*765.6 ± 58.5*	
Difference		*-417.8 ±64.3*	*0.0000*

Source: Own data computation

The mean comparison statistics indicate that modern beekeepers are better off in terms of income but this does not imply that the difference is solely due to improved beekeeping management. Other factors (both observable and unobservable) might have contributed to the income difference between the modern and traditional beekeepers.

4.2.2. Matching results of household income

The first hypothesis (**H1**) stated that modern beekeeping improves household income. Table 4 presents the matching estimates of the average treatment effect of improved beekeeping on the treated (ATT) for the household income. Based on the alternative matching methods adopted for assessing the robustness of the estimated results, the overall average income gain due to improved beekeeping ranged from 2679 to 2888 Birr and was significant at 1% level based on the radius, kernel, stratified and nearest neighbor, matching methods. This robust result indicates that (relying on selection observables and assuming no selection bias) the mean income of households has significantly increased due to improved beekeeping.

Table 4. Matching methods and household income

Matching method and outcome	*Number of treated group (Modern beekeepers)*	*Number of control group (traditional beekeepers)*	*Average treatment effect on the treated (ATT)*	*Standard error*	*t-statistics*
Nearest Neighbor matching	*99*	*48*	*2888.382*	*402.770*	*7.171****
Kernel Matching	*99*	*101*	*2733.339*	*331.964*	*8.234****
Radius matching	*99*	*100*	*2679.873*	*334.552*	*8.010****
Stratified matching	*99*	*91*	*2737.821*	*291.554*	*9.390****

Source: Own data computation

, **, * indicate significant differences at 10%, 5% and 1% levels, respectively; standard errors are bootstrapped.*

The second hypothesis (**H2**) stated that modern beekeeping improves the household per capita income. Table 5 presents the matching estimates of the average treatment effect of improved beekeeping on the treated (ATT) for the per capita income of the household. like the income, educational expenditure and human capital the per capita income of the household the alternative matching methods adopted for assessing the robustness of the estimated results, the overall average per capita income gain due to improved beekeeping ranged from 428.4 to 493.5 Birr and was significant at 1% level based on the stratified, radius, kernel and nearest neighbor matching methods.

Table 5. Matching methods and household per capita income

Matching method and outcome	*Number of treated group (Modern beekeepers)*	*Number of control group (traditional beekeepers)*	*Average treatment effect on the treated (ATT)*	*Standard error*	*t-statistics*
Household per capita income					
Nearest Neighbor matching	*99*	*48*	*493.463*	*76.363*	*6.462****
Kernel Matching	*99*	*101*	*456.735*	*67.121*	*6.805****
Radius matching	*99*	*100*	*437.520*	*66.669*	*6.563****
Stratified matching	*99*	*91*	*428.438*	*55.395*	*7.734****

Source: Own data computation

, **, * indicate significant differences at 10%, 5% and 1% levels, respectively; standard errors are bootstrapped.*

However, there is a risk that these estimates are biased due to unobservable characteristics. It was used Heckman regression to test selection bias. Estimated result of the Heckman regression model is given below indicates there is no selection bias because lambda is significant at about 52% (Table 6).

Table 6. Heckman selection model -- two-step estimates

Number of obs = 200
Censored obs = 101
Uncensored obs = 99
Wald chi2(5) = 275.82
Prob > chi2 = 0.0000

	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
Income Bee						
Modern	398.363	61.97485	6.43	0.000	276.8946	519.8315
Tradi	1278.941	88.45986	14.46	0.000	1105.563	1452.319
Mediahelp	-324.3463	151.3243	-2.14	0.032	-620.9366	-27.75608
Beetraining	-818.303	1126.567	-0.73	0.468	-3026.333	1389.727
QualitProb~m	3982.705	671.5055	5.93	0.000	2666.578	5298.831
_cons	-2888.648	1882.004	-1.53	0.125	-6577.309	800.0126
UseImprovh~e						
Edusq	-.7892756	.2139275	-3.69	0.000	-1.208566	-.3699854
NoFamilysq	.009598	.0041915	2.29	0.022	.0013827	.0178133
lnage	.6060848	.39731	1.53	0.127	-.1726285	1.384798
landsizesq	.006333	.013099	0.48	0.629	-.0193406	.0320066
__cons	-2.513756	1.438554	-1.75	0.081	-5.33327	.3057588
mills	688.5497	1059.34	0.65	0.516	-1387.719	2764.818
lambda						

Source: Own data computation

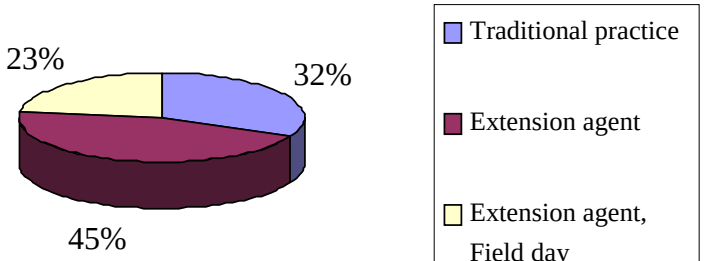
4.2.3. Changes in capacity development of beekeeping

Some measures have been taken by governmental and non-governmental organizations to facilitate growth of the beekeeping sector in the study area. Effective beekeeping related training and technical assistances have been delivered to farmers; 69.5% of the respondents have got training and the rest 30.5% respondents did not get the training.

As a result of the training and other interventions, 8% of the respondents have got a sharp increase beekeeping products; likewise 68% of the respondents replied that the trend of beekeeping products have increased from the time when they start. On the other hand, 22% answered it was decreased and 2% have got no change in their beekeeping product trend. This result indicates most beekeepers have got the capacity to manage their bee colonies properly.

Farmer beekeepers of the woreda have well developed skill along with long standing traditional beekeeping skills. Fig 2 shows the media for the development of beekeeping skills and describes that 45% was guided by extension agents and 23% in combination with extension agent and field day. The rest 32% of the respondents have got the knowledge from their parents. In the woreda beekeeping is mostly practiced in the house either under separate shelters or around the house wall or even inside the house with domestic animals and family members. 54% of the respondents their beehives were kept in the house and 27.5% at backyard further more, 9%and 8.5% of the beehives was in out backyard, under the roof respectively.

Fig 2. Skill development



Source: Own data computation

Table 7 provides evidence for the advantage of modern hive compared to traditional hive. The table clearly shows the technology improvement and its dissemination in the woreda. From the 99 respondents of modern beekeepers, 58.6% have got high honey yield and 37.4% achieve very high honey yield. Like wise, 63.6% of the modern beekeepers obtain high honey quality and 33.4% attain very high quality. The result implies modern beekeepers have better honey yield and quality which has an influence on income and well being. The highest price for top quality honey from box hive is 60 Birr/kg. Similarly the highest price for honey from traditional hive is 50 Birr/kg which was taken from the survey.

Modern beekeeping productions require more expensive establishment cost, accessories, (further cost) and skill training although yield better quality and quantity honey (Mahari, 2007). Another way, from the modern beekeepers 71.7% reply the cost is medium as compared to its advantage and 28.3% answered that though its advantage is unquestionable still its cost is high. On the supply of modern beekeeping 61.6% reply medium supply and 36.4% respond that there was high supply.

Table 7. Perception of modern beekeepers of improved hive compared to traditional hive

Rank of improvement	*honey yield*	*Honey quality*	*Skill*	*Supply*	*Cost*
	Percent	*Percent*	*Percent*	*Percent*	*Percent*
Low	*1*	*0*	*0*	*1*	*0*
Medium	*30.3*	*3.03*	*54.6*	*61.6*	*71.7*
High	*58.6*	*63.6*	*36.4*	*36.4*	*28.3*
Very high	*37.4*	*33.4*	*9.0*	*1*	*0*
Total	*100*	*100*	*100*	*100*	*100*

Source: Own data computation

In addition to the honey yield and quality Table 8 illustrates the detail skill improvement of modern beekeeping and they have improve their knowledge (skill); 27% of the modern beekeepers have got medium skill and 18% have high skill similarly 4.5% gain very high skill improvement.

Table 8. Skill development of improved beekeeping

Rank of improvement	*Honey harvest*	*Honey extract*	*Transferring*	*Inspection*	*Colony split*
	Percent	*Percent*	*Percent*	*Percent*	*Percent*
Very easy	*0*	*0*	*0*	*2*	*1*
Easy	*45.5*	*42.4*	*35.4*	*29.3*	*9.1*
Medium	*31.3*	*32.3*	*38.4*	*56.6*	*54.5*
Difficult	*21.2*	*24.3*	*24.2*	*12.1*	*30.5*
Very difficult	*2*	*1*	*2*	*0*	*5.1*
Total	*100*	*100*	*100*	*100*	*100*

Source: Own data computation

About 8.5% of the interviewed farms have obtained sharply increased profit from the sale of beekeeping products similarly 67% have got increased trend of profit. On the other hand 22.5% of the beekeepers their profit was decreased and 2% have no change in the trend this was due to the occurrence of drought in the woreda.

4.3. Changes in social issues at household level

The change in social issues related to education, health and nutrition, wealth status and gender participation was discussed. Health and nutrition, wealth status and gender participation was presented in percentile while the educational expenditure and human capital of modern and traditional beekeepers was in matched results.

4.3.1. Health and nutrition

The difference in the percentage of sickness between households adopting improved beekeeping and traditional beekeeping management is given in Table 9 which indicates 63.6% of the modern beekeepers were not sick in 2008. In addition to this, one and two times of sickness consist 12.1% and 11.1% respectively. Similarly, 4.1% for the three times of sickness and 9.1% for greater than three times was indicated. The table also shows 43.6% of the traditional beekeepers were not sick and 17.8% were sick one times. Two and three times of sickness were indicated by 12.9% and 16.8% respectively. The traditional beekeepers sick greater than three times were 8.9% in 2008.

The results indicated that improved beekeeping adopters showed greater percentage (63.6%) than traditional beekeepers (43.6%) on no sickness in 2008. This implies modern beekeepers have improved the health of their family.

Similar to this study, in where areas with caloric intake is low, the inclusion of honey in the diet will help supply needed carbohydrates. If basic calorie requirements are met, protein foods may be used by the body as protein (Kerealem et al., 2009).

The increase of honey production in rural Ethiopia is important for the control of malnutrition in children (Hussien, 2000).

Table 9. Frequency of sickness by modern and traditional beekeepers

No. of sickness/year	Modern	Traditional
	Percent	Percent
0	63.6	43.6
1	12.1	17.8
2	11.1	12.9
3	4.1	16.8
>3	9.1	8.9
Total	100	100

Source: Own data computation

Moreover, Table 10 indicated that before introducing improved beekeeping technology 72.7% of the Modern beekeepers' daily meal was two times and the remaining 27.3% had three meals per day. Unlike the past 56.6% and 36.4% respondents of modern beekeepers their meal per day after having modern bee colonies had four times and three times meal per day respectively. Besides to that, 6% of the respondents had four times meal per day. This result indicates that the modern beekeepers get better than the traditional beekeepers in their consumption.

Table 10. Number of meals per day by modern and traditional beekeepers

Before intervention (2004)					After intervention (2008)			
Meal per day	One times	Two times	Three times	Four times	One times	Two times	Three times	Four times
Percentage	0	72.7	27.3	0	0	7	36.4	56.6

Source: Own data computation

Similarly, Table 11 describes the common food eaten per day before and after the improved beekeeping. The outcome shows owners of modern bee colonies have increased their meal nutrition for instance, meat from 1-20% to21-40% and egg from 1-20% to 21-40% likewise vegetables and fruits from 1-20% to 41-60% as well milk products from 21-40% to 41-60%.

Table 11. Types of meal by modern and traditional beekeepers

Before intervention (2004)					After intervention (2008)			
Meal in rank	1-20%	21-40%	41-60%	61-80%	1-20%	21-40%	41-60%	61-80%
	Perc	Perc	Perc	Perc	Perc	Perc	Perc	Perc
Meat	79.8	19.2	1	0	28.3	45.5	22.2	4
Milk product	0	61.6	37.4	1	13.1	26.3	35.4	15.2
Vegetables & fruits	63.6	33.33	3.03	0	17.2	28.3	39.4	15.1
Egg	68.7	28.3	3	0	23.2	43.4	17.2	13.1

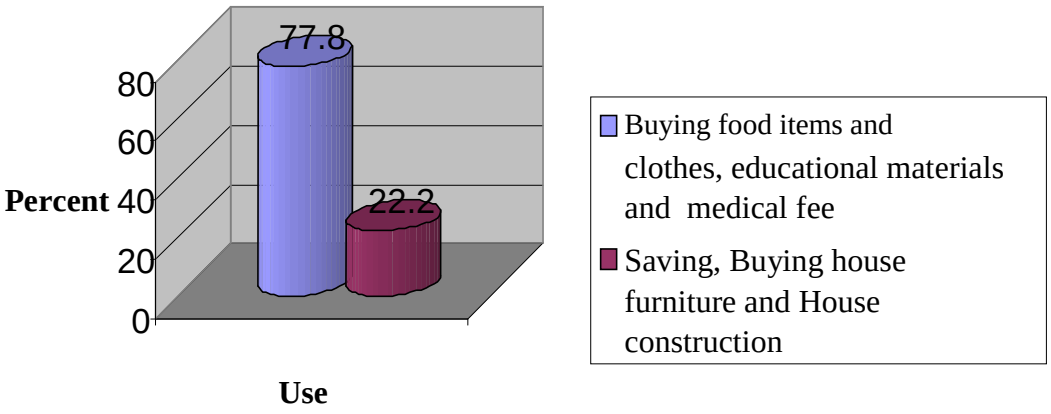
Source: Own data computation

In Atsbi Wemberta 70% of the respondents keep honey for traditional medicine and gift for the relatives beside to this 18% it is used for consumption and 12% for selling. The result implies that beekeepers have got better opportunity to prevent diseases than non beekeepers. Similarly, the natural products that honeybees produce are honey, royal jelly, pollen, propels, bee venom and, beeswax. These materials have been widely used as nutritional food and for medicinal and pharmacological purposes since ancient times (Mahari, 2007). It is also noted that in Ethiopia

since honey is regarded more as a medicine or tonic, rather than a daily food (Kerealem et al., 2009).

Fig 3 gives a picture that modern beekeepers have improved the livelihood for instance, 77.8% of the respondents have got the ability to buy clothes, food items, pay school and medical fee for their families. Similarly, 22.2% of the respondents have got the capacity to save, purchase house furniture and construct their house respectively.

Fig.3 Use of money from modern beekeeping



Source: Own data computation

Discussion was conducted with modern beekeepers in Barka-Adisabiha, Hayelom and Dibab-Akorein Tabia and the situation was stated as follows:

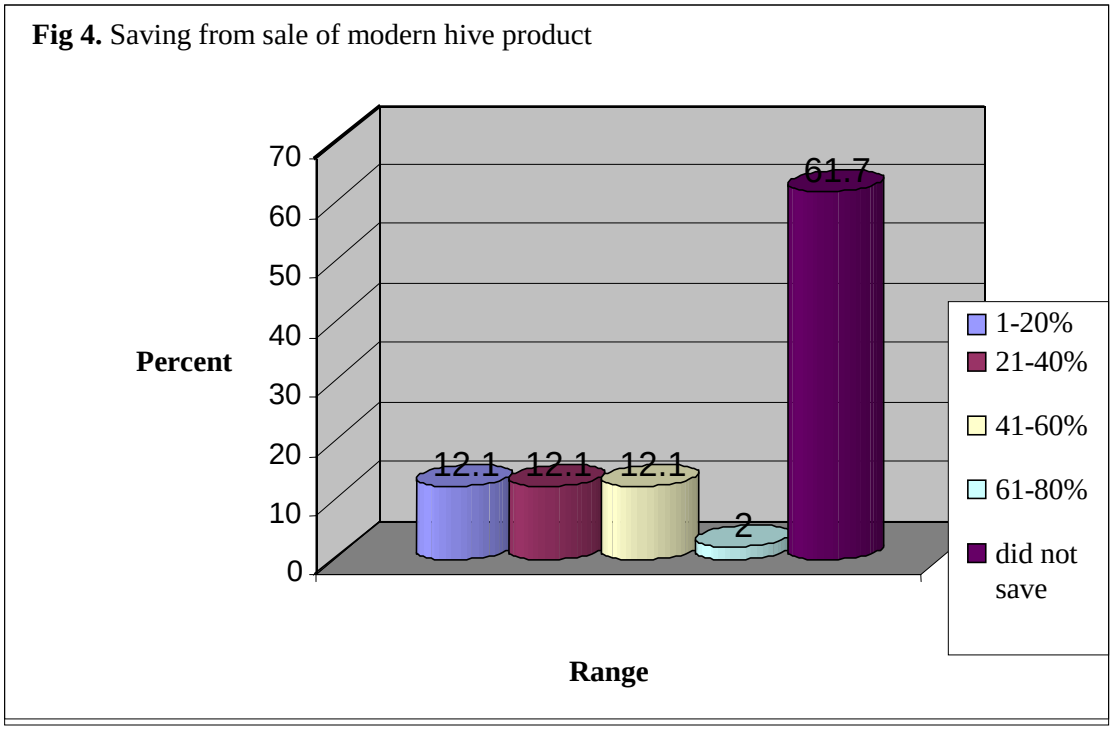
*Mr.A and Mr.B are modern beekeepers in **Barka-Adisabiha Tabia**. Mr.A has 4 modern bee colonies. He has got the construct house in Hayki-meshal which estimated about 20,000 Birr, bought 15 goats and house furniture's .Mr.B has 12 modern hives and has got the capacity to have 2 cross breed cows with their two calves and nice house (See annex Picture1).*

*Mr.C and Mr.D in **Hayelom Tabia** have the ability to own three cross breed cows, one calf, four sheep and motor for irrigation, electric power, pay the loan of breed cow respectively (See annex Picture2). Similarly Mr.E also could diversify his farming and has cow, sheep and fruits like mango, Apple, Orange and Lemon (See annex Picture3).*

*Mr.F was from **Dibab-Akorein Tabia** has 17 modern hives and has the capacity to rent land for irrigation (Tomato, other cereal crops) and bought cow. Mr.F still needs to increase the number of bee colonies because they are the primary source of income (See annex Picture4).*

Fig 4 shows the saving of modern beekeepers from the sale of bee hives products; about 61.7% of the respondents did not save because of other priorities such as consumption and investment in other areas (that was stated as additional advantages). On the other hand 12.1% of the respondents have saved from 1-20% and also 12.1% from 21-40%. Similarly, 12.1% and 2% respondents have saved from 41-60% and from 61-80% respectively.

Fig 4. Saving from sale of modern hive product



Source: Own data computation

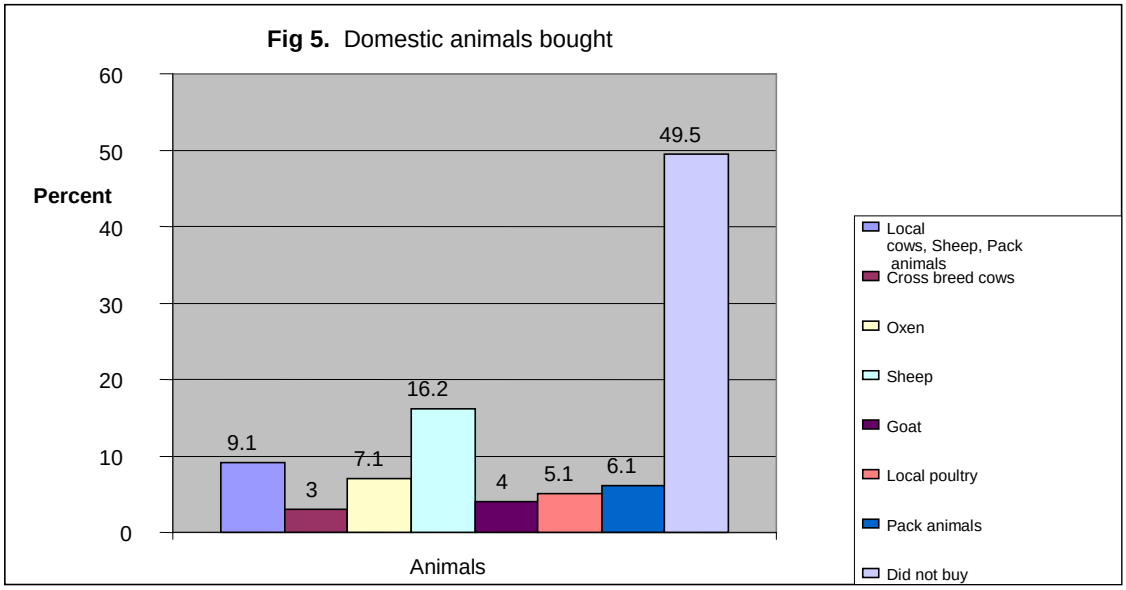
The additional advantage from participating in modern beekeeping presented in Table 12 shows about 84% of these farmers have bought additional hives, honey bee colony, domestic animal, animal feed and social acceptance due to additional money. Similarly, 13.13% for loan payment and 2.02% for trading purpose was used.

Table 12. Benefits obtained by participating in modern beekeeping

	Frequency	*Percent*
None	*1*	*1.01*
additional modern hive, honey bee colony, animal feed, social acceptance, domestic animal	*83*	*84*
For trading purpose	*2*	*2.02*
For loan payment	*13*	*13.13*
Total	*99*	*100*

Source: Own data computation

Fig 5 represents the additional advantages obtained by participating in modern beekeeping and show the buying of domestic animals which is productive investment to improve the living conditions of the household. 16.2% of the respondents have bought sheep only and 9.1% replay that they have bought local cows, sheep, and pack animals. Another 7.1% and 4% of the respondents have bought oxen and goats respectively. Similarly 6.1% and 3% have got the capacity to buy pack animals and cross bred cows and also 5% bought local poultry.



Source: Own data computation

Over all, modern beekeeping have created improved livelihood in terms of better income so as enhancing capability to buy household demands; productive investment like buying animals, saving and expenditure in different needs of the households. This result is similar to the study of Tilahun (2006) which states as a result SOS sahel project in Meket, Amhara region have got improved honey production and contribution to household food security, extra benefits included the possibility to repay fertilizer debts and buy clothes for the children (Tilahun, 2006).

4.3.2. Wealth status

Modern beekeepers in Atsbi Wemberta Woreda have improved their income and wealth status. Table13 give a picture of respondents based on their wealth status before and after the modern technology. 46.5% of the respondents were poor previous to the use of modern beekeeping; 43.4% and 10.1%of the beekeepers were medium and rich respectively. The table also describe that 62.6% of the respondents be medium likewise; 36.4% and 1% were rich, poor respectively. Still these figures showed that a set of efforts is needed to be done to improve wealth status of the modern beekeepers from medium level into rich households.

Similar studies had been taken implying that beekeeping advantages can be itemized for the socio economic impact of beekeeping. Successful beekeepers raise their socio economic standing in areas with subsistence agriculture, and farmers in the Amhara region can substantially supplement the family income, sometimes even double it. This means the family is food secured (Kerealem et al, 2009). In the same way the beekeeping sector contributes great roles in increasing household income of producers and the well being of farmers through solving the problem of food insecurity in Atsbi Wemberta (Mahari, 2006).

Table 13. Wealth status before and after use of improved beekeeping

Wealth status before use of improved beekeeping			*Wealth status after use of improved beekeeping*	
	Frequency	*Percent*	*Frequency*	*Percent*
Poor	*46*	*46.5*	*1*	*1*
Medium	*43*	*43.4*	*62*	*62.6*
Rich	*10*	*10.1*	*36*	*36.4*
Total	*99*	*100*	*99*	*100*

Source: Own data computation

4.3.3. Education by mean comparison and matched results

Table 14 shows that the average total educational expenditure of modern beekeepers and traditional beekeepers households was estimated to be 162 and 71 Birr, respectively, revealing a statistically significant (at 1% level) difference. This also indicate that using improved beekeeping provide more expenditures on education which is significant at 1% level.

Table 14. Average total educational expenditure of households (mean ± SE) with modern and traditional beekeeping

Beekeeping type	*Number of households sampled (n)*	*Average total educational expenditure*	*Pr*
Traditional(No)	*101*	*71± 9.9*	
Modern(Yes)	*99*	*162.32± 20.9*	
Diff		*-91.32± 23.02*	*0.0001*

Source: Own data computation

The third hypothesis (**H3**) stated that modern beekeeping improves household educational expenditures. Table 15 presents the matching estimates of the average treatment effect of improved beekeeping on the treated (ATT) for educational expenditures of the household. Similar to the income of the household the alternative matching methods adopted for assessing the robustness of the estimated results, the overall average total educational expenditures gain due to improved beekeeping ranged from 79.75 to 90.74 Birr and was significant at 1% level based on the kernel, nearest neighbor, stratified and radius, matching methods. This healthy result indicates that the mean educational expenditure of households has significantly increased due to improved beekeeping.

Table 15. Matching methods and household educational expenditure

Matching method and outcome	*Number of treated group (Modern beekeepers)*	*Number of control group (traditional beekeepers)*	*Average treatment effect on the treated (ATT)*	*Standard error*	*t-statistics*
Household educational expenditure					
Nearest Neighbor matching	*99*	*48*	*89.914*	*30.992*	*2.901****
Kernel Matching	*99*	*101*	*79.751*	*26.227*	*3.041****
Radius matching	*99*	*100*	*90.739*	*23.864*	*3.802****
Stratified matching	*99*	*91*	*88.516*	*30.326*	*2.919****

Source: Own data computation

, **, * indicate significant differences at 10%, 5% and 1% levels, respectively; standard errors are bootstrapped.*

In addition to this, Table 16 shows the mean of human capital was 176 and 271 for the modern and traditional beekeepers respectively. This similarly indicates the traditional beekeepers had less human capital and significant at 5% level.

Table 16. Mean of human capital of households (mean $\pm$ SE) with modern and traditional beekeeping

Beekeeping type	*Number of households sampled (n)*	*Mean of human capital*	*Pr*
Traditional(No)	*101*	*176.2$\pm$ 25.5*	
Modern(Yes)	*99*	*271.3$\pm$40.5*	
Diff		*-95.1$\pm$47.6*	*0.0237*

Source: Own data computation

In summary, the mean comparison statistics indicate that modern beekeepers are better off in terms of human capital. But this does not imply that the difference is solely due to improved beekeeping management. Other factors (both observable and unobservable) might have contributed to the human capital difference between the modern and traditional beekeepers.

Fourth hypothesis (H4) stated that modern beekeeping improves the household human capital. Table 17 presents the non-parametric matching estimates of the average treatment effect of improved beekeeping on the treated (ATT) for the human capital of the household. Similar to the income and educational expenditure of the household the alternative matching methods adopted for assessing the robustness of the estimated results, the overall average human capital gain due to improved beekeeping ranged from 82.35 to 98.45 Birr and was significant at 5% level based on the kernel, stratified, radius and nearest neighbor, matching methods.

Table 17. Matching methods and household human capital

Matching method and outcome	*Number of treated group (Modern beekeepers)*	*Number of control group (traditional beekeepers)*	*Average treatment effect on the treated (ATT)*	*Standard error*	*t-statistics*
Household human capital					
Nearest Neighbor matching	*99*	*48*	*98.454*	*70.871*	*1.389***
Kernel Matching	*99*	*101*	*82.349*	*50.215*	*1.640***
Radius matching	*99*	*100*	*95.257*	*50.091*	*1.902***
Stratified matching	*99*	*91*	*90.368*	*46.711*	*1.935***

Source: Own data computation

*, **, *** indicate significant differences at 10%, 5% and 1% levels, respectively; standard errors are bootstrapped.

4.3.4. Participation and decision making level of male and female in beekeeping activities

There was a substantial difference on the participation level for female and male in the beekeeping activities. Table18 gives clear picture in participation and decision level of female and play 30% in the input supply (hive, equipment, feeding, water) ranging from 1-20% similarly 20.5% from 61-80% and 18.5% from 21-40% also 15.5% and 7.5% female join from 41-60% and greater than 80% respectively.

Likewise female in the beekeeping improved technology such as inspect, split, and swarm control 26.5% and 25.5% participate from 1-20% and 21-40% respectively. Moreover, 18% and 14.5% of the respondents reply that female was not participated and participate from 61-80% respectively.

On the same way 11% have joined from 41-60% and 4.5% play greater than 80% in the improved technology.

Female in the processing activities for instance careful harvest, honey extract, storage & transport 25% and 20% have been participated from 1-20% and 21-40% respectively. Similarly, 16.5% and 14% of the respondents reply that they were joined from 41-60% and from 61-80% respectively. On the other hand, 7.5% play greater than 80% and 17% were not engaged in the activity.

In the honey marketing 22.5% did not participated and 20.5% have been joined from 61-80%. Furthermore, 17.5% and 13.5% have been cooperated from 1-20% and from 21-40% respectively. Likewise 13% have been participated from 41-60%. In addition to this female were engaged in the colony marketing; 18.5% and 12% have been participated from 1-20% and from 21-40%. On the other hand 50.5% did not participate.

Generally, the result shows low level of participation which is similar to Bishop-Sam brook (2004) study that indicates that few women participate in farmer research groups since it is culturally difficult for them to represent their husbands when their husband is present. Unlike to the level of participation the decision making on what to produce, how much to sell and the use of income have better position which range from 61-80%.

Table 18. The participation and decision making of female in beekeeping activities

Rank	Input supply	Beekeeping improved technology	Processing	Honey marketing	Colony marketing	Deciding what to produce	Deciding how much to sell	Decision on the use of income
	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
0%	8	18	17	22.5	50.5	19.5	8.5	10.5
1-20%	30	26.5	25	17.5	18.5	16	15.5	11.5
21-40%	18.5	25.5	20	13.5	12	15	16.5	21
41-60%	15.5	11	14	13	9	14	19.5	15.5
61-80%	20.5	14.5	16.5	20.5	8	21.5	21.5	23.5
>81%	7.5	4.5	7.5	13	2	14	18.5	18
Total	100	100	100	100	100	100	100	100

Source: Own data computation

Table 19 explain the participation and decision of men in beekeeping activities 31.5% in the input supply for example, hive, equipment, feeding, and water) ranging from 61-80% similarly 31.5% and 34% have been participated greater than 81% in beekeeping improved technology and processing activities. On the same way, 46% for honey and colony marketing and 52% in deciding what to produce,48% in deciding how much to sell and 47% on the use of income have been participated greater than 81% in activities.

The dominance of men in beekeeping activities in the woreda seemed to have downplayed the role and contribution women have made with respect to input supply, improved technology and the processing of bee products. The result over all indicates that it has similar trend with Ngatwa (2006) study states the agricultural extension service in Ethiopia is male dominated and predominantly oriented towards advising and working with male farmers of the households (Ngatwa, 2006).It is also have similar trend with the role and contribution of women in Milola and Kinyope villages in Tanzania with respect to managing bee reserves and habitats, harvesting of crude honey, and the processing of bee products.

Table 19. The participation and decision making of men in beekeeping activities

Rank	Input supply	Beekeeping improved technology	Processing	Honey marketing	Colony marketing	Deciding what to produce	Deciding how much to sell	Decision on the use of income
	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
0%	7	7	8	8.5	21	6.5	6.5	8
1-20%	2	3.5	5	3	0.5	0	1.5	0.5
21-40%	10	10.5	6.5	2	3.5	4	3.5	5.5
41-60%	22.5	21	16.5	12.5	12	19.5	17.5	15
61-80%	31.5	26.5	30	28	17	18	23	24
>81%	27	31.5	34	46	46	52	48	47
Total	100	100	100	100	100	100	100	100

Source: Own data computation

Chapter V- Conclusions and recommendations

This study was designed to develop an understanding on the process of beekeeping development and diffusion of improved beekeeping management and impacts of market oriented beekeeping development in Atsbi Wemberta, Eastern Zone of Tigray. Accordingly, efforts have been made to assess the skill development, the improvements achieved on meal per day and its nutritional status, health improvement, the utilization of money and additional investments from modern beekeeping; the improvements gained from modern beekeeping on income, per capita income, educational expenditure and human capital of the household. The methods employed (descriptive statistics, propensity score matching (PSM) and focus group discussion) were useful in addressing the aims and leading to the following conclusion and recommendation.

The result indicates that ownership of honeybees in the woreda is regarded as an investment and beekeeping has many advantages that help farmer beekeepers to improve their well being. The modern beekeepers obtain better honey yield, quality and skill improvement which has an influence on income and well being; improve their meals, nutrition and health condition. The result show most modern beekeepers have got medium skill in the improved technology. The econometric results of the matching method indicated that the mean income of households with improved beekeeping was significantly higher than the mean income of households with traditional beekeeping. On the same way for per capita income were estimated and the result of matching method indicated that the mean of per capita income of households with improved beekeeping was significantly higher than the mean of per capita income of the households with traditional beekeeping.

Moreover, modern beekeepers have got the capacity to buy clothes, food items, bee colonies, domestic animals, pay school fee, animal feed and social acceptance due to additional earning. Similarly, they have the power to save, for loan payment, to purchase house furniture and construct their residence.

Similarly, the impact of modern beekeeping on household educational expenditure was estimated and the result of the matching method indicated that the mean of educational expenditure of

households with improved beekeeping was significantly higher than the mean of educational expenditure of households with traditional beekeeping.

The level of women participation in beekeeping activities was low. On the contrary, the decision making of women on what to produce, how much to sell and the use of income have better position; which range from 61-80%. But the level of male participation dominates in the beekeeping management.

Over all, modern beekeeping have created improved livelihood in terms of better income so as enhancing capability to buy household demands and productive investments and finally, it is suggested that future research and development interventions should focus on the modern beekeeping development technologies specially for women as the interventions contribute most to the economic and social issues. Furthermore, provision of relevant training ideas and technical assistances need to up grade for the improvements in beekeeping production.

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Annex 1: Pictures of assets of modern beekeepers

Traditional beehive

Modern beehive

Picture1. Mr.B *in Barka-Adisabiha Tabia*; *house, Cows and Calves*

Picture2.Mr.D in Hayelom Tabia; Cows,Calf and Sheep’s

Picture3. Mr.E in Hayelom Tabia; Sheeps, cow and fruits

Picture4.Mr.F in Dibab-Akorein Tabia; Calf and Tomato

Annex 2 Matching Results

pscore UseImprovhive Edusq NoFamilysq lnage landsizesq ,pscore(p) comsup

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

The treatment is UseImprovhive

1-2	Freq.	Percent	Cum.
No	101	50.50	50.50
yes	99	49.50	100.00
Total	200	100.00	

Estimation of the propensity score

Iteration 0: log likelihood = -138.61944
Iteration 1: log likelihood = -125.39287
Iteration 2: log likelihood = -125.16066
Iteration 3: log likelihood = -125.15977
Iteration 4: log likelihood = -125.15977

Probit regression — Number of obs = 200
LR chi2(4) = 26.92
Prob > chi2 = 0.0000
Log likelihood = -125.15977 — Pseudo R2 = 0.0971

UseImprovh~e	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Edusq	-.7892756	.2139275	-3.69	0.000	-1.208566	-.3699854
NoFamilysq	.009598	.0041915	2.29	0.022	.0013827	.0178133
lnage	.6060848	.39731	1.53	0.127	-.1726285	1.384798
landsizesq	.006333	.013099	0.48	0.629	-.0193406	.0320066
_cons	-2.513756	1.438554	-1.75	0.081	-5.33327	.3057588

Note: the common support option has been selected
The region of common support is [.18150618, .89944512]

Description of the estimated propensity score in region of common support

Estimated propensity score

Percentiles		Smallest		
1%	.1997112	.1815062		
5%	.2407943	.1997112		
10%	.2777272	.2043632	Obs	190
25%	.383916	.210706	Sum of Wgt.	190
50%	.5269823		Mean	.5139536
		Largest	Std. Dev.	.1613183
75%	.6397036	.8015479		
90%	.7189016	.8039837	Variance	.0260236
95%	.761616	.819486	Skewness	-.1362576
99%	.819486	.8994451	Kurtosis	2.163719

****
Step 1: Identification of the optimal number of blocks
Use option detail if you want more detailed output
****
The final number of blocks is 5

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

****
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

Inferior of block of pscore	1-2 No	1-2 yes	Total
.1815062	0	2	2
.2	35	15	50
.4	36	35	71
.6	19	44	63
.8	1	3	4
Total	91	99	190

Note: the common support option has been selected

****
End of the algorithm to estimate the pscore
****

```
. heckman IncomeBee Modern Tradi Mediahelp Beetraining QualitProblem, twostep s
> elect(UseImprovhive =Edusq NoFamilysq  lnage landsizesq) rhosigma

Heckman selection model -- two-step estimates   Number of obs      =       200
(regression model with sample selection)          Censored obs      =       101
                                                  Uncensored obs    =        99
                                                    Wald chi2(5)    =    275.82
                                                    Prob > chi2     =    0.0000
------------------------------------------------------------------------------
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
IncomeBee    |
      Modern |   398.363   61.97485     6.43   0.000     276.8946    519.8315
       Tradi |  1278.941   88.45986    14.46   0.000     1105.563    1452.319
   Mediahelp| -324.3463   151.3243    -2.14   0.032    -620.9366   -27.75608
 Beetraining |  -818.303   1126.567    -0.73   0.468    -3026.333    1389.727
QualitProbm |  3982.705   671.5055     5.93   0.000     2666.578    5298.831
       _cons | -2888.648   1882.004    -1.53   0.125    -6577.309    800.0126
-------------+----------------------------------------------------------------
UseImprovhe|
       Edusq |  -.7892756   .2139275    -3.69   0.000    -1.208566   -.3699854
   NoFamilysq |  .009598   .0041915     2.29   0.022     .0013827    .0178133
       lnage |   .6060848    .39731     1.53   0.127    -.1726285    1.384798
   landsizesq |    .006333   .013099     0.48   0.629    -.0193406    .0320066
       _cons |  -2.513756   1.438554    -1.75   0.081     -5.33327    .3057588
-------------+----------------------------------------------------------------
mills        |
      lambda |  688.5497   1059.34     0.65   0.516    -1387.719    2764.818
-------------+----------------------------------------------------------------
         rho |   0.25393
       sigma |  2711.5552
      lambda |  688.54966   1059.34
------------------------------------------------------------------------------


attnd IncomeBee UseImprovhive Edusq NoFamilysq  lnage  landsizesq ,pscore(p)

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

      99         48    2888.382      402.770      7.171
------------------------------------------------------
Note: the numbers of treated and controls refer to actual nearest neighbour matches
```

. attk IncomeBee UseImprovhive Edusq NoFamilysq lnage landsizesq ,pscore(p) boot

 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
99	101	2733.339	.	.

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

Bootstrapping of standard errors

command: attk IncomeBee UseImprovhive Edusq NoFamilysq lnage landsizesq , pscore(p) bwidth(.06)
statistic: attk = r(attk)
note: label truncated to 80 characters

Bootstrap statistics Number of obs = 200
  Replications = 50

Variable	Reps	Observed	Bias	Std. Err.	[95% Conf.	Interval]	
attk	50	2733.339	22.12853	331.9644	2066.231	3400.446	(N)
					2149.531	3310.586	(P)
					2062.66	3258.462	(BC)

Note: N = normal
  P = percentile
  BC = bias-corrected

ATT estimation with the Kernel Matching method
Bootstrapped standard errors

n. treat.	n. contr.	ATT	Std. Err.	t
99	101	2733.339	331.964	8.234

. attr IncomeBee UseImprovhive Edusq NoFamilysq lnage landsizesq ,pscore(p) radius(.1)

 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
99	100	2679.873	334.552	8.010

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

. atts IncomeBee UseImprovhive Edusq NoFamilysq lnage landsizesq ,pscore(p) blockid(5) comsup boot rep(10) dots

ATT estimation with the Stratification method
Analytical standard errors

n. treat.	n. contr.	ATT	Std. Err.	t
99	91	2737.820	328.380	8.337

Bootstrapping of standard errors

command: atts IncomeBee UseImprovhive Edusq NoFamilysq lnage landsizesq , pscore(p) blockid(5) comsup
statistic: atts = r(atts)
.....

note: label truncated to 80 characters

Bootstrap statistics Number of obs = 200
Replications = 10

Variable	Reps	Observed	Bias	Std. Err.	[95% Conf.	Interval]	
atts	10	2737.821	-32.10742	291.5543	2078.279	3397.362	(N)
					2208.133	3070.002	(P)
					2208.133	3070.002	(BC)

Note: N = normal
P = percentile
BC = bias-corrected

ATT estimation with the Stratification method
Bootstrapped standard errors

n. treat.	n. contr.	ATT	Std. Err.	t
99	91	2737.821	291.554	9.390

```
. attnd TotalEduExp UseImprovhive Edusq NoFamilysq  lnage  landsizesq ,pscore(p)

 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
------------------------------------------------------------
      99         48          89.914      30.992      2.901
------------------------------------------------------------
Note: the numbers of treated and controls refer to actual nearest neighbour matches

. attk TotalEduExp UseImprovhive Edusq NoFamilysq  lnage  landsizesq ,pscore(p) boot

 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
------------------------------------------------------------
      99         101          79.751         .         .
------------------------------------------------------------
Note: Analytical standard errors cannot be computed. Use the bootstrap option to get bootstrapped
standard errors.

Bootstrapping of standard errors

command:      attk TotalEduExp UseImprovhive Edusq NoFamilysq lnage landsizesq  , pscore(p)
bwidth(.06)
statistic:    attk       = r(attk)
note: label truncated to 80 characters

Bootstrap statistics                          Number of obs    =       200
                                              Replications     =        50
------------------------------------------------------------------------------
Variable     | Reps  Observed      Bias  Std. Err. [95% Conf. Interval]
-------------+----------------------------------------------------------------
       attk |   50  79.75143  3.810451  26.22697   27.04636   132.4565   (N)
            |                                      34.24971   122.7158   (P)
            |                                       10.99257   122.7158  (BC)
------------------------------------------------------------------------------
Note:  N   = normal
       P   = percentile
       BC  = bias-corrected
```

ATT estimation with the Kernel Matching method
Bootstrapped standard errors

n. treat.	n. contr.	ATT	Std. Err.	t
99	101	79.751	26.227	3.041

. attr TotalEduExp UseImprovhive Edusq NoFamilysq lnage landsizesq ,pscore(p) radius (.1)

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
99	100	90.739	23.864	3.802

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

. atts TotalEduExp UseImprovhive Edusq NoFamilysq lnage landsizesq ,pscore(p) blockid(5) comsup boot rep(10) dots

ATT estimation with the Stratification method
Analytical standard errors

n. treat.	n. contr.	ATT	Std. Err.	t
99	91	88.516	23.564	3.756

Bootstrapping of standard errors

command: atts TotalEduExp UseImprovhive Edusq NoFamilysq lnage landsizesq
> , pscore(p) blockid(5) comsup
statistic: atts = r(atts)
.....

note: label truncated to 80 characters

Bootstrap statistics Number of obs = 200
Replications = 10

Variable	Reps	Observed	Bias	Std. Err.	[95% Conf.	Interval]	
atts	10	88.51598	-1.186127	30.32582	19.91422	157.1177	(N)
					33.25229	121.3176	(P)
					33.25229	121.3176	(BC)

Note: N = normal
P = percentile
BC = bias-corrected

ATT estimation with the Stratification method
Bootstrapped standard errors

n. treat.	n. contr.	ATT	Std. Err.	t
99	91	88.516	30.326	2.919

. attnd humancapital UseImprovhive Edusq NoFamilysq lnage landsizesq ,pscore (p)

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
99	48	98.454	70.871	1.389

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

. attk humancapital UseImprovhive Edusq NoFamilysq lnage landsizesq ,pscore(p) radius(.1)

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
99	101	82.349	.	.

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

. attr humancapital UseImprovhive Edusq NoFamilysq lnage landsizesq ,pscore(p) radius(.1)

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
99	100	95.257	50.091	1.902

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

. atts humancapital UseImprovhive Edusq NoFamilysq lnage landsizesq ,pscore(p) blockid(5) comsup boot rep(10) dots

ATT estimation with the Stratification method
Analytical standard errors

n. treat.	n. contr.	ATT	Std. Err.	t
99	91	90.368	49.105	1.840

Bootstrapping of standard errors

command: atts humancapital UseImprovhive Edusq NoFamilysq lnage landsizesq , pscore(p) blockid(5) comsup
statistic: atts = r(atts)
.....

note: label truncated to 80 characters

Bootstrap statistics Number of obs = 200
Replications = 10

Variable	Reps	Observed	Bias	Std. Err.	[95% Conf.	Interval]	
atts	10	90.36836	45.75804	46.71082	-15.29885	196.0356	(N)
					67.23158	207.1425	(P)
					67.23158	134.3125	(BC)

Note: N = normal
P = percentile
BC = bias-corrected

ATT estimation with the Stratification method
Bootstrapped standard errors

n. treat.	n. contr.	ATT	Std. Err.	t
99	91	90.368	46.711	1.935

```
. attnd  percapita UseImprovhive Edusq NoFamilysq  lnage  landsizesq ,pscore(p)


 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
------------------------------------------------------------
      99         48       493.463       76.363      6.462
------------------------------------------------------------
Note: the numbers of treated and controls refer to actual
nearest neighbour matches

. attk  percapita UseImprovhive Edusq NoFamilysq  lnage  landsizesq ,pscore(p) boot

 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
------------------------------------------------------------
      99        101         456.735         .         .
------------------------------------------------------------
Note: Analytical standard errors cannot be computed. Use the bootstrap option to get bootstrapped
standard errors.

Bootstrapping of standard errors

command:      attk percapita UseImprovhive Edusq NoFamilysq lnage landsizesq , pscore(p) bwidth(.06)
statistic:    attk       = r(attk)
note: label truncated to 80 characters

Bootstrap statistics                        Number of obs    =       200
                                            Replications     =        50
------------------------------------------------------------------------------
Variable     | Reps  Observed     Bias  Std. Err. [95% Conf. Interval]
-------------+----------------------------------------------------------------
       attk |   50  456.7349  -6.70185  67.12112    321.85   591.6199   (N)
            |                                      288.5161   555.1505   (P)
            |                                      288.5161   588.3104  (BC)
------------------------------------------------------------------------------
Note:  N   = normal
       P   = percentile
       BC  = bias-corrected
```

ATT estimation with the Kernel Matching method
Bootstrapped standard errors

n. treat.	n. contr.	ATT	Std. Err.	t
99	101	456.735	67.121	6.805

. attr percapita UseImprovhive Edusq NoFamilysq lnage landsizesq ,pscore(p) radius(.1)

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
99	100	437.520	66.669	6.563

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

. atts percapita UseImprovhive Edusq NoFamilysq lnage landsizesq ,pscore(p) blockid(5) comsup boot rep(10) dots

ATT estimation with the Stratification method
Analytical standard errors

n. treat.	n. contr.	ATT	Std. Err.	t
99	91	428.438	64.130	6.681

Bootstrapping of standard errors
command: atts percapita UseImprovhive Edusq NoFamilysq lnage landsizesq , pscore(p) blockid(5) comsup
statistic: atts = r(atts)
note: label truncated to 80 characters
Bootstrap statistics Number of obs = 200
Replications = 10

Variable	Reps	Observed	Bias	Std. Err.	[95% Conf.	Interval]	
atts	10	428.4382	-45.49464	55.39486	303.1263	553.7501	(N)
					281.9457	448.0919	(P)
					340.9785	448.0919	(BC)

Note: N = normal P = percentile BC = bias-corrected
ATT estimation with the Stratification method
Bootstrapped standard errors

n. treat.	n. contr.	ATT	Std. Err.	t
99	91	428.438	55.395	7.734

Annex 3: Structured questionnaire

Part 1.Household demographic information

1.1. Name of the household interviewee----------

1.2. Sex Male ☐ Female ☐ Number of family members ☐ Age--

1.3. Are you (interviewee) the Head of the household? 1. Yes ☐ 2.No ☐

1.4. Marital status

1. Single ☐ 2. Married ☐ 3. Divorced ☐

4. Widow ☐ 5. Widower ☐

1.5. Education of the interviewee

1= Illiterate ☐ 2= Can read and write☐ 3= Primary education (1-4) ☐

4= Junior (5-8) ☐ 5= Secondary education (9-10) ☐ 6= other (specify) ----

1.6. Religion of the household

1= Orthodox ☐ 2= Muslim☐ 3=Catholic☐ 4= Protestant ☐ 5= other (specify)

1.7. The educational level in family members in 2008

	Number of family members	Number of years of education	Remark
Female			
Male			

Part 2. Beekeeping (The process change and diffusion)

2.1. Do you own honey bee colonies? 1. Yes ☐ 2.No ☐

- ✓ Number of honey bee colonies in modern hive ----------
- ✓ Number of honey bee colonies in traditional hive ----------

2.2. When did you start beekeeping? ----------

2.3.What are the driving forces to have bee colonies?

1. Income ☐ 2. Home consumption ☐ 3. Both 1 & 2 4. Others (specify)

2.4. How did you start beekeeping?

1. By catching the swarm ☐ 2. By purchasing the honeybee colony ☐

3. Through inheritance ☐ 4. 1 & 2 ☐ 5. 1, 2 &3 ☐ 6. Any other (specify) ---

2.5 Which extension media helped you most to learn about improved beekeeping?

1. Extension agent ☐ 2 .Radio ☐ 3. Field days ☐ 4. Printing materials ☐

2.6. Who is responsible (the actor) for the improved management of beekeeping along its value chains? (Such as modern hive, honey extraction & market information)

1. Agricultural and rural development ☐ 2. Non Governmental Organization (NGO) ☐

3. Regional research ☐ 4. International research/IPMS ☐ 5. Any other (specify) ------

2.7. What kind of beekeeping products did you produce using traditional hives?

1. Crude Honey ☐ 2. Crude Beeswax ☐ 3. Honey bee colony ☐

4. Crude honey & beeswax ☐ 5. Honey &Colony ☐ 6. Honey, Colony & Wax ☐

7. Any other (specify) ------

2.8. What kind of beekeeping products did you produce using modern hives?

1. Pure Honey ☐ 2. Pure Beeswax ☐ 3. Queen rearing ☐

4. Pure honey and beeswax ☐ 5. All products mentioned above ☐

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

2.10. If your answer for Q.2.9 is yes, from where did you have the training?

1. Research center ☐ 2. Agricultural and rural development ☐

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

2.11. If your answer for Q.2.9 is yes, on what area did you get training?

1. Colony split ☐ 2. Honey bee colony management ☐

3. Processing, handling & storage ☐ 4. Market information and linkage ☐

5. Input utilization ☐ 6. Bee forage development ☐ 7. Other specify----------

2.12. If your answer for Q.2.9 is yes, what methods were employed during training?

1. Lecture ☐ 2. Demonstration ☐

3. Group discussion ☐ 4. Combination of all ☐ 5. Any other----------

2.13. If your answer for Q.2.9 is yes, did you find the training useful? 1. Yes ☐ 2.No ☐

2.14. What benefits have you gained due to training?

1. Understanding effective beekeeping management using modern hives ☐

2. Understanding improved beekeeping management (eg. feeding, inspecting, supering swarm control) ☐ 3. Any other (specify) ----------

2.15. Where do you keep your honeybees?

1. Backyard ☐ 2. In out backyard ☐ 3. Under the roof ☐ 4. In the house ☐
5. Any other (specify) ----------

2.16. Have you ever used improved modern hive? 1. Yes ☐ 2. No ☐

2.17. If your answer for Q.2.16 is yes, when did you start using modern hive? _____E.C

2.18. How many times do you harvest honey per annum per colony?

1. One times ☐ 2.Two times ☐ 3. Three times ☐ 4. Other specify--

2.19. When is the peak honey production period? From----------to----------Month

2.20. What kind of management has been applied for safe honey storage? ----------

2.21. Did you use honey extractor in 2008? 1. Yes ☐ 2. No ☐

2.22. Is the honey extractor equipment mobile or permanent? ----------

2.23. In transfer from traditional to modern hive did the quality of honey improved?

1. Yes ☐ 2. No ☐

If your answer in Q.2.23 is yes, how?

Harvesting ----------

Extractor ----------

Storage (container) ----------

Market ----------

2.24. Did you have honey quality related problems when selling? 1. Yes ☐ 2.No ☐

2.25. What is the amount of colony products you got in 2008?

No.	Colony product	Unit	Traditional hive	Modern hive
1	Pure honey	Kg/colony/year		
2	Crude honey	Kg/ colony/year		
3	Bee wax	Kg/colony		
4	Bee colony	Number/colony		

2.26. What was the participation and decision of the household members? Show by rank.

Rank 1 = 0 2= 1-20% 3= 21-40% 4= 41-60% 5= 61-80% 6= >81%

Activity in beekeeping	Women	Men	Children	Hired labor	Other
Input supply: hive, equipment, feeding, water					
Beekeeping improved technology (inspect, split, swarm control)					
Processing: careful harvest, honey extract, storage & transport					
Honey marketing					
Colony marketing					
Deciding what to produce? Colony or honey					
Deciding how much to sell?					
Decision on the use of income					

✓Do you think that there is difference in the decision making power of FHHs and women in MHHs on the income obtained from beekeeping? 1. Yes ☐ 2.No ☐

✓If your answer is yes elaborate the differences? ----------

✓What do you suggest as a solution to improve these decision-making power differences?

By women themselves----------

By men ----------

By government ----------

3. Market

3.1. Was there ready market for your colony products? 1. Yes ☐ 2.No ☐

3.2. If your answer for Q.3.1 is yes, where did you sell your honey?

1. At market found in near by town ☐ 2. At farm gate ☐ 3. Cooperative ☐
4. 'Tej' house ☐ 5. Farmer to farmer ☐ 6. Any other (specify) ----------

✓If your answer for Q.3.1 is yes, where did you sell your bee colony?

1. At market found in near by town ☐ 2. At farm gate ☐ 3. Cooperative ☐
4. Farmer to farmer ☐ 5. Any other (specify) ----------

✓If your answer for Q.3.1 is yes, where did you sell your bee wax?

1. At market found in near by town ☐ 2. At farm gate ☐ 3. Cooperative ☐
4. 'Tej' house ☐ 5. Farmer to farmer ☐ 6. Any other (specify) ---------

3.3.To whom did you sell your hive product? More than one answers is possible

1. Consumers ☐ 2. Intermediaries ☐ 3.Retailers ☐ 4. Farmers ☐ 5. Whole sellers ☐

3.4. The channel/coordination mechanism you use for selling honey?

1. Fragment market ☐ 2.Contract with Dimma ☐

3. Through cooperatives ☐ 4. Any other trader☐

3.5. How long did you keep the honey until you get the market? ----------

✓How long did you keep the wax until you get the market? ----------

✓How long did you keep the colony until you get the market? ----------

3.6. Was the market absorbed all the quantity you produced to sell in 2008?

1. Yes ☐ 2. No ☐

3.7.If your answer for Q.3.6 is yes how much did you earn from sales in 2008? ----------

3.8. Indicate the advantages of improved modern hives compared to the traditional hive. Show in table using ` √ `

Advantages	Very low(1)	Low(2)	Medium(3)	High(4)	Very high(5)
Honey yield					
Quality honey					
Cost					
Skill					
Supply					
	Very easy(1)	Easy(2)	Medium(3)	Difficult(4)	Very difficult(5)
Honey harvesting					
Honey extracting					
Transferring					
Inspection					
Colony split					
Feeding					

4. Benefits

4.1. Income from bee products during the cropping season in 2008?

Items	Unit	Yield/hive		Unit price (birr)		
		Modern hive	Traditional hive	Modern hive	Traditional hive	Modern hive
White honey	Kg					
Yellow honey	Kg					
Red honey	Kg					
Bee wax	Kg					
Colony	Number					
Total						

4.2. What was the trend of beekeeping product since your beginning operation?

1. Sharply increased ☐ 2.Increased ☐ 3.Decreased ☐
4. Significantly decreased ☐ 5. No change ☐

4.3. What does the trend of your profit on beekeeping?

1. Sharply increased ☐ 2.Increased ☐ 3. Decreased ☐
4. Significantly decreased ☐ 5. No change ☐

4.4. What was the average honey price (Birr/kg honey) for the top quality honey in 2008?

4.5. For what purpose did you use the money obtained from sell of bee products? More than one choice is possible

1. Saving ☐ 4.School fee ☐ 7.Medical fee ☐
2. Buying food items ☐ 5.House construction ☐ 8.All ☐
3. Buying clothes ☐ 6.Buying house furniture ☐ 9.Others specify----------

4.6. If your answer for Q.4.5 is saving where did you save your money? More than one choice is possible

1. at home ☐ 2. Dedebit credit and saving institution ☐ 3. Other banks ☐
4. Equb ☐ 5.Cooperatives ☐

4.7. What additional advantages did you obtained by participating in beekeeping? More than one choice is possible

1. Buy additional modern hive ☐ 2. Buy additional honey bee colony ☐ 3. Animal feed ☐
4. Social Acceptance due to additional income ☐ 5.Buying domestic animals ☐

4.8. If your answer for Q.4.7 is buying domestic animals which type of livestock do you own?

No.	Type of animal	Total number of heads	Unit price	Total
1	Local cows			
2	Cross bred cows			
3	Oxen			
4	Sheep			
5	Goat			
6	Local poultry			
7	Improved poultry			
8	Pack animals			

4.9. What percent /share of your household expenditure come from the beekeeping? ------

4.10. What was the wealth status of the household before the use of improved beekeeping?

1. Poor ☐ 2. Medium ☐ 3. Rich ☐

4.11. What was the wealth status of the household before the use of improved beekeeping?

1. Poor ☐ 2. Medium ☐ 3. Rich ☐

4.12. What percent of the sale from colony products did you save in 2008?

Saving from bee products	From Traditional hive	From Improved hive
1-20% of sale		
21-40% of sale		
41-60% of sale		
61-80% of sale		
>81% of sale		

5. Expense from January to December in 2008

No.	Expenditure for beekeeping production	Unit cost/birr	Total cost/birr
1	Beekeeping materials		
2	Bee forage (planting & cultivation)		
3	Supplementary feed		
4	Improved ant protection		
5	Hive shading		
6	Marketing cost(transaction costs)		
7	Storage (container)		
8	Other/specify		

6. Labor hours spent in beekeeping per week in 2008? ----------

7. What were the major problems for under taking improved beekeeping practices in 2008?

Rank 1 = 0 2= 1-20% 3= 21-40% 4= 41-60% 5= 61-80% 6= >81%

Problems	Rank
Lack of beekeeping materials	
Disease, pest and predators	
Reduction of number of honeybee colonies	
Shortage of bee forage	
Indiscriminate application of agro chemicals	
Lack of extension support	
Absconding	
Death of colony	
Drought	
Marketing	
Beekeeping skill	

7.1. Did these problems bring crisis in the family in 2008? Yes☐ No☐

8. Educational Expenses in 2008

Item	Expense/Birr
Exercise books and books	
Pens and Pencils	
Transport to and from school	
Other expenses on education	
Total	

9. Expenses on Clothing in 2008

Item	Expense/Birr
Student Uniforms	
Clothing for father/mother	
Clothing for other family members(excluding uniform)	
Shoes	
Bed sheets and blankets	
Other clothing items	
Total	

10. Frequency of sickness and medical expenses in 2008

Family members/ by age	Frequency of sickness/ year	Medical Expenditure/year
Below 7		
7-14		
15-64		
>64		

11. For what purpose did you keep honey?

1. Traditional medicine ☐ 2. Gift for relatives' ☐ 3.For consumption ☐ 4. Income ☐ 5. Other specify ----------

How many times did you eat per day	In 2004 (before the intervention)	In 2008
Rank		

Show by rank: 1= 1-20% 2= 21-40% 3= 41-60% 4= 61-80% 5= >81

12. What were the common foods that you consume show by rank?

1= 1-20% 2= 21-40% 3= 41-60% 4= 61-80% 5= >81

Type of food	Meal per day before intervention (in 2004)	Meal per day after intervention (in 2008)
Meat		
Milk product		
Vegetables &Fruits		
Egg		
Other/specify		

13. Do you have contact with extension agent in 2008? Yes ☐ No ☐

14. If your answer for Q.13.10 is yes, how many times do you contact per month in 2008? -----

15. Who assisted you for utilizing modern hive? Show in rank

1= 1-20% 2= 21-40% 3= 41-60% 4= 61-80% 5= >81

No	Category	Rank in terms of providing		
		Modern hive and accessories	Advisory service	Technical assistance
1	Agricultural and Rural development			
2	Non-Governmental Organization			
3	International Research Center/IPMS			
4	Regional research			

16. How many times did you get beekeeping training in 2008? _____ times.

17. If you got the training two or more times, how did you find it?

1. It was repeated on the same topic and not useful ☐
2. It was organized on different topic and I got more skill ☐ 3. Any other (specify) _

18. Have you visited beekeeping demonstration site in 2008? 1. Yes ☐ 2. No ☐

19. If your answer for Q.18 is yes, where did you visit?

1. Neighbor apiary site ☐ 2. Agricultural and Rural Development demonstration site ☐
3. Research center/IPMS ☐ 4. Non governmental organization demonstration site ☐

20. If your answer for Q.18 is yes, who organized the visit?

1. Agricultural &rural development ☐ 2. NGO ☐ 3. Research center/IPMS ☐ 4.Any other------

21. If your answer for Q.18is yes, what new things you learn during the visit?

1. Appropriate site selection ☐ 2. Appropriate apiary management ☐ 3. Other (specify) -------

22. Do you make experience sharing with beekeepers using box hives? Yes ☐ No ☐

23. If your answer for Q.22 is yes, on what occasion do you undertake?

1. during formal PA meeting ☐ 2. during beekeeping training ☐
3. during `idir` meeting ☐ 4. Any other_____

24. Access to credit and Land utilization

24.1. Did you borrow money for such as beekeeping inputs in 2008? 1. Yes ☐ 2.No ☐

24.2. Was there any time you could not use improved beekeeping practice due to lack of access to credit in 2008? 1. Yes ☐ 2.No ☐

24.3. Did you think that credit will help to improve beekeeping practice? 1. Yes ☐ 2.No ☐

24.4. If your answer for Q.24.1 is yes can you clarify how credit contributes to your beekeeping activity in 2008? ----------

24.5. If your answer for Q.24.1 is yes from where did you get credit in 2008?

1. Dedebit institution of credit and saving 2. Individuals 3. Other banks
4. Credit and saving association 5.Other (specify----------

✓Was there an equal access between FHH and MHH? 1. Yes ☐ 2.No ☐

24.6. How do you evaluate the access to credit for women compared to men?

1. Very low ☐ 2.Low ☐ 3. Medium ☐ 4. High ☐ 5. Very high ☐

24.7. If your answer for Q.13.1 is yes have you paid the lone? 1. Yes ☐ 2.No ☐

24.8. Do you own land? 1. Yes ☐ 2. No ☐

24.9. How do you evaluate the quality of your land compared to others?

1. Very low ☐ 2.Low ☐ 3. Medium ☐ 4. High ☐ 5. Very high ☐

24.10. If your answer for Q.13.8 is yes, what is the allocation (fill in table)

	Size in timad									
Land location	Own		Hired in		Hired out		Share cropping		Total	
	Irrigated	Non irrigated	Irrigated	Non irrigated	Irrigated	Non irrigated	Irrigated	Non irrigated	Irrigated	Non irrigated
Cultivated										
Grazing land										
Forest										
Uncultivated										
Total farm size										

N.B. 1 timad = 0.25 hectare (ha) 1 quintal = 1000 kg

13.11. What are the major crops and vegetables grown and yield in 2008? Fill the following table

No.	Major crops/ vegetables grown	Yield in quintal			
		Non irrigated/rain fed		Irrigated	
		Yield	Income/Birr	Yield	Income/Birr
1					
2					
3					
4					
5					
6					
7					
8					

13.12. Did you have other source of income in 2008? 1. Yes ☐ 2. No ☐

13.13. If your answer for Q.13.11 is yes what are these sources of income? More than one answer is possible

1. Remittance ☐ 2. Food aid ☐ 3. Off farm income generating activities ☐

13.14. If your answer for Q.13.12 is off farm income- generating activities what was these activities? More than one answer is possible

1. Food for work ☐ 2. Daily labor ☐ 3. Small and medium enterprises ☐
4. Marketing ☐

13.15. Percent of your household expenditure in 2008

No.	Household expenditure	Annual share in percent
1	Off farm income	
2	Remittance	
3	Food aid	
4	Livestock(excluding beekeeping)	